An Approach to the Analysis and Design of Multiagent Systems based on Interaction Frames

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Overview

- Motivation
- Interaction Frames & Framing
- InFFrA
- Example
- Conclusions

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Motivation

- Open systems on the Internet
  - virtual enterprises
  - supply chain management
  - electronic marketplaces
  - ubiquitous information access

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- New research issues

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  - virtual enterprises
  - supply chain management
  - electronic marketplaces
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- New research issues
- Something amiss?

Motivation

Three claims:

- *Socio-empirically rational* agents that
  - record interaction processes and
  - employ this experience strategically

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  are needed.
- Architectures to design and analyse such agents are missing.
- ***InFFrA is a possible solution!***

Motivation

- Introduction to InFFrA

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- Introduction to InFFrA
- Application to Multiagent Learning System

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- Introduction to InFFrA
- Application to Multiagent Learning System
- Discussion & Outlook

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Interaction Frames & Framing

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  - roles & relationships,
  - courses of interaction (trajectories),
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- Local vs. shared knowledge
  - ➡ common vs. private attributes
- Interactions are not subject to direct agent control!

Interaction Frames & Framing

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  - strategically employs frames to guide interaction behaviour.

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- Socio-centric view with individualist “touch”
- Frame & Framing concepts grounded in Goffman’s sociological theory

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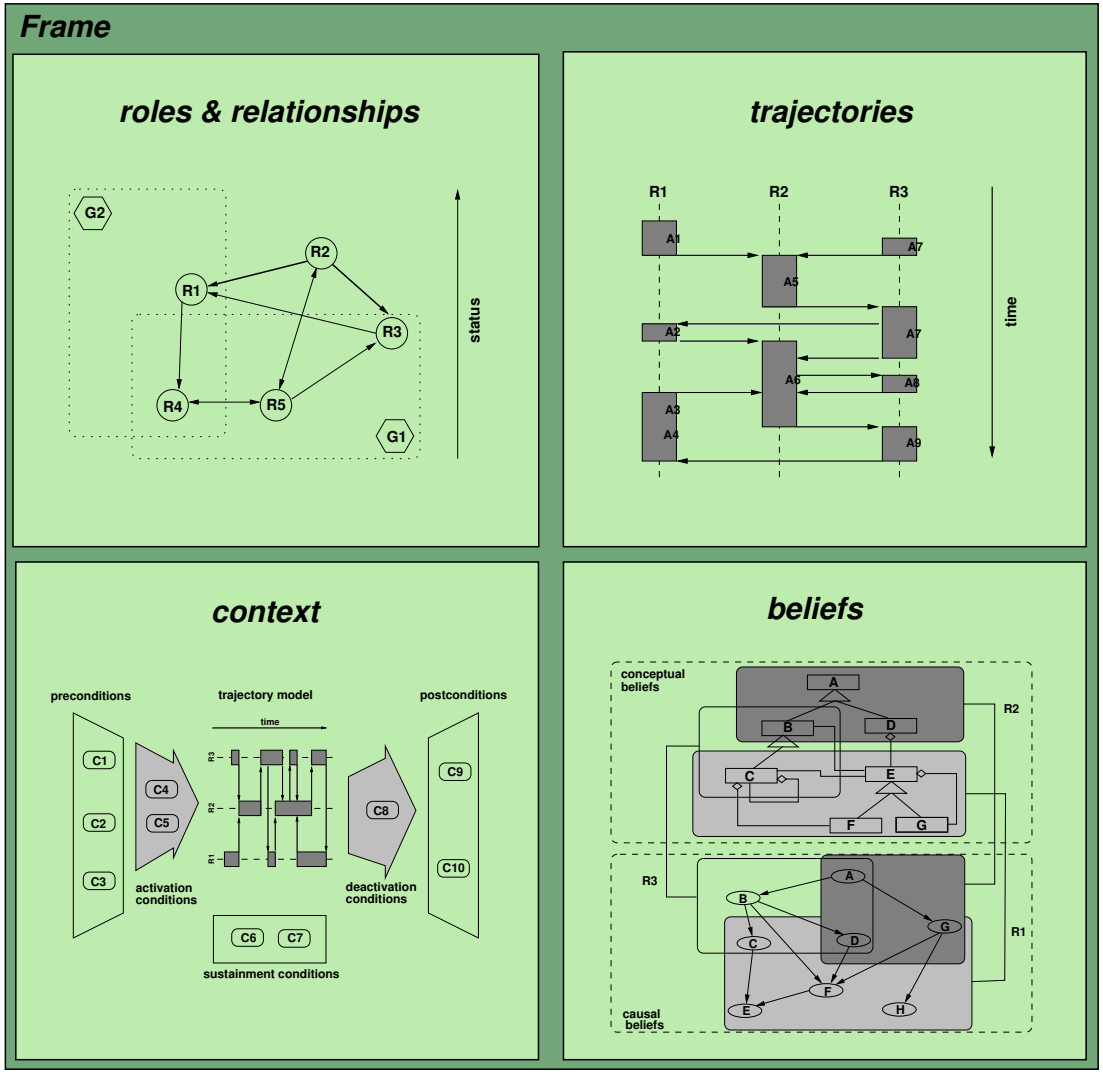

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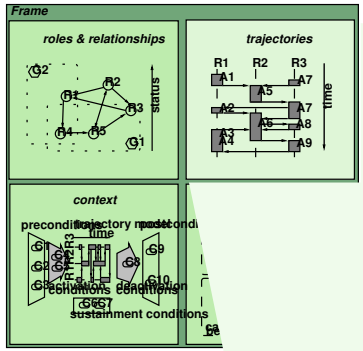

