

2nd International Workshop on

Personalisation for e-Health

Held in conjunction with UM 2007

Corfu, Greece

26th June 2007

Preface

The past years have witnessed unprecedented levels of investment in the e-Health sector, both in terms of research effort, and in terms of funding, as well as a great public interest. e-Health can be broadly defined as the application of IT (especially Internet technologies) to improve the access, efficiency, effectiveness and quality of any processes (clinical and business alike) related to health care. In the e-Health vision, intelligent systems would, for example, enable:

- citizens to take more control of their well-being, by accessing personalised and qualified health information, both medical and pedagogical, and accessing appropriate medical care from their homes;
- health professionals to manage their activity more efficiently, by receiving relevant and timely updates; and
- teams of health professionals to work together more effectively, coordinating their activities, sharing their knowledge about the patients they are collectively taking care of, and ensuring the best coordinated care is provided.

The 2nd workshop on Personalisation for e-Health intends to consolidate the trend started with the 1st edition of the workshop, which was held at UM 2005 in Edinburgh, organised by the same committee, and which successfully brought together researchers from both the computational and the medical/public health perspectives to share theoretical results, experiences, and best practices in providing better personalised services for the consumers of health care.

Like the past edition, this workshop focuses on the many aspects of personalisation for health delivery, related to e-Health environments, with contributions coming from various perspectives. We welcome especially this year the presence of two demonstrations of implemented systems, which are a sign of maturity in the field, and we hope will foster further discussion.

We take the opportunity to warmly thank all our reviewers, who did an excellent job in giving detailed feedback on the submitted papers, so contributing to what we hope will be an exciting event.

June 2007

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9:10 – 9:40	Adaptive Simulations for Communication Skills Training in Healthcare Declan Dagger, Cathy Rogers, Vincent P. Wade, Conor Gaffney, Katie Armstrong, Brian Fitzmaurice, Michael Gill, Eddie Walsh
9:40 – 10:00	Designing Tailored Arguments in Online Risk-Assessment Tools Sara Rubinelli, Davide Bolchini, Paolo Paolini, Peter J. Schulz
10:00 – 10:45	Coffee break
10:45 – 11:15	DiasNet Mobile: A Personalized Mobile Diabetes Management and Advisory Service Kasper L. Jensen, Christian F. Pedersen, Lars Bo Larsen
11:15 – 11:35	A Personalized Motivation Strategy for Physical Activity Promotion in Diabetic Subjects Angelica Morandi, Riccardo Serafin
11:35 – 11:55	How Much to Tell? Disseminating Affective Information across a Social Network Wendy Moncur, Ehud Reiter
12:00 – 14:00	Lunch break
14:00 – 14:30	Conceptions and Bayesian Network for an Adaptive Orthopedic Surgery Learning Environment Vanda Luengo, Lucile Vadcard, Dima Mufti-Alchawafa, Vu Minh Chieu
14:30 – 15:00	Data Protection Issues with regard to Research in Genetic Data Marian Arning, Nikolaus Forgó, Tina Krügel
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15:30 – 16:30	System demonstrations
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Data protection issues with regard to research in genetic data

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A person's genetic data provides information about its descent, ethnical origin, and, with a certain probability, also about future diseases and possibly about their healing chances and much more. On one hand, for these reasons, the processing of highly sensitive genetic data requires strict compliance with data protection legislation. But on the other hand, data protection authorities are obliged not to restrict human-genetic medical research, but to show possible ways to promote genetic research in compliance with the existing legal framework.

This article deals with the characteristics of data protection legislation with regard to genetic data and especially the question of whether and of how genetic data can be rendered anonymous. It is motivated by the EU research project ACGT (Advancing Clinico-Genomic Trials on Cancer), which aims at the development of a transeuropean cancer gene bank to promote better and more efficient curability.¹

1 Genetic data

As stated above genetic data contains a huge amount of information about the person it refers to. Each individual's genetic data is unique and can contain information even of yet unborn blood relatives. Therefore each person can be identified reliably by its genetic data.

Due to the amount of information they carry concerning an individual's state of health, origins and descent, genetic data has to be classified as highly sensitive, so that it has to be protected in a strict way, as the unlawful processing would put the privacy of the data subject at high risk.

2 Special characteristics of genetic data

The characteristic features of genetic data are their uniqueness and the highly sensitive quality of the information they contain. Consequently, European data

* Marian Arning, LL.M., Prof. Dr. Nikolaus Forgó and Dr. Tina Krügel, LL.M. are staffs of the Institute for Legal Informatics of the Leibniz University of Hannover/Germany (<http://www.iri.uni-hannover.de>). In the framework of the EU research project ACGT (Advancing Clinico-Genomic Trials on Cancer) the authors are responsible for legal and especially for data protection issues.

¹ <http://www.eu-acgt.org>

protection legislation ranks data concerning health, such as genetic data², as data requiring special protection (see Art. 8 para. 1 Data Protection Directive 95/46/EC³).

In general, the processing of genetic data is prohibited according to Art. 8 para 1 of the Directive, if it has to be qualified as personal data. According to Art. 2 lit.a of the Directive personal data shall mean any information relating to an identified or identifiable natural person ('data subject'); an identifiable person is one who can be identified, directly or indirectly, in particular by reference to an identification number or to one or more factors specific to his physical, physiological, mental, economic, cultural or social identity.

The processing of genetic data may only be lawful, if the data subject has given his explicit consent to the processing (Art. 8 para 2 lit a) or one of the exemptions stated in Art. 8 paras 2-5 applies.

However in the case of a scientific project it must be considered that to consent in advance to each individual operation performed upon the data is almost impossible as normally in the course of a project new research methods are developed which may demand other operations performed upon the data than the patient has consented to. Also the cooperation with other scientists may require the extension of the consent. It can be doubted whether a consent, which is worded too extensively, is valid.

Art. 8 para. 3 and 4 of the Directive state important exception for scientific research projects, permitting the processing of sensitive data. But first, genetic research does not fall under the scope of these exemptions, anyway.

Second, and more important, the Directive would still be applicable, if such an exemption would be used to legitimate the processing of genetic data. It would be much more practicable for a scientific researcher involved in a trans-European project like ACGT, if the data he uses wouldn't fall under the scope of the Directive at all.

Therefore, it would be the best, if the researcher would use non-personal data for the research. But on the other hand, the identification of the data subject is needed, as the patient may benefit from the scientific research with his data.

In the following it is examined, whether genetic data can be anonymized at all and if yes under what conditions. Besides, it must always be taken into account that the data subject shall benefit from the research for example carried out in research projects like ACGT and must therefore be identifiable.

3 Anonymous genetic data

As soon as it's data is rendered anonymous, the data subject requires no further protection, because re-identification is impossible. Anonymous data can be

² See Working Document of the Art. 29 Data Protection Working Party: Working Document on Genetic Data, p. 5 (available at: http://ec.europa.eu/justice_home/fsj/privacy/docs/wpdocs/2004/wp91_en.pdf).

³ In the following: Directive.

processed (collected, stored, published...) without restrictions, as it does not fall under the scope of the Directive.

Most of the times, for researchers it is not important to know the person to which the data, he examines, refer. In practice the data subject's name etc. are often replaced with a label, in order to preclude identification of the data subject or to render such identification substantially difficult. The person can only be re-identified by using the appropriate key. The data is "pseudonymized".

The question at this stage is, whether also pseudonymous genetic data can be regarded as anonymous data. Or does genetic data always have to be qualified as personal data because of its uniqueness?

The crucial point is, how to define the term "anonymous". The Directive itself doesn't contain an explicit definition of this term. Only Recital (26) of the Directive contains a definition of this term:

(26) [...] *whereas the principles of protection shall not apply to data rendered anonymous in such a way that the data subject is no longer identifiable [...]*

According to the wording of Recital (26), data can only be classified as anonymous, if the re-identification of the data subject is impossible for everybody.

But a complete anonymization of genetic data is impossible. Take the example of a HIV study. In the course of the study, a sufficiently large gene sequence is published on the internet without personal details. If there's already genetic information about the concerned person stored for a different purpose, e.g. because of a salivatestor as a compulsory requirement for a life insurance contract, an identification of the person concerned and his disease would be possible for all persons, who have access to these databases, by a matching-procedure.⁴

This example shows that the unique quality of genetic data causes the problem, that despite comprehensive anonymization, a re-identification of the said person is possible, if relevant additional knowledge exists.

Nevertheless, on the basis of European legislation, too, the anonymization of genetic data seems to be possible, accepted and not objected. For example, the Article 29 Data Protection Working Party accepts the anonymization of genetic data as a means to limit the dangers of genetic research.⁵

Indeed, there is a new view in coming: In the First Report on the implementation of the Data Protection Directive 95/46/EC,⁶ the Commission states, that the interpretation of the Directive must be sensible and flexible, and draws attention to an article of the European Privacy Officers Forum (EPOF),⁷ which

⁴ Huge databases containing genetic data are in use already e.g. by law enforcement agencies, insurance companies and in the USA even in labor relations (see Weichert, Der Schutz genetischer Informationen, in: DuD 2002, S.133).

⁵ See Working Document of the Art. 29 Data Protection Working Party: Working Document on Genetic Data, p. 11 (available at: http://ec.europa.eu/justice_home/fsj/privacy/docs/wpdocs/2004/wp91_en.pdf).

⁶ First report on the implementation of the Data Protection Directive (95/46/EC) of 2003; available at: <http://eur-lex.europa.eu/LexUriServ/site/en/com/2003/com2003.0265en01.pdf>.

⁷ EPOF, Comments on Review of the EU Data Protection Directive (Directive 95/46/EC) of 2002, available at: <http://www.html.dk/log/D25.pdf>.

emphasizes the practical orientation and exemplary function of the German definition of “anonymization”.

The German transposition of the Directive contains a broader definition. Section 3 para. 6 BDSG (Federal Data Protection Act) defines anonymization as the modification of personal data, so that the information concerning personal or material circumstances can no longer or only with a disproportionate amount of time, expense and labour be attributed to an identified or identifiable individual. In conclusion, the BDSG accepts also a second group of anonymous data: *de facto anonymous data*, because it can only be turned into personal data with a disproportionate amount of time, expense and labour.⁸

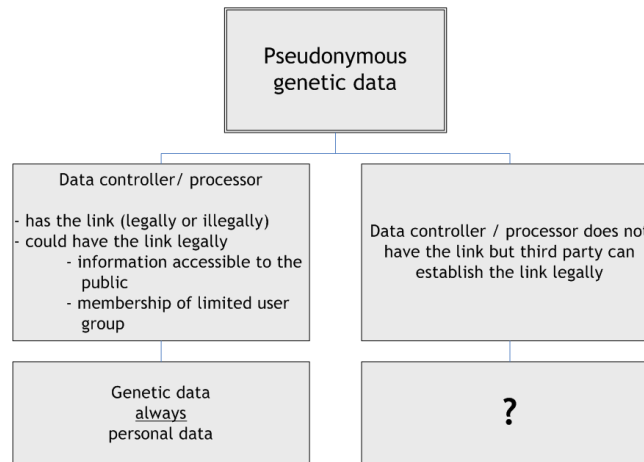
According to that definition, genetic data can be regarded as anonymous data under certain conditions. But the question is, how to define the term disproportionate and especially for which person the amount of time, expense and labour has to be disproportionate to de-anonymize the data. In this context it is important, that the term “personal data” is relative. For each single data controller it has to be determined separately, whether he has the knowledge to identify the data subject or not, or whether additional knowledge has to be attributed to that particular data controller. In other words: it’s possible, that genetic data is anonymous for one researcher, while it’s personal for another. Therefore the central question is always, whether de-anonymization is possible for this particular data controller or not.

As stated above, pseudonymized data is significantly more useful in the framework of a medical research project. If the data controller does not have access to the pseudonymization key and if he has no access to other additional knowledge (e.g. a biobank) enabling him to identify the data subject, the data in question is anonymous for this particular data controller.⁹ Otherwise the genetic data has to be treated as personal data, with all restrictions of processing. It is beyond dispute, that additional knowledge, which the data controller actually has, is attributable to him, even if he doesn’t plan to use the additional knowledge to identify the data subject.¹⁰ As a second step the question arises, if and to what extent additional knowledge he does not have, but which could be obtained by him or any other person is attributable to the data controller.

⁸ See: Metschke / Wellbrock, Datenschutz in Wissenschaft und Forschung, Berlin 2002, pp. 20 ff., available at: http://www.datenschutzberlin.de/infomat/dateien/mat_28.pdf.

⁹ See for example: Gola, Peter/ Schomerus, Rudolf: BDSG, Munich 2005, §3 marginal number 46.

¹⁰ Gola, Peter/ Schomerus, Rudolf: BDSG, Munich 2005, §3 marginal number 44.



4 Relevance of the character of data processing for the distinction between personal and anonymous data

Austria introduced a new category of data in addition to personal and non personal data in the course of the transposition of the Data Protection Directive: indirectly personal data.¹¹

Data is indirectly personal *“when the data relates to the subject in such a manner that the controller, processor or recipient of a transmission cannot establish the identity of the data subject by legal means”*.¹² The use of indirectly personal data is not considered an infringement of confidentiality interests requiring protection, even if sensitive data is processed.¹³ If data is only indirectly personal for a recipient (e.g. pseudonymized data), transborder transmission and committing of data do not require authorisation.¹⁴

If data is only indirectly personal for the controller and will be used for scientific or statistical research purposes, whose goal is not to obtain results in a form referring to specific data subjects, the controller has the right to use indirectly personal data without having to comply with further requirements.¹⁵ In this case he doesn't need an informed consent of the concerned data subject to process its data lawfully.

In conclusion, according to the Austrian data protection legislation, additional knowledge is only attributable to the data processor, if it is accessible to him by legal means, e.g. by using Internet. The ability of third parties to re-establish the reference to the individual concerned remains unconsidered.

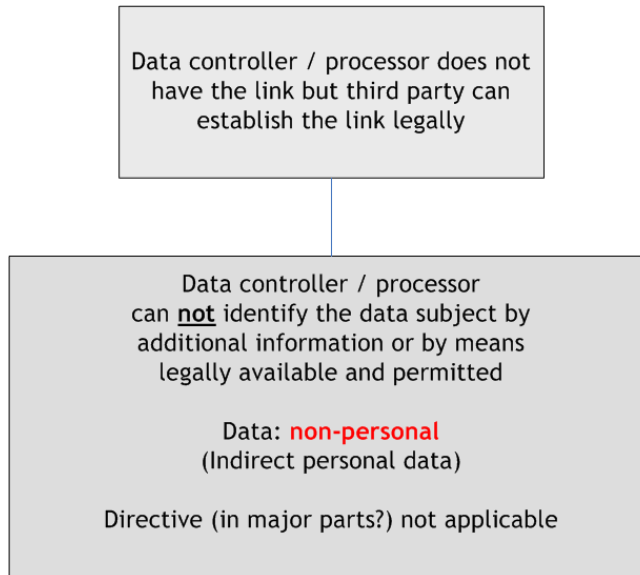
¹¹ Sec. 4 no. 1 of the Austrian Federal Act Concerning the Protection of Personal Data (DSG 2000).

¹² Sec. 4 No. 1, 2. clause DSG 2000.

¹³ Sec. 9 no. 2 DSG 2000.

¹⁴ Sec. 12 sub-para. 3 no. 2 DSG 2000.

¹⁵ Sec. 46 sub-para. 1 no. 3 DSG 2000.



