Humanistic Computer Simulations

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Some humanities simulations

- structural patterns of narratives in 19th C. novels

- how literary genres evolve over time

- why the Anasazi people disappeared from American Southwest mid-14th C.

- how scientific theories change over time

- origin of vague concepts, development of linguistic conventions

- the development of morality

- how culture spreads given innovation, teaching, biases

- how consensus and disagreement arise.

- historical publishing and letter transmission networks

- Ancient Roman faction conflicts

- 19th C. Battle of Trafalgar

- Medieval military logistics

- NEH's "humanities"
- I am an "analytic" philosopher of science, with interests in
  - mathematical/computer models in evolutionary biology
  - in cognitive science
  - in anthropology
- How can scientific social sciences become more "humanistic"—without becoming less scientific?

Humanities: insights from interpretation, analogy, structural relationships, e.g. between specific instances.

> His talent was as natural as the pattern that was made by the dust on a butterfly's wings. At one time he understood it no more than the butterfly did and he did not know when it was brushed or marred. Later he became conscious of his damaged wings and of their construction and he learned to think and could not fly anymore because the love of flight was gone and he could only remember when it had been effortless.
>
> (Hemingway 1964, quoted in Holyoak and Thagard 1995, 223)

- Math: insights from precise, abstract structural relationships

- Mathematical modeling in science: precise formulation, loose relationships

Use mathematical models

to study abstract patterns of change over time

in populations of organisms,

including, sometimes, spread of genetic patterns.

Use mathematical models

to study abstract patterns of change over time

in populations of people,

including, sometimes, spread of cultural patterns.

Try to approximate structural patterns with precise models,

recognizing that other dimensions of the subject are left out.

Historian Stuart Clark on Medieval reports of demonic possession:

> For it is a defining feature of cultural forms that the actions they warrant only exist at all as actions of a certain sort because of the properties arbitrarily conferred on them by systems of representation. We can, therefore, extrapolate what was physical in possession behaviour and make it yield explanations in a different context only if we divorce it from precisely those semantic circumstances that enable victims and observers at the time to say (and argue about) just what it was. (Clark, 1999, p. 410)

i.e. Treating possessions as e.g. physiological phenomena misses what they really are, in another sense. Seeing that requires understanding religious texts and traditions.

What is agent-based modeling?

- Rather than a computer program with a master plan
- Let outcomes emerge from the interaction from many relatively simple "agents".
- These outcomes reflect structural assumptions embedded within the agents.
- How-possibly insights: What could explain this? If they're abstract patterns, let's simulate them.
- Predictions when well calibrated to initial conditions.

(CultranDejanet.nlogo: 200, 10; 125, 35)

Kinds of agent-based models

- Simple agent: Agents' internal rules/processes are not complex.

- Complex agent: Agents' internal rules/processes are complex.

- Moderate-complexity agent: In between.

Tradeoffs between understanding and realism.

- Culture viewed as integrated whole
- Yet cultures differ
- And social entities are made of people—who differ.
- How does such a complex, rich, integrated messy whole come about?

- Interactions between cultural variants, and environmental factors, affect transmission

  Logical, analogical, association, emotional, "symbolic" relations

  e.g. Geertz argued that relationships in Balinese cockfighting represent social and emotional relations between people, families, etc.

Thibodeau and Boroditsky (2011; 2013) showed Americans two versions of a paragraph about crime in a city, varying one word:

"Crime is a {beast/virus} ravaging the city of Addison."

Then asked what should be done.

- Participants who saw "beast" recommended *capture* and punishment solutions relatively more often than

- participants who saw "virus", who were relatively more likely to suggest solutions involving financial, educational support, *isolating* individuals at risk from existing criminals.

Analogical interaction

- Beliefs about viruses and aggressive animals
- affect beliefs about crime
- due to metaphorical/analogical relationships.

Plausibly, such analogical effects are commonplace
(cf. Hofstadter and Sander 2013; Lakoff 2002; Gentner et al. 2001a).

Analogy:

- Is a source of creativity and tool for problem-solving, e.g. in new contexts.
- Aids communication, recollection.
- Plausibly underlies many symbolic cultural relationships

 (cf. Geertz's account of Balinese cockfight).