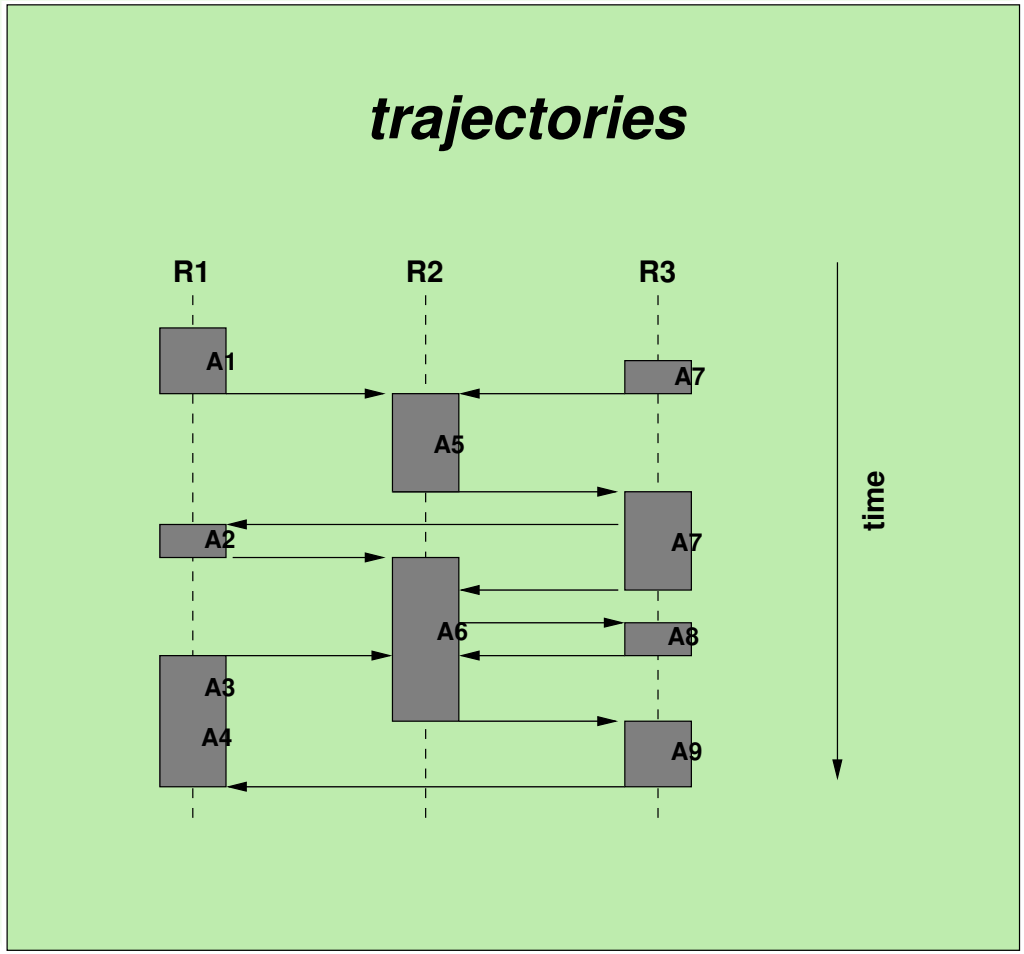

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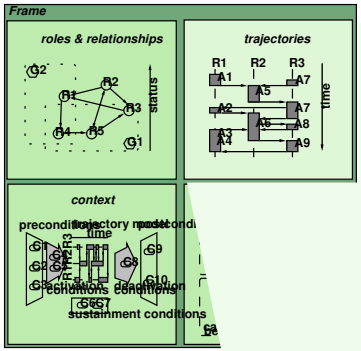
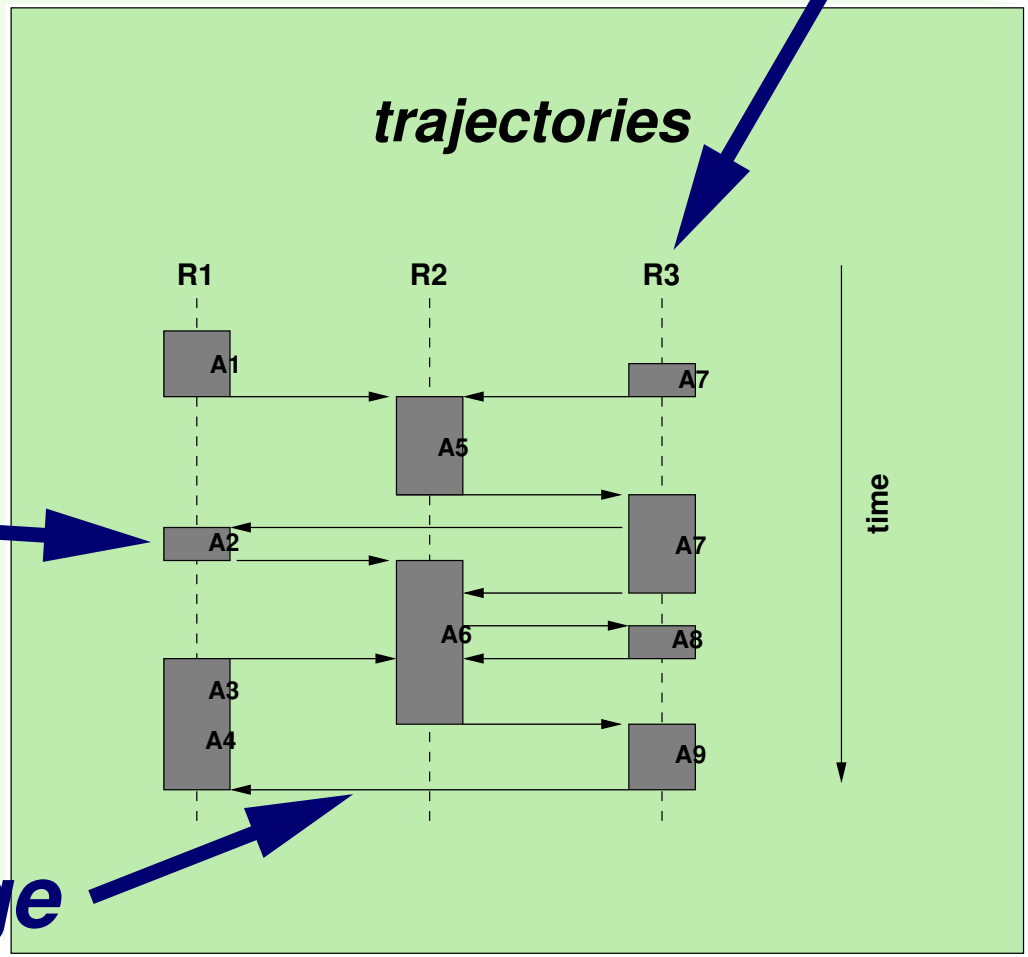


actor role

trajectories

action

message



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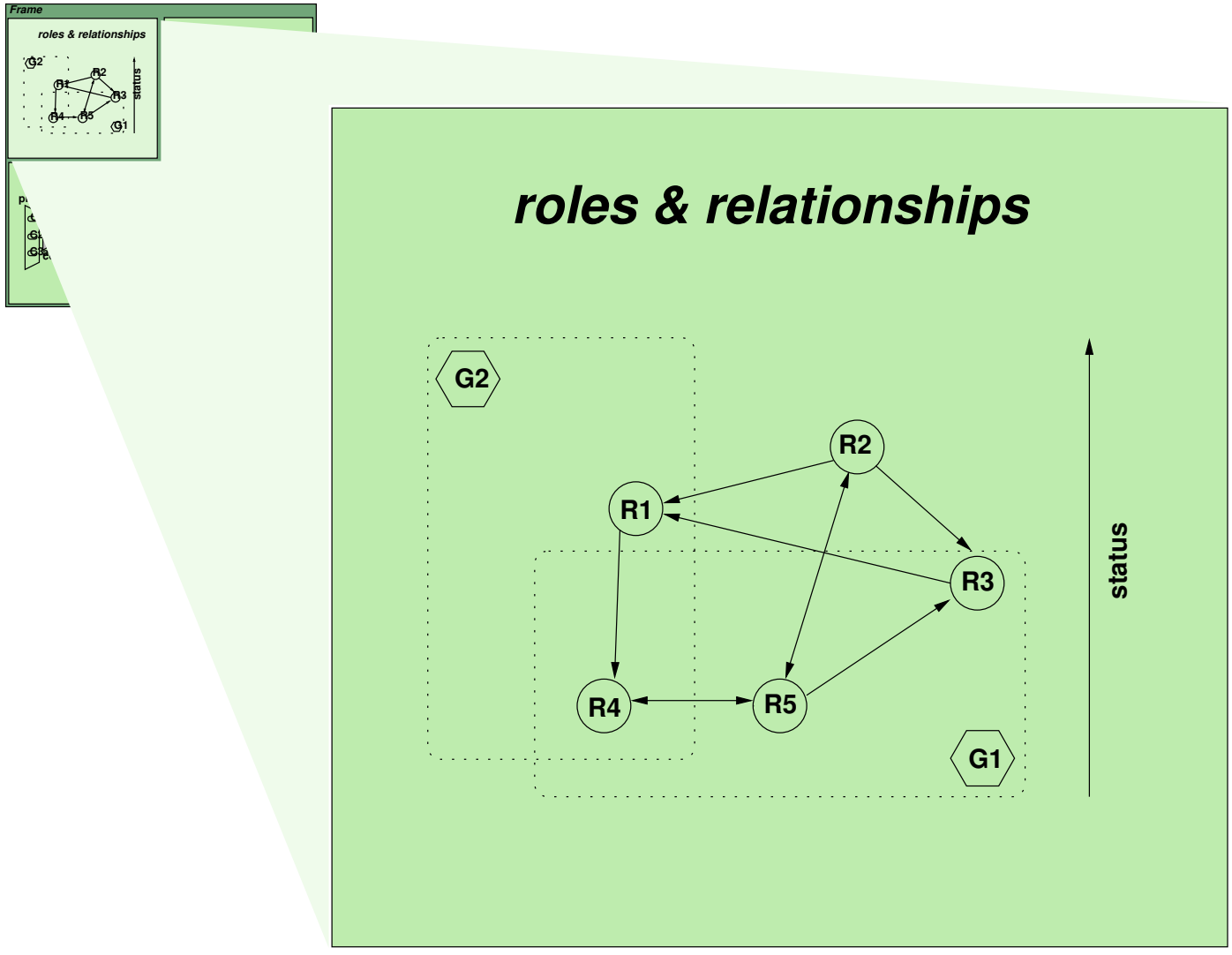

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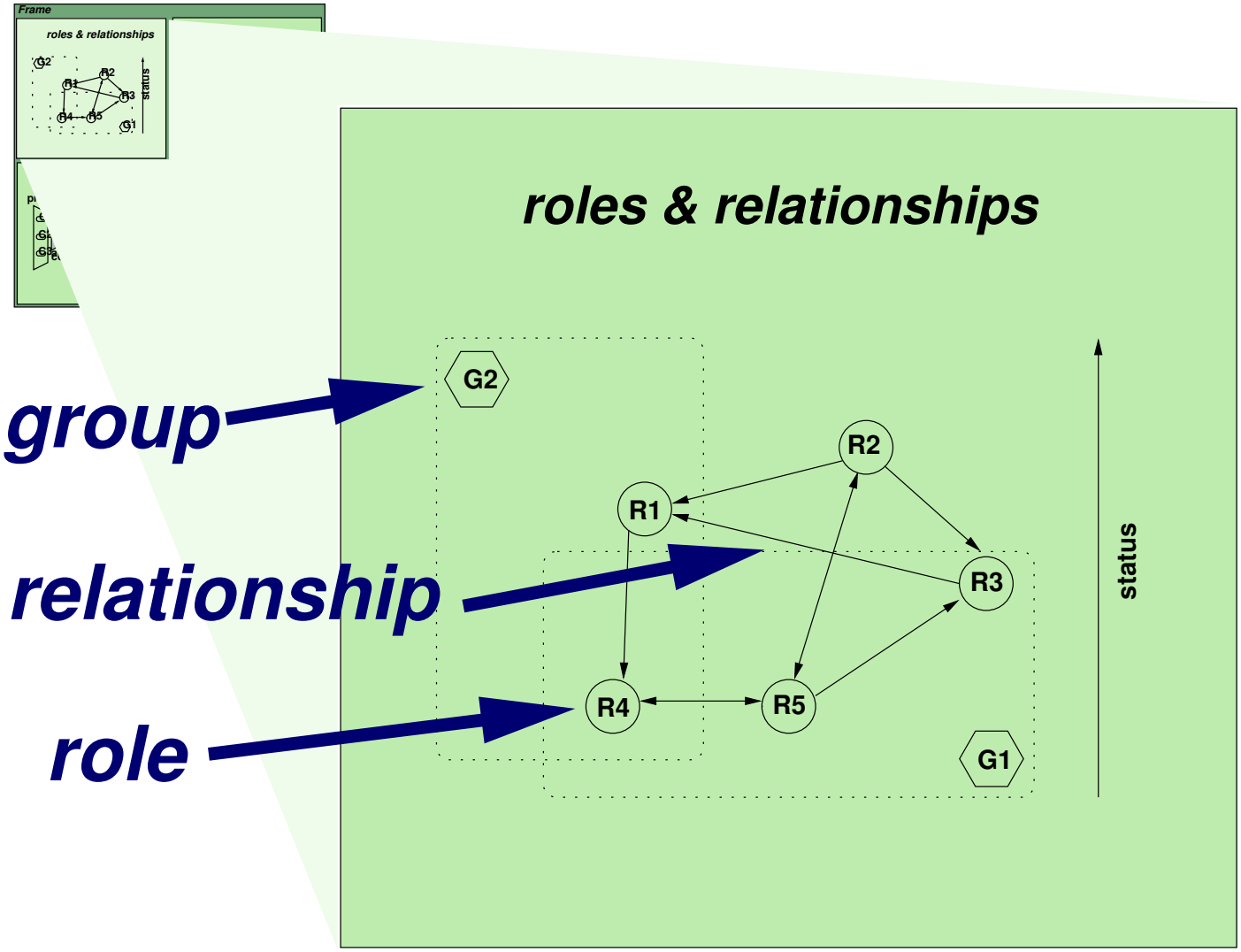