However, the Austrian regulation regarding research in genetic data in accordance with data protection requirements cannot simply be applied to other Member States. A certain amount of freedom was given to the Member States to implement the Directive into national law.¹⁶ And the Directive doesn't contain any regulation in certain areas, so that data protection legislation in the EU Member States still differs significantly.¹⁷

First it is assumed, that knowledge the data controller doesn't have himself and he could only get by using illegal means (e.g. by hacking into a biobank) is not attributable to him.

Second, the question arises, whose knowledge can be attributed to a data controller. Can only this kind of knowledge be attributed to a data controller, he himself actually has or could legally have access to? Or can also this kind of knowledge be attributed to a data controller, only a third person has access to?

¹⁶ See for example: Brühmann, Ulf: Die Veröffentlichung personenbezogener Daten im Internet als Datenschutzproblem, in: DuD 2004, p. 201 (201).

¹⁷ But national transposition of the Directive 95/46/EC must not violate fundamental rights or principles like the principle of proportionality protected by Community Law, see: ECJ "Lindqvist" judgement of 06.11.2003, C-101/01: <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:62001J0101:EN:HTML>, see summary 5 f. and holdings 87, 91 ff. The Member States may only take measures to ensure the protection of personal data that are consistent both with the provisions of Directive 95/46 and with its objective of maintaining a balance between freedom of movement of personal data and the protection of private life. However, nothing prevents a Member State from extending the scope of the national legislation implementing the provisions of Directive 95/46 to areas not included in the scope thereof provided that no other provision of Community law precludes it.

With regard to this question scientists in German legal literature predominantly hold the view, that only knowledge, which the data controller actually has or which is legally accessible for himself, can be attributed to him.¹⁸ In this respect, the German position is similar to the Austrian concept. The data controller would thus be free to deal with the data as he chooses, e.g. publish it on the Internet, as the Data Protection Directive would not be applicable in that case.

But this would enable for example law enforcement agencies or other third parties having a reference data set or link to re-establish the reference to an individual, e.g. by matching the data published on the Internet with data from their own database. The privacy of the data subjects, e.g. the patients taking part in ACGT, would be affected.

With regard to the Data Protection Directive, this opinion cannot convince. The question of whether certain additional knowledge is attributable to the data controller, and if, in consequence, a person is identifiable for the data controller, must be answered by statutory interpretation of the Directive.

Recital (26) states, that in order to determine, whether a person is identifiable, account should be taken of all the means likely reasonably to be used either by the data controller or *by any other person* to identify the said person. The interpretation of the wording of the Recital suggests, that also those means reasonably used by a third person can be attributed to the data controller. Without doubt, one of these means is the use of knowledge, which is legally accessible to this third person. The conclusion drawn from this directive-corresponding interpretation is that also knowledge, which is accessible only to a third person, can be attributed to the data controller.¹⁹

A teleological interpretation of Art. 2 lit a) and Recital (26) of the Directive suggests, that our interpretation presented above is convincing. According to Art. 1 No. 1, the Directive aims to protect in particular their right to privacy with respect to the processing of personal data.

In the framework of a genetic research project, the data processor usually doesn't have access to a reference data set to link his data used for research to a particular person. If only knowledge, the data controller actually has or could legally have access to, could be attributed to him, the data used for the research would have to be qualified as de facto anonymous data. The data processor could do with this genetic data whatever he wants, e.g. publish it or transmit it abroad.

As a result, third parties could access the data and re-establish the link to the said person, if they had a reference link to the person and an interest in the connected information. But this would be an infringement of the patient's right

¹⁸ Compare for example: Dammann, Ulrich, in: Simitis, Spiros (Ed.): Bundesdatenschutzgesetz, Baden-Baden 2006, §3 marginal numbers 37 ff. Saeltzer, Gerhard: Sind die Daten personenbezogen oder nicht?, in: DuD 2004, p. 218 (222); Roßnagel, Alexander Scholz, Philip: Datenschutz durch Anonymität und Pseudonymität - Rechtsfolgen der Verwendung anonymer und pseudonymer Daten, in: MMR 2000, p. 721 (723).

¹⁹ See also: Bygrave, Lee A: Data Protection Law, London 2002, p.45.

of privacy. The aim of data protection law and the Data Protection Directive 95/46/EC would be undermined.

For this reason it's necessary, in accordance with the wording and the sense of the Directive, to attribute to the data controller also that kind of additional knowledge, to which only a third person has legal access. If a third party can legally access knowledge, which can be used to identify the said person, the genetic data concerned is personal data for the data processor as well, although the data processor himself cannot identify the person.

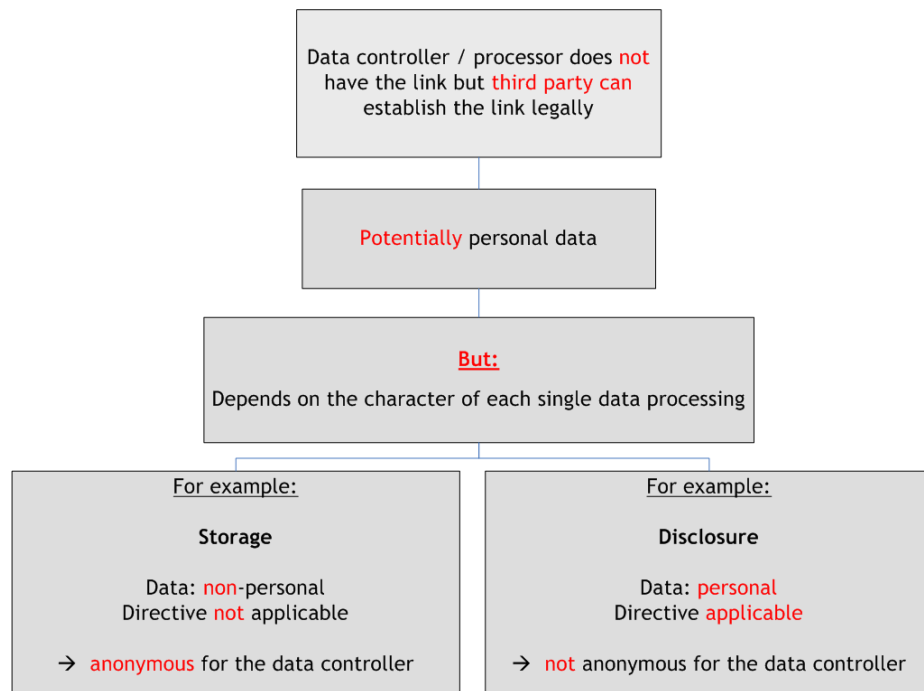
As consequence, the data processor would have to treat all genetic data as personal data in order to avoid responsibility, as he cannot know, whether there is a reference link to a person for a certain set of genetic data he uses available to a third party. Therefore the data controller would need an informed consent for each data processing operation as consequence of that opinion, since a legal basis is generally not available for this kind of data processing taking place within genetic research projects like ACGT.

On the one hand, the said person's privacy would be effectively protected. But on the other hand, this interpretation would have the effect of a strong restriction on medical research, as an informed consent would be needed for each single data processing operation.

For this reason, the interpretation supported above must be applied restrictively. The privacy of the concerned data subject is not in danger, if, first, the data processor himself cannot legally access the additional knowledge of a third party and, secondly, the third party cannot access the data processor's data used for the research. In these cases, when neither the data controller nor the third party can establish the link alone, the identification of the said person is not possible. Attributing additional knowledge of third parties to a data controller also in these cases would extend the scope of data protection legislation too far and would oppose the aim of data protection.

In conclusion, the attribution of additional knowledge of third parties depends on the data processing operation in question. If there's a danger, that a third party can access the data processor's data (e.g. following publication or transmission) and identify the said person, data protection legislation must provide effective protection of the individual's privacy. Therefore, additional knowledge of a third party must be attributed to the data controller, if data processing causes any danger for the person's privacy, e.g. in case of transmission or publication. In consequence this would mean, that for every transmission or publication of genetic data permission (by law or consent) is required, because the data processor cannot know, for which of the genetic data sets to be processed additional knowledge exists.

Data processing operations, which do not cause any danger for privacy, e.g. storage or use (research), do not require any consent or permission by law.



This opinion is also in accordance with Recital (26) of the Directive. Reasonably, a third person only uses means to identify the said person, if he can also access the data to be processed. If he cannot access the data, the third person does not reasonably use any means for identification, so that, following the directive-corresponding interpretation of Art. 1 No. 1 and recital (26) of the Directive, these means and also the third person's knowledge cannot be attributed to the data controller with the result, that this data for him is de facto anonymous.

The above explained and supported opinion offers a solution for the attribution of additional knowledge, which not only corresponds with the Data Protection Directive and guarantees the privacy of the patients, but also has a practical orientation and promotes medical progress.

Adaptive Simulations for Communication Skills Training in Healthcare

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Abstract. Communication skills play a crucial role in everyday business and life, including but not limited to the healthcare sector. They are cognitively complex to learn and can span a wide range of educational settings. Teaching communication skills is also a complex task typically consisting of highly interactive, high fidelity and context sensitive environments such as actors playing “patients”, videotaped interviews and conversations, and with the growing demand for eLearning solutions, e-simulations and e-games. Simulations provide the means to “learn by doing” in practical and safe environments. They support higher order cognitive skills such as application, analysis, synthesis and evaluation while providing structured environments to practice. However, there are a number of key challenges regarding simulations which must be addressed going forward to promote their widespread use, such as fidelity, cost, complexity, flexibility and maintenance. This paper explores the novel application of adaptive hypermedia principles to dialectic based simulations for teaching communications skills and briefly describes the design, development and initial evaluation of an Adaptive Simulator for Personalised Interactions in Realistic Environments (ASPIRE), which is being used as a training tool for communications skills in medicine at the University of Dublin, Trinity College.

1. Introduction

‘If you can’t communicate it doesn’t matter what you know’ Gardner, C 1982. Communication skills are central to successful human endeavour. They are the key skills of most professions but are especially important within the field of healthcare. Poor communication in healthcare results, not only in misdiagnosis, inefficiency and error but patient dissatisfaction, complaints and litigation.

Communication skills in medicine, once considered a minor subject, are now ranked a core clinical skill [1], requiring ongoing training, practice and feedback across the continuum of medical education. Given the widespread deficits in patient-doctor communication reported in academic research literature, large-scale consumer surveys and complaints to professional medical associations, an increased emphasis on teaching communication skills is essential [2][3]. The consequences of effective teaching strategies are far reaching since good patient-doctor communication has been shown to have positive influences on patient and physician satisfaction and the frequency of malpractice claims [4][5].

When doctors and other allied health professionals use communication skills effectively, patient’s problems are identified more accurately [6], patients are more satisfied with their care and better understand their problems, investigations and treatment options. They are also more likely to adhere to treatment and follow advice on behaviour change [1].

Traditional teaching methods have included lectures, tutorials and handouts which can help in gathering knowledge about communication skills, however putting this knowledge into practice requires high levels of cognitive engagement. Furthermore students typically observe senior health professionals at ward rounds or in clinics. They are then often expected to start at the ‘deep end’ by conducting interviews with real patients. Students have described this as a very anxiety provok-

ing experience continuing for varying periods of time, depending on the student, before they feel comfortable conducting patient interviews.

To improve on this approach trainers have used modelling whereby students are presented with demonstrations of the key skills in action either through audiotapes or videotapes of real consultations. Alternatively, an ‘interactive demonstration’ can be used with a facilitator conducting a consultation as he or she would in real life but using a simulated patient (actor/actress). The trainees can then practice their own skills with the simulated patients.

A further approach involves video-recording students conducting interviews with both simulated-patients and real patients with small group feedback. This has been shown to be a very effective approach to teaching communication skills [6]. However, this approach is extremely expensive, labour intensive and requires considerable resources each time for a large number of students. As a result, the teaching of these essential communication skills is being neglected.

An international consensus statement on communication teaching and assessment in medical education, which is relevant to both graduate and continuing medical education programmes, was published in 1999. This highlighted the need to have the teaching based on a broad view of communication in medicine, to be consistent, complementary and help students achieve patient-centred communication tasks. It also recommended that the teaching methods need to be evaluated [7]. The creation of interactive tools using videos and other electronic materials has been advocated as the logical progression in teaching both clinical and communication skills [8]. At this juncture, it is envisioned that the application of Adaptive Hypermedia principles to the interactivity of dialectic based simulations will herald a new era of user-centric, highly interactive, context rich, engaging and personalised eLearning experiences.

Adaptivity in eLearning or personalised eLearning offers an important alternative to the traditional ‘one size fits all’ [10] approach of online learning [11] [12] [13]. More specifically it offers the potential of uniquely addressing the specific learning goals [14], prior knowledge [15] and context of a learner [16] to improve their satisfaction and motivation, thus creating a more engaging experience. Personalised eLearning is seen as a key element for next generation eLearning systems [17] [18].

The core goal of personalised eLearning is to support eLearning content, activities and collaboration, adapted to the specific needs and influenced by specific preferences of the learner and built on sound pedagogic strategies [19] [20]. In an eLearning experience, for example, personalisation could involve the selection of the most appropriate learning resources based on the learner’s preferred learning style (more pragmatic learners could receive more examples or more interactive content) or the selection of the most appropriate subject concepts based on the learner’s prior knowledge of the specific subject area or the selection of the most appropriate learning paths. In achieving this goal, personalised eLearning can offer many tangible benefits to the entire educational process such as teacher and learner empowerment [21] [22], educational community collaboration and tailored eLearning delivered “just in time” and “just for you”.

This paper explores the challenges of adaptive simulation design, the design and development of an Adaptive Simulator for Personalised Interactions in Realistic Environments (ASPIRE) and the initial evaluation results of using ASPIRE as a tool for teaching communications skills in healthcare at the University of Dublin, Trinity College.

2. Challenges

A number of key challenges for adaptive dialogue-based simulations must be addressed going forward. These include;

Fidelity: Fidelity is a measure of the accuracy with which a computer system can reproduce something modelled from the real world. It is a key aspect of simulation that directly affects many other factors such as content, interactions and presentation. There has been much research into how fidelity and learning are related. The general thought being that high fidelity produced high learning and transfer. But this was realized not to be the entire truth; their relationship was indeed significantly more complex.

Over the years many different results have shown how the two (fidelity and learning) were related; Miller [23] who predicted a normal ogive curve for similarity and transfer; Robinson [24]

who predicted a U-shaped curve. These many differing results led to the hypothesis that the relationship between fidelity and learning is non-linear; that this relationship depends on a number of other variables such as the competence level of the student, which is illustrated in Figure 1 [25].

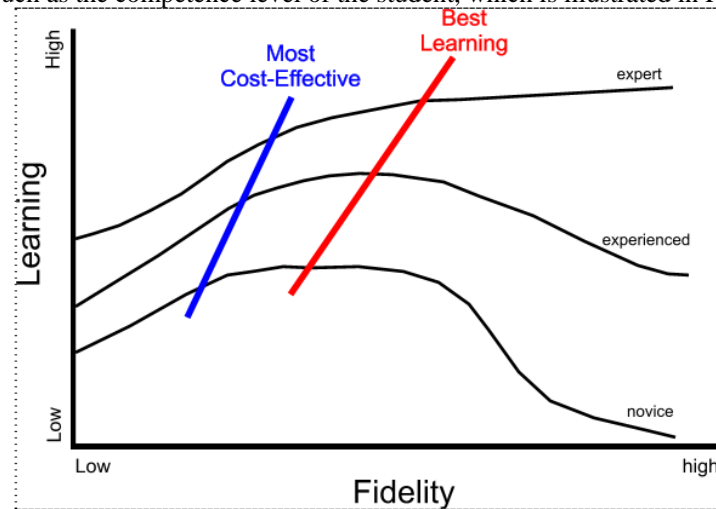


Figure 1, Hypothesized relationship of fidelity and learning

Examining Figure 1 we can see that in simple terms there are three different levels of student; novice, experienced and expert. For each level the amount of learning gained with respect to the fidelity of the simulation is different. While the expert student will excel when fidelity is high, the novice student's learning experience suffers. This is typically due to the fact that the novice is overwhelmed and distracted by the realism of the simulation. As you start to layer the different variables on top of such a hypothesis, such as roles, context, etc. you begin to realize the ineffectiveness of trying to create a single static simulation for all user's under all circumstances.

