



Value-driven Reasoning for Software Agents



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For IHMC

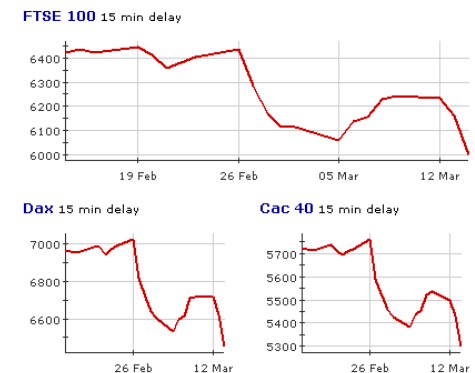
Date: 21 Mar 2007



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Aim: To discuss 'value' in the context of human enterprise and to engage in discussion on its role in human-machine cognition



01 Value - What and Why?

- What we value drives what we do:
 - differences lead to confrontations and conflicts
 - courses of action are influenced by value
 - allegiances and groupings are strengthened by value
- Increasingly, value overtly influences the world stage:
 - National - cannot rely on political, military or financial power
 - Company - increased scrutiny on ethical trading
 - Social - diversity and inclusivity - interactions more complex
 - Individual - vast range of values supported through Internet
 - Sustainable - climate change setting new agendas
 - Capital - not just about financial and manufactured capital, but also natural, human, social and environmental
- Agent-based support to human endeavour should employ value

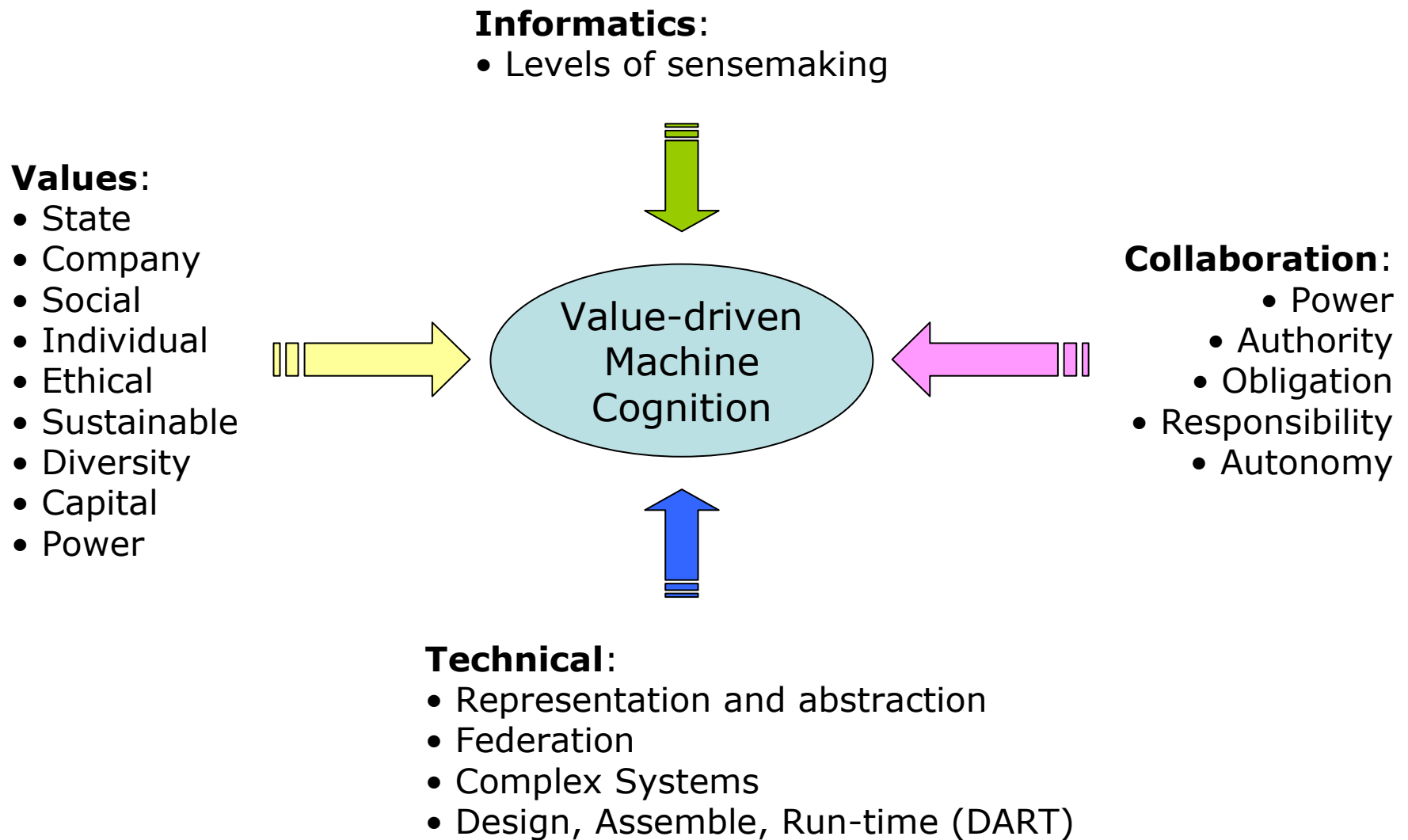
01 Value - What and Why?

