SWINBURNE UNIVERSITY OF TECHNOLOGY

IIDLE: Immunological Inspired Distributed Learning Environment

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Overview

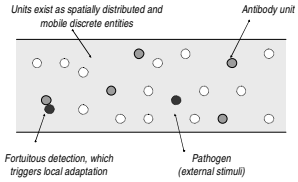
1. Conceptualisation of the Immune System
2. Design Goals for IIDLE
3. Implementation of IIDLE
4. Summary of Experimentation
5. Future for IIDLE

Conceptual Immune System – *Top-down*

- External Stimulation
- Continuous Surveillance *(always on)*
- Situated *(adaptation to local conditions)*
- Learning & Memory
- Consistent Defence
- Robustness & Resilience

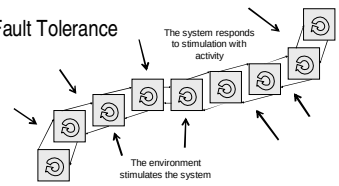
Conceptual Immune System – *Bottom-up*

- Triggered Adaptation
- Diversity (*heterogeneous and spatially distributed*)
- Mobility (*lymphocyte recirculation*)
- Localised Processes (*decentralised*)
- Redundancy



IIDLE – *Immunological Design Goals*

- Context Specific Learning
- Self-Regulated Resource Maintenance
- Decentralised Control
- Triggered Adaptation
- Robustness & Fault Tolerance

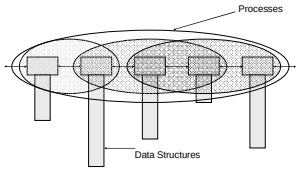


IIDLE – *Additional Design Goals*

- Distributedness
- Simple & Lightweight
- Modular & Extensible
- Scalable
- Configurable *(Tuneable)*

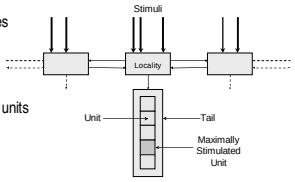
IIDLE – *Architecture & Processes*

- **Architecture** (*data structures*)
  - ☐ Interchangeable modular implementation
  - ☐ Independent structures with connectivity
  - ☐ Population based (discrete)
- **Processes** (*behaviour*)
  - ☐ Active component
  - ☐ Operate upon data
  - ☐ Variably scoped



IIDLE – *Architecture*

- **Locality** (*interface*)
  - ☐ Control over local processes
- **Tail** (*local data structure*)
  - ☐ Data storage and recall for units
- **Unit** (*information packet*)
  - ☐ Substrate for system affect and learning

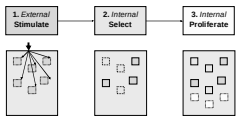


IIDLE – *Processes*

- **Decay Process** (*resource maintenance*)
  - ☐ Facilitate bounds on space complexity & efficiency
- **Movement Process** (*migration*)
  - ☐ Facilitate unit redundancy and information sharing
- **Expansion Process** (*adaptation and learning*)
  - ☐ Facilitate adaptive learning

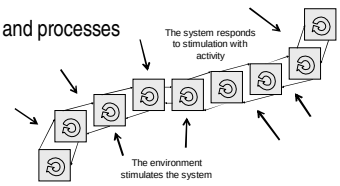
IIDLE – *Expansion Process*

- **Stimulation** (*triggering event*)
  - ☐ External, allocation of resource, available data
- **Selection** (*useful units*)
  - ☐ Matching, evaluation scoring
- **Proliferation** (*replicate and vary*)
  - ☐ Adapt units towards some end



Summary of IIDLE *(a pause for breath)*

- Spatially distributed population
- Lightweight adaptive learning framework
- Modularised clonal selection algorithm
- Decentralised and distributed
- Data structures and processes



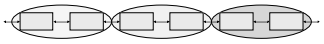
Parallel Hybrid Search – *Concept*

- Modular learning process *(interchangeable components)*
- Replace learning process
- Mix-and match components

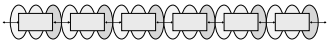
	CSA	GA	Pop-ACO	PSO
Stimulation	cost function	cost function	cost function	cost function
Selection	n-best	tournament	all	n-nearest
Proliferation	clone, mutate	crossover, mutate	step-wise construction	updated position

Parallel Hybrid Search – *Experiment*

- **Representation**
  - consistent for all chosen algorithms
- **Configuration**
  - Partitioned
  - Mixed



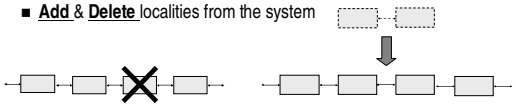
- **Results**



  - Interesting niching behaviour in the partitioned configuration
  - Better results when combining the search techniques

Dynamic Structural Changes

- Investigate the robustness of the system
- **Add** & **Delete** localities from the system

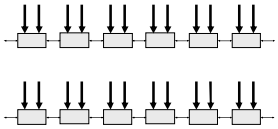


- Results
  - Better performance on optimisation with consolidated stimulation

Static	Added (x increased to y)	Removed (x decreased to y)
50→50	10→50	50→40
40→40	20→50	50→30
30→30	30→50	50→20
20→20	40→50	50→10
10→10	-	-

Multiple Objective – *Experiment*

- Stimulation as evaluation by a cost function
- Varying the cost function across localities
- **Configuration**
  - Partitioned
  - Mixed



- **Results**
  - Implicit niching effects with the partitioned configuration, much like in the case of hybrid search

IIDLE – *Future Research*

- **To-do**
  - Benchmarking & analytical models of process
- **Augmentations**
  - Memory cells?
  - Lymphocyte homing / pathways (intelligent movement)
- **Future Application?**
  - Interactive & collaborative search
  - Collaborative Filtering? Dynamic optimisation?

The End – Questions?

- IIDLE Java software & reports available online
  - http://www.it.swin.edu.au/personal/jbrownlee/