Flow: Flow, although can be in some way affected by fidelity, involves the sequencing and the semantic paths of the simulation. With dialogue-based (dialectic) simulations this includes the logical structuring of the dialogue, the sub-dialogues and the dialogue elements and how they are linked together to form a consistent and effective learning experience for the user of the simulation. However, different flows may be required for different users based on such things as role in the simulation (doctor, nurse, patient, etc.), competence level (first med, trainees, consultants, etc.) and user context (time constraints, environmental constraints, etc.). These issues are very difficult to address in static simulations and often their solution leads to one-off simulation designs.

Adaptivity: Adaptivity can introduce a dynamic layer of user scaffolding whereby the simulations become personalised and individualised. The potential benefits of bringing adaptivity into simulations are immense. However, there are a number of interesting challenges to be addressed involving selection and sequencing. One of the most crucial challenges involves the process of adapting or personalising a simulation while maintaining the correct levels of fidelity while also maintaining a consistent and semantically appropriate flow. Another key challenge involves the representation and realization of the adaptive mechanisms. This challenge is two fold. The first involves the representation and association of adaptivity at design-time; i.e. when the simulation is being designed and developed, how do we promote best practice in the application of adaptivity. The second involves the presentation of the adaptivity mechanisms and the control metrics within the simulation itself, i.e. how does the adaptivity effect the presentation and the navigation of the simulation and how do you give ownership over the ability to adapt to the user of the simulator (user-centric adaptivity).

3. Design and Development

A number of design decisions have been made in order to address the challenges as detailed in the previous section. Firstly, an initial online simulator was designed, developed and extensively evaluated. This first simulator called VISION (Virtual Interviews for Students Interacting online)

was focused on teaching good interview techniques for psychiatry students and professionals. This provided a platform for testing and evaluating a series of decisions such as the complex processes involved with creating the knowledge models for the simulations and the control metrics as presented in the simulator. During this phase of development 4 ‘virtual’ interviews were created to address the various learning objectives and skills essential to the task of effective communication in psychiatric care. For each interview we would initially decide the general context and area of the scenario. A variety of skills and objectives i.e. the learning outcomes had to be addressed within each scenario. For example each scenario would look at how to greet and orientate the patient, how to gather information about the presenting problem while maintaining rapport and how to use a wide variety of question styles, facilitation techniques and empathic statements etc. A list of other more specific learning objectives needed to be addressed within individual scenarios. For example, when interviewing the manic patient it was important to maintain some form of control over the direction the interview was going by gently interrupting and using directive comments. The benefit of creating virtual interviews meant that we could also script alternative dialogues which enabled the students to see what might happen if they used the wrong interview techniques. Within the safety of using the simulator they experienced the patient becoming increasingly angry, frustrated and walking out of the interview. They learnt how to deal with such stressful events which of course can often happen in the real life situation. The users interact with and control the simulator by choosing paths within a series of dialogues and sub-dialogues pertinent to the current scenario. They can dynamically follow dialogue paths to completion or they can choose to change their line of questioning which brings them to different places within the dialogue. For each question the interviewer asks, there is an appropriate video clip associated with it that provides the interviewee with the patient’s response. The simulator provides feedback on the semantics of that specific piece of dialogue, i.e. the type of question asked (closed, open, etc.), the type of clinical information which can be gleaned from the patient’s response (family problems at home, not sleeping well at night, etc.) and a written transcript of the dialogue. At this point the simulator also provides a range of support materials for the interviewer such as a detailed glossary of psychiatric terms and links to detailed learning material by experts in the field, e.g. tips from consultant psychiatrists on best practice interviewing techniques. The interviewer’s competencies are then tested at the end of the simulation through the completion of a quiz with appropriate feedback on their performance. The key to this approach to learning is that the learner interacts with and engages the patient rather than being a passive recipient of information.

This approach was highly rated by the students and, as later identified during the preliminary evaluations; all of the users of the simulations described an increase in confidence. It allowed those users to practice their interviewing techniques repeatedly in the safety of a simulated environment, thus reducing overall anxiety. However, the issue of fidelity versus learning as detailed in the previous section had still not been addressed. In addressing this variance, the need for adaptivity was highlighted.

Applying adaptivity in simulations meant that the design of an Adaptive Simulator must be based on the principles of good design from the fields of Adaptive Hypermedia and Adaptive Web Based systems and the Semantic Web. This involved the “separation of concerns” [26]; where each component of an intelligent system be defined and modelled separately; and the abstraction of adaptivity mechanisms [20]; where adaptivity is not defined at the atomic level, i.e. explicitly applied to pieces of content, but at the strategic and more abstract level, i.e. describing adaptive strategies. This means that the adaptive simulator is designed in such a way that not only is the simulator itself completely reusable but so too are the knowledge models that it operates on.

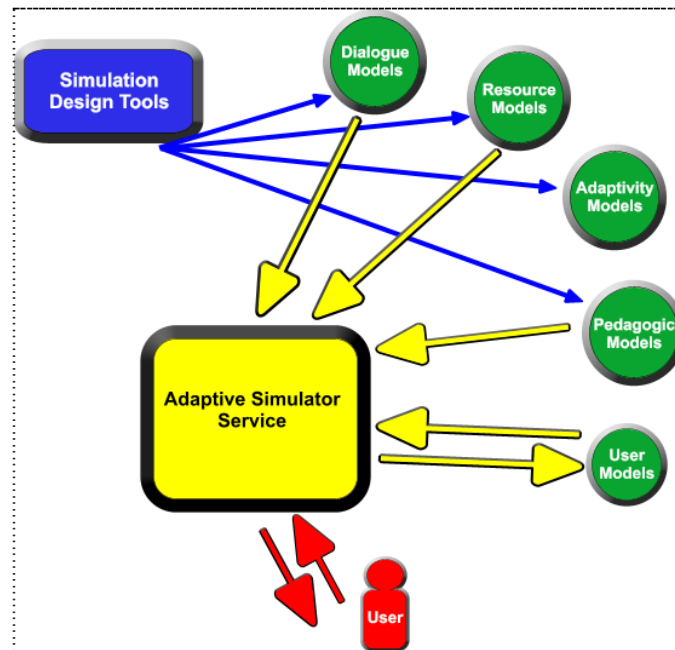


Figure 2, Adaptive Simulator

As illustrated in figure 2 above, the adaptive simulator is a service which operates across a collection of knowledge models to produce personalised simulations for the end user. These knowledge models consist of; dialogue models describing the dialogues, sub-dialogues, dialogue elements and how they relate to each other within a scenario; the resource models which describe the types of learning resources available for the simulation; the pedagogic models which describe the educational principles behind the simulation; and the adaptivity models which describe the types of adaptivity and personalisation that the simulation supports.

The simulation designer, through the suite of simulation design tools, can now focus their efforts on best practise in the design of their simulations and not on the technologies and techniques for realising the simulations.

This adaptive simulator has been designed and developed as part of an Enterprise Ireland commercialisation initiative. It is currently being evaluated at the University of Dublin, Trinity College as a training tool for communications skill in healthcare. The following section details the initial findings from these evaluations and the strategy for further evaluation.

4. Initial Evaluation

It is important to note that at this initial stage we were looking at how to evaluate the effectiveness of this tool for teaching communication skills in the area of psychiatry. Research has shown that students self ratings are higher when not given communication skills training, students are more confident but less competent. So with less effective communication skills training, such as non-interactively watching a video of an interview, we would expect the students to be over confident and not so competent. We would hope that being able to interactively interview a virtual patient would decrease the students' confidence but make them more competent heading into the real life situation.

The initial prototype simulator, VISION (Virtual Interviews for Students Interacting Online), contained a single interactive interview with a depressed patient. To evaluate the effectiveness of the simulation at this early stage we conducted a randomised controlled trial on Trinity College Dublin medical students completing their two month psychiatric rotation over a two year period (October '04 to March '06). The students were randomly divided into 2 groups. We compared the demographics of both groups and were confident that the randomisation was effective. One group (interactive) were exposed to the interactive simulator of the depressed patient interview, the other

group (non interactive) watched the video of the virtual interview but were not able to interact. Both groups had access to the additional web-based teaching resources.

Questionnaires at baseline and at the end of their rotation looked at the students' experience of using the tools as well as their self-reported assessment of confidence and competence conducting psychiatric interviews.

We have preliminary results; comparisons made using independent t-tests. 189 Students consented to participate in the RCT. Of these 152 (80%) completed all of the questionnaires. The mean time students used the simulator was 1 hour 43 minutes (ranging from 10 minutes to 10.5 hours). All students who used the simulator reported higher confidence and competence levels at the end of their rotations. Although there was no significant difference between the interactive and non-interactive groups on their self-reported assessments of confidence and competence, there was a definite trend towards the control group being more confident and the interactive group were less confident. This is in accordance with previous research in this area. 82 students (54%) thought that the simulation was realistic and felt they were 'virtually interviewing a patient. Initially only 30 (20%) felt that web based resources were useful compared to 115 (76%) who were more inclined to use the internet for learning after using the simulator.

Obviously there are limitations to this evaluation in that the groups were only exposed to one interview. Also self assessment of students' own communication skills is often unreliable with students over estimating their skills. To address this we have conducted objective assessment of the students' performance by analysing video recorded interviews using validated scales and hope to have more robust evaluation of whether the tool is effective in teaching communication skills

It is important to note that at this early stage we did not objectively assess the usability of the tool however focus group discussions provided many useful comments from the students which enabled us to update this prototype version incorporating their suggestions.

To continue this evaluation into the domain of adaptive simulations we have established the following strategy going forward. The adaptive simulator will be trialled along side the non-adaptive simulator with a group of 20 medical trainees. The evaluation will address issues such as the levels of fidelity experienced by the users in relation to flow (navigation) and resources engaged (presentation). The evaluation will also look at the impact of adaptivity on the simulations and the user's conceived control and ownership of the simulations. This is a crucial point in supporting the need for user-centric and engaging environments when teaching higher order cognitive skills.

5. Conclusions

Good communications skills are a global requirement in the majority of professions, especially so in the area of healthcare. Traditional teaching methods, as described earlier in this paper, typically fail to address the complexities involved with teaching such engaging skills in an economical, efficient and effective manner. The more advanced teaching approaches to communication skills provide highly successful but highly restrictive and costly solutions, such as actors playing patients or video analysis of student patient interviews. The use of simulation as a training tool is a novel approach to teaching these types of skills. However, it too has a set of challenges to be addressed in order to be successful. Simulations provide a more efficient approach to teaching communications skills than traditional teaching methods, however, users at various levels feel disenfranchised due to a number of reasons such as fidelity and flow, as previously described.

Adaptive Simulations are seen as a key enabler to creating realistic and personalised learning experiences for individuals to gain and retain higher order competencies in communications skills in safe and friendly environments.

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DiasNet Mobile: A Personalized Mobile Diabetes Management and Advisory Service

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Abstract. This paper presents a personalized mobile service for daily management of diabetes. Besides supporting the user in measuring and reporting blood glucose level, insulin intake and physical exercise it facilitates feedback in form of blood glucose simulations from the DIAS (Diabetes Advisory System) decision support system. The service presented in this paper is the final results of an iterative prototyping and evaluation process with potential end-users. Results from the evaluation of the service will be presented and discussed.

1 Introduction

Currently, the monitoring and treatment of diabetics is covering about 6% of the Danish health budget (approximately 335 million Euros) [6]. In this regard Denmark is representative for other Western countries. By year 2000, the number of diabetes incidents worldwide was estimated to be at least 171 million (forecast to be 366 million by 2030); and 33.33 million in Europe alone (forecast to be 47.97 million by 2030) [13]. That is, the DiasNet Mobile service is not a speculative prototype invented for technological reasons alone - it targets a highly relevant area for introducing personalized eHealth services. By making an easy to use service for the daily management of diabetes many of the diabetic complications may be averted, which could mean saving the society for millions of Euros and significantly improving the lives of the users.

The aims of this paper are threefold:

- To show how an existing decision support system for diabetes management and advisory can be integrated into a mobile and personal service for everyday use.
- To present the system and the underlying architecture both from a technical and a user's perspective.
- To present results from the evaluation process.

1.1 DiasNet

To understand the DiasNet Mobile service it is important to understand its foundation. The ideas and the underlying functionalities for the mobile diabetes management service are derived from the DiasNet research project conducted by The Medical Informatics Group at the Department of Health Science and Technology, Aalborg University [1].

DiasNet is a Danish web-based service for type-1 diabetics. Basically the user can access the system from his/her PC through a web interface and enter BG (blood glucose) measurements and other data. The DIAS (Diabetes Advisory System) decision support system is based on a CPN (Causal Probabilistic Network) that models the carbohydrate metabolism of the user. The system can predict the development of the user's blood glucose measurements by a simulation based on when and what he/she eats and when, how much and what type of insulin is injected. Ideally, the model should also take into consideration the physical activity of the users, so the system also takes exercise information as input. However, this is currently not used in the forecast. The output, as can be seen in figure 1 (from [2]), is a graph showing the actual measurements and the simulated BG concentration. Optimally,

the concentration should be within a defined threshold. If the level gets too low, the user will get very uncomfortable as he/she enters hypoglycemia and if it becomes too high, the user enters hyperglycemia, which is the primary cause for almost all the long-term diabetic complications.

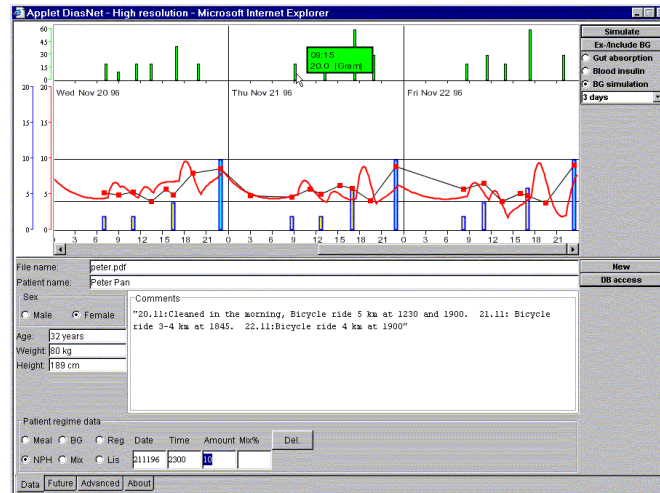


Fig. 1. Screenshot from the original DiasNet web interface

The original DiasNet service has been running in two pilot projects and has been used by a group of patients in Denmark and in the United Kingdom. The experiences from DiasNet (see [2], [4] and [5]) forms the basis for the further development of the mobile service presented in this paper.