- Acting effectively in the world requires agents to have:
 - Ability to sense, perceive and solve problems
 - Awareness of 'The Environment' [all inclusive]
 - Sense of self and sense of others
 - Identity and persistence over time [including learning]
 - 'Models' of possible futures
 - Ability to act and effect in the face of change - **agility**
- Having 'awareness of the environment' means what?
 - Not just about:
 - the 'things' and how they act 'out there'
 - Is about understanding what drives change:
 - having a sense of the deltas which can be exploited - **agility**
 - being able to reason from various viewpoints - **value**

01 Value - What and Why?

- There are many deltas / gradients / drivers:
 - energy (food, warmth, kinetic)
 - geographical (location of self and others)
 - chemical (pheromone, salinity)
 - discomfort (irritability, pain)
 - Deltas are asymmetries to be exploited to decisive effect
- Value is a key delta - a driver of human endeavour:
 - in commerce and enterprise
 - in interactions and in forming social relationships
 - in influencing beliefs, norms and behaviours
 - in problem-solving and learning
- Agents without it are socially impoverished - even dangerous

Value in a Wider Context



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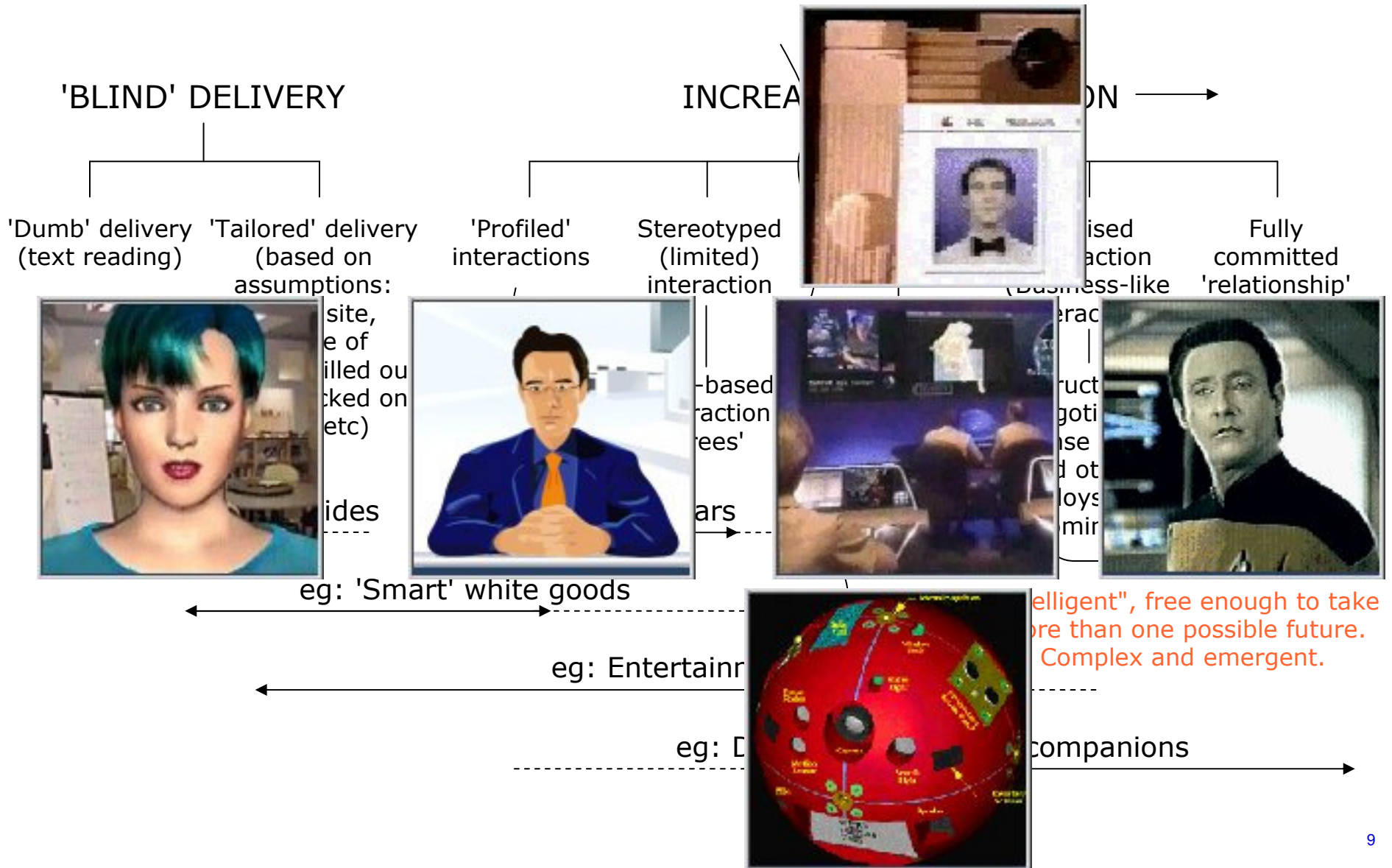
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02 Relevant Perspectives

- Perspectives which are relevant when considering value-driven agents include:
 - Collaboration - Type of relationship / CoI
 - Informatics - Levels of sensemaking
 - Technical (next section):
 - Representations and abstractions
 - Design, assemble and run-time issues
 - Dealing with federation
 - Accommodating complex system issues

02 Relevant Perspectives - Relationship



02 Relevant Perspectives - Relationship CoIs

Cols are 2 .. n 'actors'

Standing COIs

Static COIs

- Directed - authority figure appointed
- The community is pre-defined
- Info support is pre-defined
- Risk-averse

Static Pictures

Institutional COIs

- Given intent - authority figure appointed
- The community is told to form
- Info support is mostly pre-defined

Institutional Pictures

Action Groupings

Event-driven COIs

- Purposeful - authority figure 'elected'
- The community is shaped by circumstance
- Info support is on-demand

