

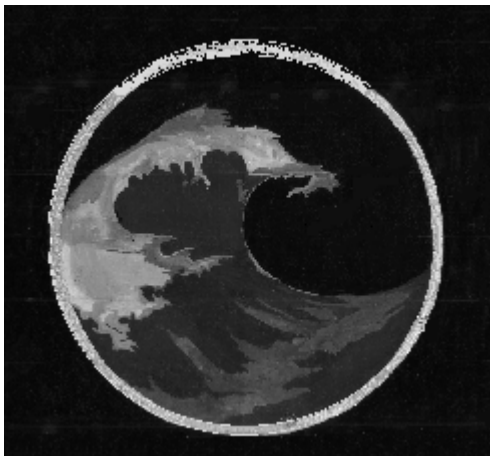
Agents, Emergence, Representation and Emotion

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Acknowledgements

- This research is funded from a number of sources
- Past
 - Vice-Chancellor's Grant, University of Birmingham.
 - School of Computing, Staffordshire University.
- Present
 - The University of Hull
 - Royal Society Conference Grant
 - Japanese Society for the Promotion of Science

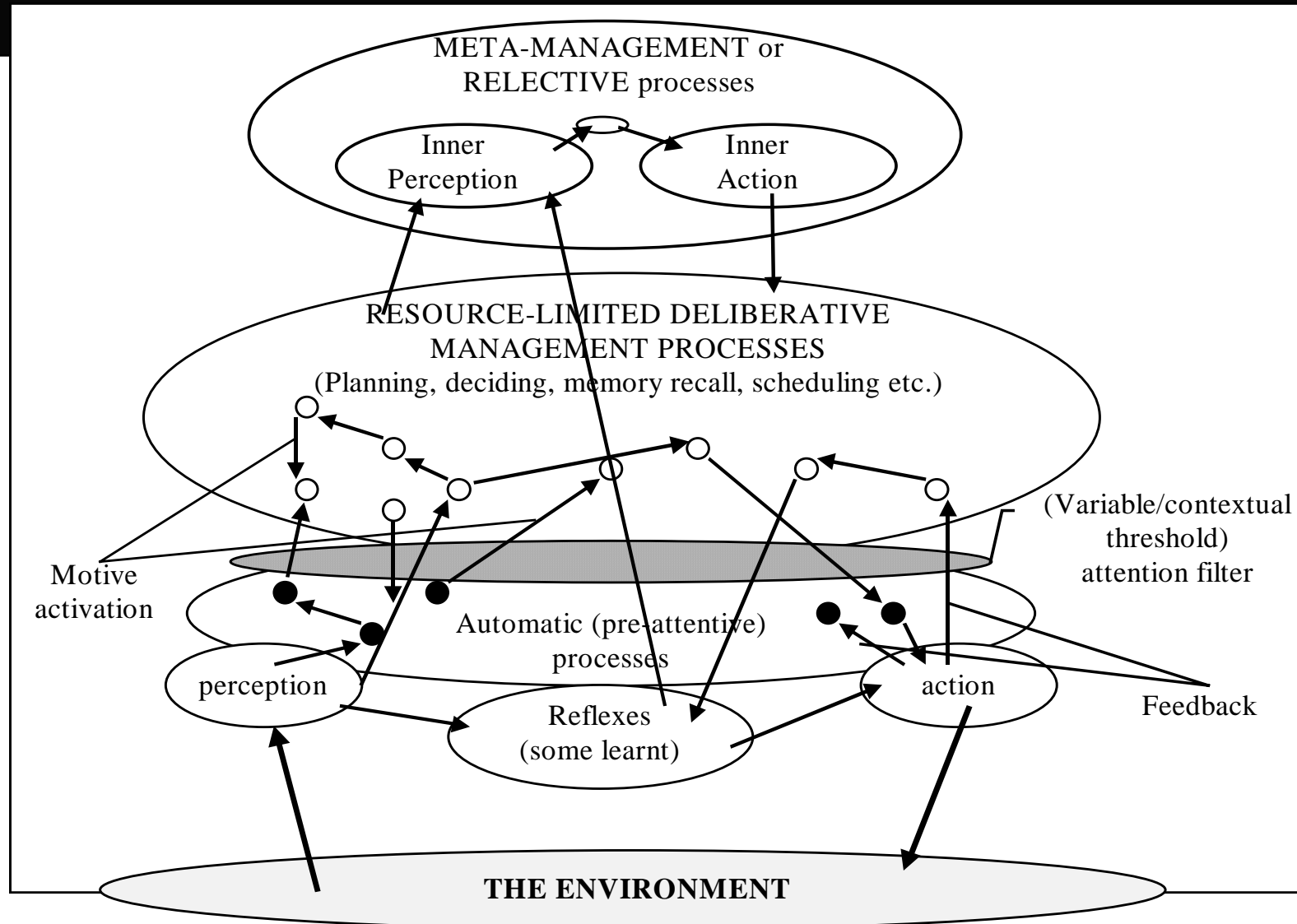
Overview

- Extends SMC99 Presentation
 - Computational Emergence and Computational Emotion
- Places work firmly in ongoing research
 - agents and a-life architectures
- Step Through Design of A-life Architecture
 - Combination of CAs and Beehive Analogy
 - Activity at one level is represented elsewhere
 - Emotion as overall guidance of processing

History of this Research

- Starting point was Sloman
 - emotion and cognition highly inter-linked
 - Gibson - ecological perspectives on psychology
 - drives not necessarily cognitive - conative
 - Simon - control state theory for cognition
 - animate beings and synthetic systems
 - Newell - united theory of cognition
 - needs to be an explanation that
 - unifies all possible cognitive acts, states, processes

