An Architecture Approach to Modeling the Remote Associates Test

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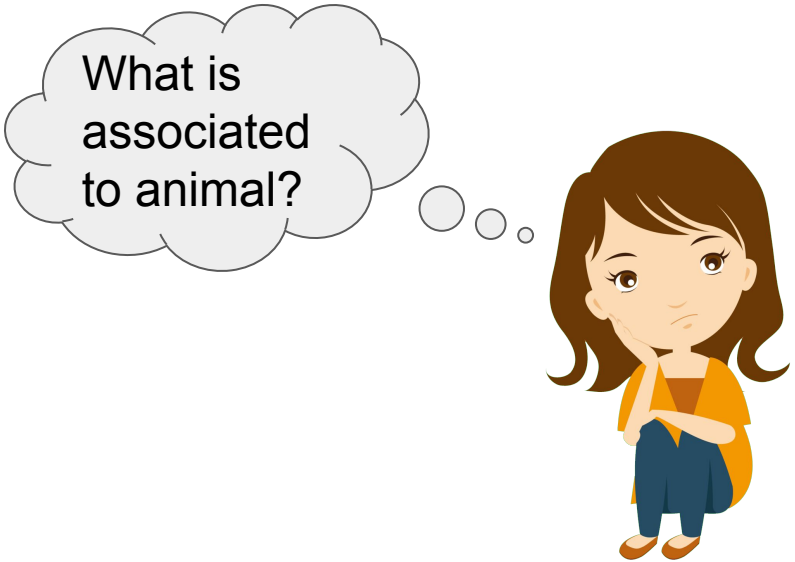
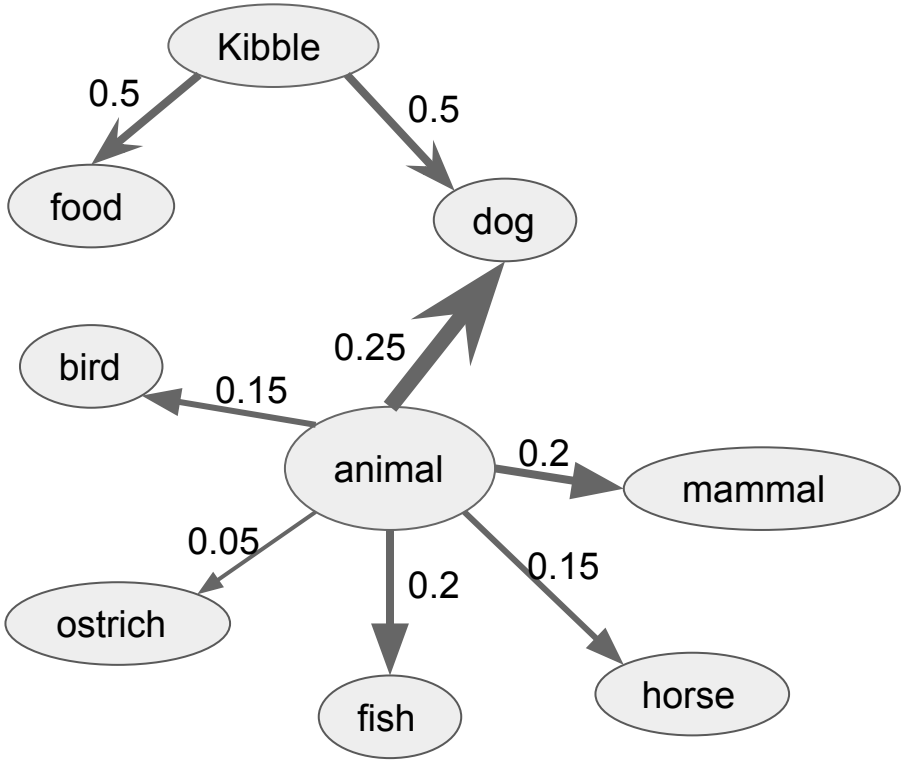
University of Michigan

Outline

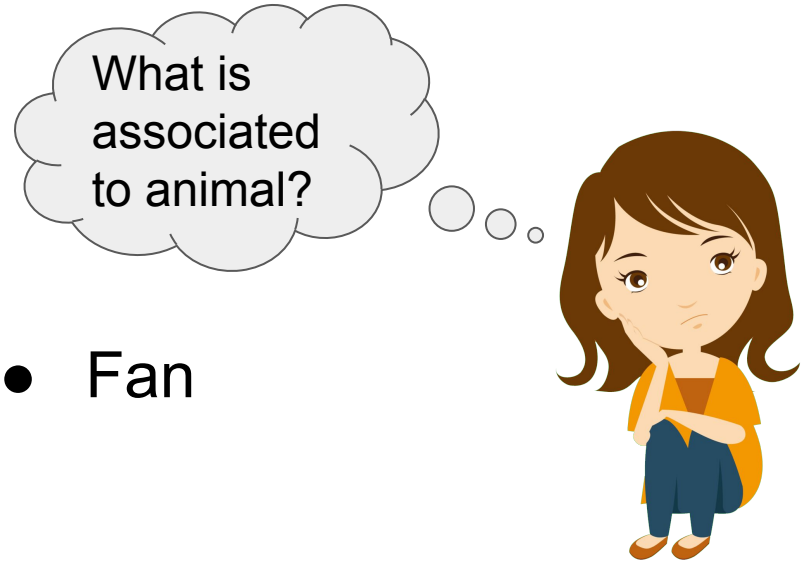
1. Background
    a. Overview of spreading activation
    b. Overview of the Remote Associates Test (RAT)
2. Work Done
    a. Description of the knowledge base
    b. Description of the two cognitive process models
3. Results
    a. Modifications