1.2 MAGNET

DiasNet Mobile has been developed during the MAGNET (My personal Adaptive Global NET) project and it's continuation project MAGNET Beyond [3]. MAGNET is focused on introducing novel technologies for personal networking with a profound emphasis on the user. Personalization is a key element in this vision. The focus on eHealth and diabetes is situated in one of two major application areas of the project, named MAGNET.Care. The aim is to show how the integration of MAGNET technologies in the healthcare domain, i.e the realization of personal networks, can improve peoples quality of life.

User-centricity is another key element in the project and through the whole development process a UCD (User-centered design) approach has been taken by directly involving diabetics, medical doctors and nurses in the process.

1.3 Paper outline

First the developed system is discussed in section 2 both with regard to the envisioned system and the implemented prototype Then section 3 discusses the evaluation strategy and methods with emphasis on how end-user involvement has been central for the whole process. The results from the evaluation is presented in section 4 and further discussed in 5. Finally a status of the study and conclusions are presented.

2 The system

This section describes the system from different points of view. First the underlying decision support system is discussed, to give a clear idea of the underlying concepts. Then

the envisioned full scale system is presented followed by a description of the implemented prototype. The prototype is presented both from a technical point of view, i.e. the devices and underlying architecture, and from the user's perspective, i.e. the functionality and how it is used.

2.1 The decision support system

The backend of the DiasNet Mobile service is the DIAS server which runs the CPN model of the user's carbohydrate metabolism. The CPN has been created and trained on the basis of real patient data and all simulations are done based on a generic model. The model is updated based on the user's personal measurements, and the simulation results can thus be considered as personalized feedback to his/her diabetes management.

In order to perform a simulation of the blood glucose level DiasNet needs three types of measurements: insulin, carbohydrate intake and previous BG measurements. These data are among others the ones which medical doctors use when they give advice about diabetes treatment and management. Although the carbohydrate metabolism is a complex mechanism and a lot of other factors influence how the individual patients react, e.g. endocrine diseases, pregnancy, stress, alcohol etc., the DIAS system has proven to give quite good predictions based the three abovementioned parameters [4].

In order to obtain a proper simulation result, three days of data must be present before the two days of data, which are of interest when simulating. So to perform a simulation for two days, five days of coherent data are needed. If none of the three types of measurements are present in any of the five days, no simulation should be performed, as this might result in a poor simulation.

Although this service seemingly replaces the doctors role as an advisor, it should more be viewed as a tool for communicating medical data and advice between the doctor and patients. It should be noted that the decision support system is an approximation, and it is by no means perfect. Thus it is very important that the user is always critical about the results. For this reason this system has not been designed to give direct advice e.g. like "take so and so much insulin".

An important benefit of reporting the measurements electronically is that the doctor can quickly get an overview of the patients status. The regulation of the treatment can thus be done more efficiently. This can also enhance the communication between the patient and the diabetes clinic, as the competent patient can be allowed to be more autonomous in the management and the focus can be put on those patients that need more directions from the health professionals.

From a learning perspective, the simulations also serves as a tool for visualizing the causality of the carbohydrate metabolism. Thus they can learn about the basics of their carbohydrate metabolism, as they can see the simulated results of e.g. eating a specific amount of food or taken a specific dose of insulin at a given time. The simulations will show if the user's BG levels has been out of the threshold, and as the main goal of diabetes management is to keep the level within these bounds, the user can use this feedback to regulate his routines. The resulting graph could be motivating factor for the diabetics, as it can be seen if it looks "nice and within bounds".

From the above it is easily seen that the existing DiasNet have many positive prospects, so the challenge is to make it as easy to use and available to the diabetics for them to actually use it in their everyday life. This is the rationale for DiasNet Mobile.

2.2 The envisioned system

Although DiasNet Mobile is rooted in health informatics it was brought into the MAGNET.Care case as an example of how personal networks can be used in the healthcare domain. As such it was chosen as a proof-of-concept application of the advanced network technologies which are to be developed through the MAGNET project. In the MAGNET project DiasNet Mobile was called DiasNet-PN (Personally Networked) reflecting the emphasis on Personal Networks. [7] presents the service in this context and [8] documents its

evaluation in a MAGNET perspective. However, since the focus of this paper is not on personal networks and advanced networking concepts, the following discussion of the system will not include these aspects. Instead, the system is presented as a more simple mobile system using existing wireless technologies like GRPS and Bluetooth, which is in fact also the case for the current fully functional prototype.

Figure 3 illustrates the overall system architecture and users. The diabetic user can interact with the system both through the original DiasNet web application and through DiasNet Mobile. The collected data is submitted to the DiasNet server, where it is stored and used for the DIAS simulations. The health care professionals could be doctors and nurses at the diabetic clinic or any other medical staff associated with the treatment of the diabetic. They have access to the user's data from the DiasNet web interface as well, and can remotely monitor the progress and management of the disease. The dotted line in figure 3 encapsulates the DiasNet Mobile part which has been implemented and tested with the current prototype. Other people might also be interested in monitoring the user's progress e.g. family, friends and/or caretakers for elderly or disabled. They could also interface to the system through either their PCs or mobile devices. This aspect is very important in the MAGNET project.

2.3 The implemented prototype

The current DiasNet Mobile devices are a Bluetooth enabled blood glucose meter and a Nokia 7710 mobile phone as shown in figure 2. The measurements can be reported directly on the mobile phone or through the blood glucose meter which is used to wirelessly transmit data to the phone. When the user enters a measurement it is done through the GUI. When the mobile phone has received a measurement either directly from the user or the blood glucose meter, it is uploaded to the server via a GPRS connection.

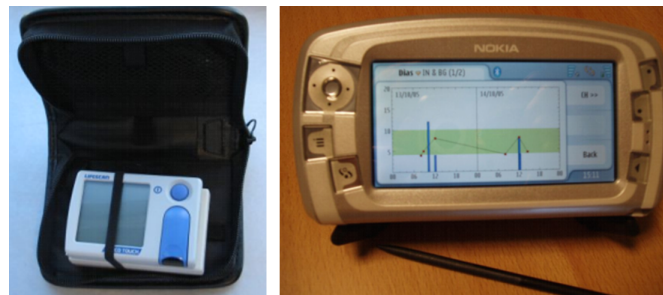


Fig. 2. The Bluetooth enabled BG-meter(left) and the Nokia 7710 running the DiasNet-PN client (right)

2.4 From the user's perspective

The following gives a walkthrough of the client application on the phone, which is the main user interface for the service. Figure 4 serves as a reference as it shows the most important screens through which the user will interact with the system. Each screen has been labeled with a letter by which it will be referred in the following description. As the figure illustrates, the functionality can be broken down into the main menu and three categories: input of data, viewing data and other functions.

As can be seen the DiasNet Mobile has a main menu which is the opening screen (A) of the program. Selecting any of the menu items will take the user to the respective subscreens. The tree-like structure of the GUI is a simple way to divide the functionality. By keeping the depth of the tree to a minimum makes the program simple and easy for the users to grasp DiasNet Mobile in its entirety. The input screens, i.e. Blood glucose (B), Carbohydrate (C),

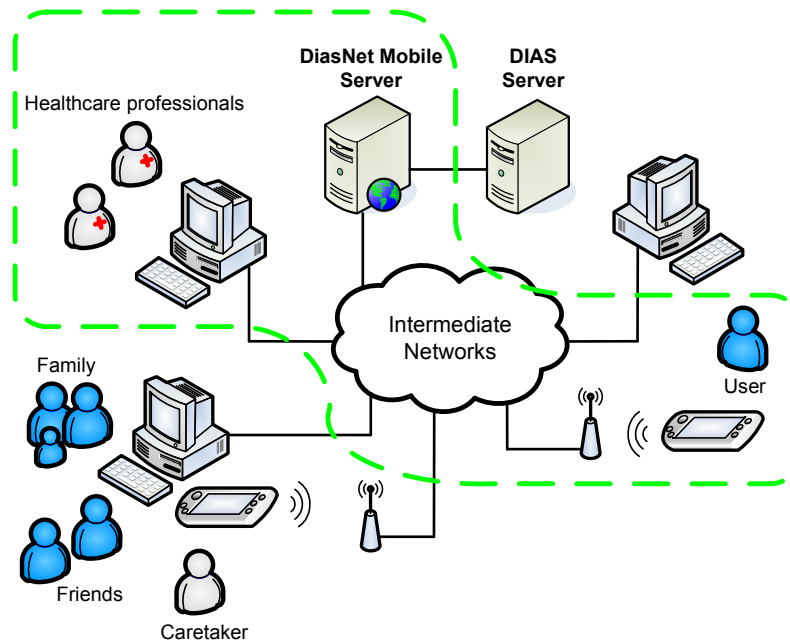


Fig. 3. The envisioned system

Insulin (D), Exercise (E) and Comments, do not add extra depth in terms of additional subscreens, however the Graph (H) and Table (F) viewing screens does (as can be seen in figure 4).

All the input screens are quite simple and allows the user to input one category of information to the service and submit this. The only input screen which is not shown in figure 4 is the Comment screen, which allows the user to add a comment to his dataset (e.g. "late measurement due to busy morning" or "high BG level, celebrated juniors birthday, had cake").

In the Graph screen (H) it is possible to switch between two viewing modes; one showing insulin and blood glucose levels (I) and another showing the carbohydrate intake (J). Each of these show a timeline consisting of the previous and current day, allowing the user an easy overview of the latest measurements. A colored band is shown in the insulin and blood glucose graph screen indicating safe blood glucose levels. Likewise, in the same screen is a trend curve showing the simulation of the blood glucose level which is similar to the one found in the original web based DiasNet application.

The Table screen (F) allows the user to get a table view (E) containing time stamped events of the blood glucose measurements, insulin and carbohydrate intakes, etc. Basically, it provides the same information as the Graph presented in a different way. It is also possible to switch directly from Graph to Table viewing of the same time period (not shown in figure).

The other functionality (G) (which is not detailed in figure 4 includes settings and a message system. The Message screen shows the incoming messages from the medical team associated with each diabetic. It works in the same way as a traditional email client by showing the content of the inbox with sender and date of message. The Settings screen allow to the user to configure the service and to input relevant data like e.g. which type of long- and short-acting insulin should be used as default.

When using the BG meter to take measurements as shown in figure ?? the confirmation on the phone can be disabled in the settings, so that the user does not have to use two devices, but rather the measurements are sent directly to the server. From a user's perspective the confirmation might make the system feel more secure, so that wrong measurements are not submitted by error, but on the other hand it might be more convenient with no confirmations, as this allows for direct data submissions with no need for using the phone.

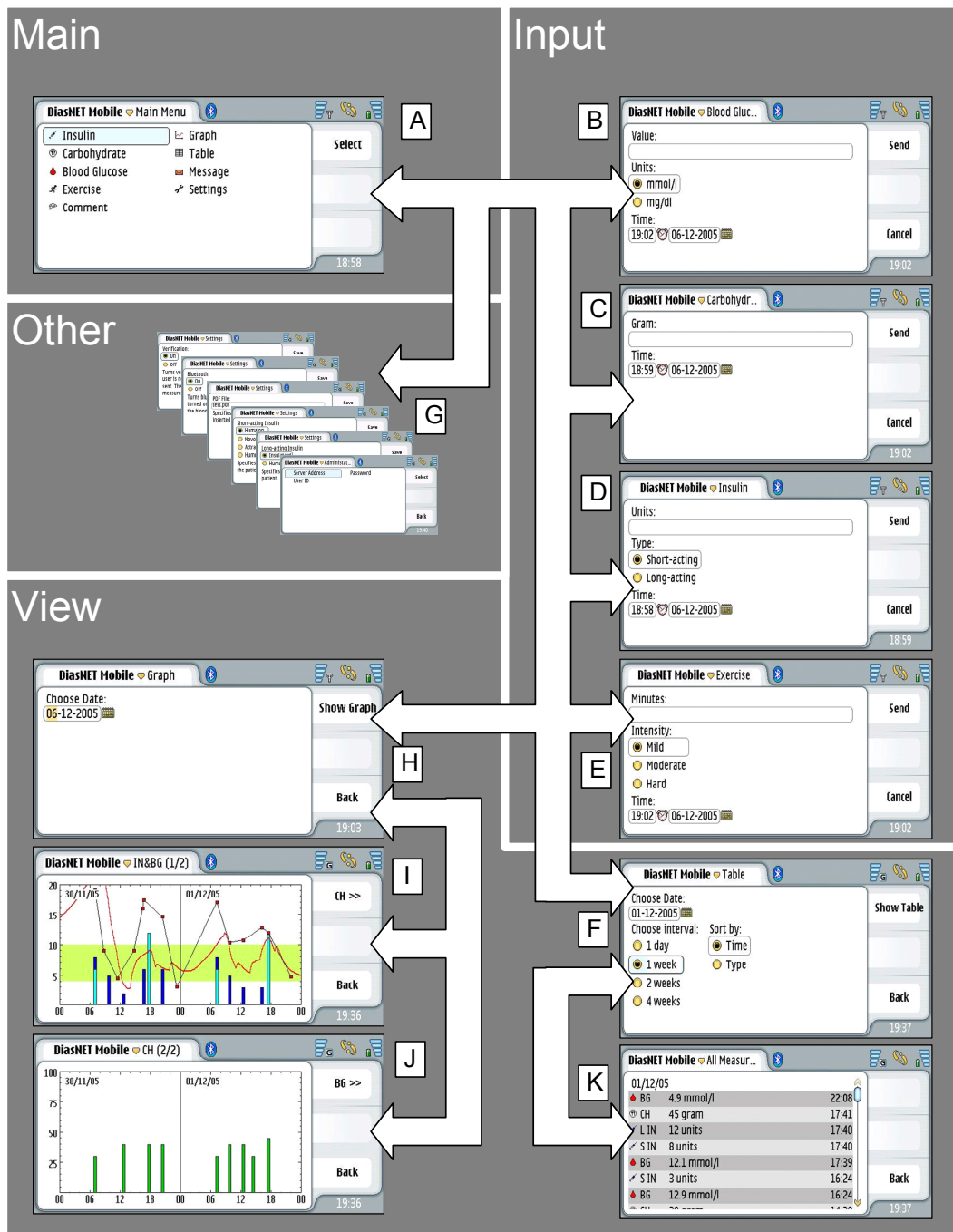


Fig. 4. An overview of the main DiasNet Mobile functionality and GUI. See section 2.4 for further description.

3 Evaluation

The evaluation of the prototype system is an iterative process parallel to that of designing and implementing the prototype system. Every step in this process produces new knowledge about the usability of the system, which is fed back to the development process and helps iterate both the design and implementation [10]. In the spirit of UCD, the potential end-users has been involved through-out this period.

An evaluation strategy was chosen based on principles from interaction design [11] and usability testing [12] practices, and a series of activities has been conducted to produce quantitative as well as qualitative data for evaluation of the service prototype:

User workshop: An end-user workshop with the research team, five diabetics, two nurses and a medical doctor was carried out to give initial input to the functionality and design of the service. From this a conceptual model and design was made and a low fidelity prototype was created.

Expert evaluation: The first functional prototype of DiasNet Mobile was subjected to an expert evaluation in the form of a heuristic evaluation [9] to ensure compliance with general usability.

Lab usability test: The service has been tested through a standard think-aloud usability test in a lab setting to ensure that no critical usability errors persisted. Seven users without prior knowledge of DiasNet and diabetes management was used to verify that even new users would find it intuitive and easy to use. The users went through characteristic scenarios with input of data, viewing data and changing the settings of the service.