What is analogy
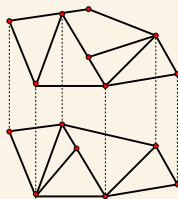
- A "good" analogy maps elements (properties, objects, propositions) of one domain to elements of another, preserving structural relations as well as possible.
- An isomorphism-like relation (roughly: structure-preserving)
- Higher-order pattern matching

(Gentner, 1983; Holyoak, 1982; Hofstadter at al., 1996)

- 3 populations
- 40 persons per population speaking about crime.
- Who talks to whom is random.
- What each says is affected by beliefs.
- The world intermittently tells everyone that each crime proposition is true.
- Populations:
  - *beast* bias: everyone has beast analog (not virus)
  - *virus* bias: everyone has virus analog (not beast)
  - *both* bias: everyone has both analogs
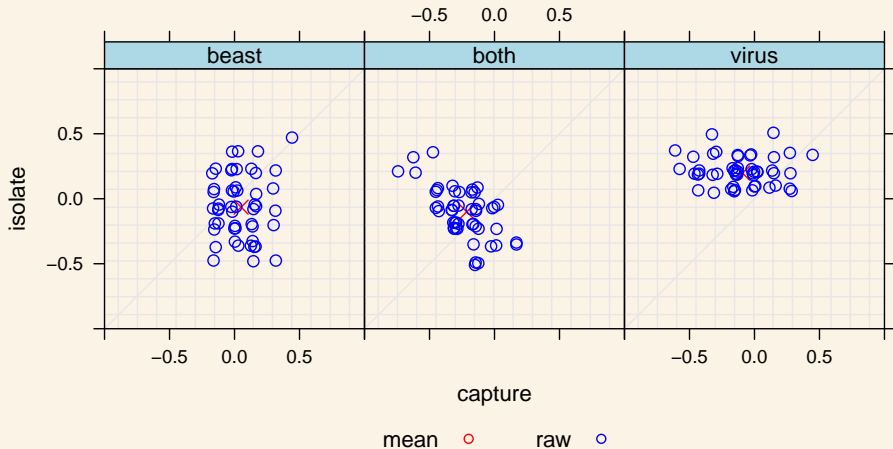- Processes within each person are deterministic.

Degrees of beliefs, 6 popco persons
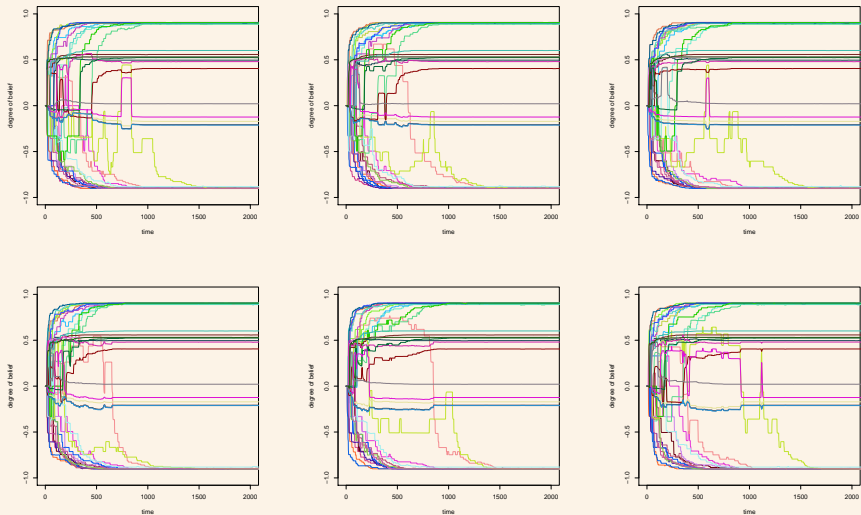
2000 time steps with same bias

**Mean activations of "capture" vs. "isolate" beliefs
for 3 analogy biases at time step 5000 in 50 simulation runs**

(With added noise to show density.)