Overview

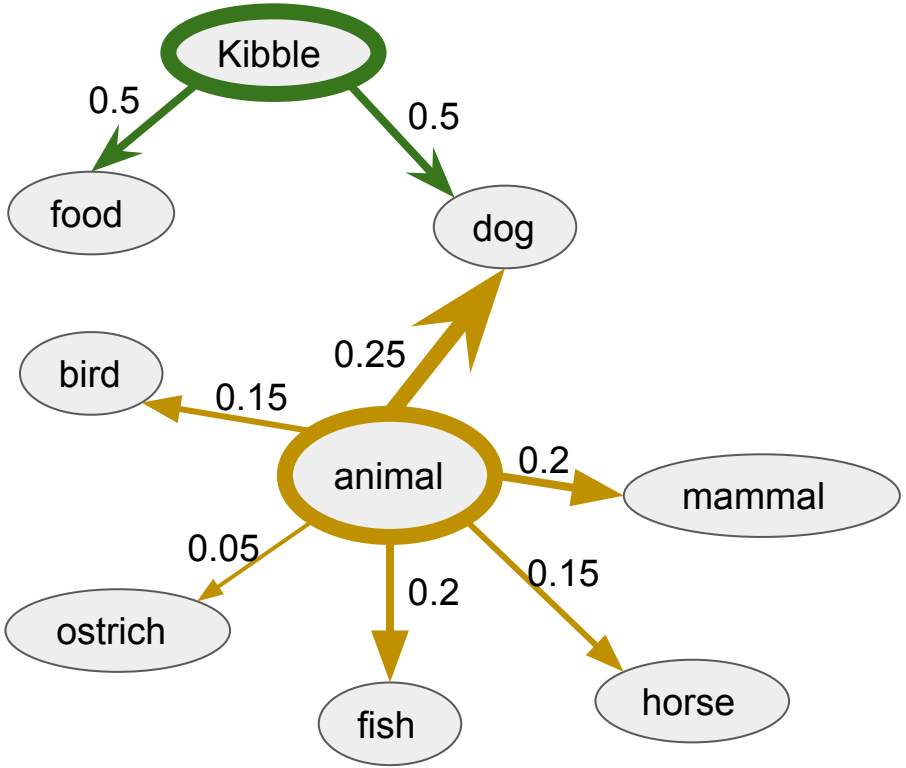

What is associated to animal?


Kibble
0.5
0.5
food
dog
0.25
bird
0.15
animal
0.2
mammal
0.05
0.2
0.15
ostrich
fish
horse

Overview



- Fan



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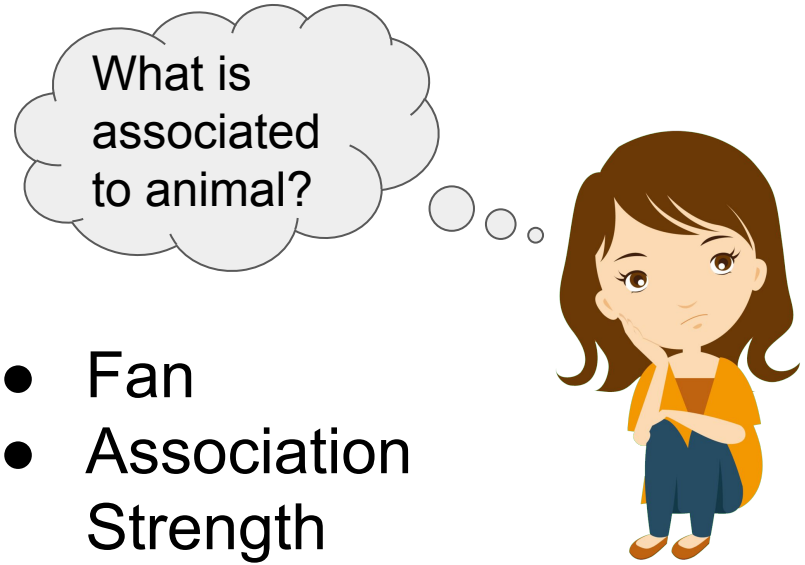
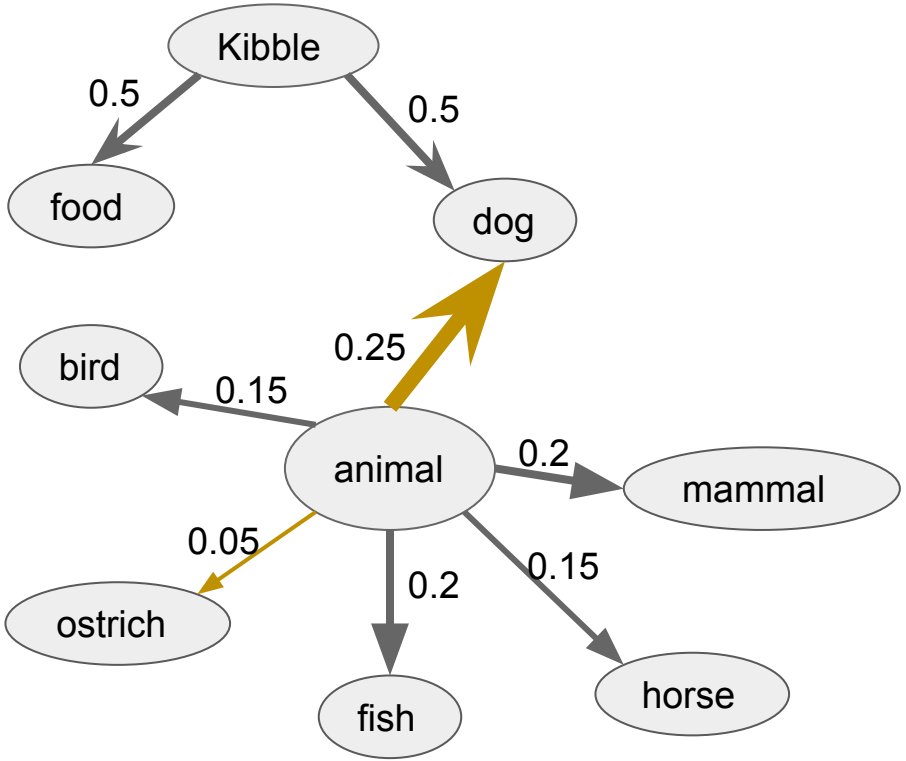


- Fan
- Association Strength



The Remote Associates Test (RAT)

Given three words, what is a fourth word that is associated with all three words?

Mednick, S. (1962). The associative basis of the creative process. *Psychological Review*, 69(3), 220-232.