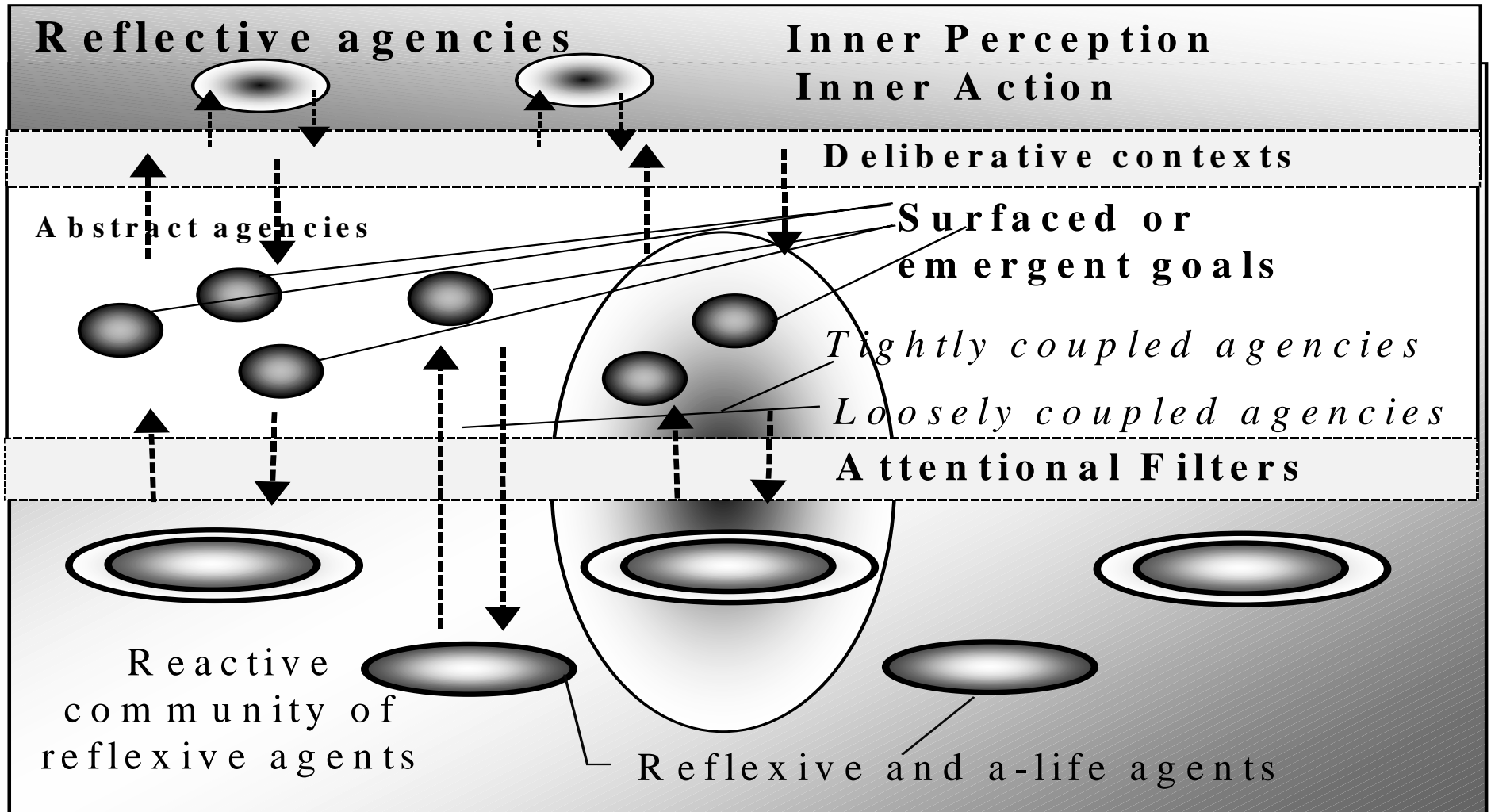
Architectural Basis - 1995



Earlier Work

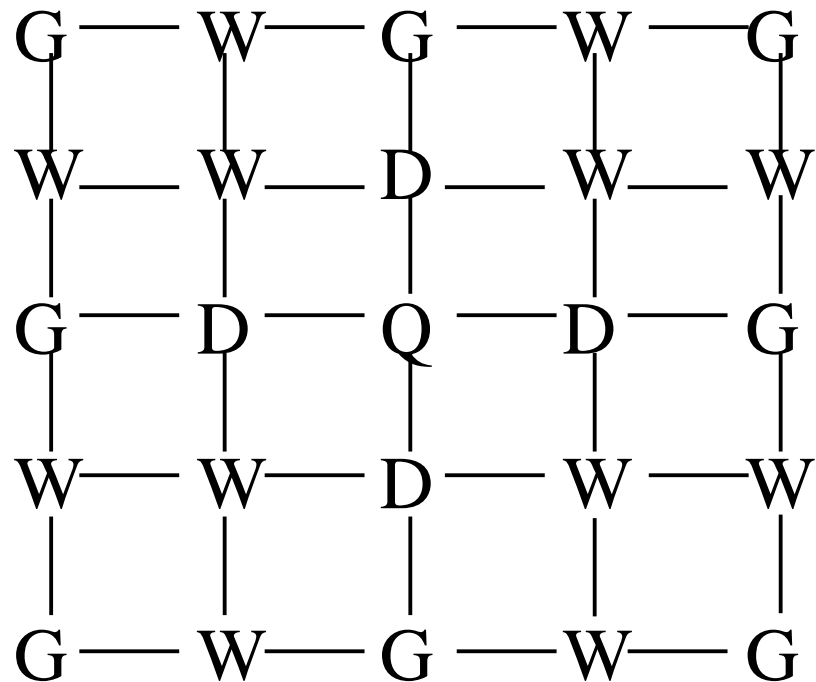
- Earlier work on Cognition and Affect
 - ill specified 2D designs
 - ill specified internal communication
 - ill formed ideas of reflective layer