Event-driven Pictures

Social COIs

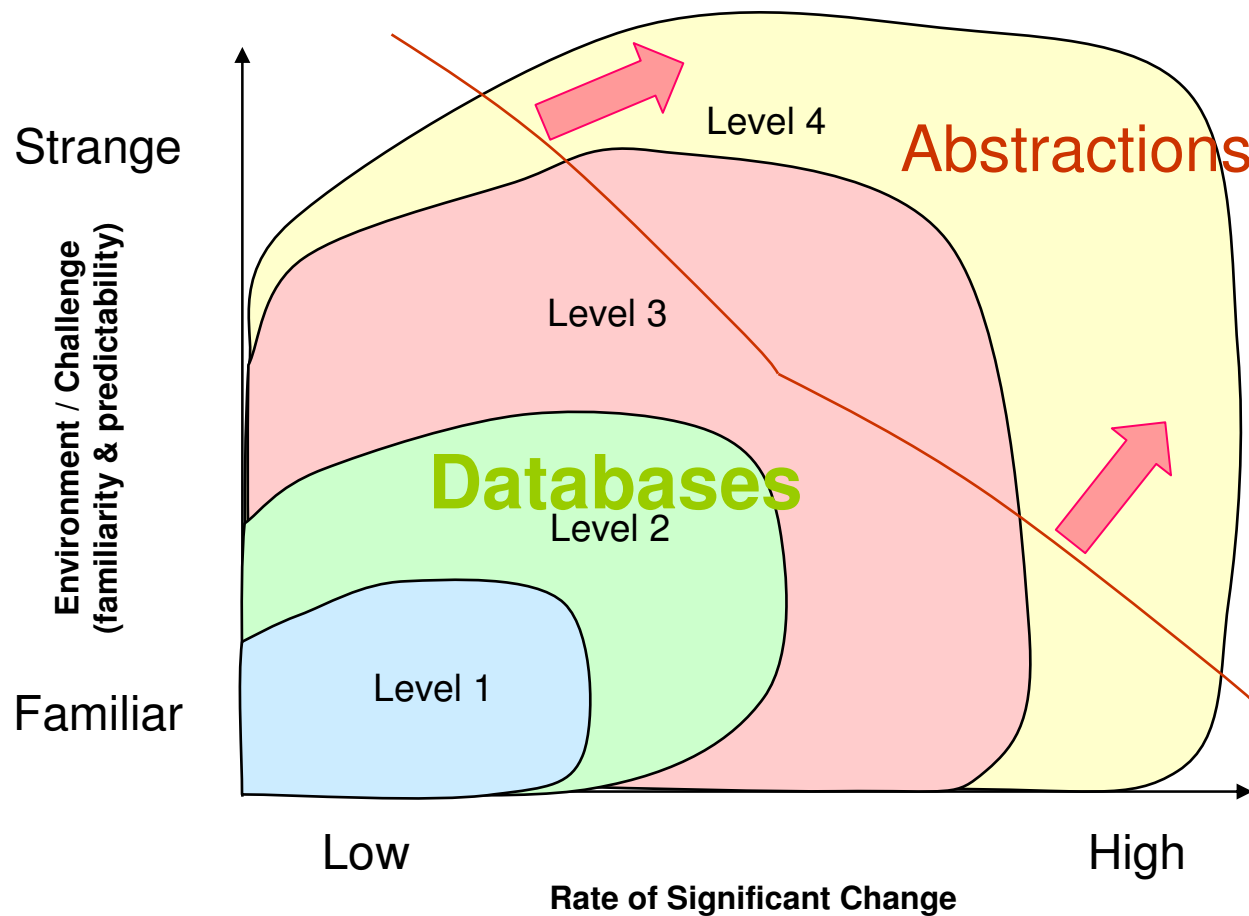
- Ad-hoc formation of communities
- Authority figure is 'alpha' person
- Tribal mechanisms
- Info reqts are hard to capture

Social Pictures

Distributed, heterogeneous information

02 Relevant Perspectives - Sensemaking

Level 3 / 4, abstract sensemaking, is decisive in conflict and includes: hunches, intentions, hypotheses, weights of evidence, networks of relationships and other advanced abstractions that cannot be represented and manipulated as if they are fact-like