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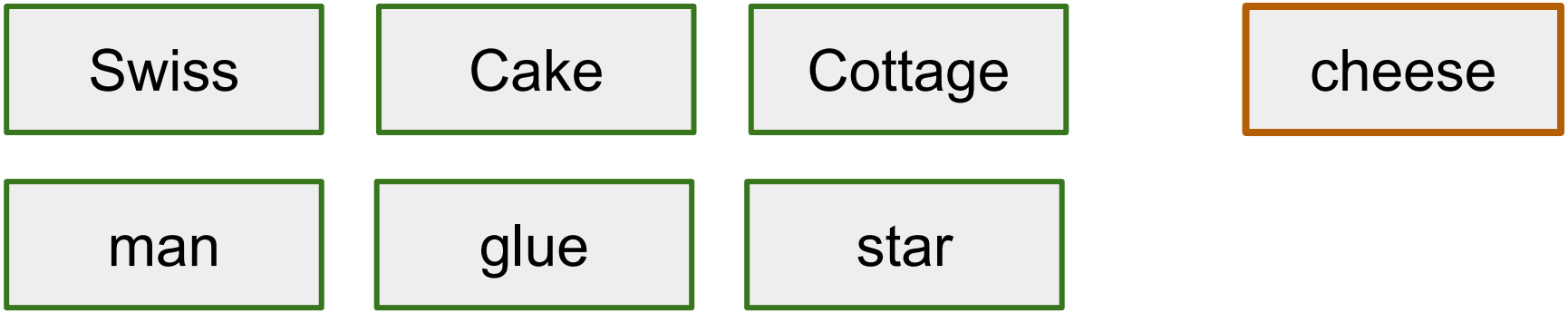

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Swiss	Cake	Cottage	cheese
man	glue	star	super

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Cognitive Process Models

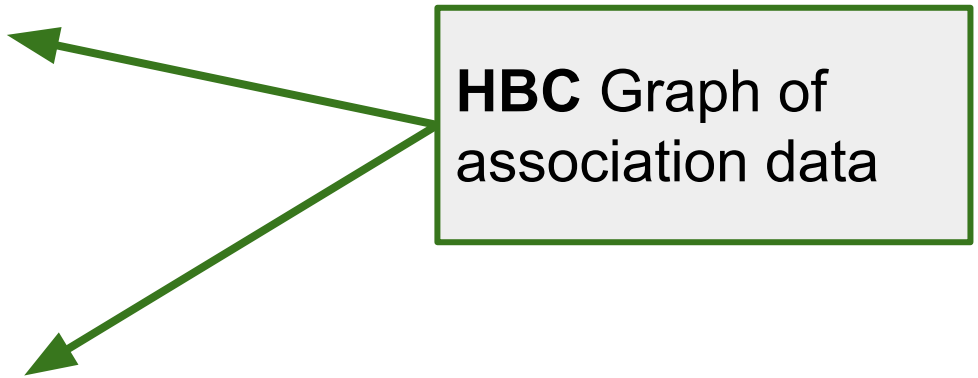
Cued Retrieval Model

Relies on queries with hard constraints

Free Recall Model

Relies on spreading activation. AKA fan and association strength

Knowledge Base



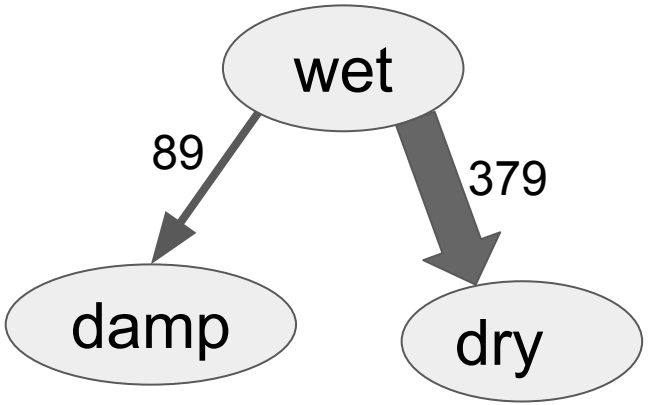
Human Brain Cloud (HBC) Knowledge Base

- 231,851 unique words
- 2,403,203 associations between words

Data from HBC

word1	word2	Association count
dry	wet	379
damp	wet	89

Semantic Memory



Gabler, K. (2013). Human brain cloud. Retrieved from https://humanbraincloud.com/

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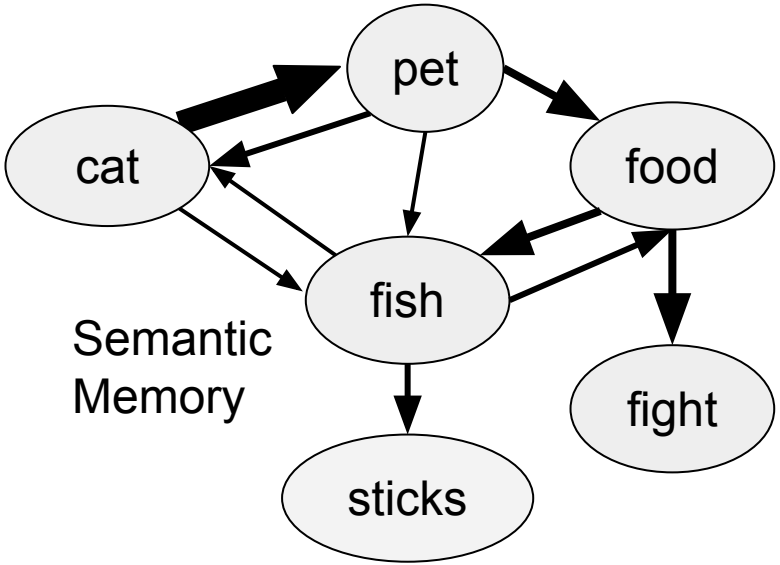

Cued Retrieval Model

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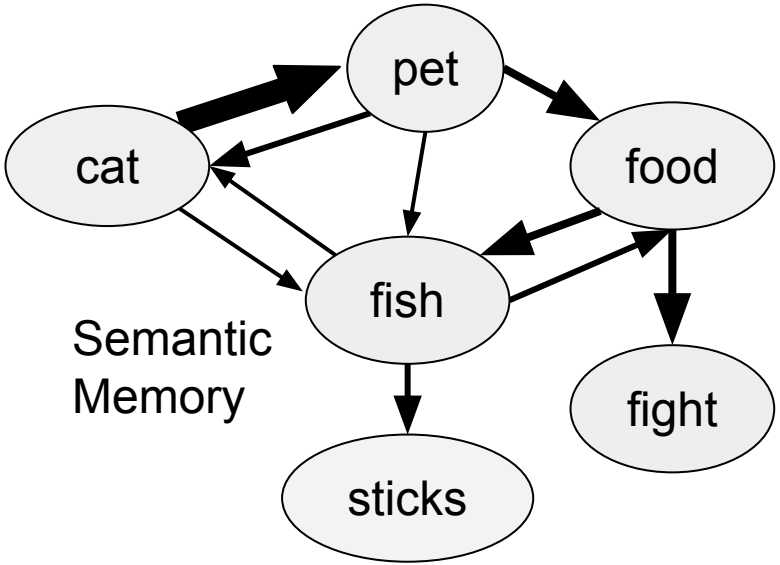