Using a cross-cultural data set Sanday (1981) argued for the existence of a pattern of correlations between several dimensions of cultural variation:

| creator, creation process	sex roles (inner/outer)	male parenting	subsistence importance
male/animal, sky/far, magically	men dominate women	distant, disciplinarian	large game
female, earth/water/body	equal/different	involved, nurturing	gathering/fishing

Sanday also suggested informal, evocative, semi-metaphorical psychological hypotheses about why these correlations exist.

How do these correlations between creation stories, male-female relations, parenting styles, and food gathering methods come about?

Sanday-simulation propositions

Each person in my POPCO models has:

- Propositions about current human interactions:
    - Propositions concerning parenting and childbirth.
    - Propositions concerning large-game hunting.

- Propositions about human origins:
    - Propositions characterizing a creator who is from the earth, is female, is nurturing, and created humans from inside her body.
    - Propositions characterizing a creator who is male, comes from the sky, is both helpful and harsh, and created humans magically.

Sanday model 1, mean activations for all 100 persons
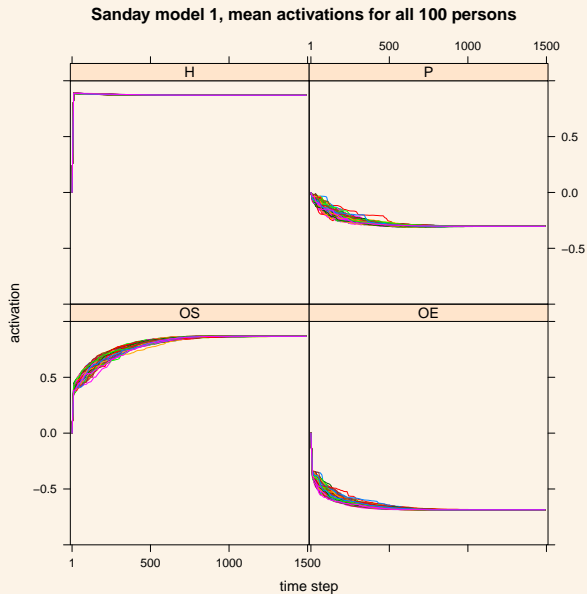
Initial input for each agent:

Propositions in predicate calc form:
```
inside (child woman) [propn-1]
alive (child)        [propn-2]
causes (woman propn-1 propn-2)
                      ⋮
```
A few semantic rules:
```
similarity-of helps harms -.5
                      ⋮
```

agents

analogy network (ACME)

belief/propn network

link weights in belief net updated from analogy net activations

network activations partially settle

agents converse: propositions sent, networks updated

Propositions in predicate calc form:
⋮
A few semantic rules:
⋮

Propositions in predicate calc form:
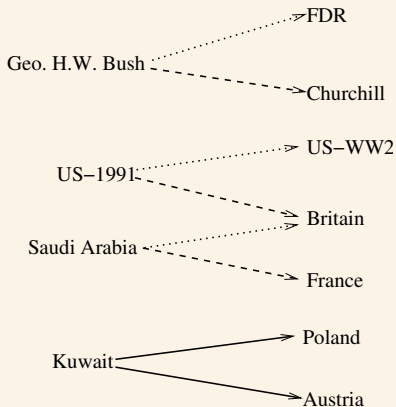⋮
A few semantic rules:
⋮

repeat the process
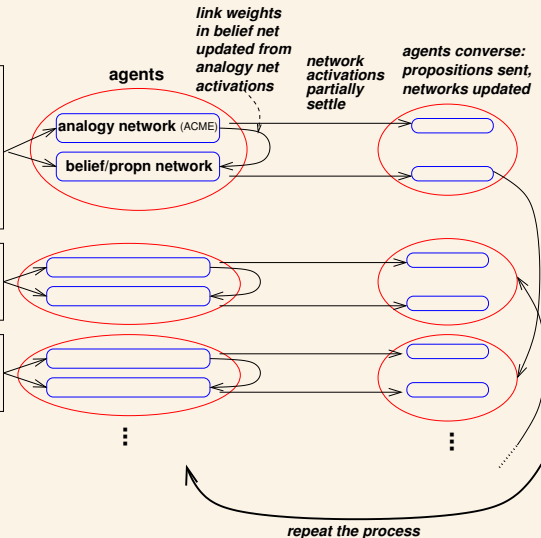
(Abrams 2013 in *Complex Adaptive Systems Modeling*) incorporates ACME (Holyoak and Thagard, 1989).
cf. (Gentner, 1983; Hofstadter at al., 1996; Wilson et al., 2001; Kokinov and Petrov, 2001)