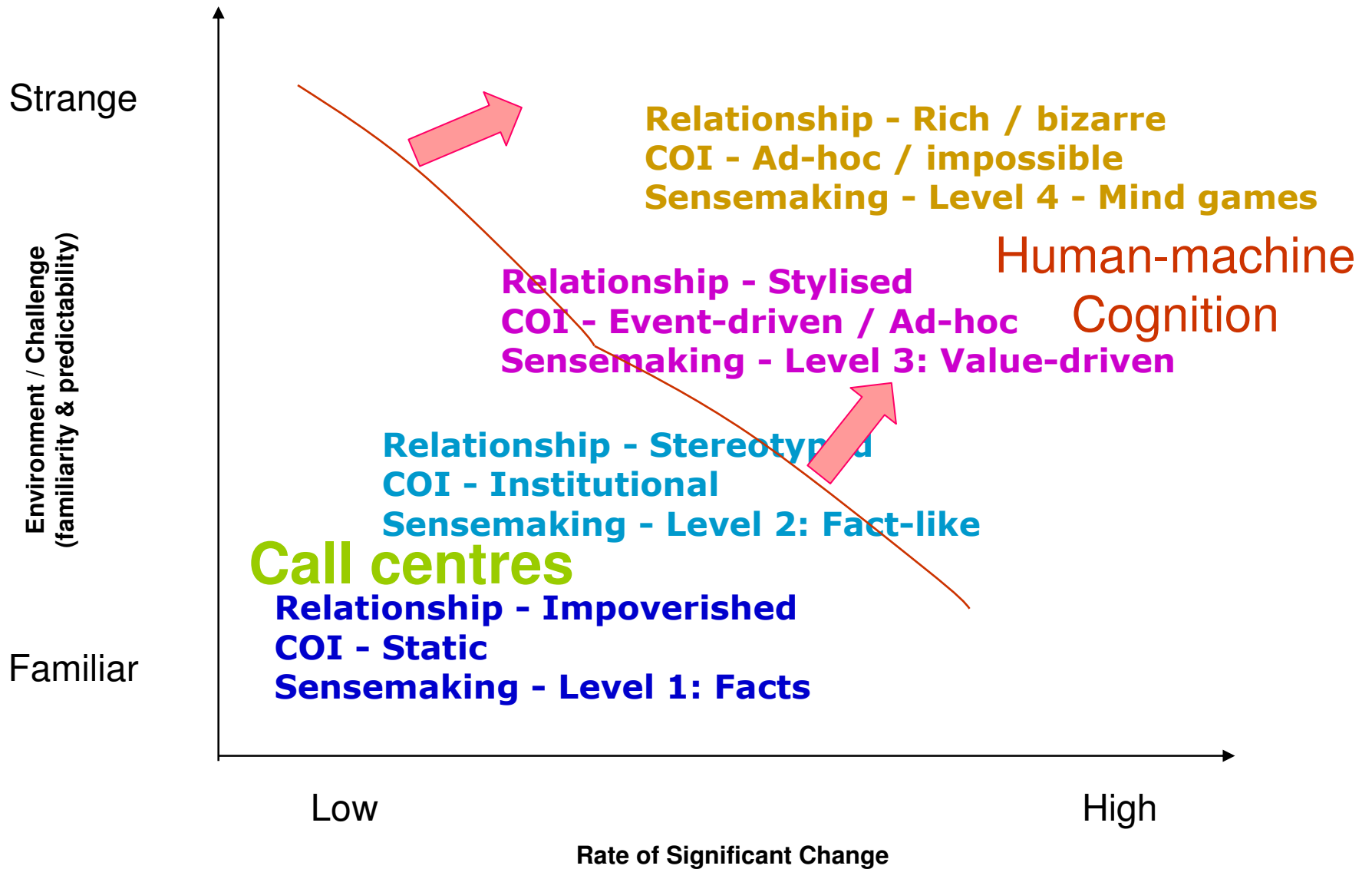
Any pre-defined 'sensor grid' is predicated on Level 1 / 2 and is useless against opponent who operates in the 'abstract region'.

Level 4 - Bizarre - where ability to reason about non-things is vital. The data you don't have is significant etc. Hence is cognitive mind-game - you can't search databases for non-things!

Level 3 - eg Fallujah. Is as much about absence of signal as presence of signal.

Level 1 / 2 - Conventional Western warfighting. We can be structured - presumption is that things are easy to sense and identify, ie the 'object' has significance (not the background)

02 Relevant Perspectives - Envelope of behaviours



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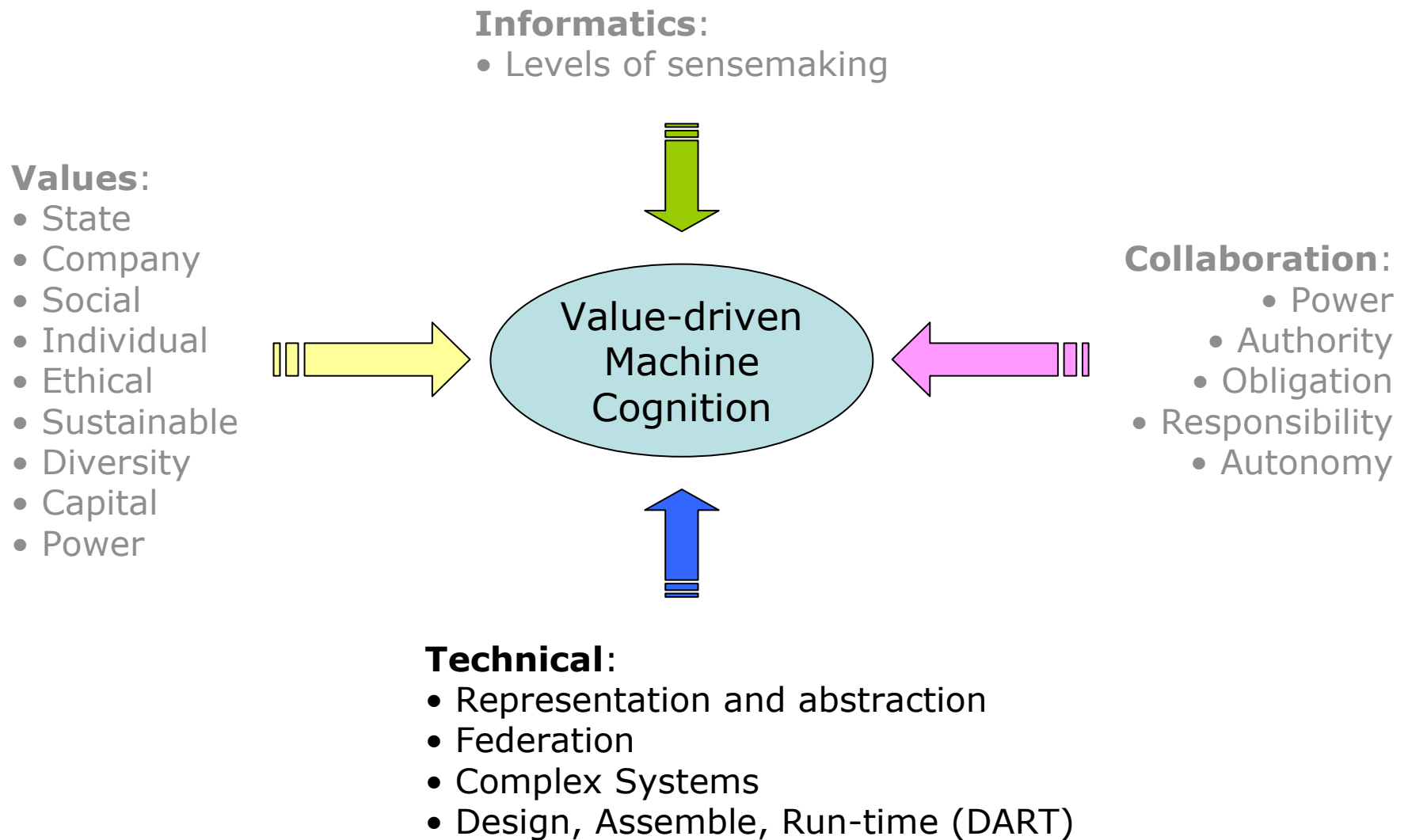
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Value in a Wider Context