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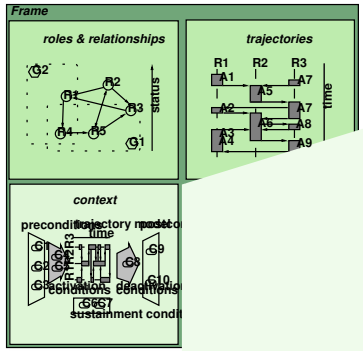


context

preconditions

trajectory model

postconditions

time

C1

C2

C3

C4

C5

R3

R2

R1

C8

C9

C10

activation conditions

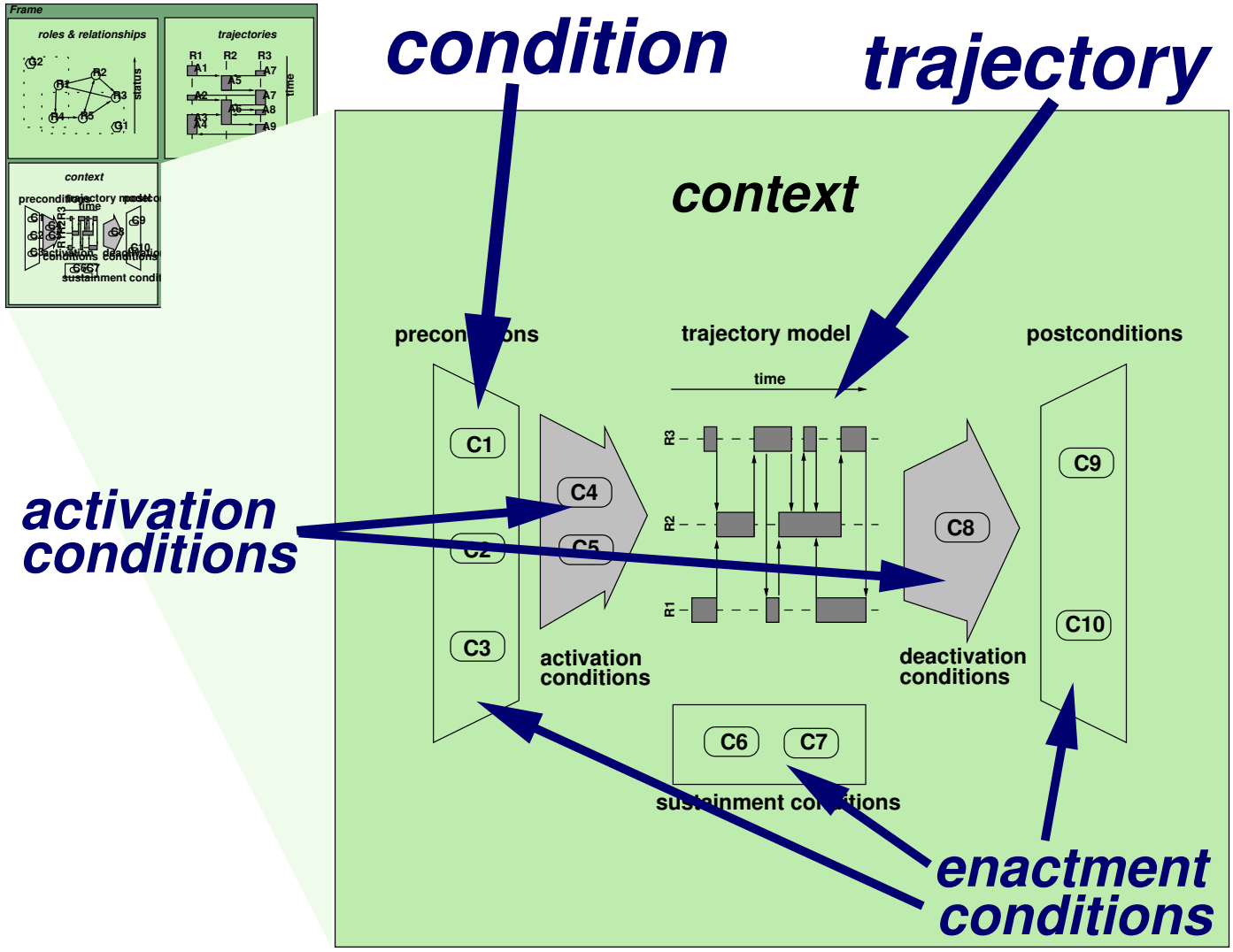
deactivation conditions

C6

C7

sustainment conditions

InFFrA – Frames



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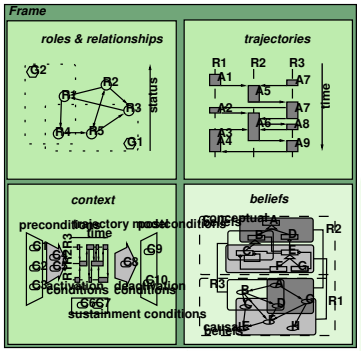