Analogy processing

Possible mappings involved in treating Saddam Hussein in the first Gulf War (1991) as analogous to Hitler in World War II.
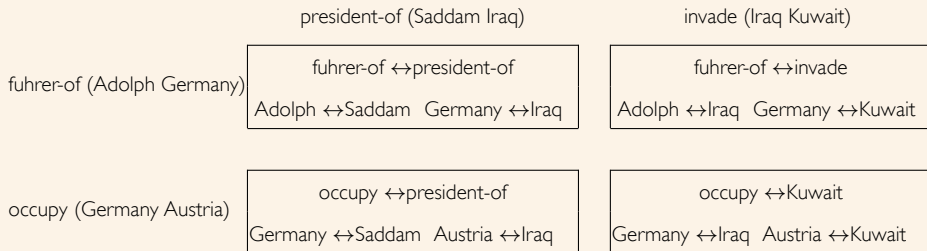

After (Holyoak and Thagard, 1995, fig. 5.1, p. 105)

Partial input to network-generation routines in ACME (Holyoak and Thagard, 1989) looks something like this:

```
president-of (Saddam Iraq)       invade (Iraq Kuwait)
fuhrer-of (Adolph Germany)       occupy (Germany Austria)
```

Generation of nodes:

	president-of (Saddam Iraq)	invade (Iraq Kuwait)
fuhrer-of (Adolph Germany)	fuhrer-of ↔ president-of Adolph ↔ Saddam Germany ↔ Iraq	fuhrer-of ↔ invade Adolph ↔ Iraq Germany ↔ Kuwait
occupy (Germany Austria)	occupy ↔ president-of Germany ↔ Saddam Austria ↔ Iraq	occupy ↔ Kuwait Germany ↔ Iraq Austria ↔ Kuwait

after
Holyoak & Thagard 1995 Fig. 10.3, p. 250
(with added propositional mappings)
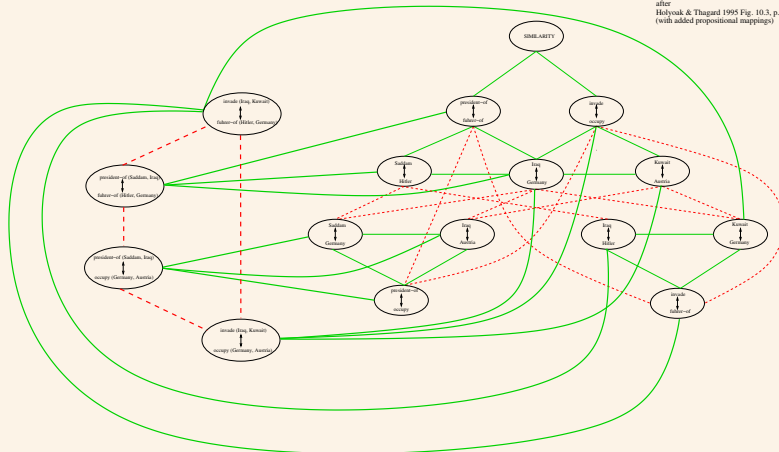
(MOV files)

(text files
text/crimepropns.nt1
text/crime3withnotes.lisp [or sanday])