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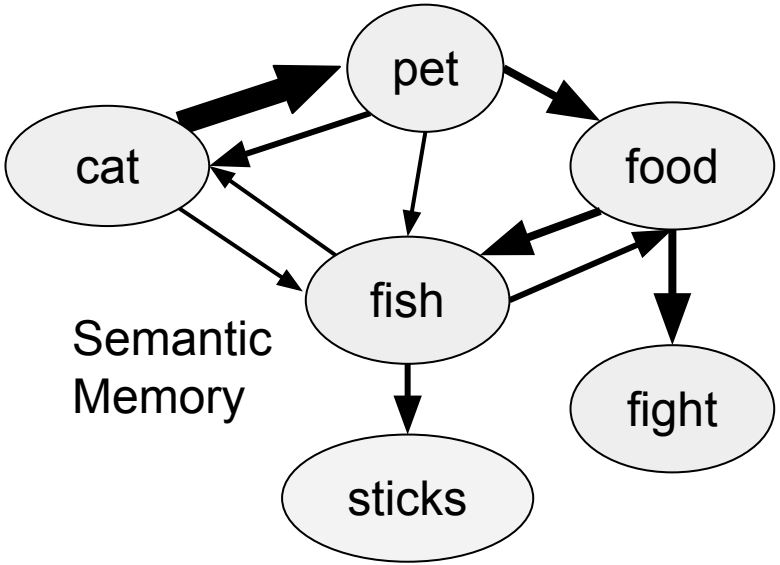
2. Model queries its memory for a word directly associated with all 3 given RAT items



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1. Model is given RAT items “cat”, “food”, “sticks”
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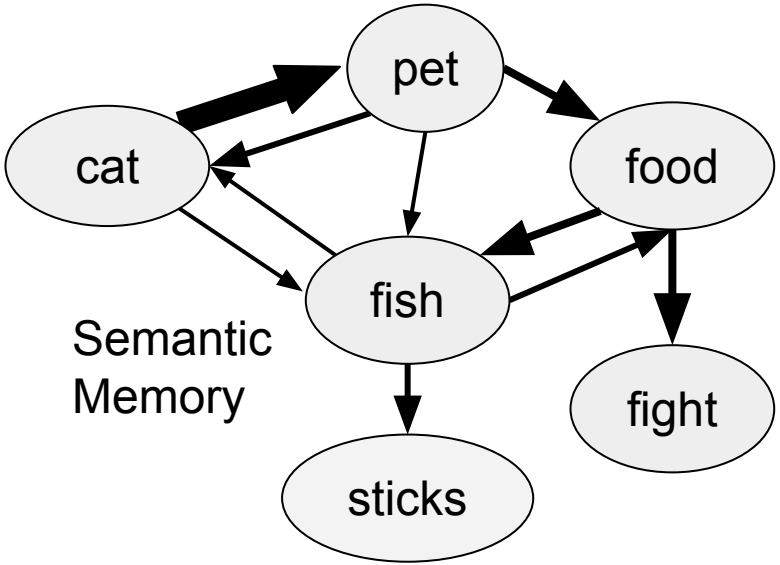
   a. Receives “fish”



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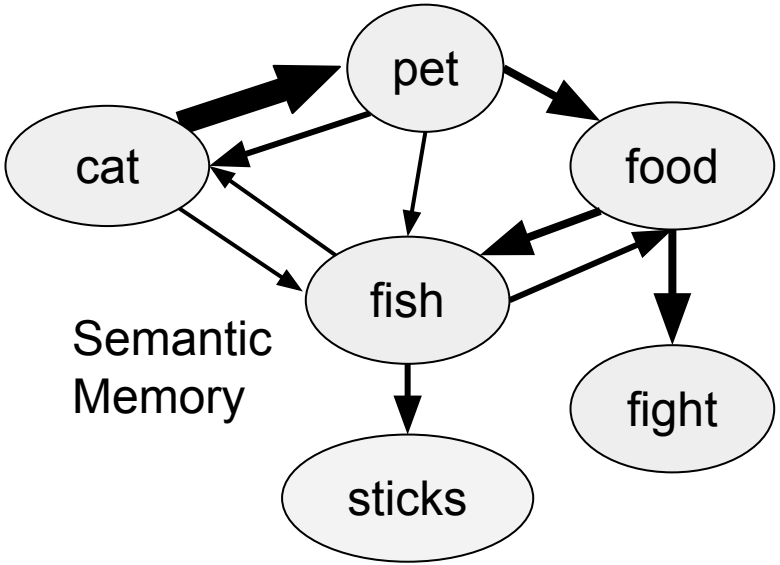