- Here address some of these inadequacies
- Recent work based on Cellular Automata
 - game of go
- Develop these ideas in a new direction

Design Overview



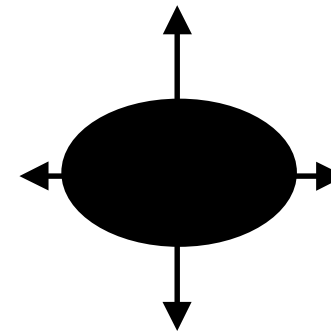
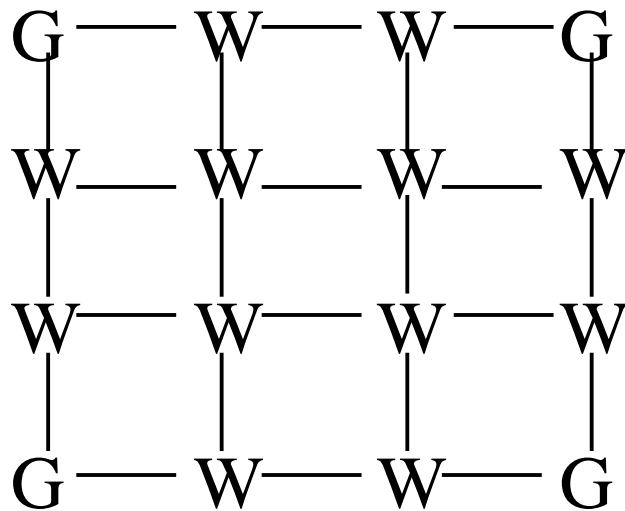
CA-Reflexive Level