03 Technical Issues

- Technical issues which are relevant when considering value-driven agile agents include:
 - Representing and reasoning with 'value':
 - requires abstractions (not like dealing with facts)
 - Design, assemble and run-time issues (DART):
 - must be acknowledged and appropriately employed
 - Dealing with federation and communities of interest:
 - requires dynamic adjustment (not over-control)
 - Accommodating complex system issues:
 - inevitable, yet too often ignored (cf AAMAS DAMAS)
 - Plus dealing with collaboration, CoIs and sensemaking:
- All must be dealt with for industrial-strength exploitation

03 Technical Issues - DART

Design Time

Concepts and
'Design'



Building Blocks

Design
Techniques

Assembly Time

Assemble and
Deploy
integrated
building blocks

Assemble
Mechanisms

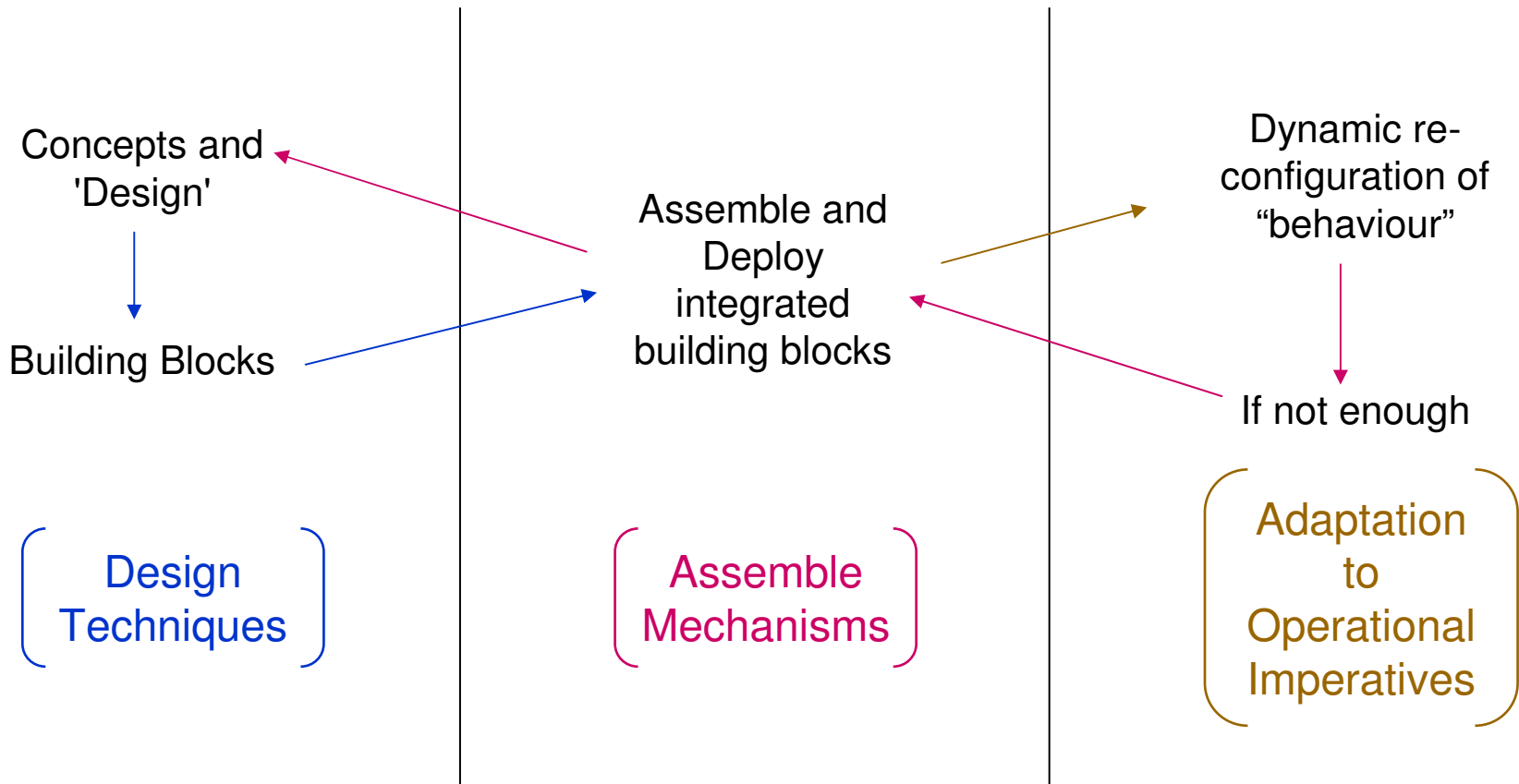
Run Time

Dynamic re-
configuration of
"behaviour"

