Inside the Psychology of the Agent
Information, Association, Attraction and Repulsion
Inside the Psychology of the Agent
Information, Association, Attraction and Repulsion

Circularity is ... the key to unlocking the mystery of the apparent time-reversed causality of self-organizing and teleological processes.

Terrence Deacon, 2006
Inside the Psychology of the Agent: Overview

• Primary Inspirations – Floridi, Grim & Information Revolutions
• Mechanical vs. Symbolic Computation: Circuits not Algorithms
• Target Model: Conquering Go with a Hybrid Architecture
• Review of Static Feature Detection Networks
• Dynamic Associative Networks & Initial Intelligence
• Teleodynamic Systems and the Search for the Perfect Attractors
• Modulating Agent Psychology by Sensitivity to Global Variance
Primary Inspirations

• The 2001 Computing and Philosophy Conference at Carnegie Mellon University

• Luciano Floridi – [18] Open Problems in the Philosophy of Information

• Patrick Grim – The Emergence of Communication: Some Models for Meaning
Mechanical vs. Symbolic Computation: Circuits not Algorithms

“It is ... quite difficult to think about the code entirely in abstracto without any kind of circuit.”

- Alan Turing 1947

Bell Lab’s Voder:
Conquering Go with a Hybrid Architecture

- Why the game of Go?
- Not yet solved by artificial intelligence
- If Chess can be, why not this game?
- Requires “global” (non-local) sensitivity
Conquering Go with a Hybrid Architecture

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Play is not defined solely in terms of neighboring pieces and thus requires long distance communication across the game space. As a consequence, modeling Go in an ABM serves as a paradigm case for understanding military strategy, dynamics of group psychology, economics, the functions of government and public policy, the social impact of media, neural modulation, etc.
Conquering Go with a Hybrid Architecture

Game 1

Game 2

Game 3

From http://en.wikipedia.org/wiki/Go_(game)
Conquering Go with a Hybrid Architecture

“Strategy deals with global influence, interaction between distant stones, keeping the whole board in mind during local fights, and other issues that involve the overall game. It is therefore possible to allow a tactical loss when it confers a strategic advantage.”

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Conquering Go with a Hybrid Architecture

“Strategy deals with global influence, interaction between distant stones, keeping the whole board in mind during local fights, and other issues that involve the overall game. It is therefore possible to allow a tactical loss when it confers a strategic advantage.”

What are the agents in this system? What are their properties?
Review of Static Feature Detection Networks

- Poker Hand Identification
- Identification and classification of animals based on overlapping properties
Review of Static Feature Detection Networks

- Poker Hand Identification
- Identification and classification of animals based on overlapping properties
- Identification of shapes without regard for where they appear on a grid (pattern extraction)
- Puzzle piece resolution (PPR)
Static Feature Detection Networks - PPR

6 x 6 grid ...

... decomposed into 36 “puzzle pieces”
Static Feature Detection Networks - PPR

6 x 6 grid ... ... decomposed into 36 “puzzle pieces”
Static Feature Detection Networks - PPR

6 x 6 grid ...  
... decomposed into 36 “puzzle pieces”

3
Static Feature Detection Networks - PPR

6 x 6 grid ...

... decomposed into 36 “puzzle pieces”
Conquering Go with a Hybrid Architecture

• For simplicity, we will start with a set of thirty-nine 13 x 13 grids. Why? (See 1dimgoboard.xlxs)

• A single layer ABM lacks the sensitivity to allow compound patterns to interact across distances, but provides a convenient interface for visualization and human/computer interaction.
Conquering Go with a Hybrid Architecture

- For simplicity, we will start with a set of thirty-nine 13 x 13 grids. Why? (See 1dimgoboard.xlsx)

- A single layer ABM lacks the sensitivity to allow compound patterns to interact across distances, but provides a convenient interface for visualization and human/computer interaction.

Level 1: NetLogo ABM  |  Level 2: Multidimensional PPR Array  |  Level 3: ???
Dynamic Associative Networks & Initial Intelligence

Note that I have not yet talked about information, attraction, repulsion or agent psychology. I have discussed association, but only indirectly.
Dynamic Associative Networks & Initial Intelligence

- DANs vs ANNs
- Hebbian Learning with Circuits
Dynamic Associative Networks & Initial Intelligence

- DANs vs ANNs
- Hebbian Learning with Circuits

1. Object identification with context sensitivity
2. Comparison of similarity and difference
3. Automatic document classification

4. Shape recognition on a grid
5. Association across simulated sense modalities
6. Primary sequential memory

7. Network branching across subnets
8. Eight-bit register control
9. Rudimentary natural S&R language processing
Dynamic Associative Networks & Initial Intelligence

Time to play ... but one caveat first.
Selmer Bringsjord’s Advice about Using Excel

“Tony, if you put all this in MatLab, people *might* take you seriously.”