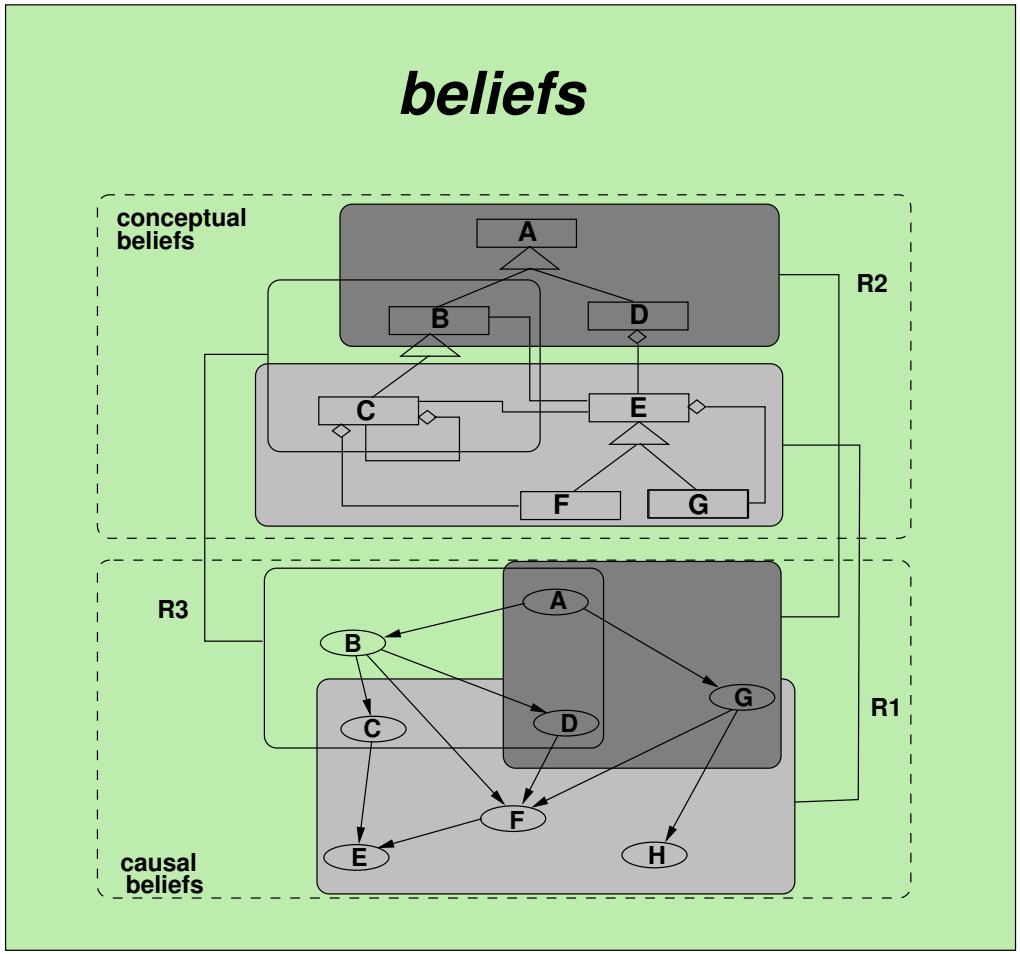

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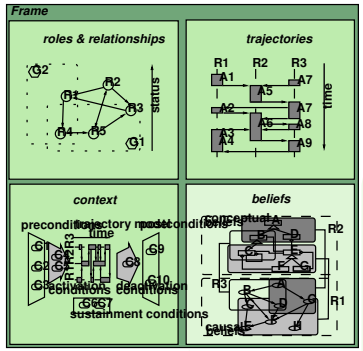
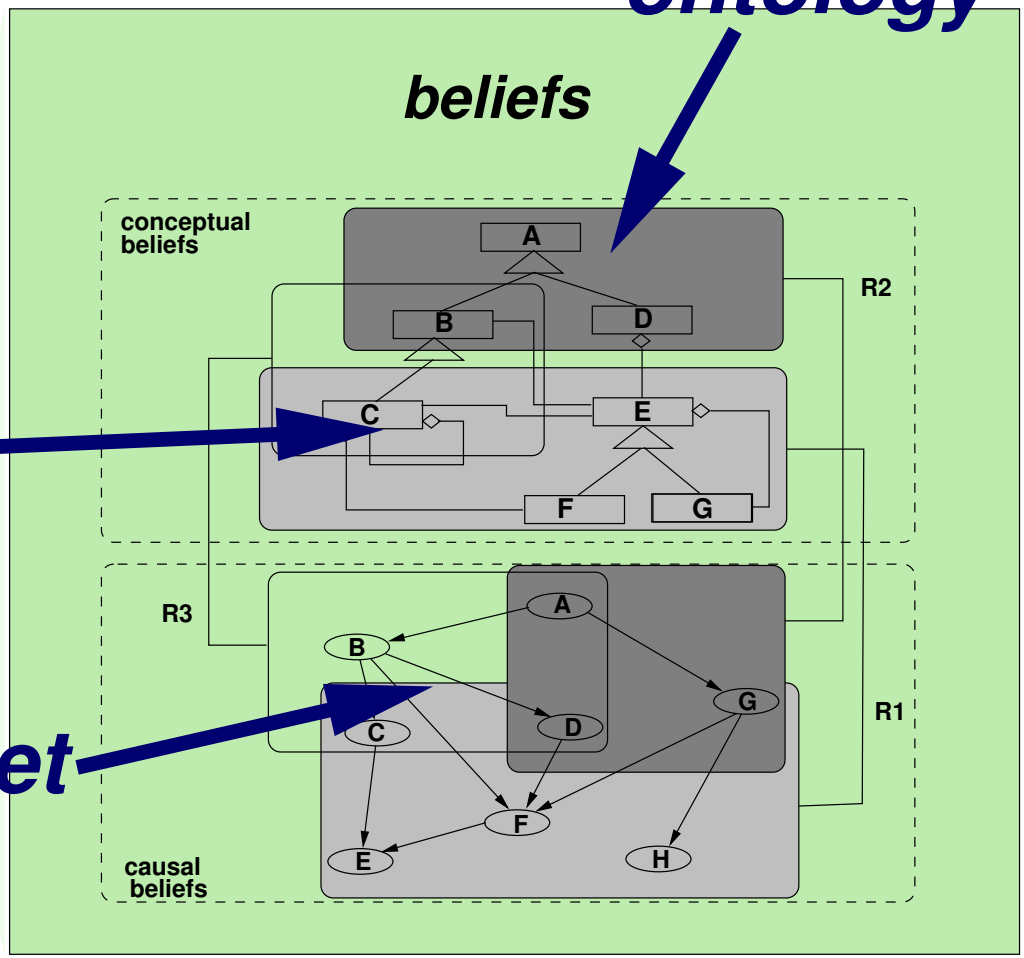


ontology

beliefs

role

belief net



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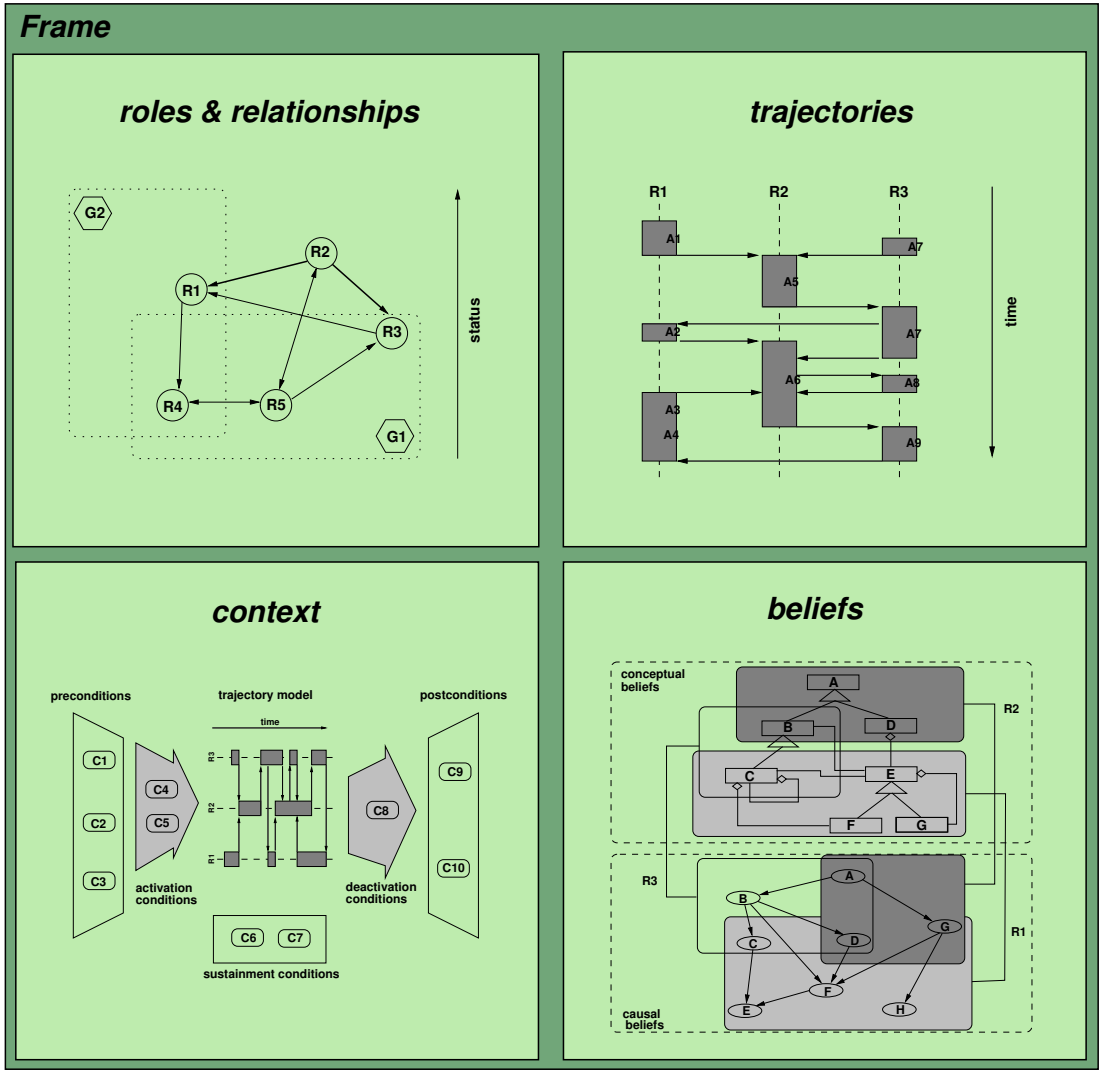

Further Features

- Private attributes

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  - Status slots for common attributes
  - Mappings and assessments

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- Private attributes
  - Status slots for common attributes
  - Mappings and assessments
- Meta-frame attributes
  - Links (“alternative”, “variant”, etc.)
  - History (of frame evolution)