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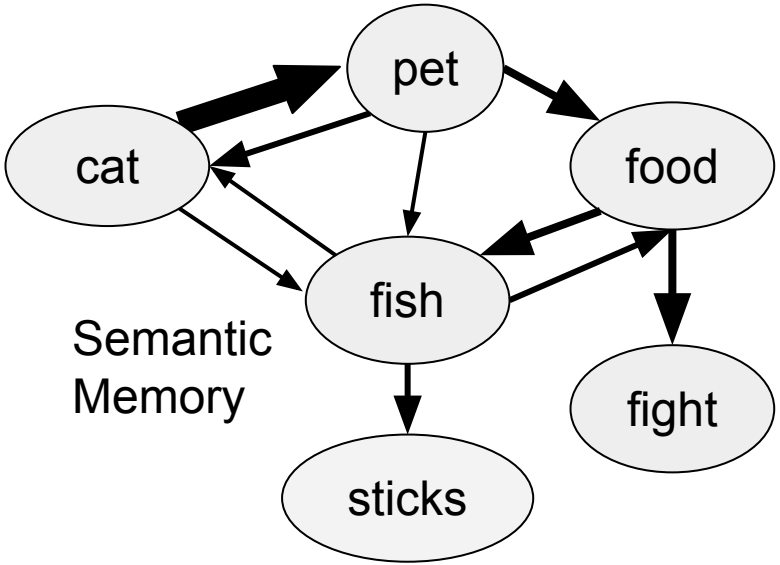
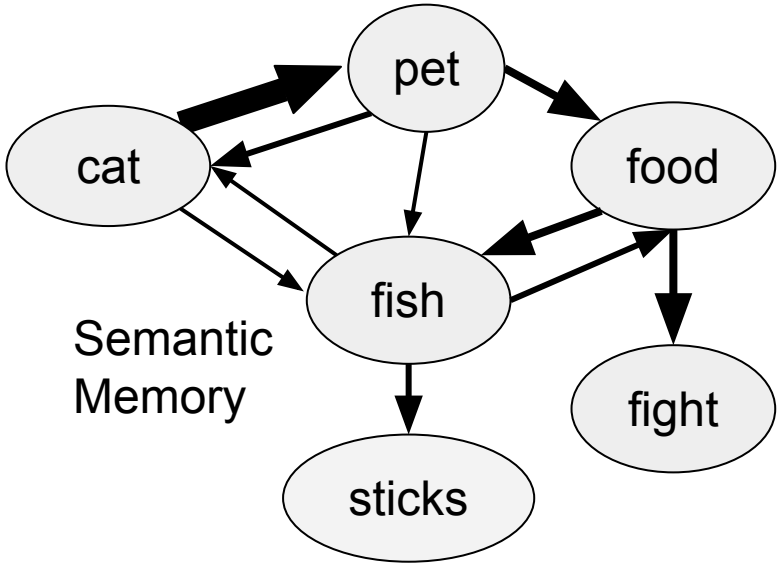


Relies only on connections existing

Free Recall Model



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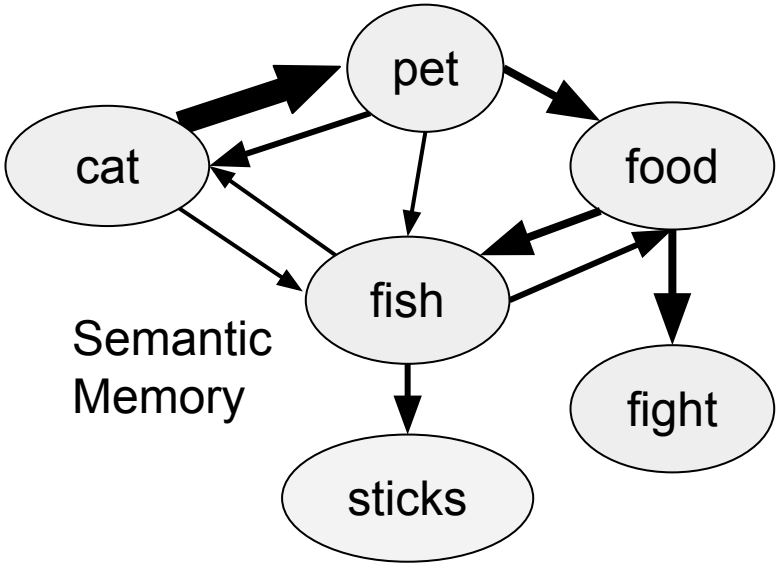

Free Recall Model

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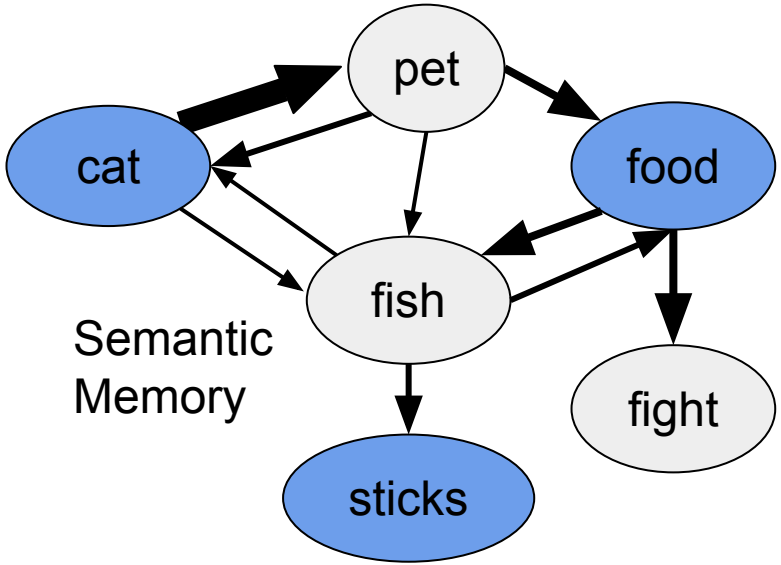
2. Model retrieves the words from semantic memory



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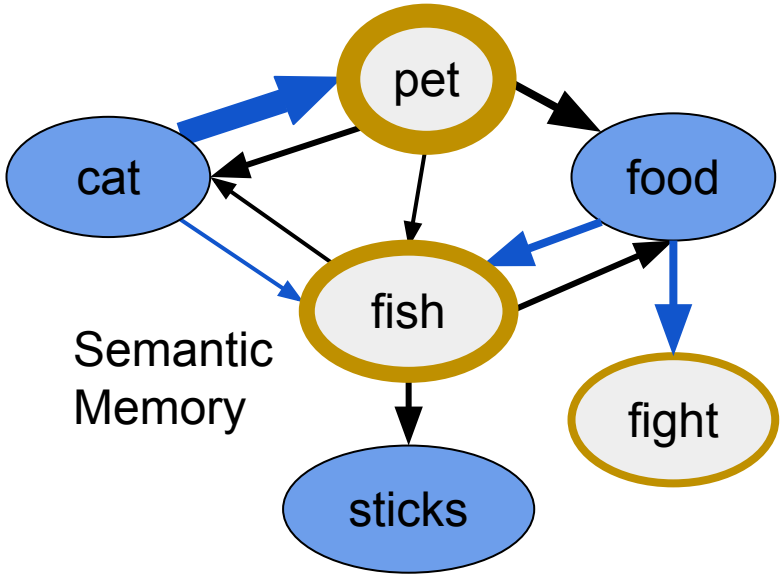

