

Why Strategic Modelling....

Towards an Intentional and Agent-Oriented Modelling Language for CIS

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CIS Themes

- **Cooperation**
 - multiple agents, shared/divergent interests, social paradigm
- **Change**
 - evolution (not just behavioural dynamics)
 - propagation (locality of impacts)

Why Strategic Modelling

- **agent autonomy**
 - partial knowledge about / control over other agents
 - uncertainties, failures, risks
- **want to reason about strategic change**
 - e.g., business redesign
 - wants, abilities, commitments, beliefs/assumptions, rationales, ...
 - opportunities, vulnerabilities -- enforcement, assurance, insurance,...

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Example setting 1: Health Care

- Scenario: You visit your family doctor, go for tests, get sent to hospital, go through admissions, get assigned a ward, do more tests, get radiologist report, monitored by nurses and residents, consultation with cardiologist, get prescriptions, medication from pharmacy, scheduled for operation (bookings for room, personnel, equipment, materials), receive operation, more tests, discharged, reports sent to family doctor, follow-up visits to hospital, specialists, ...



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“imperfections” in the real world

- What are the uncertainties, potential failures, breakdowns,...?
“Where” are they located? (not just physical location)
- What kinds of uncertainties/details do you want to encapsulate/ hide? at what times? from whom?
 - What (and how much detail) do other agents need to know about / control you in order to “cooperate” and get work done?
- How to “contain” these uncertainties?
 - through “commitment” from agents with goals, knowhow, and resources.
 - pharmacist to fill prescription accurately
 - nurse to administer medication correctly and on time
 - doctor to cure patients with reasonable rates of success
- What if the containment doesn’t work? (“leakage”)

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Why strategic modelling

- How to improve one's strategic positioning? (redesign/reconfigure strategic relationships among agents)
 - if doctors are overloaded and become negligent, are there responsibilities that can be shifted to nurses?
 - if the pharmacy has a high error rate in filling prescriptions, what checks should be instituted? to be done by whom? What information systems to install?
- Need strategic modelling and reasoning
 - ability, viability, believability,...
 - enforcement, insurance, ...
- Traditional modelling languages not suitable because
 - focus on i/o (non-intentional flows), states, behaviour,...
 - no support for modelling intentional and social aspects
 - rely on completeness, certainty, consistency, correctness for analysis

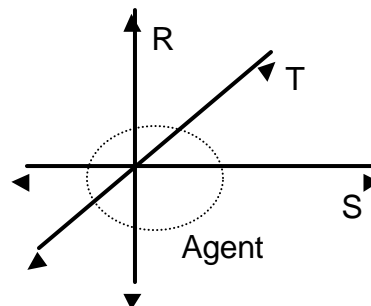
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Intentional and Agent-Oriented Modelling

- use intentional concepts to deal with incompleteness, failures, ...
 - e.g., specify *what*, *why*, rather than *how*, allow alternative *means to ends*
- use agent concept to encapsulate/contain incompleteness, failures, ...

Ontological Framework

An agent as a bounded region in a multi-dimensional space

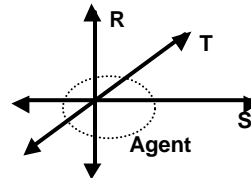


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Ontological Framework

- What are the appropriate dimensions?

- S - “spatial” dim., physical or conceptual
- T - temporal dim.
- R - reflection/intentional dim.



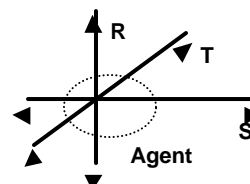
- What is/are the nature of the boundaries?

- boundary => discontinuity
- what is preserved/not preserved across boundaries?
- what is propagated across boundaries?
- how to define the “interface”

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Why an Ontological Framework

- help us incrementally build up towards intentional and social ontologies
- help us enumerate and decide what features to include/exclude in pragmatic language design



- 1D - static ontology (e.g., ER)
- 2D ST- static + dynamic (most of CS)
- 2D RS - intentional ontology (e.g., NFR goal graph)
- 3D - (e.g., NFR w/ change)
- 3D w/ boundaries - social ontology (e.g., i^* (actually 2½D))

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What's the "R" dimension?

