Call Phone Fence
Car Valve
Caltech MIT
Pen Blue Cheese
Babylon Tablet
Part of H. M.’s brain is removed for treating epilepsy in 1953. After the surgery, he suffered from severe amnesia. Scientists worked with H.M. for more than 40 years.
“Do you remember what went with Metal? Baby? Crush?...”

First trial: **Iron**
Second trial: **Cries, Iron, Flower**
Third trial: **Apple, Cries, Iron**

Henry Molaison or H. M. (1926-2008)

William Scoville (1906 – 1984)
Brenda Milner (1918 - )

Metal – Iron
Baby – Cries
Crush – Dark
School – Grocery
Rose – Flower
Obey – Inch
Fruit – Apple
Cabbage – Pen
The Story of S.

“Nel mezzo del cammin di nostra vita …”

“(Nel) – I was paying my membership dues when there, in the corridor, I caught sight of the ballerina Nel’skaya.

(Mezzo) – I myself am a violinist; what I do is to set up an image of a man, together with Nel’skaya, who is playing the violin.

(Del) – There’s a pack of Deli Cigarettes near them.

(Cammin) – I set up an image of a fireplace close by.

(Di) – Then I see a hand pointing toward a door.”
Memory champions have average memories.

They memorize in a different way using navigation, association and visualization.

Good memories can be trained.
Association and Creative Thinking

Creative thinking connects different ideas together and generates a new idea.

Prof. Mednick proposed remote association tests in 1960s for evaluating a person’s creativity.

- Cream
- Skate
- Ice
- Water
Remote Association Test

- Fence
- Cue #1
- Cue #2
- Card
- Solution
- Post
- Master
- Cue #3
We want to *synthesize* the process for solving RATs.

Why?
Wouldn’t it be nice if …
Astronomy

Jet Propulsion Laboratory

Caltech

Pasadena
Why do we want to solve RAT

• **Captures word associations**
  – Building blocks for associating large datasets, e.g., webpages, databases, documents.

• **Potentials for interesting applications**
  – Artificial brainstorming.
  – Brain-like memory organization.
  – Artificial experts.
Solving RATs

Human: Knowledge + Strategy/Tricks

Machine: Database/Data structures + Algorithms

- Captures word associations
- Search in data structures
A Good Database

- Human Brain Cloud
  - [http://www.humanbraincloud.com](http://www.humanbraincloud.com)
  - A social game by Kyle Gabler.
  - Word associations contributed by crowd sourcing.
Why HBC Database?

http://www.humanbraincloud.com/#stats

- Using humans
- Completeness
  - Many words
  - Many connections
HBC Graph Demo

Demo #1
\( D(x, y) \): the shortest distance from \( x \) to \( y \)

\( D(\text{Caltech}, \text{Telescope}) = 2 \)

Asymmetric
Symmetric Distance: \( SD(x, y) = \min\{ D(x, y), D(y, x) \} \)

\[
SD(\text{Caltech}, \text{JPL}) = \min \{ 2, 1 \} = 1
\]
Sphere(w, r): all the words within distance r

Sphere(Pasadena, 1) = \{JPL, Caltech, Sunny\}
Sphere(Pasadena, 2) = \{JPL, Caltech, Sunny, Telescope, Astronomy, University\}
Sphere Intersection

\[ \text{Sphere(Astronomy, 1)} \cap \text{Sphere(JPL, 1)} = \{ \text{Telescope} \} \]
An Algorithm of the RAT Solver

- Compute the radius-3 sphere intersection of the cue words*
- Prune the sphere intersection
  - take the words with minimum sum of symmetric distances from the cue words.
- Shorten the candidate set with predefined metric to yield top-K solutions
  - e.g. using the multiplication of the edge probabilities

*our demo to be shown later uses radius-2 ball intersection for faster execution speed.
A Toy Example

Astronomy

Caltech

Pasadena
Prune Sphere Intersection

\[
\begin{align*}
\text{SD(Telescope, Astronomy)} & + \text{SD(Telescope, Caltech)} + \text{SD(Telescope, Pasadena)} = 5 \\
\text{SD(Sunny, Astronomy)} & + \text{SD(Sunny, Caltech)} + \text{SD(Sunny, Pasadena)} = 6 \\
\text{SD(JPL, Astronomy)} & + \text{SD(JPL, Caltech)} + \text{SD(JPL, Pasadena)} = 3 \\
\text{SD(University, Astronomy)} & + \text{SD(University, Caltech)} + \text{SD(University, Pasadena)} = 6
\end{align*}
\]
Walk-through Examples with Real RATs

Demo #2
Performance ($k = 1$)

In 84.9% RATs, the real solutions appear in the pruned intersection. In 70.8% RATs, the final solution is correct.

Difficulty characterized by the average solving time of human beings.

*All RATs are collected from www.remote-associates-test.com*
Performance \( (k = 3, 4, 6, 8) \)

In 80% RATs, the real solutions appear in the top-k solution list.
Average Precision ($k = 1, 3, 4, 6, 8$) increases slowly with $k$ when $k > 3$.

A better association graph is needed.
Ongoing Work for Solving RATs

• Better algorithms
  – Improving distance metric
  – Lowering complexity

• Better databases
  – Generating association graphs with better quality
    • Utilizing the semantics of and the relationships between words
Future Directions

• How to generate association graphs?
  – How to determine the quality of a graph?
  – Domain specific graph
    • Medicine, NSA, marketing, patents, papers, people
    • How to access the quality of a domain specific graph?
  • How to determine the difficulty level of a RAT?
  • Can we create RAT using an association graph?
Ideas and Questions

If you have any questions, new ideas, or want to work with us, please drop us an email!

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Thank You