virus, prevention/isolation propositions

```lisp
(defvar virus-propns
  '(
    (is-infected (vpers0) v-ip)              ; Person 0 has infection.
    (not-infected (vpers1) v-na)             ; Person 1 lacks infection.
    (is-infected (vpers1) v-ia)              ; Person 1 has infection.
    (harms (vpers1) v-ha)                    ; Person 1 is harmed.
    (cause (v-ia v-ha) v-ci->ha)             ; That person 1 has infection is harmful to person
    (infect (vpers0 vpers1) v-ipa)           ; Person 0, who already has infection, infects per
    (cause (v-ipa v-ia) v-ipa->ia)           ; The infecting of person 1 by person 0 causes per
    (inoculate (vpers1) v-ica)               ; Person 1 gets preventative methods applied, etc.
    (prevent (v-ica v-ipa) v-ia->spa)        ; That person 1 has preventative methods applied p
    (cause (v-ia->spa v-na) v-iaspa->na)     ; That the preventative appliction to 1 prevents t
    (quarantine (vpers0) v-qp)               ; Person 0 is quarantined.
    (prevent (v-qp v-ipa) v-qp->spa)         ; That person 0 is quarantined prevents person 0 f
    (cause (v-qp->spa v-na) v-qpspa->na)     ; That (quarantining 0 prevents 0 from infecting 1
    ))


(defvar viral-crime-propns
  '(
    (is-criminal (cpers0) cv-cp)             ; Garden 0 has been attacked by pests.
    (not-criminal (cpers1) cv-na)            ; Garden 1 has not been attacked by pests.
    (is-criminal (cpers1) cv-ca)             ; Garden 1 has been attacked by pests.
    (harms (cpers1) cv-ha)                   ; Garden 1 is harmed.
    (cause (cv-ca cv-ha) cv-ca->hp)          ; Garden 1 being attacked by pests is harmful to
    (recruit (cpers0 cpers1) cv-rpa)         ; Pests move from garden 0 to garden 1.
    (cause (cv-rpa cv-ca) cv-sca->ca)        ; Pests moving from garden 0 to garden 1 causes
    (support (cpers1) cv-sa)                 ; Garden 1 is protected by fertilizer, substanc
    (prevent (cv-sa cv-rpa) cv-sa->rpa)      ; Garden 1 being protected prevents pests from
    (cause (cv-sa->rpa cv-na) cv-sarpa->na)  ; That garden 1 is protected pests from moving
    (imprison (cpers0) cv-ip)                ; Garden 0 is isolated by fences, etc.
    (prevent (cv-ip cv-rpa) cv-ip->rpa)      ; Garden 0 being isolated prevents pests from mo
    (cause (cv-ip->rpa cv-na) cv-iprpa->na)  ; That 0's isolation prevents pests from moving
    ))
```

beast, capture propositions

```
(defvar beast-propns
  '(
    (human (bpers) b-pp)                      ; Person is human. [should match cb-np]
    (aggressive (beast) b-ab)                 ; Beast is aggressive.
    (attack (beast bpers) b-abp)              ; Beast attacks person.
    (cause (b-ab b-abp) b-ab->abp)            ; Beast's aggressiveness causes it to attack person.
    (harms (bpers) b-hp)                      ; Person is harmed.
    (cause (b-abp b-hp) b-abp->hp)            ; Beast attacking human harms person. [HO1]
    (helps (beast) b-hb)                      ; Beast is benefited.
    (cause (b-abp b-hb) b-abp->hb)            ; Beast attacking person benefits beast. [HO1]
    (capture (bpers beast) b-cpb)             ; Person captures beast.
    (prevent (b-cpb b-abp) b-cpb->-abp)       ; Person capturing beast prevents beast attacking p…
    (danger-to (bpers) b-dtp)                 ; Person is subject to danger.
    (cause (b-cpb b-dtp) b-cpb->dtp)          ; Person capturing beast is dangerous to person. [H…
    ))

(defvar beastly-crime-propns
  '(
    (not-criminal (cpers) cb-np)
    (aggressive (crim-pers) cb-ap)
    (victimize (crim-pers cpers) cb-vpp)
    (cause (cb-ap cb-vpp) cb-ap->vpp)
    (harms (cpers) cb-hcp)
    (cause (cb-vpp cb-hcp) cb-vpp->hcp)
    (helps (crim-pers) cb-hp)
    (cause (cb-vpp cb-hp) cb-vpp->hp)
    (capture (cpers crim-pers) cb-cpc)
    (prevent (cb-cpc cb-vpp) cb-cpc->-vpp)
    (danger-to (cpers) cb-dtp)
    (cause (cb-cpc cb-dtp) cb-cpc->dtp)
    ))
```