- reflection, reference, representation, aboutness, ...
- conveys alternative visions of the world
 - other possible worlds besides the current "reality"
- various intentional concepts
 - goal, belief, knowledge, commitment, ability, ...

e.g., GOAL

- notion of success vs. failure
- alternatives, decision space, tradeoff, ...
- freedom within a space, specifying *what* without specifying *how*
- strategic modelling => want to reason about those freedoms, not just to achieve the goals (e.g., reducing freedom somewhere while opening up others)
- especially important because provides closure (e.g., useful as agent boundary)

- merely *intensional* (vs. extensional) if not relative to an agent (not R?)

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Example setting 2: Networked intellectual content

- Scenario: You access multiple digital libraries and other sources to collect, analyze, select, edit, compile material for a course. You consult others through phone, email, web, voice-mail. You produce several version of the course, some to be taught by others. Some versions are for distance learning, over multi-media communication links. Some are syndicated to corporate training centres. Some are live video, some async text, interactive. Sessions are recorded, excerpted and compile into courseware, entered into digital library, updated from time to time. Some sections have dynamic links to original sources.



- Ask same questions as before...
 - communication link failures
 - feature interactions
 - new service (poor) usability
 - content availability
 - people availability/timing
 - content credibility
 - format compatibility
 - version compatibility
 - charging/accounting issues

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Example setting 3: Software development

- Scenario: project planning, launch, meetings with users, stakeholders, interviews, requirements, prototypes, architectural design, detailed design, implementation, testing, integration, legacy migration, ongoing maintenance, support, evolution ...
- Many activities in parallel, some reuse, many obstacles, much backtracking, rescoping, re-negotiating,
- Ask same questions as before...
 - what uncertainties? where?
 - how contained?
 - how to do better? what IS support?
- How to model?
 - what conceptual terrain (S)?
 - what durations, time horizons (T)?
 - processes (ST)? rationales (RS)?
 - what boundaries? agents/roles?
 - what propagations? discontinuities?



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Identifying desired features using the Ontological Framework

Work in progress

	<u>element</u>	<u>link/relations</u>	<u>cross-categories</u>
• 1D			
–along S		S-S (e.g., CGA)	S-ST, S-RS, S-RT
–along T	(point and interval)	T-T	T-ST, T-RS, T-RT
–along R	(maybe only a relation makes sense)	R-R	R-ST, R-RS, R-RT
• 2D			
–ST		ST-ST	ST-RS, ST-RT
–RS		RS-RS	RS-RT
–RT		RT-RT	
• 3D			
–RST		RST-RST	RST-S, ...
• 3D w/ bdy		A-A (e.g., CGA)	A-S(goal), A-SR(softgoal)
–agent, role, position,...			A-S-A A-SR-A (sdep)

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“Tropos-Eric” desiderata

- S, T dimensions
 - mostly as in state-of-art Conceptual Modelling languages.
 - but need to work out interactions with R-dim and Agents
- R-dimension
 - intentionality enforcement - degrees of loose vs. tight
 - definable intentional concepts, eg. goal, belief, justifications, assumptions...
 - locally definable vs. hard-wired semantics
- boundaries
 - what needs to be defined at the “boundary”?
 - flows, intentional relationships?
 - definable properties that are preserved (or not) across boundaries
 - propagation of properties across boundaries
 - selective weakenings of properties, semantics of concepts

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“Tropos-Eric” desiderata (cont’d)

- identity, reference, ... mappings, parameters, bindings, ...
- definable specific degrees of formality/informality for specific types of reasoning
- degrees of precision (e.g., conceptual distances/ granularity)
- range of genericity (e.g., case-based vs. generic knowledge)
- degrees of hiding of detail
- nested intentionality - one agent attributing intentionality to another
- strategic action vs. operational action
 - strategic action changes the operational context, based on reasoning about operational freedoms
 - operational action exercises the operational freedoms
- making all R, S, T dimensions relative to each agent

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Let's go shopping

Non-intentional

- SADT, DFD, ER
- UML
- Formal methods for tight enforcement
- CM langs.

Intentional

- GORE
 - Feather, KAOS, NFR, GBRAM, NATURE, CREWS
- AI concepts for automated intentionality
 - formalization vs. implementation technologies

Multi-Agent

- AORE
 - Dubois91, F3, *i**
- DAI
- Social organization theories

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