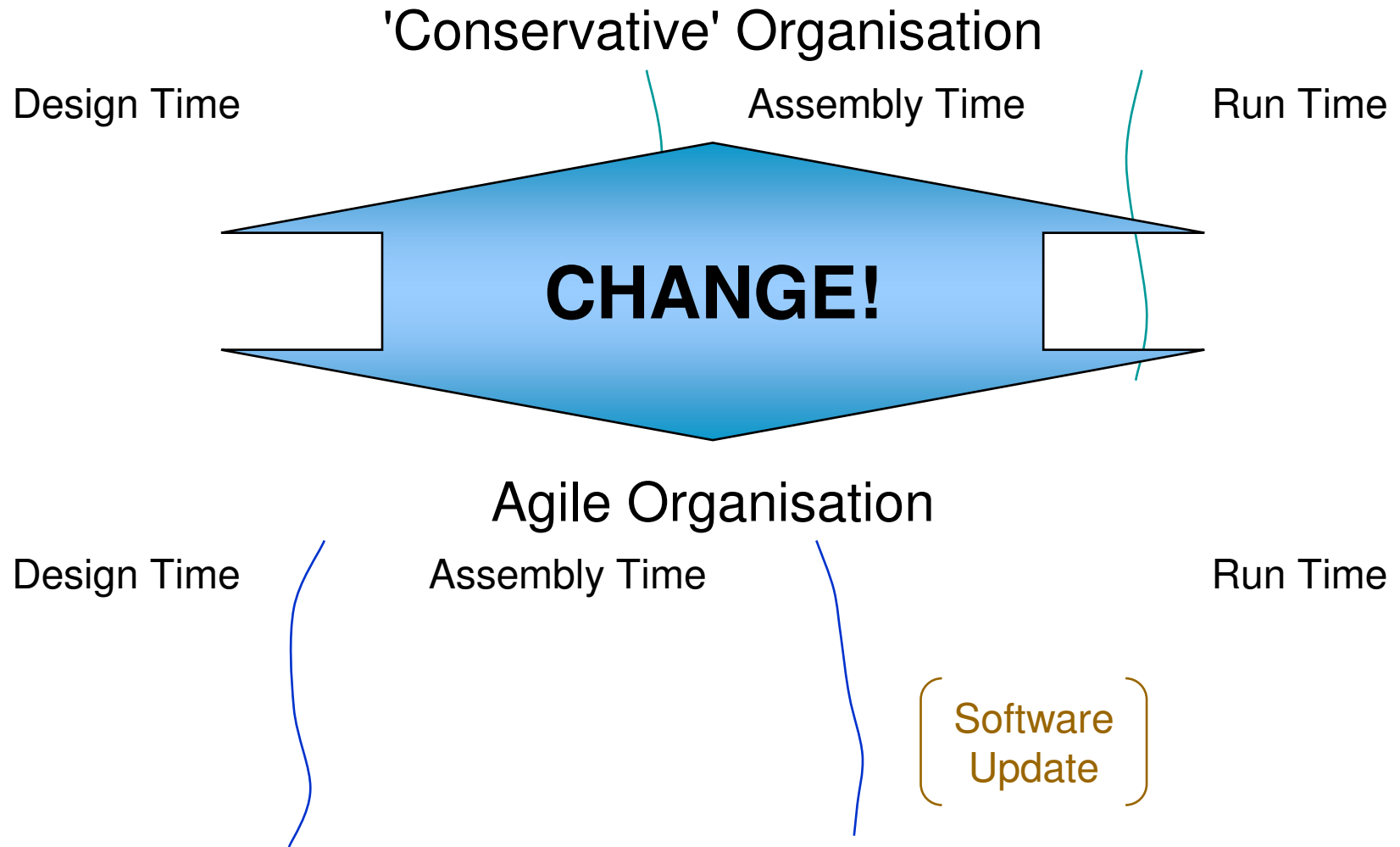


If not enough

Adaptation
to
Operational
Imperatives



03 Technical Issues - DART



03 Technical Issues - DART



03 Technical Issues - DART

Design-time
[Engineer]

Assemble-time
[Build / Structure]

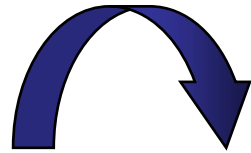
Run-time
[Evolve / Influence]

Instantiate

Activate

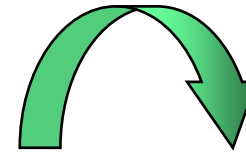
'Building Blocks':

- Devices
- Equipment
- Procedures
- Basic units



'Functional Units':

- Systems
- Structures
- Interfaces
- Services

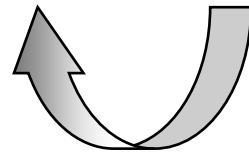


'Enterprises':

- Communities
- Networks
- Interdependencies
- Agents and actors

Features:

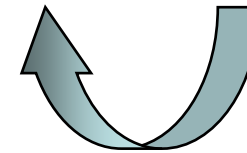
- Component level
- Objects
- Bounded
- Closed
- Dormant
- Designed



Decompose

Features:

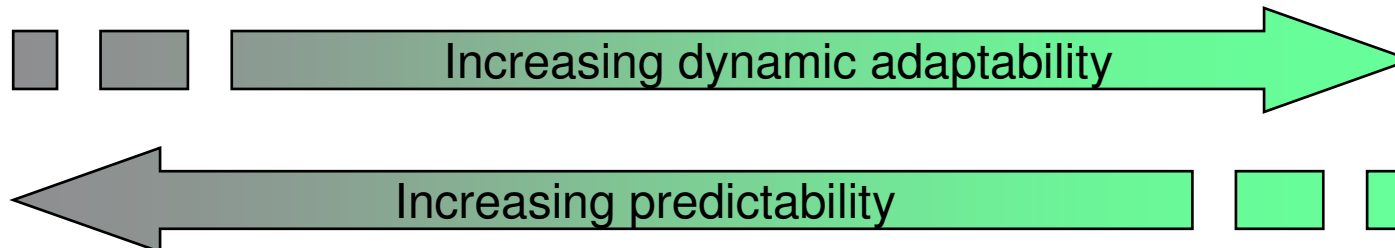
- Individual level
- Capabilities
- Nascent connections
- Open
- Model-able
- Built