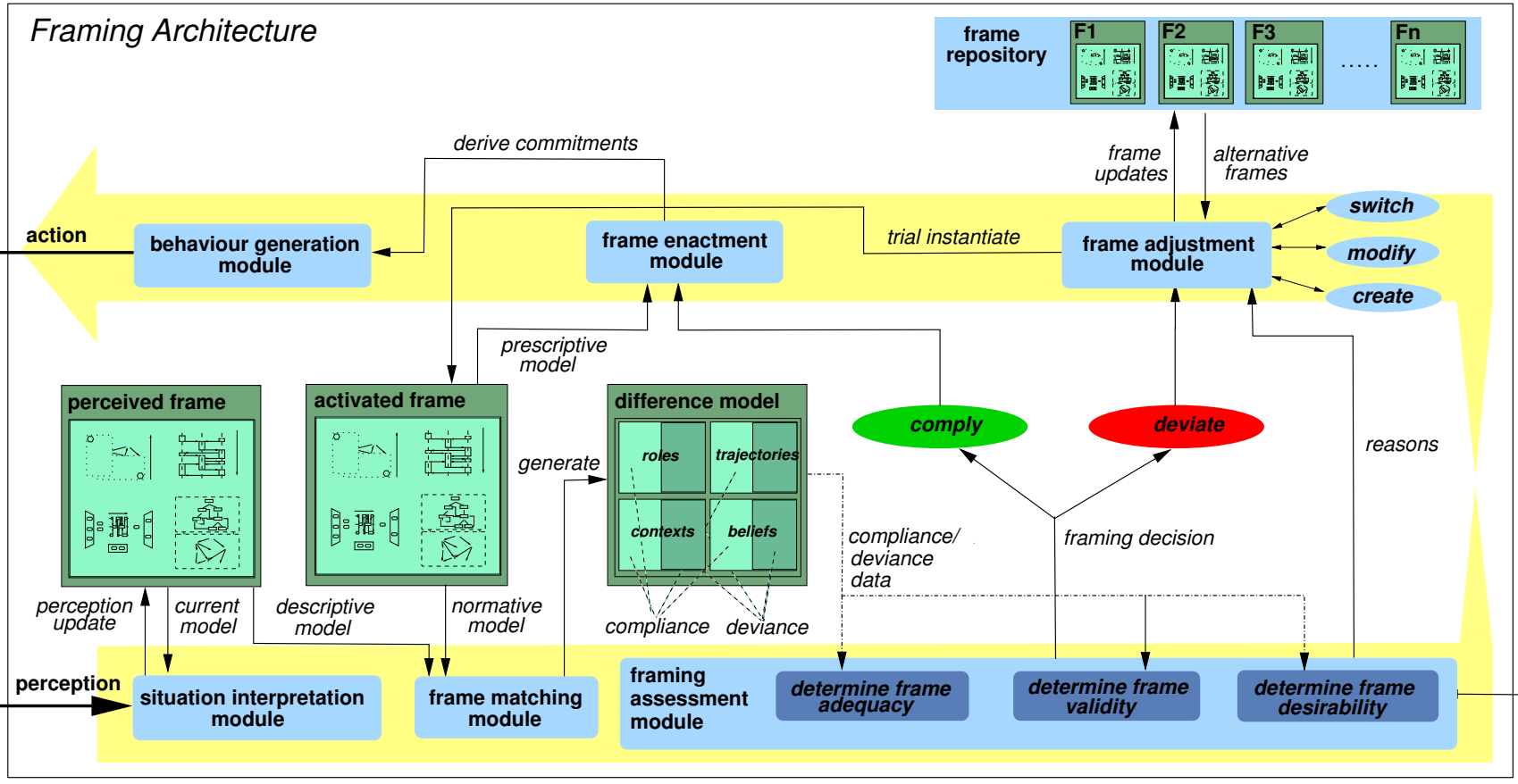
InFFrA – Framing

- Data structures:
  - Perceived frame
  - Active frame
  - Difference model
  - Trial frame
  - Frame repository

InFFrA – Framing

- Inference steps:
  - Situation interpretation
  - Matching
  - Assessment
  - Framing decision
  - Adjustment/re-framing
  - Enactment
  - Behaviour generation

Framing


Framing Architecture
frame repository
F1
F2
F3
.....
Fn
derive commitments
frame updates
alternative frames
action
behaviour generation module
frame enactment module
trial instantiate
frame adjustment module
switch
modify
create
prescriptive model
perceived frame
activated frame
difference model
roles
trajectories
contexts
beliefs
comply
deviate
reasons
generate
compliance/ deviance data
framing decision
perception update
current model
descriptive model
normative model
compliance
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sub–social level
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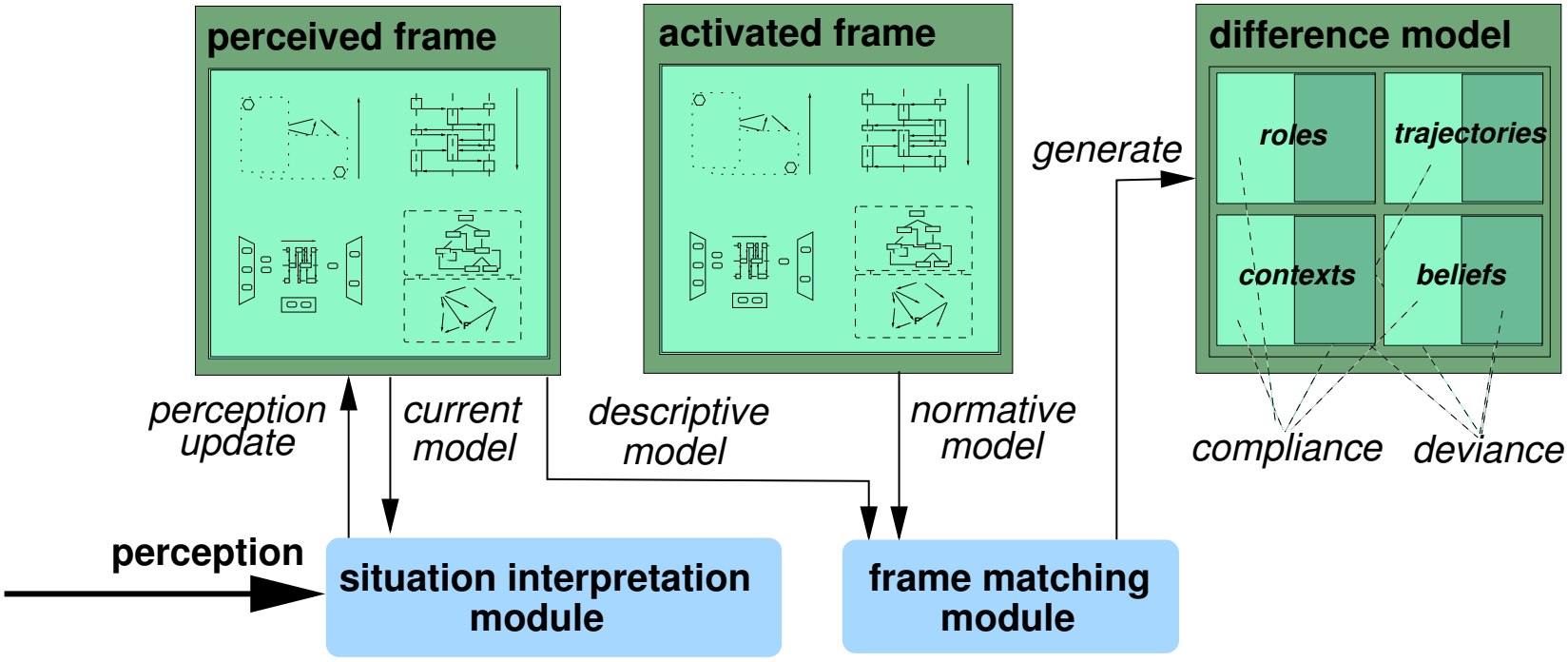
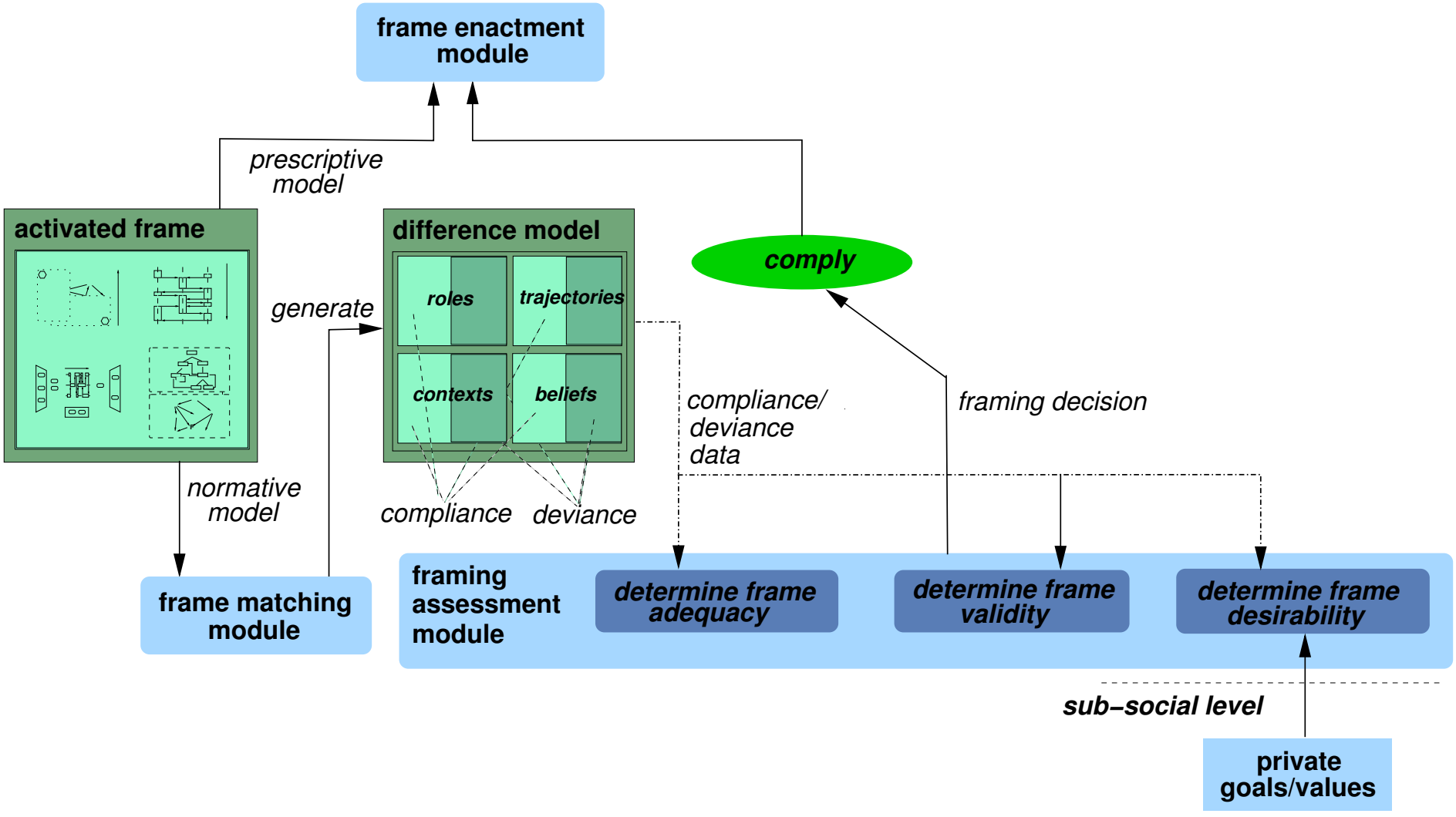
situation interpretation module
frame matching module
framing assessment module
determine frame adequacy
determine frame validity
determine frame desirability
private goals/values

