Minimal Models for Modal Logics

Fabio Papacchini       Renate A. Schmidt

School of Computer Science
The University of Manchester

April 3, 2012
(Minimal) Model Generation

Useful for several tasks:

- hardware and software verification
- fault analysis
- commonsense reasoning
- …

Minimality criteria for classical logics:

- domain minimality
- minimisation of a certain set of predicates
- minimal Herbrand models
(Minimal) Model Generation

Useful for several tasks:

- hardware and software verification
- fault analysis
- commonsense reasoning
- ...

Minimality criteria for classical logics:

- domain minimality
- minimisation of a certain set of predicates
- minimal Herbrand models

What are minimality criteria for modal logics?
From classical logics (e.g. through a translation-based approach)

- domain minimality
- minimisation of a certain set of predicates
- minimal Herbrand models

A more “modal” minimality criterion

- minimal under bisimulation
Minimality Criteria by Example

\[ p \land ( \Diamond p \lor ( \Diamond p \land \Box \Diamond ( p \lor q ))) \]

Domain Minimal Models

Minimal Herbrand Model

Minimising

Minimal under Bisimulation

F. Papacchini, R. A. Schmidt

Minimal Models for Modal Logics

April 3, 2012 4 / 4
Minimality Criteria by Example

\[ p \land ( \Diamond p \lor ( \Diamond p \land \Box \Diamond ( p \lor q ) ) ) \]

Domain Minimal Models
Minimality Criteria by Example

\[ p \land ( \Diamond p \lor ( \Diamond p \land \Box \Diamond ( p \lor q ))) \]

\[ \downarrow \{p\} \quad \downarrow \{p, q\} \]

Minimally Under Bisimulation

Minimal Herbrand Model
Minimality Criteria by Example

\[ p \land ( \iamond p \lor ( \diamond p \land \Box \diamond ( p \lor q )) ) \]

\[
\text{Domain Minimal Models} \\
\text{Minimal Herbrand Model} \\
\text{Minimising} \\
\text{Minimal under Bisimulation}
\]

F. Papacchini, R. A. Schmidt

Minimal Models for Modal Logics

April 3, 2012
Minimality Criteria by Example

\[ p \land ( \Diamond p \lor ( \Diamond p \land \Box \Diamond ( p \lor q ))) \]

Minimising \( q \)
Minimality Criteria by Example

\[ p \land (\Diamond p \lor (\Diamond p \land \Box\Diamond(p \lor q))) \]

Minimal under Bisimulation
Minimality Criteria by Example

\[ p \land ( \Diamond p \lor ( \Diamond p \land \square \Diamond ( p \lor q ))) \]

\[ \{p\} \quad \{p, q\} \]

Domain Minimal Models
Minimal Herbrand Model
Minimising
Minimal under Bisimulation

F. Papacchini, R. A. Schmidt
Minimal Models for Modal Logics
April 3, 2012
Thank You!