- Insect community approach to A-life
- Hive - static heterogeneous CA agency



CA-Reflexive Level - II

- Mobile - heterogeneous CA agency



- Plus alien - non-hive (external) data
- Reflexive \equiv synthetic-chemical communication

CAs and Communication

- 5 categories of CA here - all 4 neighbourhood
 - G - insect guards
 - W - insect workers
 - D - the insect drones
 - Q - the insect queen
 - A - the alien worker
- Communication
 - within hive (5), within mobile (2)
 - hive with mobile, alien with mobile, alien with hive

Reactive Level - CA Behaviours

- b1 - { ${}^1W_i-W_j$, ..., ${}^kW_i-W_j$ } - worker and worker
- b2 - { ${}^1G_i-G_j$, ..., ${}^mG_i-G_j$ } - guard and guard
- b3 - { ${}^1G_i-D_j$, ..., ${}^nG_i-D_j$ } - guard and drone
- b4 - { ${}^1D_i-G_j$, ..., ${}^pD_i-G_j$ } - drone and guard
- b5 - { ${}^1D_i-Q_j$, ..., ${}^rD_i-Q_j$ } - drone and queen
- b6 - { ${}^1Q_i-W_j$, ..., ${}^sQ_i-W_j$ } - queen and worker
- b7 - { ${}^1A_i-G_j$, ..., ${}^tA_i-G_j$ } - alien and guard
- b8 - { ${}^1A_i-W_j$, ..., ${}^vA_i-W_j$ } - alien and worker
- b9 - { ${}^1H_i-M_j$, ..., ${}^xH_i-M_j$ } - hive and mobile

Computational Emergence


- Gestalt Emergence
 - patterns of behaviour or signals
- Diachronic Emergence
 - develops over evolutionary time
- Representational Emergence
 - emergence of representational forms and structures
- Functional Emergence
 - unexpected or not-designed-for behaviours

Deliberative Level

- D1 - tightly coupled
 - deliberative agency responsible for hive
- D2 - tightly coupled
 - deliberative agency responsible for mobile
- D3 - loosely coupled - representation transformer
- D4 - tightly and loosely coupled
 - memory management
- D5 - tightly coupled
 - threshold and process observer and control

Nature of Communication

- Communication within and between layers



	reflexive	reactive	deliberative	reflective
reflexive	<i>N valued logic</i>	<i>none</i>	<i>community</i>	<i>none</i>
reactive	<i>CA behaviour</i>	<i>implied</i>	<i>none</i>	<i>none</i>
deliberative	<i>none</i>	<i>behaviour</i>	<i>KQML-KIF</i>	<i>ANN input</i>
reflective	<i>none</i>	<i>behaviour</i>	<i>ANN output</i>	<i>feedback</i>