Additional semantic specifications

```
(defvar semantic-relations
  '(
    (similar 'cause 'prevent (* -1 *ident-weight*)) ; avoid mapping cause to prevent
    (similar 'is-beastly 'is-infected (* -1 *ident-weight*))
    (semantic-iff 'cb-vpp 'v-ipa -.1) ; kludge, prevent mapping
    (semantic-iff 'cv-rpa 'b-abp -.1) ; keeps code simpler
   ))
```

Internal effects of analogies

Effect of 'perceived' propns on analogs
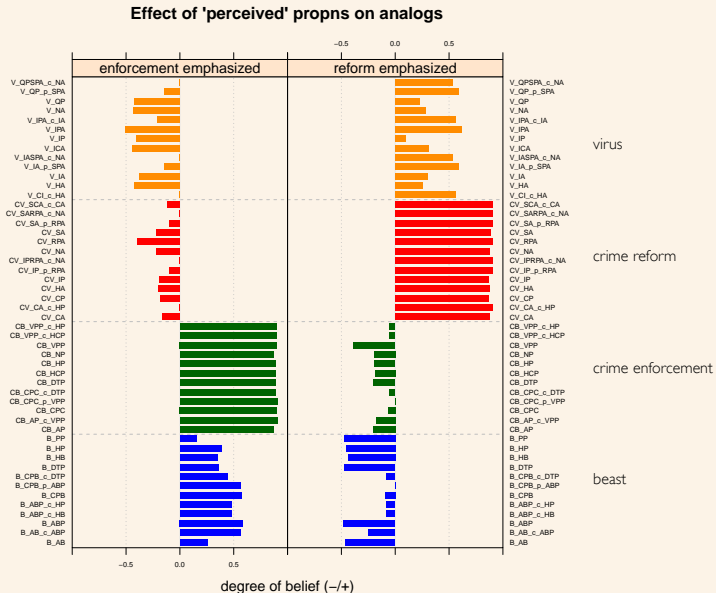
Predicate	Arguments	Proposition name	Intended meaning
Parenting :			
1. alive	(child)	*p-Child-Alive*	A child is alive.
2. intimate-agent	(woman, child)	*p-Child-Close*	Women, children are emotionally intimate.
3. inside	(child, woman)	*p-Protochild-Inside*	A child (fetus) is initially inside a woman.
4. process-from-to	(*p-Protochild-Inside, p-Child-Alive*)	*p-Child-From-Within-Woman*	There is a process that leads from (3) to (1).
5. creates	(woman, *p-Child-From-Within-Woman*)	*p-Woman-Creates-Child-From-Within*	Woman are the cause of the process in (4).
6. natural-process	(*p-Woman-Creates-Child-From-Within*)	*p-Woman-Creates-Naturally*	The preceding process is natural.
7. helps	(woman, child)	*p-Woman-Helps-Child*	Women help (nurture, etc.) their children.
8. causes	(nothing, *p-Woman-Helps-Child*)	*p-Woman-Nurtures*	Nothing causes women to nurture children.
9. nothing	(nothing)	*p-Nothing*	(Has no real meaning, but is useful.)
Hunting:			
10. feels-power	(man)	*h-Man-Power*	Men feel powerful, able to control nature.
11. power-source	(game, *h-Man-Power*)	*h-Game-Power-Source*	Game is a source of this power.
12. mysterious-process	(*h-Game-Power-Source*)	*h-Game-Power-Mysteriously*	Game being source of power is mysterious.
13. hunts-endangers	(man, game)	*h-Man-Endangers-Game*	Men hunting is dangerous to game.
14. harms	(game, man)	*h-Game-Harms-Man*	Game sometimes harms men.
15. causes	(*h-Man-Endangers-Game, h-Game-Harms-Man*)	*h-Hunting-Is-Dangerous*	(13) is a cause of (14)
16. hunts-skillfully	(man, game)	*h-Skillful-Hunting*	Hunting involves skill.
17. helps	(game, men)	*h-Game-Provides*	Game helps men (by providing food, etc.).
18. causes	(*h-Skillful-Hunting, h-Game-Provides*)	*h-Hunting-Rewards-Skill*	Skill in hunting causes game's benefit.
19. distant-agent	(game, man)	*h-Game-Distant*	Game and men are emotionally distant.
Both origin domains:			
20. alive	(human)	*o-Human-Alive*	Humans are alive.
Earth origin:			
21. inside	(human, e-god)	*oe-Protohuman-Inside*	Human(s) began inside e-god.
22. process-from-to	(*oe-Protohuman-Inside, o-Human-Alive*)	*oe-Human-From-Within-God*	There's a process leading from (21) to (20).
23. causes	(e-god, *oe-Human-From-Within-God*)	*oe-God-Creates-Human-From-Within*	An e-god causes this process.
24. natural-process	(*oe-God-Creates-Human-From-Within*)	*oe-God-Creates-Naturally*	An e-god doing so is a natural process.
25. helps	(e-god, human)	*oe-God-Helps-Human*	An e-god helps humans, is nurturing, etc.
26. causes	(nothing, *oe-God-Helps-Human*)	*oe-God-Nurtures*	Nothing causes an e-god to be nurturing.
27. close	(e-god, human)	*oe-Earthly-God*	e-god is physically close to humans.
28. nothing	(nothing) [Has no real meaning, but is useful.]	*oe-Nothing*	(Has no real meaning, but is useful.)
Sky origin:			
29. creates	(s-god, *o-Human-Alive*)	*os-God-Creates-Human*	An s-god causes (20).
30. mysterious-process	(*os-God-Creates-Human*)	*os-God-Creates-Mysteriously*	The process in (29) is a mysterious process.
31. offends	(human, s-god)	*os-Human-Offends-God*	Humans offend s-god (sometimes).
32. harms	(s-god, human)	*os-God-Harms-Human*	s-god harms humans (sometimes).
33. causes	(*os-Human-Offends-God, os-God-Harms-Human*)	*os-Offense-Causes-Punishment*	Offending s-god causes punishment.
34. supplicates	(human, s-god)	*os-Human-Supplicate*	Humans supplicate, pray, etc. to s-god.
35. helps	(s-god, human)	*os-God-Helps-Human*	s-god helps humans (sometimes).
36. causes	(*os-Human-Supplicates, os-God-Helps-Human*)	*os-God-Rewards*	Supplicating is what causes s-god to help.
37. distant	(s-god, human)	*os-Heavenly-God*	s-god is physically distant from humans.