Field trial: In the final experiment the prototype is to be tested in the natural context by real diabetics over a long period of time. This is the most significant evaluation, as it will reveal whether the potential users of the service find it useful and usable. The field trial is further discussed in the following.

3.1 The field trial

The field trial has been designed as a longitudinal experiment, in order to measure the actual day-to-day utilization of DiasNet Mobile over a prolonged period of time. The ultimate goal is to measure the impact on the everyday life of diabetic patients. Especially to see if the "anytime-anywhere" paradigm will change the usage patterns of the diabetics over time and help them better manage their disease. The usage patterns can then be compared to their existing patterns from the original DiasNet service.

We are interested in looking at the usage both on the large scale (which functionalities are used, when and how often etc.) and at the lower level of the interaction scale (e.g. which buttons are pressed, how long does it take to input a BG measurement, etc.). This is to ensure that the service is indeed both useful and usable.

In the field trial an elaborate data logging scheme is implemented to obtain these data. It is done in the background and is completely transparent to the user (although they are informed about this before the experiments). Also, no personal or other sensitive data is logged. The following are representative examples of usage data which will be logged during the field trial:

- When the service is started and stopped
- Time spend doing each activity e.g. reporting an insulin injection
- Any changes in settings
- Erroneous data entries, exceptions any unexpected system behavior
- Use of the BG-meter

The field trial has been divided into a pilot phase and a main phase. The pilot phase was run as a three month experiment with one user. Currently only the pilot phase has been conducted, and the experiences from the pilot study will be used to refine both the service and the main field experiment before the larger scale main phase is initiated with 7-10 users.

The user selected for the pilot phase had the following characteristics:

- Middle aged male.
- Diagnosed type 1 diabetic and 13 years experience with disease management
- Proficient computer user and had knowledge of mobile phones and wireless devices.
- Familiar with the original DiasNet service

The participant was chosen for the pilot phase because of his computer literacy and the fact that he is accustomed with mobile technology and DiasNet. The pilot phase could then be started at an earlier point in development, as he would be able to tolerate more technical errors in the prototype than a person with less experience.

4 Results

The section presents some central findings from the various phases of evaluating the service. They are all explicitly or implicitly related to whether or not the developed service is useful and the usable and/or what aspects should be considered to ensure this from the user's point of view.

It should be noted that only a few preliminary results from the field trial are presented. This is partly because the data analysis from the pilot study is not yet complete and partly because that study was only conducted with a single user; thus it would not be enough to conclude about the service from this.

4.1 User workshop

The needs and wishes of diabetic patients and health care professionals were explored and user groups were defined based on age and ability: children, teenagers, adults and elderly. Each group has special needs and preferences with regard to functionality and way of interacting with the device. E.g. services for kids and elderly should support remote monitoring by other persons like parents or care takers, as others will often be responsible for managing the disease. Teenagers and adults are more concerned with self-control of their disease and independency which should be reflected in the service being less intrusive.

The most desired functionality from the health care professionals point of view was to take and report insulin and blood glucose measurements in an easy, safe and quick way. Managing the disease can be done more efficiently if more data is available. Normal practice when using the DiasNet service was to note down measurements on paper and manually enter them into the system at some later time (if ever). Many diabetics use their blood glucose measurements for regulating their insulin intake on a daily basis, and do not consider these measurements as part of the long term management of their disease.

The healthcare experts and users do not necessarily share the same view of what a "good" service is. Patients do not want to be too influenced by the service i.e. feel that they are encumbered or controlled by the use of the service.

All patients wanted to carry as few devices as possible, preferably having the service incorporated into the devices they already use.

4.2 Usability testing in the lab and field

The usability of the service has been verified through both the heuristic evaluation and the lab test. The participants found that the service was intuitive, easy to use and the functionality clearly laid-out in the menu structure. Even though several minor usability issues were found (and corrected) the overall evaluation was positive. This view was shared by the pilot test user in the field trial.

The pilot user also found the mobility aspect very convenient since he used it for three months. Being familiar with the original system, he appreciated that he did not have to boot up his PC to enter a single measurement. From the data log it can also be seen that he has been using the service through the whole day including numerous times while he was on work. This finding indicates that the mobile and ubiquitous potential of the service might give rise to new use patterns. Simply because it is easy and quick to report data anytime, anywhere.

5 Discussion

If one is to consider the significance of the evaluation results, care should be taken before concluding about the service. Especially, there are a number of uncertainties associated with the field trial and looking at data logs. Of course the experiment, even though placed in a natural setting, is an artificial situation, and the user behavior might be influenced by the fact that he/she is part of an experiment. The philosophy is that doing a longitudinal study will negate this effect. Logged data can also be tricky, since it can be difficult to see what the user's actual intention was.

While the usability has been verified through several experiments, the claim of usefulness is much more elusive. Empirical data from a longitudinal field trial with ten users will definitely make a stronger case than the pilot phase of this study. Since it has only been conducted with one user.

To argue for the usefulness of the service, the following instead summarize the most important ways in which the user can benefit from the system. These are key points which are equally valid for both the original DiasNet and DiasNet Mobile:

- Learning about diabetes and how their carbohydrate metabolism works.
- Easy way of keeping status both for the user and the healthcare professionals, and it creates a communication link between the healthcare professionals and the user.
- Better and more up-to-date data means better management of disease which ultimately means better health for the patients and savings on the public healthcare budget.
- User can be motivated by the fact that their disease management efforts are visualized both for themselves and the healthcare experts.

Besides inheriting all these from the existing service, DiasNet Mobile further adds the following benefits which should make it even more desirable for diabetics to use the service:

- It has an easy to use, simple and intuitive interface on a mobile device.
- It enables a high degree of mobility so that it can be used (almost) anytime and anywhere.
- It brings a personalized eHealth service to the users personal device.
- The user does not need to wear additional devices.

The personalization of the service could further enhanced by applying user modeling. E.g. by modeling when and how the user reports data the system interface could be adapted to emphasize functionality for supporting the most probable task of the user. Also the input range and default values when reporting data could be fit to the users profile. If the usage patterns are regular, the user model may also be used for reminding the user of a potentially forgotten report (e.g. if no carbohydrates are reported at lunch time).

5.1 Conclusions

The presented service prototype and its evaluation is an example of how future eHealth services for management of diabetes or other chronic diseases can be realized. It can be seen as a proof-of-concept that a relatively advanced eHealth service like DiasNet can be realized as a service on a small mobile device.

User centricity has been a corner stone in the development of the prototype system, and it could be argued, that the final version is an iteratively refined and improved version of the ideas which the potential users themselves has put into it from the beginning.

From the evaluation of DiasNet Mobile it can be concluded that the usability of the current prototype has been verified and that users had a positive attitude towards it. However, there is currently no experimental evidence of significance for the usefulness of the system. Further study of the service in the field will prove whether DiasNet Mobile is both useful and usable enough that diabetic patients are willing to use it on a regular basis, and even further studies must be conducted to see if it will have a significant impact on disease management.

5.2 Further work

The main phase of the field trial is in the making. Based on the experiences from the pilot phase, it is expected that the field trial will generate a large amount of usage data from which further conclusions can be drawn about the service. Hopefully this will ultimately lead to knowledge about how mobile and personal eHealth services can have an impact peoples lives.

Also the development of the diabetes service in the MAGNET.Care case is being further expanded to a more general "lifestyle companion" incorporating general health, exercise and diet related information.

6 Acknowledgments

The work presented in this paper is part of MAGNET Beyond which is a continuation of the MAGNET project (www.ist-magnet.org). MAGNET Beyond is a worldwide R&D project within Mobile and Wireless Systems and Platforms Beyond 3G. MAGNET Beyond will introduce new technologies, systems, and applications that are at the same time user-centric and secure. MAGNET Beyond will develop usercentric business model concepts for secure Personal Networks in multi-network, multi-device, and multi-user environments. MAGNET Beyond has 32 partners from 15 countries, among these highly influential Industrial Partners, Universities, Research Centres, and SMEs.

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Conceptions and Bayesian Network for an Adaptive Orthopaedic Surgery Learning Environment

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Abstract. In this paper we present an approach, based on exploiting and modelling empirical knowledge, for designing an adaptive and intelligent tutoring system. The learner solves a problem using simulation software. Tracks of the learner's actions are analyzed in terms of his or her possible involvement in identified conceptions. This diagnosis allows the didactical decision, which determines the feedback to give to the learner. From a computer architecture point of view, we separate the diagnosis from the didactical decision to be able to study and validate them separately. The surgical knowledge in the learning environment is represented by using a Bayesian network, the diagnosis is made with the inference in the Bayesian network and the decision-making process is modelled with Bayesian influence diagrams. In this paper we present the knowledge representation for the diagnosis inference and the didactical feedback.

Keywords: Bayesian network, tutoring system, didactic analysis.

1 Introduction

Intelligent problem-solving support has been an important characteristic in computer-based learning systems, in which the student solves problems without explicit assistance of the human tutor. It is hard, however, to implement intelligent support in domains such as medical education in which cases or examples are diverse, irregular, and complex, because several kinds of knowledge, especially empirical knowledge, are often not explicitly taught or explained in theoretical courses. In this paper we show an approach, based on exploiting and modelling empirical knowledge, for the design of an adaptive and intelligent tutoring system.

To tackle the previous problem, we need to answer at least two critical questions. The first one is concerned with exploiting and analyzing different kinds of domain knowledge, especially pragmatic knowledge (obtained by experience), in order to build a robust domain model (domain constraints). It should be noted that in a complex domain, students and experts sometimes use pragmatic knowledge to validate a problem-solving situation, and that this kind of knowledge is often implicit, meaning that it is not explicitly explained in theoretical courses or reference books [14]. To answer this question, we claim that a methodology for fine-grained analysis of "didactics" must be necessary.

The second question is concerned with exploiting suitable techniques in artificial intelligence in order to diagnose and give an appropriate feedback the student's actual conceptions at a given time. Conception is a conceptual structure of declarative knowledge or procedural knowledge or both of them the student holds of a concept or a device or a system [1, 14]. Understanding the student's conceptions exactly, however, must be very hard because it is difficult to know what happens exactly in the "mind" of an individual when he or she is learning a concept or solving a problem [14]. Thus, researchers often use an intuitive (uncertainty) approach to diagnose the student's conceptions [9, 16]. Bayesian networks offer a useful approach for modelling under uncertainty and have been adopted in many applications including intelligent tutoring systems [9]. It is worth, however, to note that confronting a complex problem, for example, the sacro-iliac screw fixation in orthopaedic surgery, the skilful learner (even the domain expert) often makes several tries before arriving at a correct solution: he or she makes an error, and then retries to correct the error several times. Thus, to diagnose the learner's conceptions as accurately as possible, it is necessary to take into account not only the learner's current behaviour but also his or her past one (e.g., consider the learner's correction process of his or her own solution). Temporal (or dynamic) Bayesian networks [13] could be suitable for tackling this problem effectively. A methodology (process), however, should be proposed to construct this kind of networks in a systematic manner.

In our environment the learner solves a problem using simulation software. During the diagnosis stage tracks of the learner's actions are analyzed in terms of their possible involvement in identified conceptions. This diagnosis allows the didactical decision, which determines the most appropriate feedback to give to the student. This feedback is produced with respect to the knowledge's diagnosis. The feedback can be another problem to solve, a redirection to a precise part of the online associated course, or a clinical case to consult. The choice between these possible forms is made according to the type of knowledge that focused by feedback. For example, if the focused knowledge is declarative the feedback will be with the online course but if the focused knowledge is empirical the feedback will be with another problem to solve.

The surgical knowledge in the learning environment is represented with a Bayesian network, the diagnosis is made with the inference in the Bayesian network and the decision-making process is in part modelled with Bayesian influence diagrams.

In this paper we present the knowledge representation for the diagnosis inference and the didactical feedback.

2 Knowledge Modelling

We take as a fundamental hypothesis for our research that "Errors are not only the effect of ignorance, of uncertainty, of chance [...], but the effect of a previous piece of knowledge which was interesting and successful, but which now is revealed as false or simply not adapted."([2], p. 82). In other words, we assume the hypothesis [2, 1] that a misconception is of interest from a learning point of view if it shares the properties of a knowing: it has a domain of validity otherwise it would not exist as

such. Hence, the key difference between a misconception and a knowing is that for the former it exist a refutation that is known at least to an observer.

We are not interested in the environment in all its complexity, but only in its features that are relevant with respect to a given piece of knowledge. The learner as an epistemic subject is a kind of a reduction of the person to her cognitive dimension.

Therefore, for didactical analyze and knowledge representation we adopt the cK ϕ (conception, knowledge, and concept) model that provides a computational framework for didactical research in artificial intelligence [1]. We choose this model for two main reasons: it is adapted to our working hypothesis concerning the notion of conception; and it facilitates the analysis of the knowledge to be formalized and implemented in the system.

The aspect of this model that concerns our work is the conception conceptualisation. It conceptualises a conception as:

- a set of problems (P);
- a set of operators (R) involved in the solutions of problems from P;
- a representation system (L) allowing the representation of P and R;
- a set of control structure (Σ).

Validation is a key aspect of problem solving, the presence of the control structure (Σ) in the definition aims at making explicit a meta-level with respect to action. For us, the control elements allow the subject to decide whether an action is relevant or not, or to decide that a problem or sub-problem is solved. Then, a problem solving process can be described as a succession of solving steps: $\sigma(r(p(l)))$ with $\sigma \in \Sigma$, $r \in R$, $p \in P$, and $l \in L$.

To illustrate the functionality of the model, we apply it to an example concerning the matching of 2D and 3D systems of representation in the problem of sacro-iliac screw fixation [3] (the specific anatomic vocabulary should not be an obstacle to understand the functionality of the model).

Table 1. Example of problems, operators, representation, and controls

Conception element	Description
Problem pa	insert a pin in the case of a pelvis fracture, normal bone
Operator r1	choose entry point
Operator r6	take an inlet view
Control σ_3	if the view is a real inlet, then it must show the sacral plate
Control σ_4	if the view is a real inlet, then it must show the anterior shape of the sacrum
Control σ_8	if the pin is well positioned, then it is up the anterior cortical bone of the iliac wing on the inlet view
Control σ_9	if the pin is well positioned, then it lies in front of the sacral foramen
Control σ_{14}	if the pin is too down on the inlet view, then it is too ventral (anterior) and too caudal (towards the feet) on the patient
Representation system la	medical imaging, X-ray
Representation system lb	3D mental representation of the pelvis

These pieces of knowledge have to be organized. In particular they have to be related to problems, we describe a problem as a set of didactical variables (type of lesion, quality of the bone, etc.). We can see in Figure 1 the knowledge organization.