Free Recall Model

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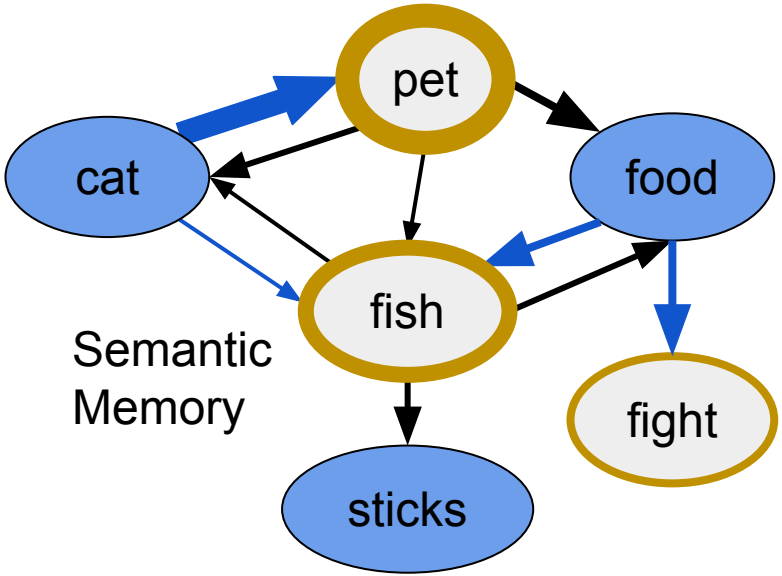
2. Model retrieves the words from semantic memory
3. Model asks for a word
    a. Receives “Pet”



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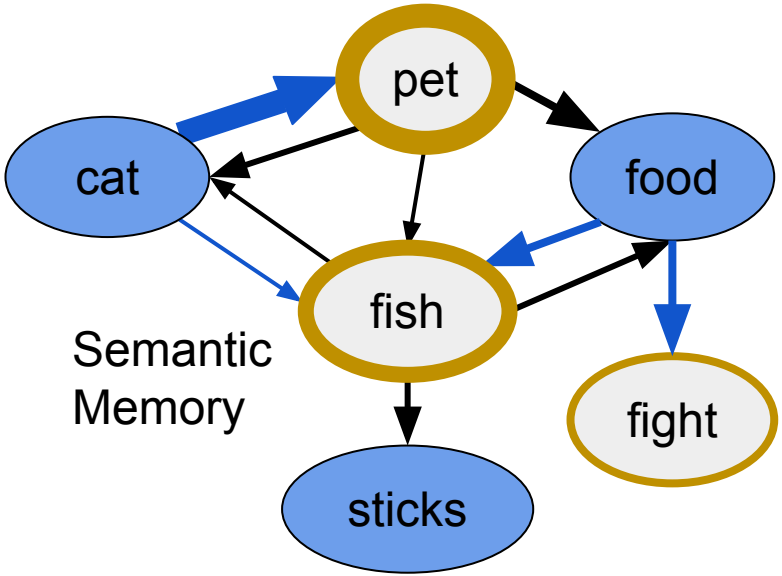

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5. Model asks for a word and inhibits “pet”
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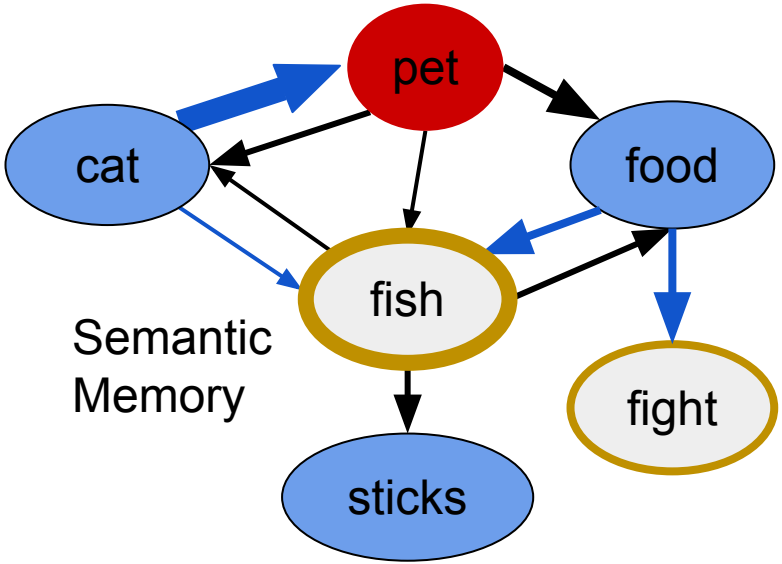

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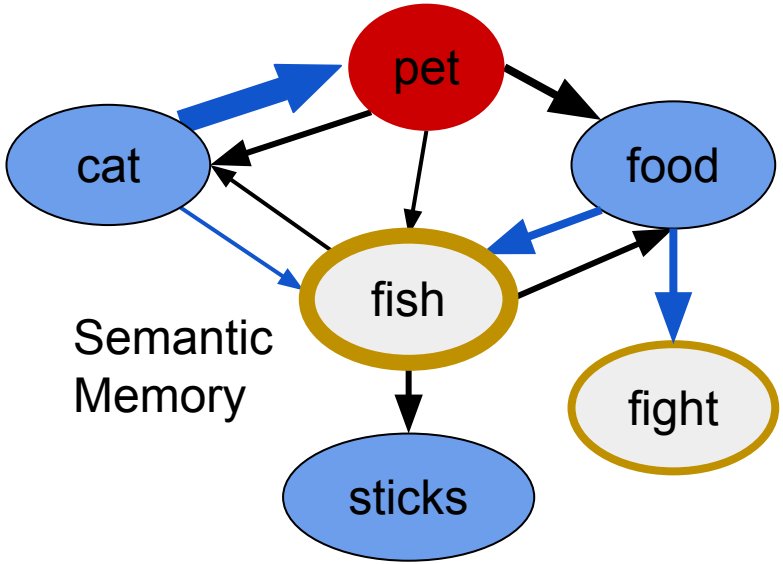
6. Evaluates “fish” as relating to 3 words