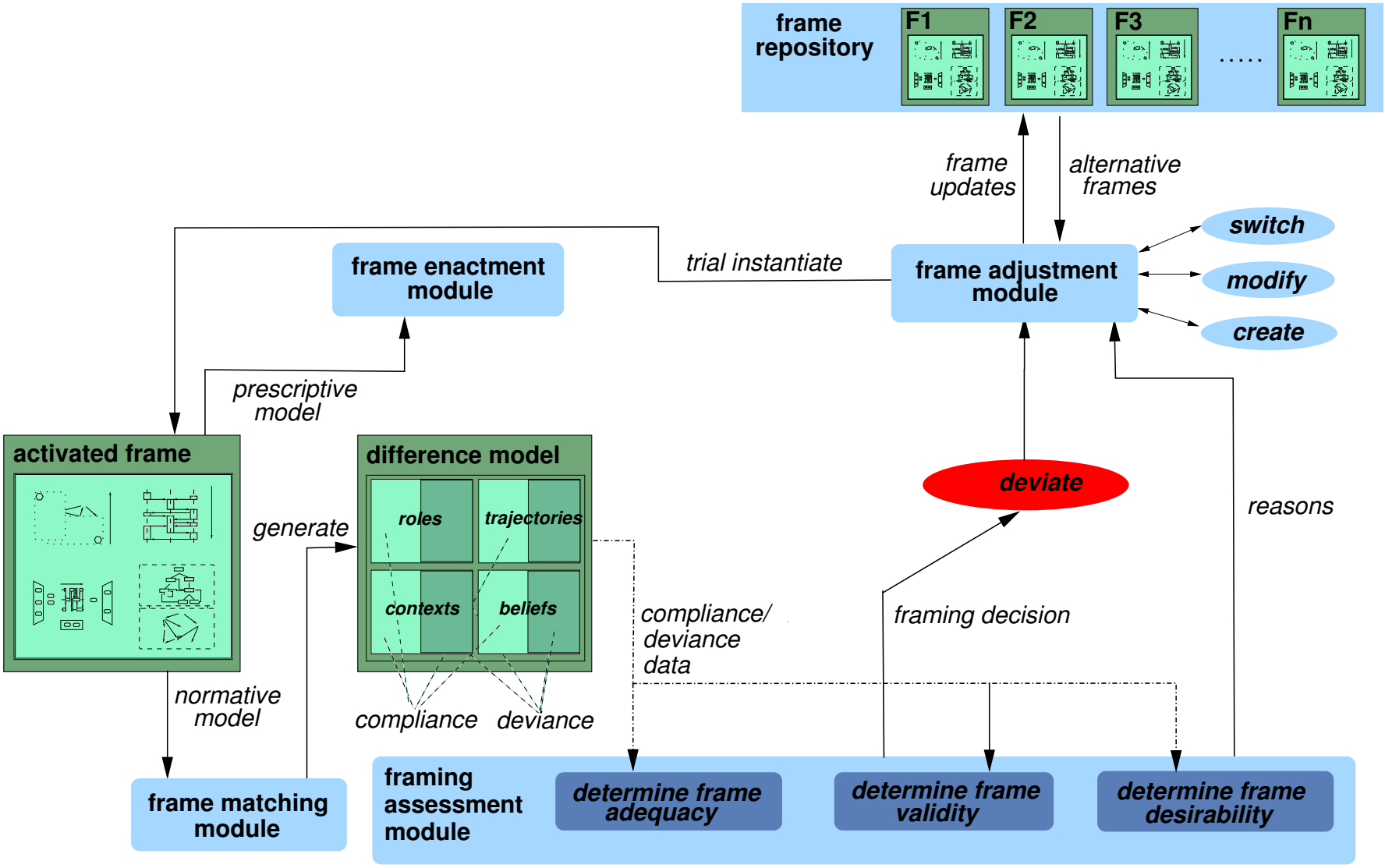
Interpretation & Matching



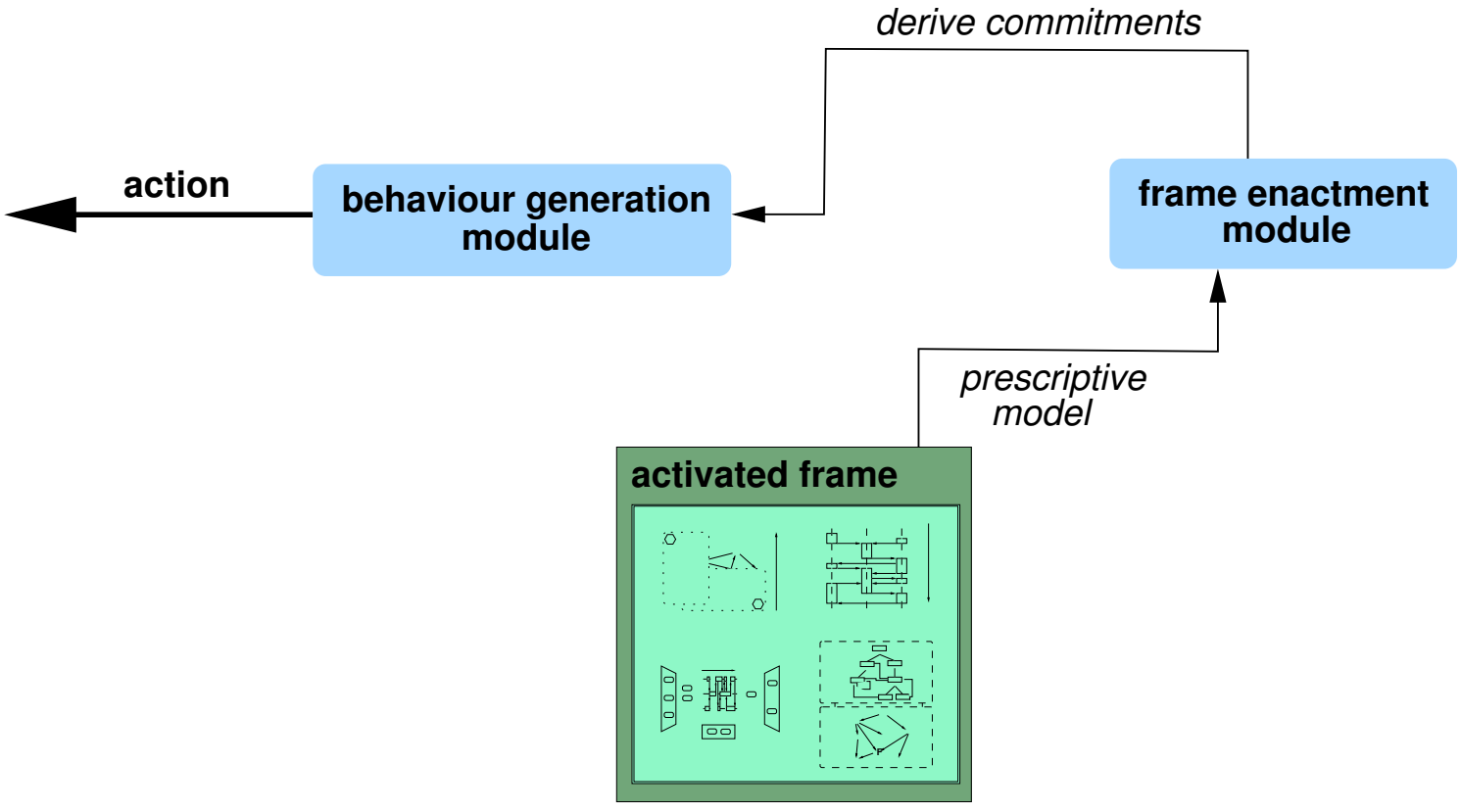
Assessment: “Comply Case”