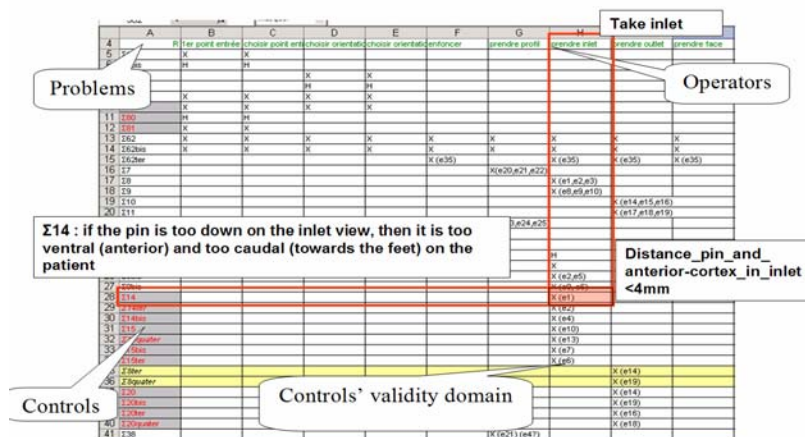


Fig. 1. Knowledge organization

For example, in order to solve the problem pa “insert a pin in the case of a pelvis fracture, normal bone”, it is necessary to apply several operators R (example: r6 “take an inlet view”). Several elements of controls Σ are identified to validate the operator r7. For example σ_{14} : “if the pin is too down on the inlet view, then it is too ventral (anterior) and too caudal (towards the feet) on the patient”. The assessment of the use of a relevant control element depends on the problem context. For example, the control validity domain of σ_{14} is that the distance between the pin and the anterior cortex in the inlet view is less than 4 millimetres.

We can see also in Figure 1 that we distinguish the declarative controls (such as σ_3 and σ_4) from the pragmatic ones (such as σ_{14}), integrated in the expert’s schemes of actions and elicited by the knowledge analyses.

3 Computing Diagnosis and Didactical Decision

The knowledge diagnosis model is represented with Bayesian network. This computer representation allows the calculation of the state of the user’s knowledge with a degree of uncertainty. Thus, the Bayesian network has been increasingly used in intelligent tutoring systems, especially in student modelling (for example [4, 11]).

3.1 Diagnosis Model

Our model of diagnosis allows deducing the state of knowledge elements that used by the learner during the problem-solving process [3]. In other words, it detects which pieces of knowledge are used by the learner and the relevance of their use (it was used in a valid or invalid way). We can see one example in the next scenario (Figure 2).

It takes into account, thus, the last states of diagnosis results. Every element of knowledge has three possible states: *used_invalid*, *used_valid*, and *didn't_use*. These states correspond to the possible uses of this element by the learner and indicate if this use was valid, invalid or not used according to the problem context. Thus, the diagnosis results are for each element a probability distribution for the three states. For example if the probability distribution for an element e_1 was [$P(\text{used_valid})=73\%$, $P(\text{used_invalid})=11\%$, $P(\text{didn't_use})=16\%$], that means that it is more probably that the learner used this element in a valid way in his/her solution.

The decision model uses this diagnosis results. In the next paragraphs, we present how the decision model uses these results to produce feedback.

3.2 Didactical Decision Model

The computer didactic decision-making process allows the production of feedback relevant to the user's knowledge state. The model of decision generates the most relevant feedback from learning point of view by taking into account the didactical analysis criteria and the knowledge diagnosis results. We define this process in four steps.

Firstly, the model of decision decides the knowledge element that will be the target of feedback. Secondly, it determines the apprenticeship objective of feedback for the chosen target. Thirdly, according to the target and the objective, the model chooses the relevant form of feedback from the existing forms in the learning environment. Finally, according to the form, the model formulates the feedback on defining its content.

We use influence diagrams to represent part of this decision [12]. An influence diagram allows the design of decision model and it is a graphical tool used to capture the essence of a problem. It is used to represent and to calculate the decision-making in several applications (for example: [5, 6, 7]).

In our diagram (Figure 4) there are "knowledge element" nodes (the controls from the diagnosis), an apprenticeship utility node (hexagonal node) and target decision node (rectangular node). The inference allows the selection of a knowledge element as target, the target decision node then creates a list of candidate elements. In order to apply the inference in the diagram, we defined the apprenticeship utility function (detailed in [10]) to initialise the utility node. This function calculates the a priori utility to focus the feedback on an element of knowledge C in taking into account the set of knowledge elements in the model E .

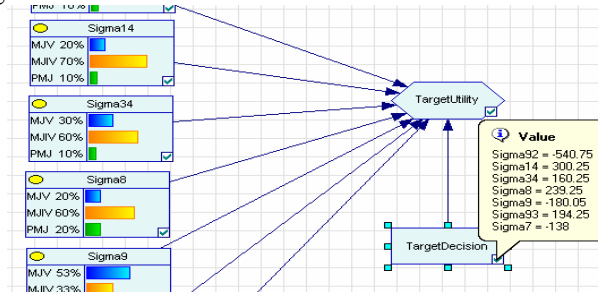


Fig. 4. The influence diagram for the target decision of feedback

In our research, the utility function is calculated with the apprenticeship point of view [10]. It allows the initialisation of the apprenticeship utility node. Thus, the definition of utility function is according to the factors that influence the target decision: the element states (Used_Invalid, Used_Valid, and Didn't_Use) and the element characteristic (empirical or declarative, appear order and validity domain).

The inference in the diagram takes into account the probabilities resulting from the knowledge diagnosis and it is based on the "utility theory" from the decision analysis domain to calculate the estimated utility for each decision. The estimated utility to select an element *C* as a feedback target is calculated according to its a priori utility and the likelihood of each state of the diagnosis results for all elements of knowledge in *E*.

4 Discussions and Conclusion

Bayesian networks have been applied to model the student's knowledge under uncertainty [9, 4, 11]. Those researches have been done in the context of introductory learning. We believe, however, that in complex and ill-structured domains such as medical education, an empirical approach needs to be used in order to model the domain knowledge and the student knowledge effectively. Indeed, the approach we have applied in this paper allows us to exploit and model a significant number of controls related to empirical knowledge, which is often used by the expert and the student in complex and real problem-solving situations. Our assumption is that such modelling may help diagnose the student's actual knowledge effectively, provide the most appropriate feedback to him or her, and therefore improve learning outcomes.

In our computer process of decision-making, we use different strategies [9]. The decision of the target is based on decision-theoretic pedagogical strategy. This strategy has been used in some ITS to select tutorial actions that maximise expected utility [9, 11]. In our approach, we used it to select a target element that maximises the apprenticeship utility. In our learning environment, there are not formalized prior solutions or scenarios of problem solving, so, it is not possible, as the other systems, to define a prior list of actions as expected feedback. Moreover, for selecting a target element we have defined a utility function to calculate the estimated utility from learning point of view. The positive aspect in the target decision is its independence to knowledge domain. This aspect is related to the possibility to customise the didactical hypothesis in the model, but that increases the computation complexity.

To validate our proposition, we are developing a multi-agent, Java-technology-based learning system. The system has a simulation-based learning environment for the surgical orthopaedic. A Web-course component has been implemented successfully [8]. A clinical case data base has been developed also. The diagnosis component has been implemented as well. Finally the didactical decision component is constructing.

We have validated some computational aspects related to the possibility to produce feedback from diagnosis results. The validation is made with a set of classical and critical scenarios proposed by the experts. Actually we prepare experimentation to evaluate the relevance of decision in our model with educational scientists.

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How Much to Tell? Disseminating Affective Information across a Social Network.

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Abstract. We are developing a computer system which provides information about babies in neonatal intensive care to family members and friends. A key question is how to personalize the content and complexity of this sensitive affective information appropriately for varied recipients. A novel approach to modeling user requirements for this personalization is described, that employs a simplified social network technique. Further refinements of the model to incorporate people's information requirements and ability to cope with affective material are then discussed.

Keywords: Social networks, user model, tailored patient information, medical informatics, neonatal intensive care, affective information.

1. Introduction

When a newborn baby is sent to a Neonatal Intensive Care Unit (NICU), friends and family members are understandably concerned and wish to know how it is doing. Unfortunately, the parents are often under considerable stress, and can find it difficult to respond to numerous well-intentioned requests for information. Yet if family and friends are aware of the crisis, they are more able to give essential support.

We are developing a system called **BT-Clan**, which will provide information to these friends and family, which we call their 'clan'. An important challenge is modeling the information that a diverse set of users should receive from the system. We suggest that such models can largely be based on the parents' social networks¹.

BT-Clan is part of the **BabyTalk**² project, which is developing a range of systems which provide tailored information summaries about babies in NICU for distinct audiences: doctors, nurses, parents, 'clan' members. Information is based on data which is automatically extracted from sensors and event records. These systems fall into the "Personalization for e-Health" area.

BT-Doctor generates short summaries of a baby's medical status; this is intended to help doctors and other medical professionals make treatment decisions [4,8]. **BT-Nurse** generates draft shift summaries, which nurses can edit if desired; this is intended to save nurses' time, and also ensure that key information is not accidentally omitted from a report. **BT-Parent** generates summaries of a baby's medical status for parents of the baby, supplementing oral communication with medical staff. The summaries are intended to make parents feel more knowledgeable and "in control", and hence reduce their stress.

BT-Clan is at a very early stage. We have carried out a pilot study to explore requirements analysis and user-model acquisition, but we have not yet built a computer system which deploys the user model data to give information to clan members. We welcome feedback and advice from other researchers interested in personalization for e-Health.

¹ For simplicity within the paper, the existence of a mother and a father will be assumed.

² The BabyTalk project is being carried out by the Universities of Aberdeen and Edinburgh, and the Royal Infirmary of Edinburgh

2. Related Research

A considerable amount of research has been done on generating personalized information for patients [1,3,5], particularly for their medical circumstances. We are not aware of any previous research on personalizing the information for presentation to a patient's friends and family. While existing research that explores tailoring information by relevance, importance and comprehension for patients is also applicable to family and friends, there are questions of personalisation specific to friends and family. How much does the patient/ parent wish a particular friend or relative to know? How much detail does that friend or relative want?

We believe that personalization for social relationships can be based partially on social networks. Although social networks used to map information flow between individuals or groups are generally highly complex [2], we propose using a much simplified version to model parents' information dissemination needs [6]. Parents with babies in NICU may have very limited IT and literacy skills. On average, babies are in NICU for less than two weeks. Therefore any modeling tool developed for parents to use must be intuitive and highly usable.

3. Pilot Study

We carried out a pilot study to find out what information parents currently provide to friends and family, and how this depends on position in the social network.

3.1 Study Design

The study was carried out with a group of parents whose babies had previously been in NICU, consisting of 5 women and 2 men (including 1 couple). A paper prototype was used. We asked parents to illustrate their social network by arranging a selection of counters to represent the members of their social network on a set of pre-drawn concentric bands, with a counter for the baby at the centre (Figure 1). Spatial distance from the centre reflected the individual's relationship with the baby, and hence what information it would be appropriate for this person to receive [7]. We also asked them what they told individuals in their network about the baby.

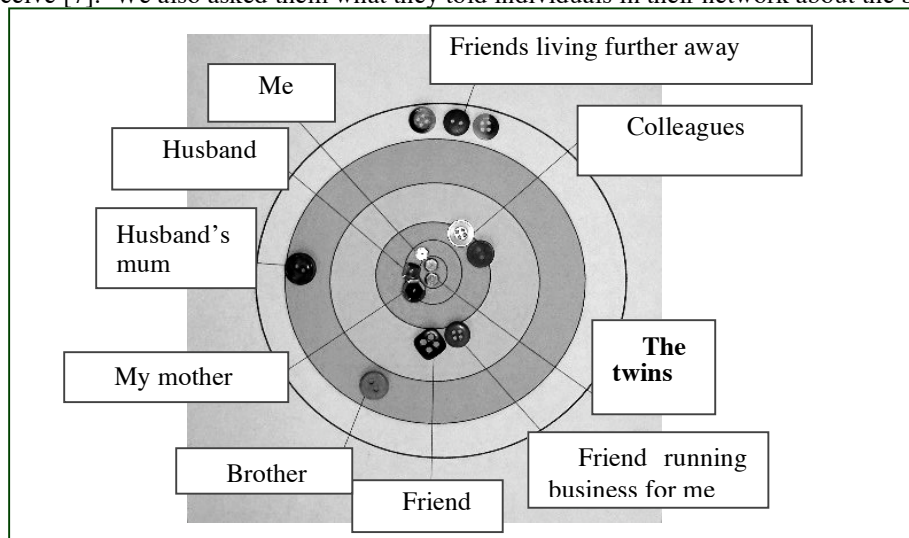


Fig. 1. Social network map of a mother with twins

3.2 Findings

All parents successfully used our tool to create a social network: we believe it is simple enough to be used by those with limited IT and/or literacy skills. Through use of the tool, and discussion, we found that information is both pushed and pulled.

Based on their position in the social network, as reflected in the parent's map, friends & family had differing degrees of information about the baby pushed out to them. Although parents claimed not to discriminate between members of their social networks, their subsequent comments revealed that most did tailor information content, based on intimacy, and the recipient's perceived degree of interest in the baby, and ability to cope with affective information that was distressing or stressful.

Mothers relied on one or two nominated clan members as "information brokers" to push most information out for them. These brokers were the closest to the mother and baby on the mother's map – usually her partner and the baby's maternal grandmother. They controlled information content and initial destination, acted as a contact point for clan members, and protected the mother from a barrage of solicitous enquiries. Reliance on information brokers could have advantages and disadvantages. One mother of twins particularly valued her information broker's activities, in emailing news and photos about the twins. Long-lasting, demonstrable support was generated. In contrast, two mothers commented that their (male) partners did not communicate optimally about the baby to the social network. There was some evidence to corroborate this: maps created by men were more simplistic than women's. However, the number of subjects was too small to draw firm conclusions: we will investigate these perceived differences in mixed and single sex focus groups.

Although this was not explored specifically, it is recognized that clan members also pushed information back to parents [9]. Text messages, gifts, cards, oral communication and visits were all used to communicate support and concern.

Clan members also pulled information to them during communications with parents and information brokers. When clan members did not express the expected degree of interest about the baby, the parents felt hurt, even abandoned. In some cases, relationships were permanently damaged.

4 Discussion: Refining the User Model

The social network map was easy to use. It articulated parents' social networks simplistically, modeling differing degrees of information provision to clan members which were sometimes subconscious.

Some refinements are needed to capture more detailed data. A mechanism for creating a shared social network map for both parents is needed, given the possible gender differences identified, and the likelihood that parents may have different perceptions of their social networks. Possible options are for parents to create a shared map themselves, or to generate an amalgamated map from the two individual ones, with differences in distance between the two maps for specific nodes averaged out.

The recipient's degree of interest, and ability to cope with affective information, are not captured as separate dimensions on the map. Refinements to the map could allow these to be captured, with degree of interest specified by the recipient rather than the parent.

5 Next Steps

To refine the user model further, we will work with parents in NICU. Contextual inquiry, diaries, mixed- and single-sex focus groups will be used to find out the amount and type of information parents want to be given out to different clan members. Subsequently, NLG (Natural Language Generation) prototypes will be trialled with parents & their clan members, who will be placed in a series of bands based on their social network position, and a sample report generated for each band. A "first stab" at defining bands is shown in Table 1. Report contents, band numbers and widths will be refined iteratively, based on discussions with parents and clan members.

Given the sense of support derived from clan members' communications, clan members in all bands will also be able to send messages to the parents or baby via a message-board, to intimate support. Parents and information brokers will be able to read, filter and reply to these messages.

6 Conclusion

A considerable amount of research has been done on providing personalized patient information to patients, but little on providing personalized information to friends and family. This is relevant not only to NICU, but to any situation where communication with the social network is desirable despite the absence of the patient's own communication abilities. We believe that tools fulfilling this function can be based on a social network model, and are working on such a system, BT-Clan. Any system created must stimulate human communication, not replace it. It must let clan members know that their friend/family member has a problem, and provide opportunities to offer corporeal and virtual support.