Reconfigure

Features:

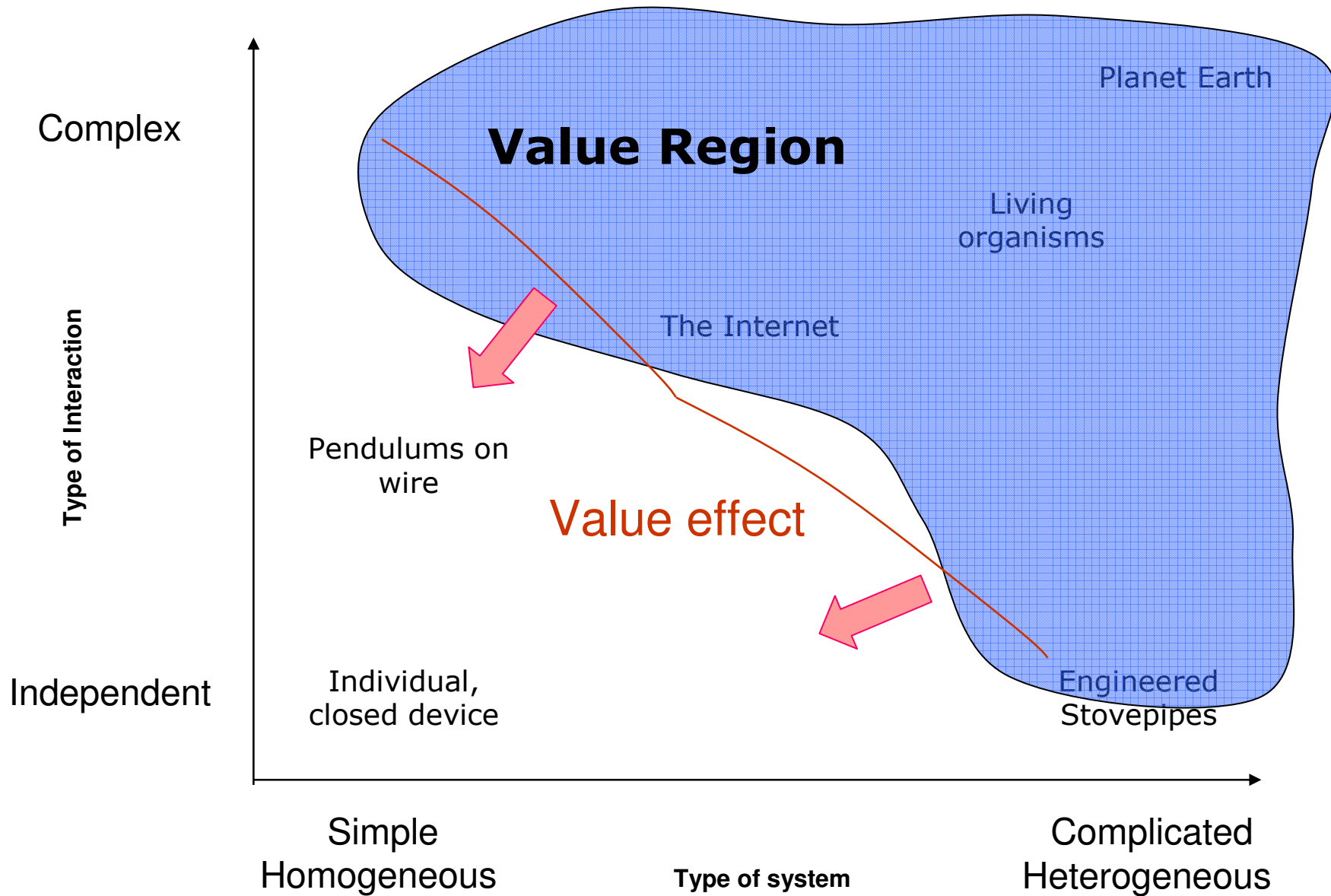
- Social level
- Ecosystems
- Adaptive
- Dynamic
- Purposeful
- Grown



03 Technical Issues - CoIs and Federation

- CoIs formed:
 - institutionally - A system or system of systems (SoS)
 - event-driven / socially - Not a system or SoS, a federation
- Federations:
 - networks of value-driven relationships
 - no single locus of authority or responsibility
 - necessary diversity in ways of working / local concerns
 - cannot be standardised
 - inevitable information ecologies:
 - diversity and wide distribution
 - complex adaptive behaviour available to be exploited
 - requires federation engineering ...

03 Technical Issues - Complex Systems



03 Technical Issues - Complex Systems

- To operate purposefully and effectively in the real world enterprises must be able to adapt:
 - To adapt, enterprises must be agile enough to generate novelty
 - Novelty cannot be defined a-priori, it must be generated at run-time
 - Enterprises use novelty to generate 'option spaces'
- Enterprises employ various aspects of CAS to:
 - Self-organise, regulate (autopoiesis), maintain / sustain (autonomic)
 - Acknowledging concurrent scales (time, extent of effect etc)
- Dealing with value as a modifier of behaviour in enterprises means embracing complex system issues ...