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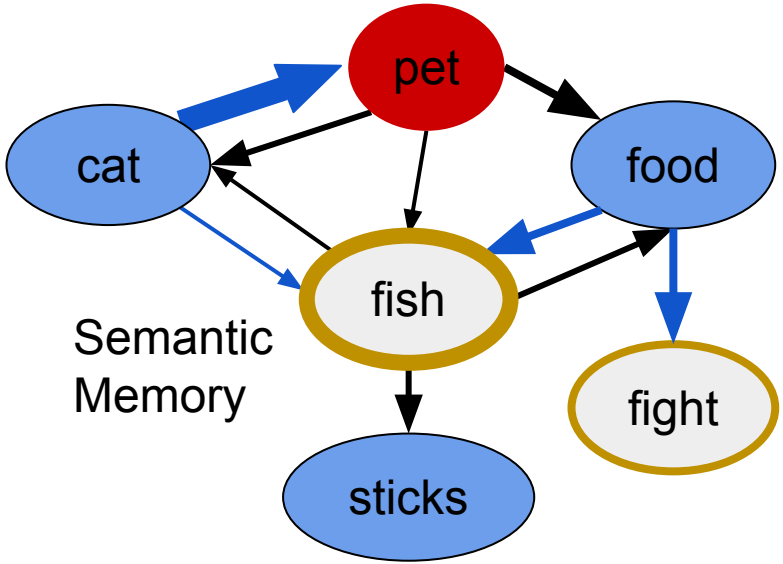

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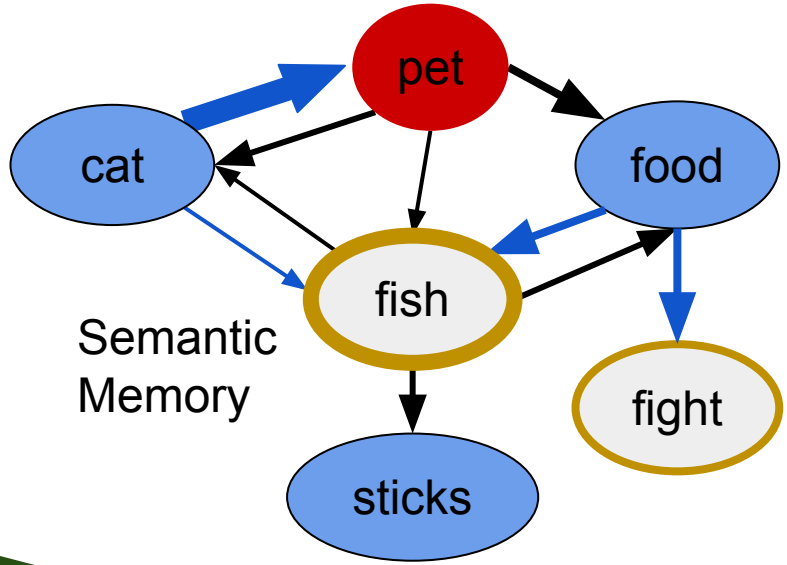

Attempt 1

Attempt 2

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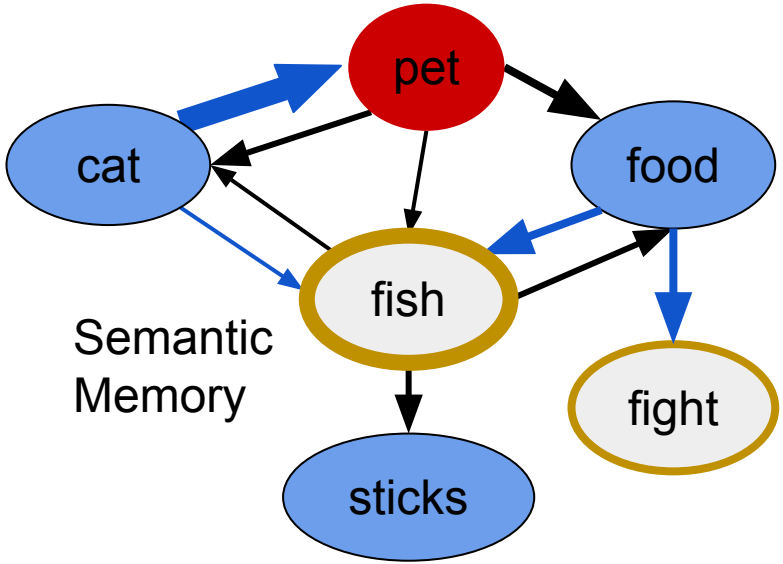
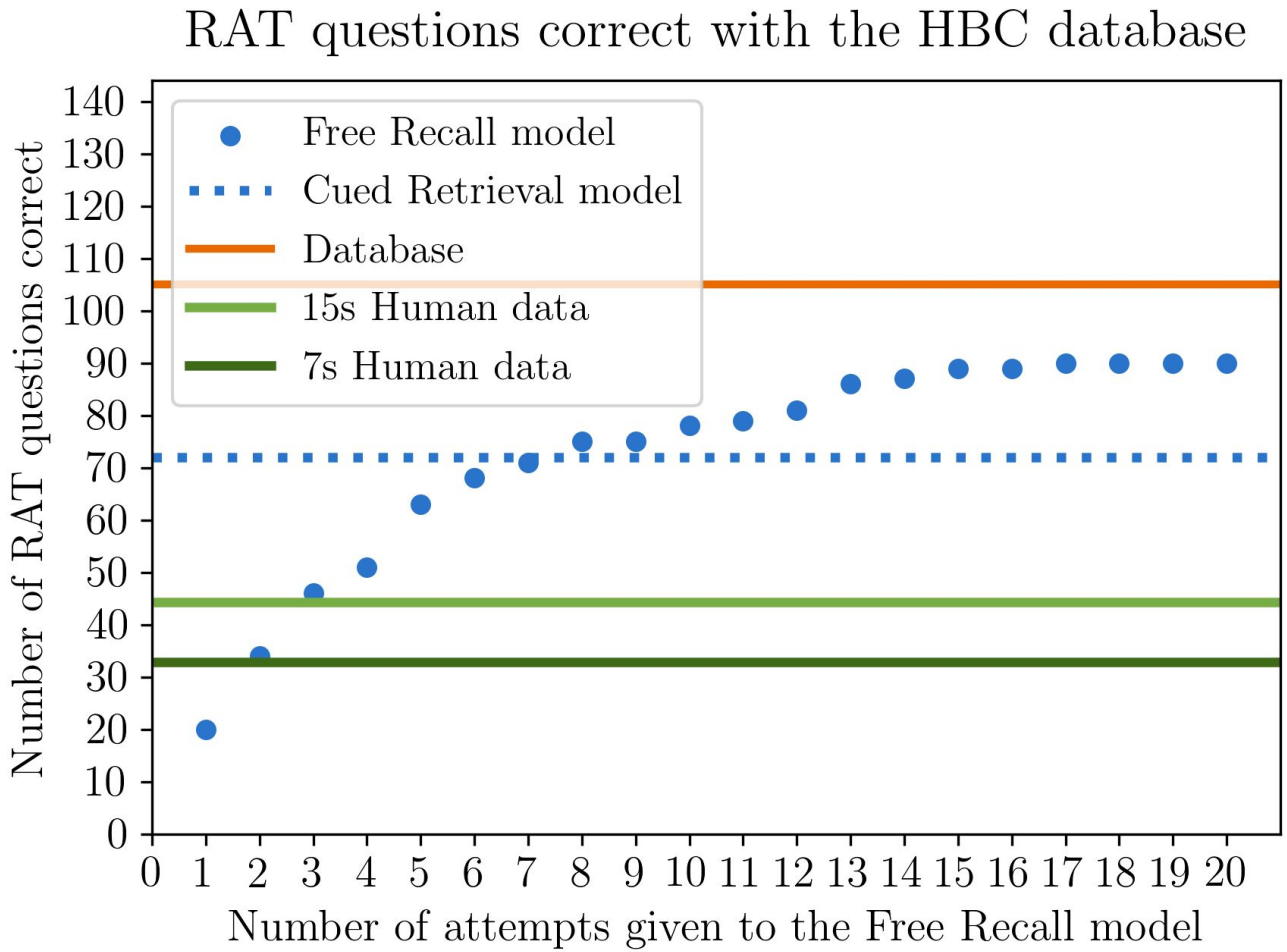