Table 1. Information bands for maps

Band	Proposed information content of report
A	Detailed report + current image(s) of baby.
B	Mildly summarized version of report, avoiding medical terminology, current image(s) of baby + hospital visiting times.
C	Extensively summarized version of report, avoiding medical terminology + hospital visiting times.
D	New developments, but no serious bad news.
E	One-off communication to say that the baby has been admitted to NICU, with the option to get Band D information if requested.

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A personalized motivation strategy for physical activity promotion in diabetic subjects

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1 Introduction

In the last two decades the attention of the diabetic world has focused on the quality of life, especially in terms of physical activity. Regular physical activity is particularly advantageous in Type II diabetes and research demonstrated its efficacy in reducing the risk of developing diabetes by 60% in subjects with impaired glucose tolerance [6]. Therefore, it is crucial to understand how to promote physical activity in persons with diabetes and understand the psychological determinants of exercise behavior. Some studies have demonstrated the efficacy of an individualized counseling strategy with periodic sessions where doctors stimulate discussions and strategies focused on motivation and self efficacy supplemented by other approaches (pleasure, support, comprehension, lack of impediments, and diary) that have been demonstrated to play a positive role in promoting physical activity ([5], [4]).

In this paper we present a novel motivation strategy to promote physical activity in diabetic citizens. The proposed strategy is personalized along several dimensions and delivered through ICT solutions and devices, allowing to constantly support the patients during their daily lives.

The proposed strategy has been designed in the context of the European research project PIPS (Personalised Information Platform for Health and Life Services), with the aim of exploring the effectiveness of e-health platform jointly with appropriate motivational tools for health promotion.

In order to implement a high level of personalization in the support tools, including socio-demographic and individual characteristics, PIPS introduces a motivation assessment determining the stage of behaviour change the user is at, as well as a detailed profiling and medical assessment. PIPS then provides a personalized and incremental target in terms of number steps, walking time, speed and caloric consumption and gives the patient a pedometer, that has been demonstrated to be a valid monitoring and motivation tool [2]. With the pedometer walking data are constantly updated and corrective/motivational messages are delivered just-in-time to the user mobile phone, thus supporting patient compliance with a real time response.

In the remaining of this paper we will present the key components of the motivation strategy we propose focusing on the personalization elements, and an exercise program, called “Strolling and Motivation” we have defined with respect to such a strategy. We will also present our plans to validate the strategy we are proposing by means of an extended user trial, and we will conclude with some final remarks.

2 Motivation Strategy and Personalization

The strategy we propose is based on the theory of “Stage of Behaviour Change” [1] and the extension proposed in [3]. After an initial assessment of the user predisposition toward a physical activity behaviour change and the collection of profiling information, the patient is given a mobile phone and a pedometer to collect daily walking information and provide motivational feedbacks. To guide the user activity a personalized target is computed with the assistance of a doctor and a self-determined exercise plan configured. Moreover, information about the patient emotional status are collected and employed to further tailor the motivational messages. Finally, appropriate support for patient failures in target achievement and for training are provided.

In the remaining of this section each of the elements mentioned above will be described in details and examples provided when needed.

2.1 Stage of Behaviour Change Questionnaire

In order to be able to place the user in a behaviour change stage a questionnaire/survey instrument was developed based on the selected model. It takes into account the substantive factors influencing the adoption and readiness of individuals to perform a health behaviour change and in parallel to do it by means of an e-health application. The questions try to find out the attitude of the user towards the two specific variables: one related to the interest in health (how the user relates to the healthcare stage) and the other related to their motivation and skills to use ICT to promote their well-being (whether the user would be ready to use an e-health application)¹. On the basis of the answers given by the patient the system sets the stage of behaviour change the patient is at.

2.2 Preferences and Habits Questionnaire

In order to personalize motivational messages a profiling phase is needed. The walking suggestions will then be generated on the basis of the patient habits and preferences, about physical activity in particular. This questionnaire is not leading to a classification of the patient in clusters, but the answers are collected only to be used in the personalization of the motivation messages (see 2.7).

2.3 Exercise Target

The main objective of the model developed for the Exercise Target was the definition of a path that brings the patient, step by step, to reach a stable clinically relevant level of physical activity, giving her/him a personalized walking program.

The system assigns to the patient the starting point in the progressive target curve according to the speed s/he maintains at 60% of the max heart rate during an initial treadmill walking test which determines the fitness basal level.

Every step in the achievement scale represents an increase in METs, i.e. an increase in walking speed. The proposed walking program recommends to perform a walking activity for a certain time during the day at a determined speed, increasing the speed during the program progress.

Patients are asked to maintain the stated exercise level for a period of one month by default (the period length can be shortened or prolonged by the doctor). After this period the system proposes to progress to the successive step in the achievement path, i.e. to increase the exercise intensity (walking speed) or walking time.

This representation is dynamic because it is automatically adapted according to eventual changes in weight during the study, and the progression can be modified by the doctor in every moment (e.g. changing the scale order, adding or deleting steps in the scale, changing the duration etc..) or by the system if some events are detected (e.g. failures).

2.4 Exercise Plan

The Exercise Plan allows the patient to choose the period for each day of the week in which s/he prefers to have the exercise. The importance of this element is based on the establishment of a kind of contract, with the patient committing her/himself to respect a self-determined organization of her/his daily time. This commitment is made explicit through the Exercise Plan, where a reciprocal interaction mechanism between the system and the person is developed.

The Exercise plan is then used by the system to trigger appropriately the generation of the motivational messages, checking if the patient respected her/his commitment and possibly providing support in case of failure.

2.5 Pedometer and Mobile Phone

All the patients participating to the program are given a pedometer and a mobile phone: the pedometer is able to measure, extract and keep in memory the number of steps per minute of the user.

¹ The motivation towards ICT has not been explicitly included in the motivational strategy yet, therefore we will not mention this aspect again in the remaining of the paper

Every day it sends the collected data to the mobile. The data communication is completely automatic and no participation is required to the user. Once the data collected by the pedometer are received by the mobile phone, they are sent to the PIPS back-end server through GPRS/UMTS communication.

On the mobile phone it is possible to view all information sent by the system (i.e. Target, Results, Messages) as well as to input user data (i.e. Diary, Vital Signs, Settings). Therefore, it becomes the mean for a reciprocal relation between the patient and the system, one of the key element of the motivation strategy.

2.6 Diary

The diary allows to express the level of patient satisfaction in four fields of her/his daily life: (1) Working day - the patient can express the level of gratification and pleasure of the working day, (2) Family/friends - the patient can express the level of pleasure and serenity of the social relations during the day, (3) Weather - the patient can communicate her/his perception of the daily weather and (4) Mood - The patient can express her/his daily mood (e.g. choose among few emoticons with the facial look that better express her/his mood).

Through the collection of these data it is possible to find a connection between the patient level of activity and the personal emotional status, which will be reflected in the motivational messages (ref. 2.7).

2.7 Messages

A Motivational Message is a message received each day of the week one or more times/day. The peculiarity of this message is that it has the aim both to inform the patient about her/his activity and to motivate her/him to do better, giving advices to support her/his walking activity.

During the development of the program the patient will receive several kinds of motivational messages: depending on the day of the week a "normal" message is sent, or the "Friday Special" message delivered with suggestions for the weekend, or again the "Sunday Summary" message is sent with an overall judgement of the week performance.

Each message is personalized along several dimensions:

- Motivational Stage - the main communication goal for each message is set with respect to the current motivational stage of the patient (ref. 2.1, e.g.. for Perceived Susceptibility "Did you know that a regular and constant physical exercise makes the heart more resistant to possible ischemia?");
- Performance Level - the messages contain an evaluation of the patient performance level detected by the step counter with respect to the daily target (e.g. with 85% achievement: "Very Good! You're maintaining you performance!"; with 60% achievement: "Not bad, but you can do much more!"; with 40% achievement: "Poor performance, you must try to recover tomorrow.");
- Emotional Status - a correlation between the emotional status of the patient as it as been declared in the diary and the daily performance is included in the message (e.g. with an 80% achievement and a bad mood: "Excellent performance! Probably walking helps you to relieve your stress.");
- Progress along the exercise path - at the beginning of the training program some comments, especially in case of low performances, are made softer and more encouraging (e.g. "Don't be discouraged! Changing habits is a process that evolves along time: the difficult part is most all at the beginning.");
- User preferences - while providing suggestion on how to improve the performance level a set of tips is considered which includes only tips coherent with the user profile (e.g. the patient is suggested to walk the dog *only* if he owns one, or to try parking the car farther from his house when s/he returns home from work *only* if he goes to work by car);
- Location - in the "Friday Special" message a suggestion for the weekend is proposed. Depending on the weather forecast for the place where the patient lives, a suggestion for an indoor or outdoor activity is proposed (e.g. "The Weather Forecast says it will be probably raining this weekend. Why don't you go and visit an exposition near your town?");

- Perceived walking obstacles - if the patient constantly fails to achieve her/his target the failing strategy is activated (see 2.8). In this case, s/he will indicate which are the reasons why s/he is not walking and in turns specific tips to overcome the indicated obstacles are included (e.g. “If you think walking is boring, change your pace varying your pace every few minutes with a Walking Workout. Do different workouts on different days.”);

The last day of the month the patient also receives a report of the month, which is intended to invite the patient to think about the reasons of success/failure, so as to increase self awareness and eventually modify personal strategies.

The message generation is done with a constraint-satisfaction composition algorithm selecting from roughly 1000 canned text segments.

2.8 Failing

The proposed strategy also contemplates the plan of actions to be performed in case the patient fails to achieve her/his target. Two main kind of failure are recognized and managed by the system: (1) One or more days of no walking (i.e. null data) - this type of failure is managed with a set of interactions, first automatically by the system via SMS and then with a health operator, either by phone or at the hospital and (2) Low percentage of target achievement - If in the last seven days the patient performs less then 50% of the target achievement for more than three days, the patient receives a message inviting her/him to fill a questionnaire in order to signal the reason behind her/his walking difficulties. The patient will then receive a phone call by the doctor or the health operator, who will give some suggestions on how to overcome the problem expressed.

3 Validation

To evaluate the efficacy of the proposed strategy a twofold approach has been followed: focus groups and an extended trial.

PIPS team met patients in Diabetes Unit of Hospital San Raffaele in Milan. The activity is ongoing and till now 40 patients from the Diabetes Unit of Hospital San Raffaele were selected for the focus groups, including patients with diabetes Type II, age 35-70 and without physical impairments. A first questionnaire on ICT and Physical Activity predisposition have been proposed to patients; then a presentation on PIPS Strolling and Motivation system was shown and a second questionnaire was filled, investigating the interest and the willingness to use an e-health platform and to participate in such a walking program with the use of technology (mobile and pedometer). The first results of the validation interviews demonstrated that patients affected by Diabetes Type 2 need support for Physical Activity: they feel that PIPS system could help them in doing it and the technology is seen as a valid support. About the 80% of patients interviewed never participated to a structured and monitored program of physical activity and their interest towards the usefulness of these programs was low. After PIPS presentation all patients believed that, under medical advice, they would take part to a personalized walking program. About 85% would use technology to help diabetes management and about 80% were interested in a system like PIPS to manage their physical activity. In the next period further steps of the validation activity will propose a demo of the system in focus groups: patients involved will have the opportunity to walk with the pedometer and will have a demonstration of the feedback and interaction the system allows, viewing the personalization of the motivational message on their profile, walking performance and personal status. In July 2007 a pilot study will be conducted with 50 participants who will use the system for few weeks: the results of these activities will be useful for the refinement of the system for the clinical trial.

The trial, developed in collaboration with the Diabetological Unit of San Raffaele Hospital, will evaluate the ability of the PIPS platform to affect the patients' lifestyle and the effects of an increase of physical activity on the clinical and metabolic conditions of patients. It will be structured in two branches: a control group and a motivated group. Both branches will receive the same dietary indications and will be given the pedometer and mobile phone. For the control group only step collection functions will be enabled, while the motivated group will have access to all the functions and services presented in this paper accordingly to the motivation strategy so far illustrated. The study will last almost 14 months for each patient, for an overall duration of 18/24 months. The

recruiting process should start by June 2007, with the first subject actively being motivated from August.

4 Conclusion

In this paper we presented a novel motivation strategy for physical activity promotion in diabetic citizens by means of the PIPS e-health platform. We have introduced the key strategy components and discussed the personalization elements. The system described has been completely developed, both server and client components, on mobile and personal computer platforms, and it is currently being tested.

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Designing Tailored Arguments in Online Risk-Assessment Tools

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Abstract. OPERA is a tool for genetic breast cancer risk assessment. The main goal is to reduce the anxiety of those who do not have a significant family history of disease and, at the same time, to inform them of possible risks of developing breast cancer, encouraging them to join the UK National Screening Programme. One of the key features of OPERA is, therefore, to provide a convincing, tailored and effective communication to the user. The “persuasiveness” of the feedback is significantly difficult when the risk is “low”, since in this case (by far the most common) the lack of relevant data (for determining high risk) must be carefully explained, and convincingly conveyed to a worried user. In order to achieve its goal, OPERA generates a tailored feedback by building on the theoretical framework of argumentation developed by Toulmin (1958). OPERA has been designed and implemented by TEC-LAB and ICH of the University of Lugano, following requirements laid down by *Cancerbackup* (the leading UK provider of information for cancer patients), which is also responsible for the experimentation and the actual deployment.

Keywords: risk assessment, argumentation, tailoring, explanation.

1 Introduction and Background

Many people are concerned about their family history of breast cancer, and are anxious about the possibility of developing breast cancer themselves. The UK National Institute of Health and Clinical Excellence has published guidance for the National Health Service on the management of familial breast cancer¹. That guidance lays down clear criteria for categorising risk level and the appropriate management options.

Cancerbackup², the UK leading provider of information for cancer patients, has devised OPERA (Online Patient Education and Risk Assessment), an interactive application which captures the individuality of the user’s situation in a comprehensive way, and then produces tailored explanations. OPERA invites users to enter details of their personal and family history of breast and/or ovarian cancer. OPERA also gathers information on age, sex, ethnicity and history of other cancers that are relatively rare but may be important in assessing an individual’s risk of developing inherited breast cancer.

The user is led through the process by a series of clear unambiguous questions. Once the information is collected, OPERA provides a summary in the form of a simple table for the user to verify. Multimedia additional material is also provided to the user, either as background information or as commentary to the various questions

At the end, tailored information is presented to the user explaining the risk assessment process, and the various management options that would be expected to be available to the user for his/her peculiar risk situation. In the rest of the paper, we illustrate the communication challenge posed by the development of OPERA, the theoretical approach we used to address it and how OPERA is designed to meet these needs.

¹ Clinical Guideline 041, partially updated in October 2006, www.nice.org.uk.

² www.cancerbackup.org.uk

2 The Communication Challenge

An important goal of OPERA is to reduce the anxiety of those who do not have a significant family history of disease down to the level of those without any family history. However, such women should still be concerned enough about every woman's risk of developing breast cancer to join the National Screening Programme when they are 50. Whereas it is straightforward and simple to convince users at high risk that they should consult their physician (and OPERA is not primarily designed to discover high-risk, which should have been hopefully discovered beforehand through other means), the real challenge which OPERA faces is in properly informing those who are at *low risk* of developing inherited breast cancer, balancing the good news of low inherited risk with the ever present risk of sporadic breast cancer which every woman faces. This communication challenge may be summarized in the following questions: how to be convincing about low risk in presence of potentially dangerous risk factors? What kind of explanation should we communicate to the user to mitigate the anxiety about an ever present risk with the reassurance about his/her specific low risk situation? How to automatically generate a tailored explanation which addresses this challenge? Moreover, the task of making this sort of messages understandable and convincing is even bigger considering that they are composed and communicated by an online application that has, on the one hand, the possibility of reaching a vast audience but, on the other hand, it can produce failure due to its inner incapability of challenging and approaching users' eventual doubts, should these doubts arise during and about the process of risk assessment.

