Copycat

The Emergence of Understanding in a Computer Model of Concepts and Analogy-making

What is a coffee cup?


Tony

Introduction

Who: Douglas R. Hofstadter & Melanie Mitchell

When: Late 80's and early to mid 90's with work continuing.

Where: CRCC here at IU (Stop by and say hello!)

What: A computer model investigating the mental mechanisms underlying the fluid and adaptable nature of human concepts.

Which mechanisms?

- recognition
- categorization
- analogy-making

Fundamental Ideas

- High-level perception emerges from a system of many independent processes running in parallel.
- These processes compete and support each other by creating and destroying temporary perceptual constructs.
- Changing activations levels and degrees of overlap in an associative network of permanent concepts with blurry conceptual boundaries.
- No global executive deciding what will run next and what each individual process will do-- all decisions made by relatively simple , independent agents acting probabilistically.
- Self-organizing and emergent.

Microdomain

An idealized letter-string analogy microdomain.

abc -> abd
ijk -> ?

- All 26 letters of the alphabet are known, but only as abstract categories.
- Shapes, sounds, words, linguistic and graphic facts are completely unknown.
- The only explicit relations are predecessor and successor relations between immediate neighbors in the alphabet.
- This seems like it might be too trivial to takes seriously...

Justification

abc -> abd
iijjkk -> ?

abc -> abd
mrrjjj -> ?

abc -> abd
kji -> ?

abc -> abd
xyz -> ?

Slipnet

- Contains the permanent concepts of the system.
- Each node has a fluctuating activation that corresponds to how relevant it is at the current moment in the run.
- Nodes are connected by relations that are themselves other nodes in the Slipnet, allowing for the potential of concept 'slippages'. (e.g. first and last are related by opposite.)
- There is also both decay, when an node is no longer relevant in the solutions, and the spreading of activation along links to neighbor nodes.
- Concepts are not the nodes themselves but are encoded in the both the links and activations. Therefore, concepts in Copycat are fluid and emergent.

Workspace

- Initially Copycat is given three strings of letters, with each letter given some low level descriptions.
  - Instance category (e.g. 'a' is an instance of category A)
  - Leftmost, rightmost and middle letters.
- Over the course of the run, perceptual structures are built up from nodes in the Slipnet, depending on what is relevant.
- Bonds (relations), Groups, Correspondences, Descriptions.
- Structures have a strength based on how well they mesh with other structures being built.
- Sometime structures must fight to the death in order to be built, if they are incompatible.

Coderack

- Houses Codelets, the individual agent processes in Copycat.
- Codelets that investigate the possibility of building a particular structure at a probabilistically chosen location.
- Codelets that actually build those structures.
- Both bottom up and top down codelets.
- Each codelet has an age and an urgency that is used in determining who gets chosen to run or possibly destroyed to make room for new ones.
- At any point during the execution of a codelet, if there is a situation that arises that invalidates that line of search (such a the structure already being built) the codelet can 'fizzle'.

Temperature

- Roughly measures "entropy" of the system.
- Function of the amount and quality of perceptual or organizing structure that has been built so far.
- At the beginning of a run, any 'solution' is possible, and hopefully toward the end of the run, the temperature will be relatively low.
- In this way you can get a rough feeling of the quality of an answer.
- Also used as a feedback mechanism in the choosing of codelets. The higher the temperature, the less sure Copycat is of its structures and so the less it should trust them in making decisions.

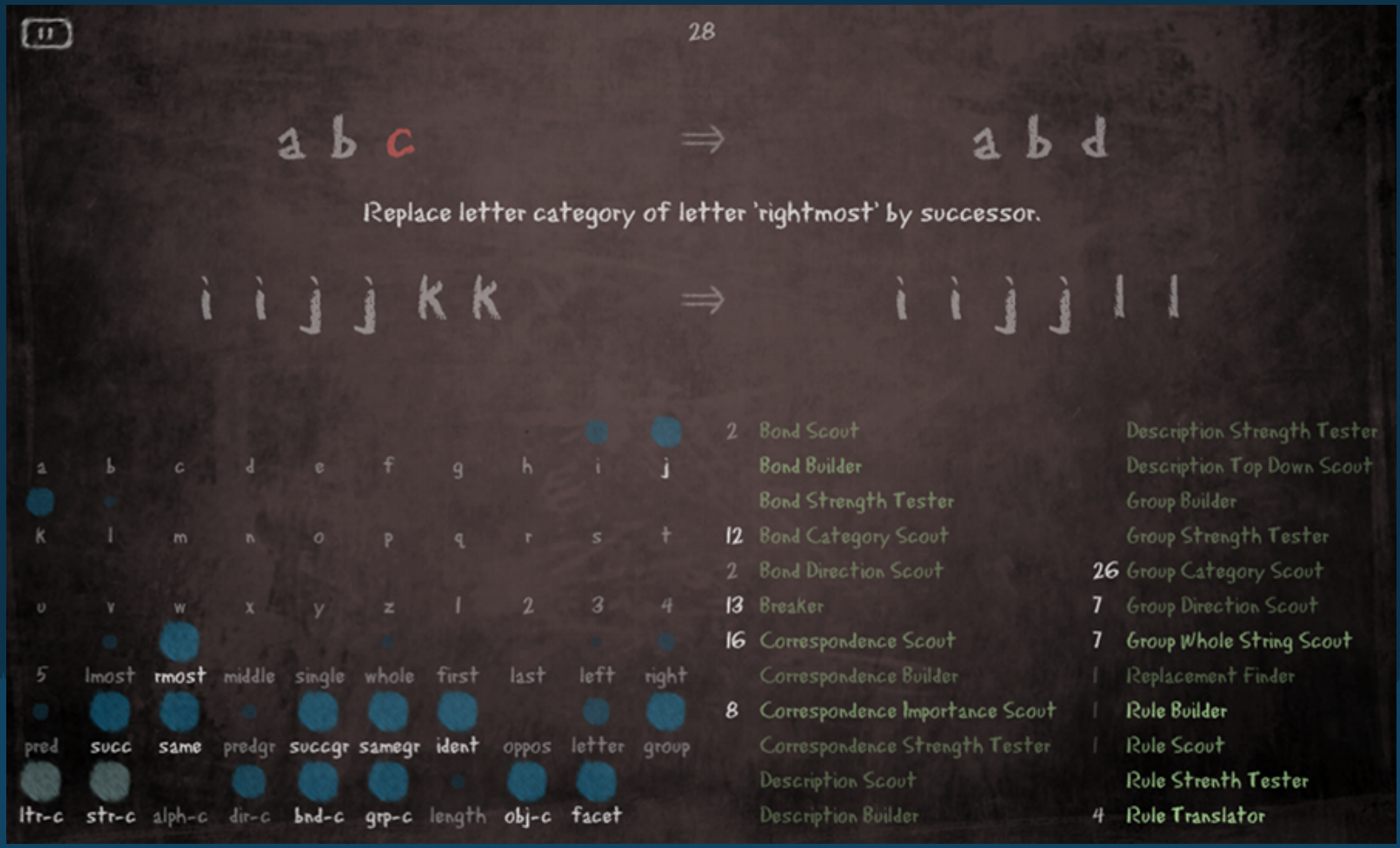
Example Runs

Scott Bolland - Java version

http://www.itee.uq.edu.au/~scottb/_Copycat/

Shameless Plug

http://github.com/ajhager/Copycat



Sources

- Analogy-Making as Perception - Melanie Mitchell
- Fluid Concepts and Creative Analogies - Hofstadter et al.
- http://www.jimdavies.org/summaries/hofstadter1995.html