03 Technical Issues - Complex Systems

- Three aspects:
 - Top-down - by the 'directing mind', shaping and tuning
 - Self-adjustment - through regulatory mechanisms
 - Bottom-up - emergence and spontaneous-organisation
- Factors to consider:
 - The precursors that need to be in place
 - Balancing 'growing' the necessary structures or letting them emerge
 - Exploiting with the many levels at which interactions take place and the degrees of 'coupling' between these levels - link dynamics are key
 - Identifying opportunities and mechanisms for influence
- CAS work exists which can be exploited in context of value

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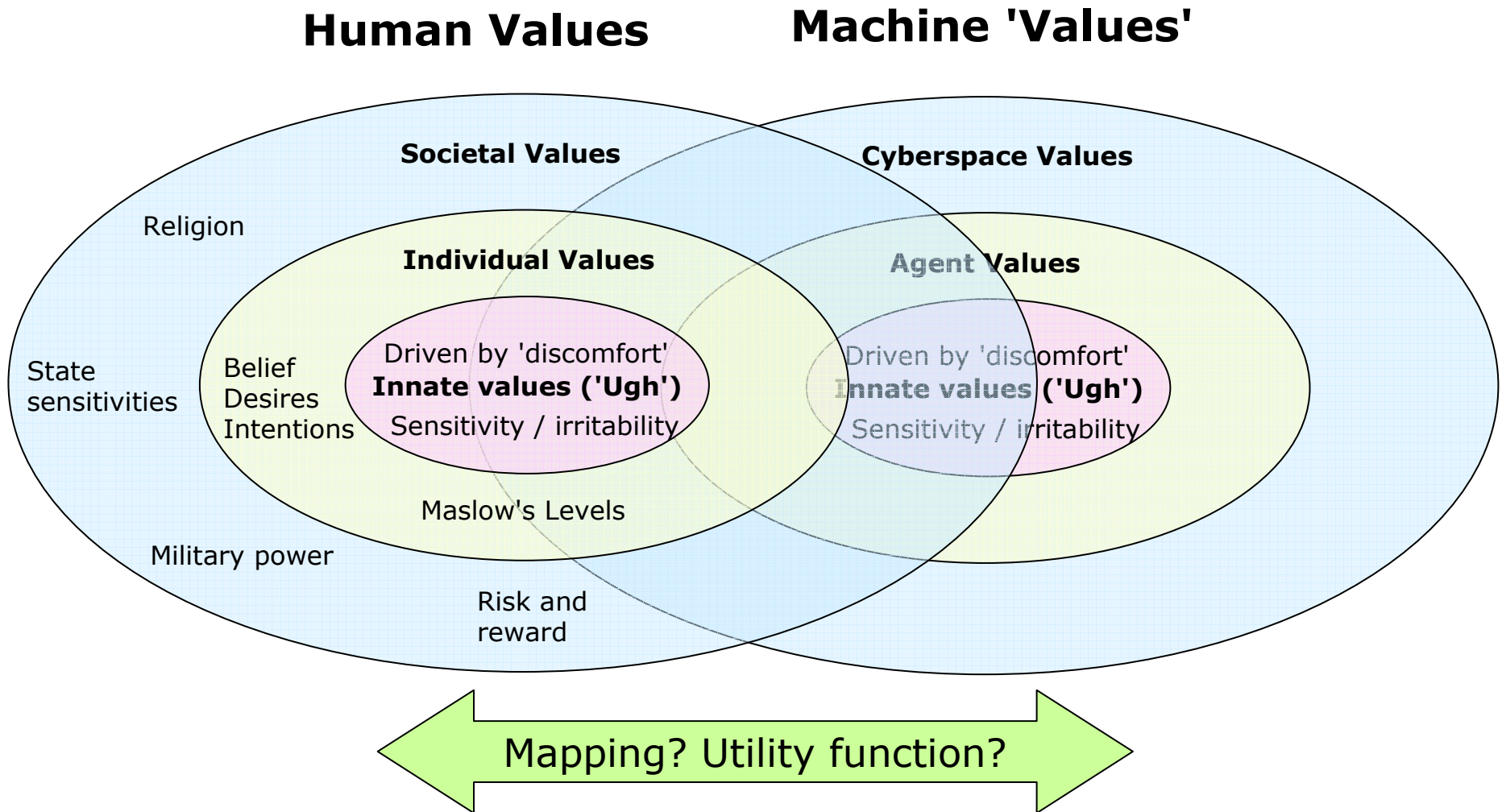
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04 Value-driven Agent Model



The machine 'value-space' has its own drivers which, innately, are not the same as those in human-space. For agents to reason on our behalf, it is necessary to perform some mapping. The question is, what are the meaningful equivalents in terms of what can be sensed / perceived / reasoned about / effected etc?

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Santa-Fe Institute - ARCS (Adaptive and Resilient Computing Security):

- 2002: <http://discuss.santafe.edu/defense/agenda>
- 2003: <http://discuss.santafe.edu/bnadaptive/>
- 2004: <http://www.arcs-workshop.org/>

05 Exploitation Routes and IHMC

- Extending scope of existing research:
 - Adding agility / complex systems capabilities
 - Sustainability / sustainable enterprises - value
- Relevance to IHMC topics:
 - Adaptive prosthesis --> augmented cognition on the move
 - Collaborative HMI / Visualisation --> intelligent desktops
 - Cognitive systems engineering --> CAS / fed'n engineering
 - Computer-mediated cognition --> holistic sensemaking
 - Intelligent data and uncertain inference --> abstraction
 - Knowledge representation and sharing --> value
 - Software agents --> value-driven agents
 - Designable futures --> DART for mapping value

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06 Discussion

- Implementing value-driven approaches involves:
 - Understanding value (eg, power, sustainability drivers)
 - Dimensions of collaboration and relationships
 - Range of CoIs and impact of federation
 - Agility in relation to the envelope of possible behaviours
 - DART (Design, assemble and Run-time mechanisms)
 - Significance of sensemaking levels
 - Potential role of complex adaptive systems mechanisms
 - Need for suitable representations and abstractions
- Fundamental challenge is:
 - Mapping between the human value-space and 'equivalents' in the machine 'value-space'



Questions, comments?