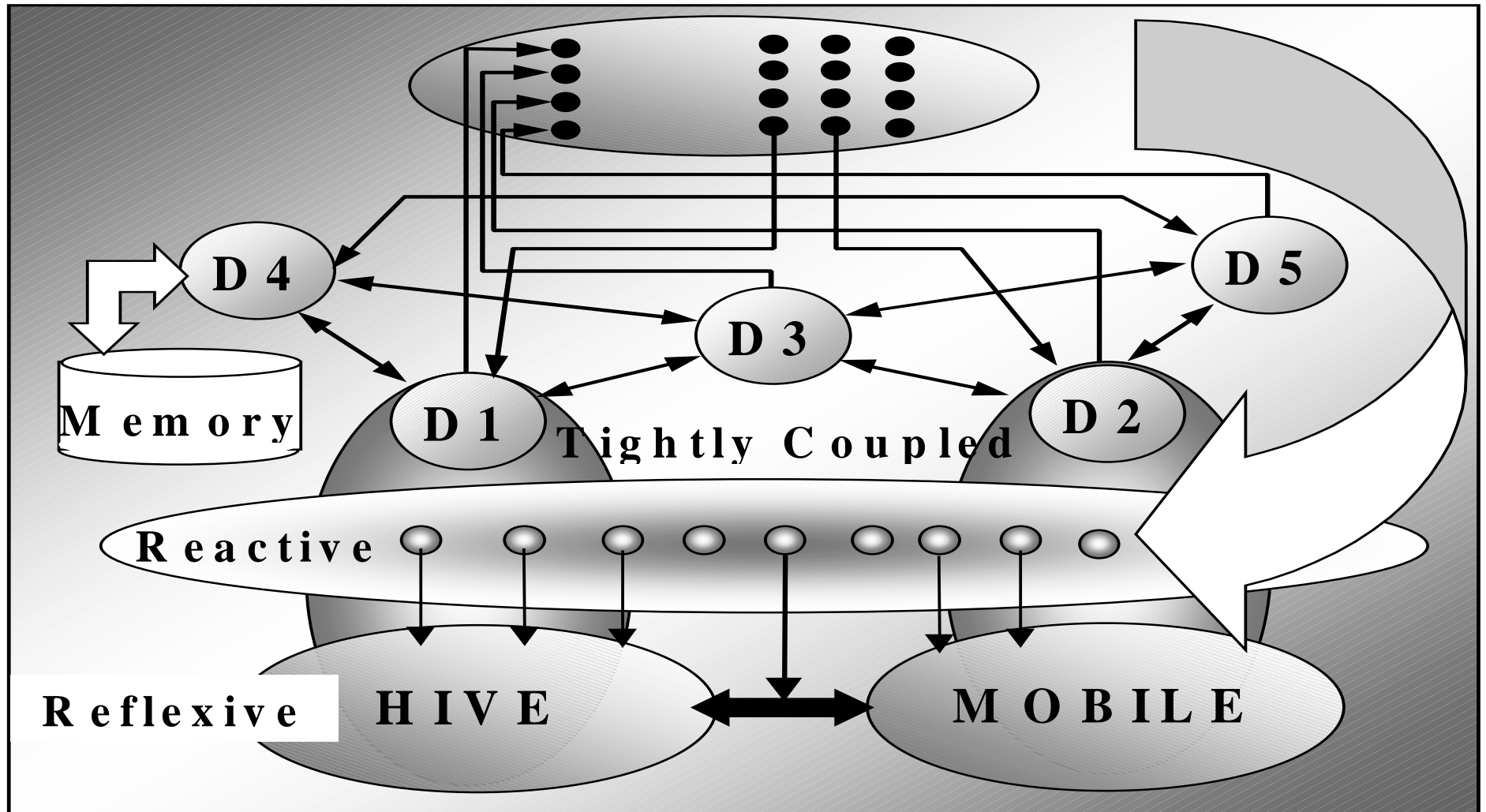
Psychology and Basic Emotions

- Based on Power and Dalglish
- Fear
 - Physical or social threat to self or valued role or goal
- Anger
 - Blocking or frustrations of a role or goal through perceived other agent
- Disgust
 - Elimination or distancing from person, object, or idea repulsive to self and to valued roles and goals

Psychology and Basic Emotions - II

- Sadness
 - Loss or failure (actual or possible) of valued role or goal
- Happiness
 - Successful move towards or completion of a valued role or goal
- Provides 4 dimensional model
 - Sadness-Happiness are extremes on one dimension
 - computationally tractable as hybrid ANN of some type
- Suitable model for reflective level agency

Design at its simplest



Implementation?

- Partial implementations of some components
 - Some CA work on GO
 - Multiple CA communities - reflexive and deliberative
 - Multi-layer Agents for simulating robot factory
 - Deliberative, reactive and reflexive layers integrated
 - Mobile agents for e-commerce
 - KQML and KIF
- Hybrid Artificial Neural Network
 - Reflective computational model of emotion

And The Future?

- Early days in this research
 - Need to develop fully integrated agencies
- No particular application but
 - Go - already multiple levels and communities of CAs
 - Computational models of synthetic mind
 - Perturbance as emergent emotional states
 - Creativity
 - Music, Art?
 - Virus checking over heterogeneous networks?
- Can always keep it completely theoretical

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