(similar 'helps 'harms (* -1 *ident-weight*))
(similar 'feels-power 'alive (* -.75 *ident-weight*))
(similar 'woman 'human (* .5 *ident-weight*))
(similar 'man 'human (* .5 *ident-weight*))
(similar 'distant 'distant-agent (* .5 *ident-weight*))
(similar 'close 'intimate-agent (* .5 *ident-weight*))
(similar 'offends 'harms (* .5 *ident-weight*))
(semantic-iff 'oe-Earthly-God 'os-Heavenly-God -.5)
(semantic-iff 'oe-God-Creates-Naturally 'os-God-Creates-Mysteriously -.5)
(semantic-iff 'os-Heavenly-God 'os-God-Creates-Mysteriously .1)
(semantic-iff 'oe-God-Creates-Naturally 'oe-God-Creates-Human-From-Within .5)
(semantic-iff 'oe-God-Nurtures 'oe-God-Creates-Human-From-Within .1)
(semantic-iff 'oe-Human-From-Within-God 'oe-God-Creates-Human-From-Within .5)

(semantic-iff 'oe-God-Creates-Human-From-Within 'os-God-Creates-Human-From-Object -.5)

How to get started

- NetLogo is free, includes many example programs to use as starting points.

- NetLogo site has tutorials.

- I recommend R (graphics, statistics), Gephi (network graphics and analysis).

- For more flexibility, Clojure and other lisps are high-level, flexible languages that allow poking around in your data and investigating newly-changed code on the fly

- Clojure makes it easy to use Java libraries (software tools), and can generate Javascript code.

- There are good books and tutorials.

How to get started

- I mentioned various simulations used in literature studies, history, and philosophy. I'm happy to provide references.

- Please talk to me about POPCO if interested.

- My ''A Moderate Role for Cognitive Models in Agent-Based Modeling of Cultural Change'' in *Complex Adaptive Systems Modeling* 2013 has details on POPCO and references on analogy, etc.