3 Theoretical Approach: Explanations as Arguments

In the last few years, due an increased availability of genetic tests and a growth in genetic counselling, the study of risk communication in the field has produced several important contributions [1]. Yet, although the issue of delivering information about cancer genetics according to people's level of risk has arisen in the literature [2][3] and, also, there are several studies on online genetics risk communication [4] also in the field of decision support for medical care planning [5], the issue of how to balance good news does not seem to have been addressed in the perspective of our study.

To ground the design of OPERA on an empirical basis, we made a content analysis of letters written by genetic counsellors to their patients to inform the construction of the personalised information packages within OPERA. These letters are tailored documents summarizing services and information provided to the patient, which the genetic counsellor writes after a face to face consultation. In the analysis, we noted that many counsellors instinctively support any statement they make with an explanation, subconsciously following the argumentation theory. In other words: they make use of argumentation. The benefit of using argumentation theory in communicating information about uncertainty is not new [6].

We have stretched this concept further by tailoring the final message delivered to the users by the tool according a specific model of reasoning, namely Toulmin's theory of argumentation [7]. Indeed, we noted that Toulmin's structure allows an identification of *all* the elements that are relevant for implementing the proposed frame of risk communication.

More specifically, central to his theory is a six-element structure that can be use to generate the explanations. This structure reads as follows: 1) *Data*: the evidence, facts, background data and information we use to make the claim; 2) *Warrant*: the component of the argument that establishes the logical connection between the data and the claim, acting as the reasoning process used by the speaker to arrive at the claim; 3) *Backing*: the grounding material that supports the warrant in the argument; 4) *Rebuttal*: an exception or dissociation of aspects for which the claim presented is not valid; 5) *Qualifier*: the verbalization of the relative strength of an argument; 6) *Claim*: the assertion or conclusion put forward for general acceptance. The above scheme results in the information package for OPERA users composed of 5 parts, namely: 1) **Your present situation**: an indication of the risk level (*e.g. Your answers suggest that there is a slightly increased chance that there is a*

faulty breast cancer gene in your family); 2) **Explanation**: the justification of ‘your present situation’ on the basis of the data inserted and national guidelines; 3) **What next?**: a description of possible options which may be offered; 4) **What might change your current situation**; 5) **How confident can you be?**: stating that the information package is based on the NICE Guideline. Other sources of support are also offered. One of the key premises from which argumentation theory proceeds is that influencing real audiences is not simply a matter of presenting a set of reasonable arguments. With high risk users, there are medical objective parameters (personal and family history) on which to play for composing the explanation of the risk. With the low-risk group the situation is different. People resulting in this category do not have a significant personal or family history. Yet, they must have a reason for utilising the tool that has to be addressed to prevent potential resistance to good news. The phenomenon of risk perception resistance is known in the literature [8]. This aspect is particularly critical when users have reasons for using OPERA that go beyond an explanation of the form ‘*You do not have any significant personal or family history*’. To help formulate the question for assessing users’ motivations, a content analysis of media articles published in British newspapers in the last 12 months was performed in order to ascertain factors which influence people’s understanding and worries about breast cancer in the family. Three main categories of influence came to light: 1) *Influence from healthcare workers*; 2) *Influence from relatives and friends*; 3) *Influence from the media*. All the above elements have been taken into account while designing the architecture, the interface and the “inner engine” of OPERA.

4 Designing OPERA: Risk Assessment and Explanations

OPERA is web application that can be configured in order to ask different set of questions. Once a configuration has been performed, users can take their test. As the user answers a variable set of questions about his/her demographic data and family history situation, the engine determines which questions should be asked next, the level of risk and how to tailor the final feedback (summary, explanation, recommendation, ...). A number of “rules” determine the inner working of the engine.

Rules have the “conjunctive form”, **IF (A and B and C and ...).IMPLIES α** ; where “ α ” can be:

- a question number (determining if a question should be asked or not)
- a level of risk (“low”, “medium”, “high”)³
- a piece of information (determining if that piece should be delivered to the user or not)

“X” is an <attribute – value> pair, determined after each question has been answered. Attributes (and corresponding values) are used in order to represent the relevant data gathered, independently from the specific way to formulate a question or to characterize a possible answer.

The design of the test questions (their order, grouping, and logical preconditions) and the specific issues for risk-assessment are not illustrated and discussed in this paper, which focuses, instead, on the information delivered at the end of the test.

Let us focus now on the feedback delivered to users after the test; it comprises several basic elements, which are used to formulate the “information package” (mainly “Your present situation” and “Explanation” parts – see section 3):

- “*Summary*”: a textual expression of the most relevant data; the goal is to make sure to the user that the system has gathered whatever (s)he feels is important to state his/her case.
- “*Risk assessment*”: a well-rounded sentence expressing the level of risk.
- “*Risk-group*”: text based on the fact that the user belongs to a risk-group, disregarding specific individual data. The following, for example, is a recommendation for a “**female with low risk and personal history with breast cancer**”:

[..]it is probably unlikely that your family will be offered genetic testing or extra screening on the NHS.

Notice that individual specific data are not used in this example.

- “*Tailored feedback*”: text strictly dependent on individual data. The following text, for example, is used to explain why the level of risk is only “low” (and not “medium” or “high”):

³ The risk is obviously handled in a monotonic way: the rule is applied only if it determines an increase of the risk level currently assessed.

Your answers suggest that it is unlikely that there is a faulty breast cancer gene in your family. [...]

*(You stated that) you have **had breast cancer**, but you developed it **above the age of 40** and you **do not have any close relatives** with breast or ovarian cancer [...]*

OR

*You stated that you **have not had breast or ovarian cancer**, but you have **one female relative who has had cancer in both breasts**. However, her cancers were diagnosed when **she was over the age of 60** [...]*

Bold face text are explicit formulations of data collected. The difficult part, here is to determine which “negative data” (data that may worry the user) should be commented, and which “positive data” (i.e. data that according to conjunctive rules) prevent the determination of a higher level of risk. Another technical difficulty is to avoid repetitions and to use suitable text fillers in order to make the text natural and almost “human”.

The user should now be able to understand the reasons behind his/her low risk (with the possibility of browsing related resources for a more detailed illustration) and be reassured that, even if there are factors which may appear to increase the risk level, there are others which definitively mitigate this risk.

5 Conclusions and Practical Implications

Our research has focused on crucial aspects of dialogue argumentation strategy, seeking to implement in an automated system dialog strategies that can enhance the persuasiveness of its claims. We are planning to test our framework in three pilot studies (respectively with samples of 20, 100 and 300 users, in the UK) that will be conducted starting from June 2007, where we expect to be able to understand in more depth and anticipate how this sort of argumentative messages impact on people. Our research investigates the possibility of building a more human-like automated dialogue for risk assessment systems by relying on insights from humanistic disciplines. The proposed approach follows current trends of computer-assisted persuasion, but extends its applicability in the field of health-care advising, and shows its benefits for addressing communication barriers in the risk-assessment field and efficiently engage with users in an informed way.

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DiasNet Mobile Demonstration

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This demo presents a personalized mobile service for daily management of diabetes. Besides supporting the user in measuring and reporting blood glucose level, insulin intake and physical exercise it facilitates feedback in form of blood glucose simulations from the DIAS (Diabetes Advisory System) decision support system. The demo is associated with the paper in this volume by the same authors.

TELEOS Project

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TELEOS Architecture

To validate our research work (present in the same workshop), we have developed (fig. 1) a multi-agent, Java-technology-based.

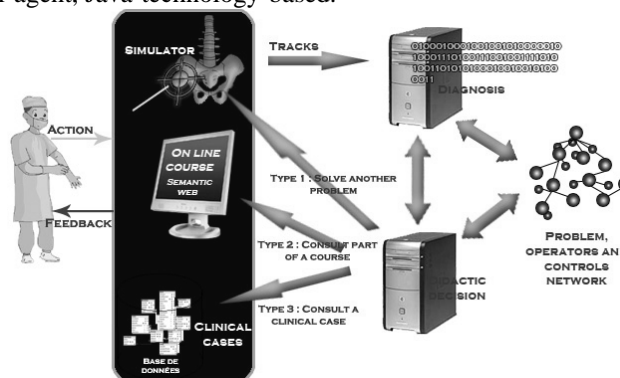


Fig. 1 Orthopedic learning system architecture [1]

As we can see in Fig. 1, in TELEOS learning system the user solves a problem using the simulation software. Tracks of the user's actions are analyzed and diagnosed. This diagnosis allows the didactical decision determines the user's feedback. This feedback can be another problem to solve with a simulator, a redirection to a precise part of the online course, or a clinical case to consult.

The surgical knowledge in the learning environment is represented with Bayesian Networks, the diagnosis is made with the inference in the Bayesian network [1] and the decision-making process is modeled with Bayesian Influence Diagrams [3].

In order to understand the system we present, in the next section, the resources that the learner uses: simulation, Web course and clinical cases data base.

2 Simulation Agent

We have an on-line simulation for the training of the percutaneous placement of screws in the pelvis, developed in Grenoble, the English version is available at

<http://www.voeu.rwth-aachen.de>. We are transforming it into a Java 3D version. This simulation is designed to come near certain aspects of the real activity of the surgeon in situation. The user is shown a 3D pelvis representation, with skin and landmarks.

Multimedia Course Agent

This agent is based on the educational multimedia resources for orthopaedic surgery from the VOEU project [4]. This course delivers declarative knowledge about this specific intervention. In TELEOS platform, we have developed a module to improve the use of this online course: it allows the redirection to precise and relevant parts of the online course. This module allows not only syntactic links, but also semantic ones [2]. This part of the system is accessible for the knowledge engineers for the editing, visualization and maintenance of declarative knowledge. This computer tool is improved by interactions between the didactical expert and surgeons. Thus, a part of this system is constituted of a user interface, medical protocols and anatomy expressed in an object-based representation formalism, and one solver to find the best feedback in relation to a given error.

Surgical Clinical Cases Agent

This agent is based on the Virtual Observatory described in the VOEU project [5]. The role of the Clinical Case agent is to illustrate the consequences of a give proposed trajectory. We can propose an example of a set of clinical cases related (female, 44 years, with one kind of operation) with some images takes in pre-operation phase. We can find some pertinent information related to different phases (before, during and after the operation). One pedagogical feedback is for example the film during the operation.

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Demonstration: Personalize Motivation Strategy for Physical Activity Promotion in Diabetic Subjects

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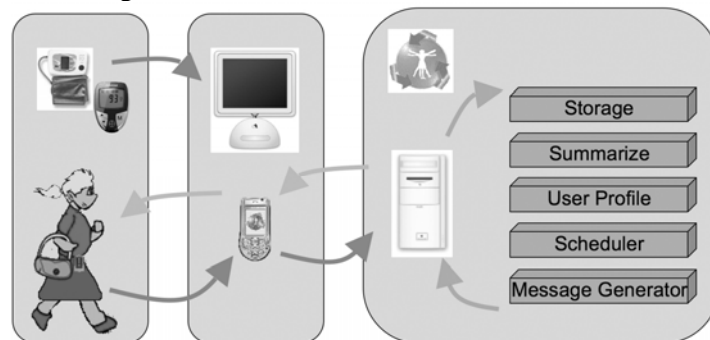
Background

To demonstrate our research work we have exploited the PIPS Platform (Dominguez et al., 2006) and created a specific instantiation of the same to support the motivation strategy to promote physical activity in diabetic citizens presented in the workshop. The proposed strategy is personalized along several dimensions and delivered through ICT solutions and devices, allowing to constantly support the patients during their daily lives.

The strategy includes an initial assessment of the user predisposition toward a physical activity behaviour change and the collection of profiling information. The patient is then given a mobile phone and a pedometer to collect daily walking information and provide motivational feedbacks. To guide the user activity a personalized target is computed with the assistance of a doctor and a self-determined exercise plan configured. Moreover, information about the patient emotional status are collected and employed to further tailor the motivational messages. Finally, appropriate support for patient's failures in target achievement and for training are provided.

All the patients participating to the program are given a pedometer and a mobile phone: the pedometer is able to measure, extract and keep in memory the number of steps per minute of the user. Every day it sends the collected data to the mobile via bluetooth connection during two communication windows, the time of which changes accordingly to the Exercise Plan. The data communication is completely automatic and no participation is required to the user. It is also possible to activate the communication procedure on demand, to update the collected data as often as the patient wishes.

Once the data collected by the pedometer are received by the mobile phone, they are sent to the PIPS back-end server through GPRS/UMTS communication.



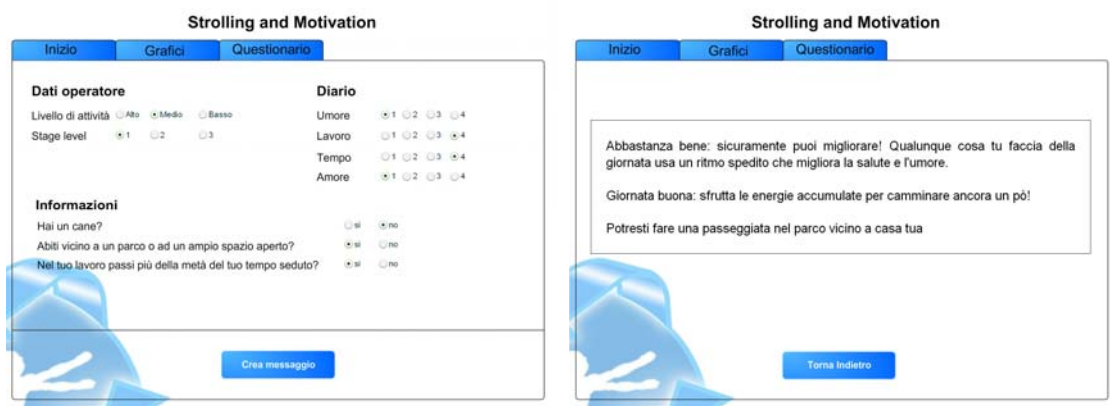
On her/his mobile phone the patient has the possibility to access different functions:

- Target - allow to view the walking target of the day in terms of walking speed, walking time at the suggested speed, caloric consumption;
- Results - allow to view the achievements with respect to the target, also in graphical form;
- Messages - allow to read the motivational SMS that PIPS sends to the patient during the day;
- Diary - allow to compile the diary of the day;
- Vital sign monitoring - allow to insert vital sign measures (glycemia pre/post prandial, weight, blood pressure);
- Settings - allow to set some parameters for the mobile system (e.g. time for the message arrival).



Demonstration

During the demonstration the complete data acquisition and feedback generation process will be presented, showing the communication between the pedometer and mobile phone, the application developed on the mobile phone and how the user can interact with it. We will also demonstrate a small application that has been developed for evaluating with target users the message generation algorithm. The application allows the user to modify on the fly his/her profile and to see how the system would adapt the motivational message to the new context. The user also have the possibility to rate the generated message along several qualitative dimension and the result collected are being used to further tailor the motivational messages. Examples of the month report and how the user can correlate his/her activity level to the emotional status expressed by the daily diary.



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