Assessment: “Deviate Case”



Enactment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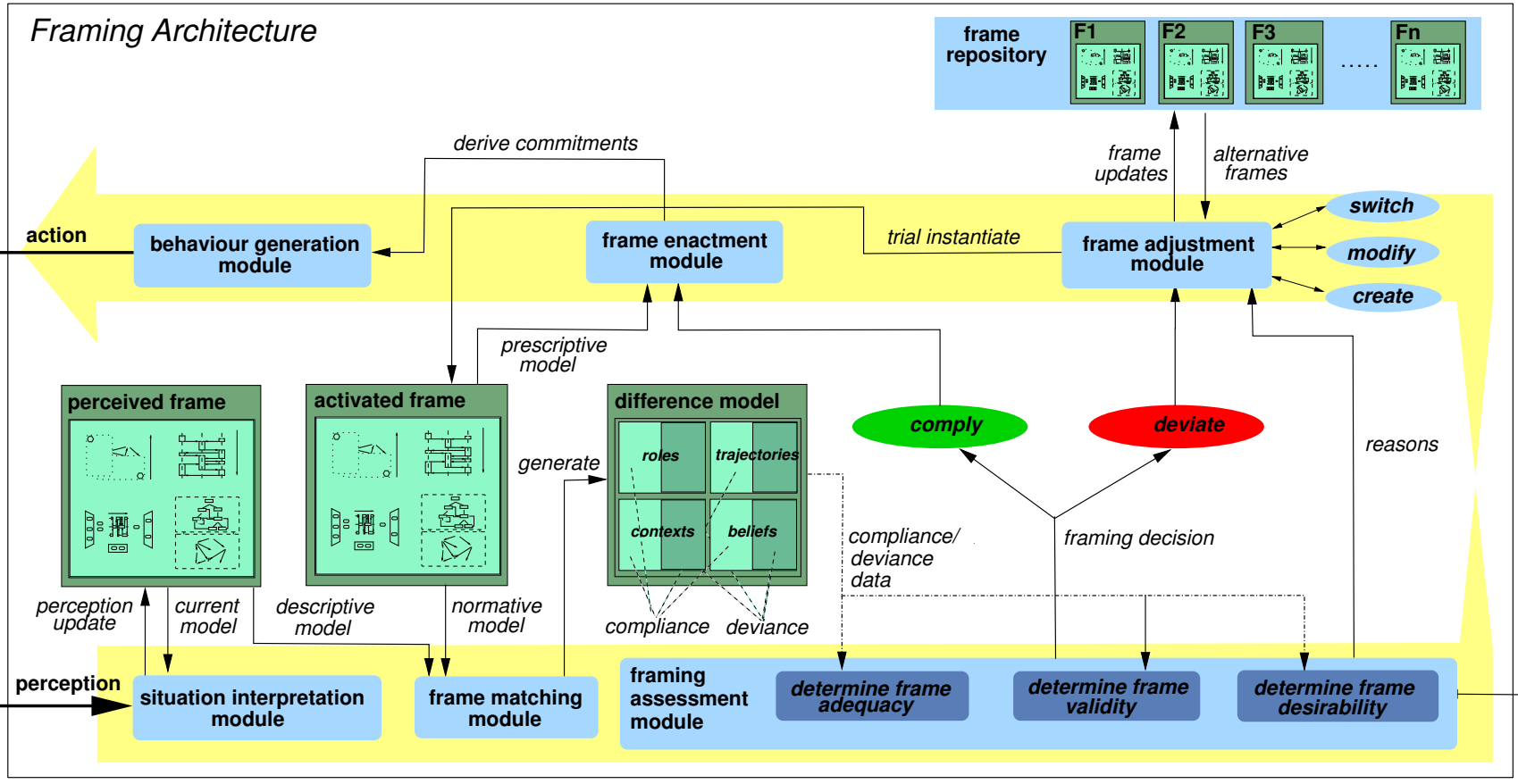
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- AdHoc agents classify opponents dynamically in iterated multiagent games
- Scenario:
  - randomly moving agents on toroidal grid
  - fixed number of PD games upon encounter
  - goal: utility maximisation

Example – AdHoc

- Opponent class models c consist of:
  - Deterministic finite automaton describing behaviour of c [Carmel & Markovitch 96]
  - Q-table for optimal counter-strategy [Watkins & Dayan 92]
  - Similarity values $\sigma(a, c)$
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- Similarity = Ratio of encounters with opponent understood by class model

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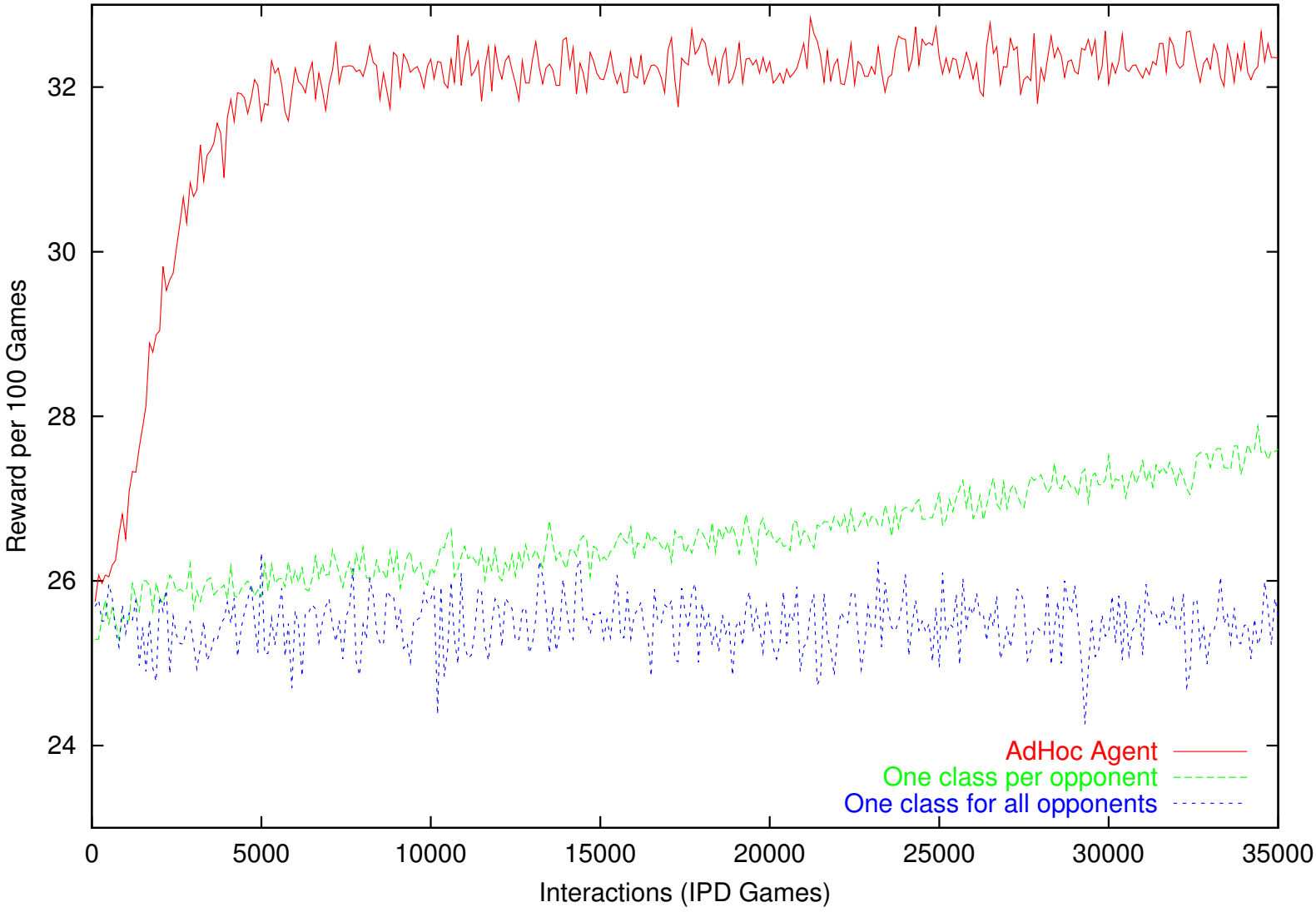
- Adaptive (bounded) number of classes
- Long-term integration of similar classes
- Convergence to actual number of opponent classes
- Problem: AdHoc vs. AdHoc agents
- Can be solved “heuristically”