Current POPCO project is on interactions between sustainable farming practices and religious traditions in Bali.

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[]Abrams, Marshall (2013). A moderate role for cognitive models in agent-based modeling of cultural change. *Complex Adaptive Systems Modeling* 1(16):1–33.

[   ]Clark, Stuart (1999). *Thinking With Demons: The Idea of Witchcraft in Early Modern Europe*. Oxford University Press, Oxford, UK.

[ ]Duncker, K. (1945). *On Problem Solving*, vol. 58 of *Psychological Monographs*. American Psychological Association.

[   ]Gentner, Dedre (1983). Structure-mapping: A theoretical framework for analogy. *Cognitive Science* 7:155–170.

[   ]Gentner, Dedre; Bowdle, Brian; Wolff, Phillip; and Boronat, Consuelo (2001a). Metaphor is like analogy. In Gentner et al. (2001b), chap. 6, pp. 199–253.

[ ]Gentner, Dedre; Holyoak, Keith J.; and Kokinov, Boicho N., eds.
(2001b). *The Analogical Mind: Perspectives from Cognitive
Science*. MIT Press, Cambridge, Massachusetts.

[ ]Gick, Mary L. and Holyoak, Keith J. (1980). Analogical problem
solving. *Cognitive Psychology* 12:306–355.

[   ]González, Roberto J. (2001). *Zapotec Science*. University of
Texas, Austin, Texas.

[   ]Hemingway, Ernest (1964). *A Moveable Feast*. Charles
Scribners' Sons.

[   ]Hesse, Mary B. (1966). *Models and Analogies in Science*.
University of Notre Dame Press, Notre Dame, Indiana.

[ ]Hofstadter, Douglas R. and Sander, Emmanuel (2013). *Surfaces
and Essences: Analogy as the Fuel and Fire of Thinking*. Basic
Books, New York.

[]Hofstadter at al., Douglas R. (1996). *Fluid Concepts And Creative Analogies: Computer Models Of The Fundamental Mechanisms Of Thought.* Basic Books. By Hofstadter and the Fluid Analogies Research Group.

[   ]Holyoak, Keith J. (1982). An analogical framework for literary interpretation. *Poetics* 11(2):105–126.

[ ]Holyoak, Keith J. and Thagard, Paul (1989). Analogical mapping by constraint satisfaction. *Cognitive Science* 13:295–355.

[   ]Holyoak, Keith J. and Thagard, Paul (1995). *Mental Leaps: Analogy in Creative Thought.* MIT Press, Cambridge, Massachusetts.

[   ]Kokinov, Boicho N. and Petrov, Alexander A. (2001). Integration of memory and reasoning in analogy-making: The AMBR model. In Gentner et al. (2001b), chap. 3, pp. 59–124.

[   ]Lakoff, George (2002). *Moral Politics: How Liberals and Conservatives Think*. University of Chicago Press, Chicago, Illinois, 2nd ed.

[]Penn, Derek C.; Holyoak, Keith J.; and Povinelli, Daniel J. (2008). Darwin's mistake: Explaining the discontinuity between human and nonhuman minds. *Behavioral and Brain Sciences* 31:109–130.
URL `http://journals.cambridge.org/article_ S0140525X08003543`

[   ]Sanday, Peggy Reeves (1981). *Female Power and Male Dominance*. Cambridge University Press, Cambridge, UK.

[]Thibodeau, Paul H. and Boroditsky, Lera (2011). Metaphors we think with: The role of metaphor in reasoning. *PLoS ONE* 6(2):e16782.
URL `http://dx.doi.org/10.1371%2Fjournal.pone.0016782`

[   ]Thibodeau, Paul H. and Boroditsky, Lera (2013). Natural language metaphors covertly influence reasoning. *PLoS ONE* 8(1):e52961.
URL `http://dx.doi.org/10.1371%2Fjournal.pone.0052961`

[]Wilson, William H.; Halford, Graeme S.; Gray, Brett; and Phillips, Steven (2001). The STAR-2 model for mapping hiearchically structured analogs. In Gentner et al. (2001b), chap. 4, pp. 125–159.