- @CMU, July 2010
Matthias Scheutz’s Equivalency Proof

Note that the index $i$ always refers to node $i$, and maxact refers to the maximum activation a node can have as well as the default activation an input node gets.

$$input_i(t) = f(t) = \begin{cases} 
\text{maxact,} & \text{if input applied at time } t \\
act_i(t - 1) - 1, & \text{if } act_i(t) > 0 \\
0, & \text{otherwise}
\end{cases}$$

$$net_{in_i}(t) = \sum_{i \neq j} input_j(t)$$

$$act_i(t) = \begin{cases} 
net_i(t), & \text{if } net_i(t) < \text{maxact} \\
\text{maxact,} & \text{otherwise}
\end{cases}$$

We can now combine these into the following, where extin$_i(t) = 0$ if no input is applied, maxact otherwise:

$$act_i(t) = f \left( \sum f(\text{act}_j(t - 1) - 1 + \text{extin}_j(t)) \right)$$
Matthias Scheutz’s Equivalency Proof

So, if the above captures the update equations of the network, then the additional application of $f$ is not necessary. This is because:

$$f(f(a) + f(b)) = f(a + b) \quad \text{for } a, b > 0$$

**Proof:** Suppose $a, b < \text{maxact}$, then $f(a) = a$ and $f(b) = b$ by the definition of $f$, and thus:

$$f(f(a) + f(b)) = f(a + b)$$

Now suppose that one of $a$ or $b \geq \text{maxact}$, let's say $a$. Then $f(a) = \text{maxact}$, again by the definition of $f$, and thus:

$$f(f(a) + f(b)) = f(\text{maxact} + f(b)) = \text{maxact} = f(\text{maxact} + b) = f(a + b)$$

Here we use twice the fact that $f(\text{maxact} + x) = \text{maxact}$ for $x > 0$. 
Dynamic Associative Networks & Initial Intelligence

Computed in ...

- Excel Spreadsheets
- Java w/ Network Visualization
- NetLogo
- Objective C
- Relational Databases
- MatLab (forthcoming)
Dynamic Associative Networks & Initial Intelligence

Computed in ...

- Excel Spreadsheets
- Java w/ Network Visualization
- NetLogo
- Objective C
- Relational Database
- MatLab (forthcoming)

My preferred method is still using Excel. So let us play!
Dynamic Associative Networks & Initial Intelligence

Az By Cx Dw Ev Fu Gt Hs Ir Jq Kp Lo Mn Nm OlPk Qj Ri Sh Tg Uf Ve Wd Xc Yb Za
Dynamic Associative Networks & Initial Intelligence

Bi-Modal Association across Simulated Sense Modalities
Dynamic Associative Networks & Initial Intelligence

Natural Language Processing with No Parsing of Syntax
Who? What? When? Where?
Teleodynamic Systems and the Search for the Perfect Attractors


- Thermodynamics *(first order emergence)*
- Morphodynamics *(second order emergence)*
- Teleodynamics *(third order emergence)*
Teleodynamic Systems and the Search for the Perfect Attractors


- Thermodynamics (first order emergence)
- Morphodynamics (second order emergence)
- Teleodynamics (third order emergence)

These are NOT mere philosophical distinctions!
Deacon is an anthropologist at Berkeley with specializations in biological anthropology and neuroscience.

Edited by Philip Clayton & Paul Davies, Oxford 2006.
Teleodynamic Systems and the Search for the Perfect Attractors

Thermodynamics (*first order emergence*)

- No top-down effects
- Fully reductive – can be fully explained solely in reference to parts
- Causally transparent
- Still admits of property asymmetry between parts and wholes
- Example: Liquidity

T. Deacon, “Emergence: The Hole at the Wheel’s Hub.”
Teleodynamic Systems and the Search for the Perfect Attractors

Morphodynamics (*second order emergence*)

- Emerges from thermodynamic systems
- Exhibits “simple recurrence” that enables self-organization
- Results from the instability of thermodynamic possibilities and environmental feedback that amplifies a stable pattern – past action restrains the space of future possibilities
- Examples: Bénard cells, snowflakes

T. Deacon, “Emergence: The Hole at the Wheel’s Hub.”
Teleodynamic Systems and the Search for the Perfect Attractors

Teleodynamics (third order emergence)

- Emerges from morphodynamic systems
- Exhibits goal-oriented activity thanks to memory and information
- Results from the sampling of influences that select for “self-similarity maintenance”
- Uses a circular architecture of causal self-reference analogous to “attractors”
- Examples: Memory, evolution