Example – Performance



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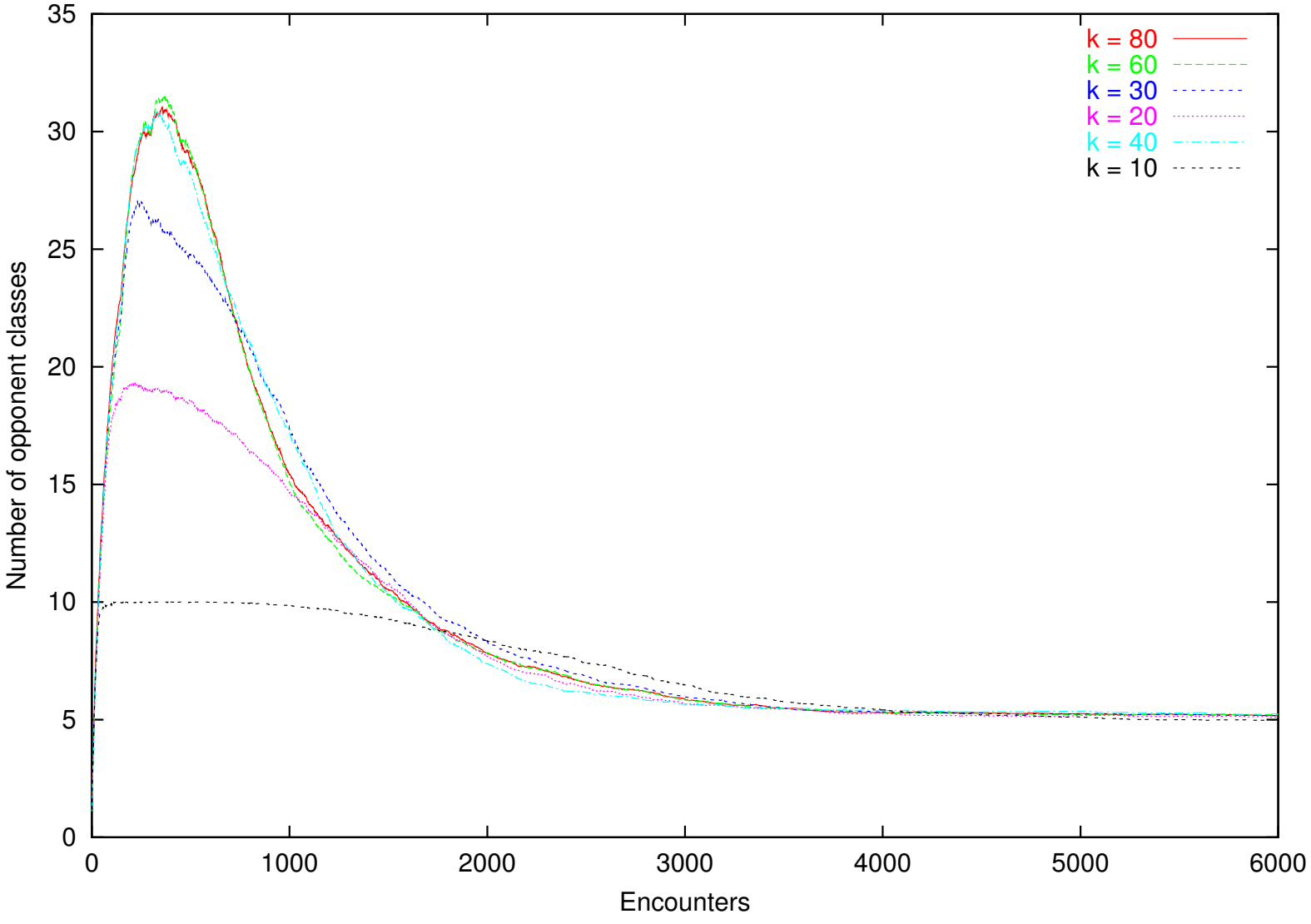

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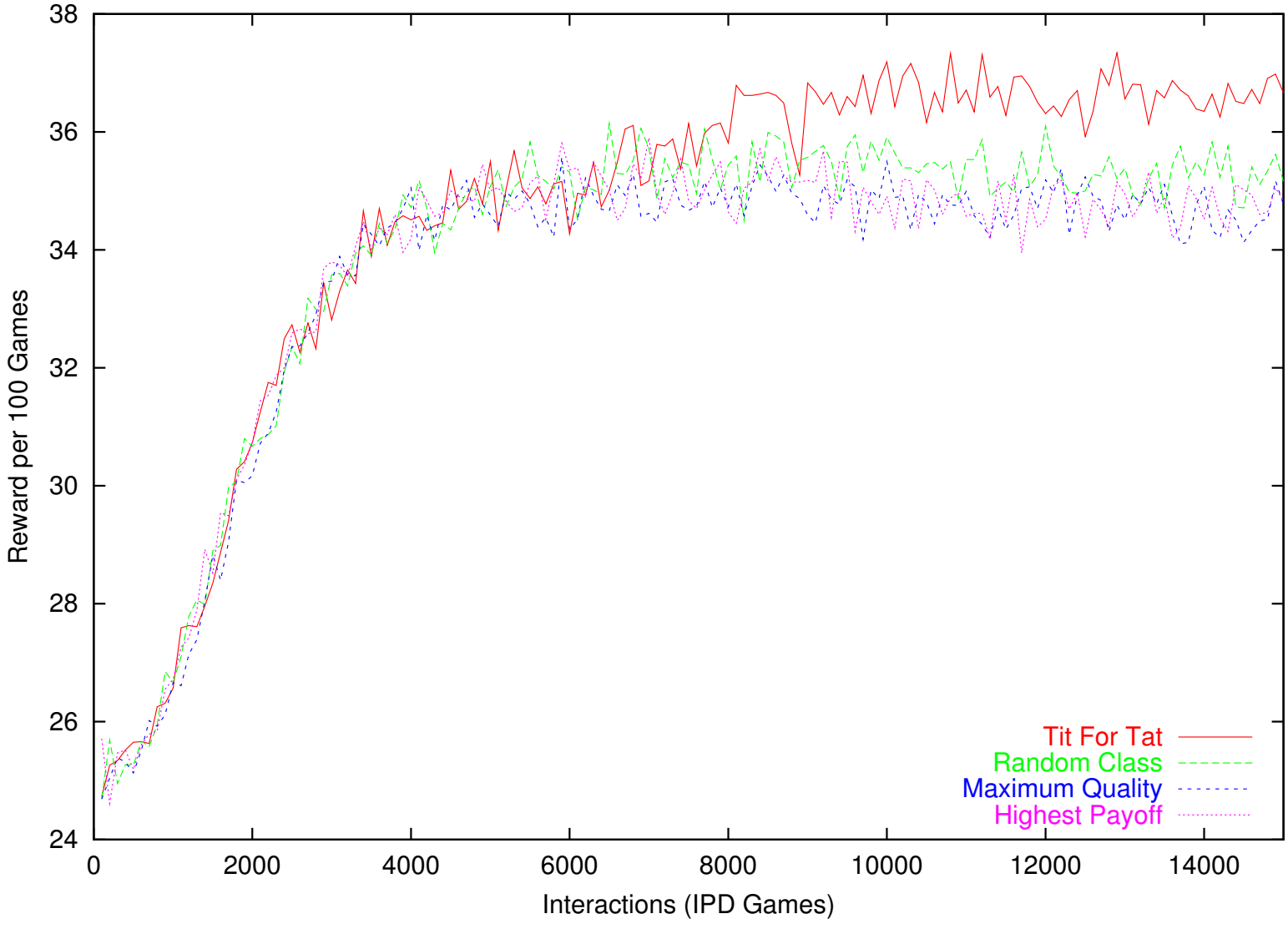

InFFrA Analysis

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  - Learning samples for class ➡ History
- Roles, links and beliefs: trivial
- Perceived frame = current encounter game sequence

InFFrA Analysis – Observations

- if opponent is known, no re-framing during encounter
- else, matching after each round
- frame matching updates *all* similarity values
- assessment and re-framing only after encounter
- no adequacy and desirability test

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- ...case-based reasoning? *Yes and No!*
  Depends on frame construction & combination.

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- ...a silver bullet for open systems?
  *Certainly **not!***
  - too few InFFrA-compliant systems
  - heavy cognitive assumptions

Outlook

- Richer communicative scenarios

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- Emergence of globally valid frames?

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- Organisational interaction frames
- Develop adaptive InFFrA agents

Things to remember!

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- Sociological grounding: frames and framing

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- Socio-empirically rational agents
- Sociological grounding: frames and framing
- InFFrA meta-architecture

Things to remember!

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- Socio-empirically rational agents
- Sociological grounding: frames and framing
- InFFrA meta-architecture
- Multi-perspective applicability

Thank you for your attention!