T. Deacon, “Emergence: The Hole at the Wheel’s Hub.”
Teleodynamic Systems and the Search for the Perfect Attractors

Teleodynamics (*third order emergence*)

“Third-order emergent dynamics are ... intrinsically organized around specific absences. This physical disposition to develop toward some target state of order merely by persisting and replicating better than neighboring alternatives is what justifies calling this class of physical processes *teleodynamic*, even if it is not directly and literally a ‘pull’ from the future.” (143)

T. Deacon, “Emergence: The Hole at the Wheel’s Hub.”
Teleodynamic Systems and the Search for the Perfect Attractors

Shannon Information Entropy (1948)

The more random a piece of information the more informative it is.

\[ H(X) = - \sum_{i=1}^{n} p(x_i) \log_b p(x_i) \]

As entropy rises so does the informativeness of a piece of information. In what follows, we use the concept and not the formula for information entropy.
Teleodynamic Systems and the Search for the Perfect Attractors

Jets and Sharks (Original Model)

- IAC Model – Interactive Activation and Competition Network
- Uses inhibitory connections within cohorts. *(This is important because we will use attractor dynamics to accomplish the same task.)*
Teleodynamic Systems and the Search for the Perfect Attractors

Jets and Sharks Dataset (Partial)

<table>
<thead>
<tr>
<th>Name</th>
<th>Gang</th>
<th>Age</th>
<th>Edu</th>
<th>M Stat</th>
<th>Occup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Art</td>
<td>Jets</td>
<td>40s</td>
<td>J. H.</td>
<td>single</td>
<td>pusher</td>
</tr>
<tr>
<td>Al</td>
<td>Jets</td>
<td>30s</td>
<td>J. H.</td>
<td>married</td>
<td>burglar</td>
</tr>
<tr>
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<td>Jets</td>
<td>20s</td>
<td>Col.</td>
<td>single</td>
<td>bookie</td>
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<tr>
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<tr>
<td>Earl</td>
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<td>40s</td>
<td>H. S.</td>
<td>married</td>
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</tr>
<tr>
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<td>30s</td>
<td>H. S.</td>
<td>divorced</td>
<td>burglar</td>
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<td>Ol</td>
<td>Sharks</td>
<td>30s</td>
<td>Col.</td>
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<td>Neal</td>
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<td>H. S.</td>
<td>single</td>
<td>bookie</td>
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<tr>
<td>Dave</td>
<td>Sharks</td>
<td>30s</td>
<td>H. S.</td>
<td>divorced</td>
<td>pusher</td>
</tr>
</tbody>
</table>

* * *
Teleodynamic Systems and the Search for the Perfect Attractors

McClelland’s Wiring Schematic
Teleodynamic Systems and the Search for the Perfect Attractors

Jets and Sharks

- Our Model – Dynamic Jets and Sharks – Version 5.0

From *West Side Story*, 1961
Modulating Agent Psychology by Sensitivity to Global Variance

The Project Work Plan

1) Build the architecture.
2) Play the game repeatedly and record both successful and unsuccessful games in a database.
3) Use DAN learning to modulate the psychology of individual “pieces” on the game board to attract optimum play. (In other words, modify the parameters for individual agents in the Agent-based Model.)
4) Repeat the process over time to allow the database to represent optimum strategy.
Modulating Agent Psychology by Sensitivity to Global Variance

Why Go?

Play is not defined solely in terms of neighboring pieces and thus requires long distance communication across the game space. As a consequence, modeling Go in an ABM serves as a paradigm case for understanding military strategy, dynamics of group psychology, economics, the functions of government and public policy, the social impact of media, neural modulation, etc.

From Herbert Simon (1965):

In the computer field, the moment of truth is a running program; all else is prophecy.
Past Work Related to this Presentation


Mechanists of the Revolution: The Case of Edison and Bell (with **B. Sigler**). In *Proceedings of the VIII European Conference on Computing and Philosophy*. Edited by Klaus Mainzer (Munich: Verlag Dr. Hut, 2010), 426-430.

Past Work Related to this Presentation


Forthcoming Work

In the Beginning Was the Word and Then Four Revolution in the History of Information. In Luciano Floridi’s Philosophy of Technology: Critical Reflections, edited by Hilmi Demir (Springer, Philosophy of Engineering and Technology Book Series, 2011), forthcoming.


Hybrid Networks: Transforming Networks for Social and Textual Analysis into Teleodynamic and Predictive Mechanisms (with C. Harrison). Institute for Advanced Topics in the Digital Humanities, Networks and Network Analysis for the Humanities, follow-up meeting, sponsored by the National Endowment for the Humanities and the Institute for Pure and Applied Mathematics (IPAM), University of California, Los Angeles, October 20th-22nd, 2011.

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