Relies on association strength and fan


RAT questions correct with the HBC database
Free Recall model
Cued Retrieval model
Database
15s Human data
7s Human data
Number of RAT questions correct
Number of attempts given to the Free Recall model
0
10
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70
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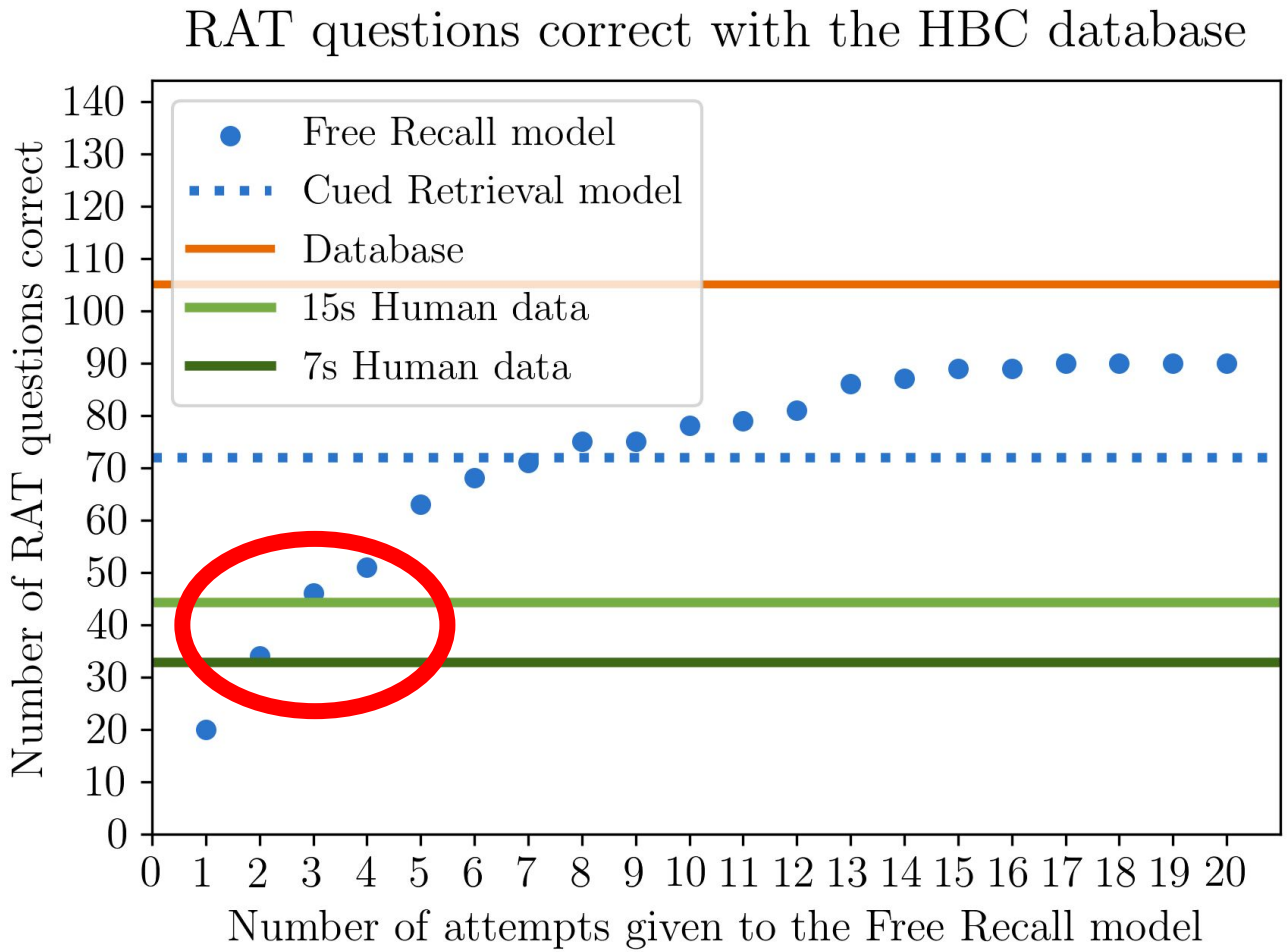
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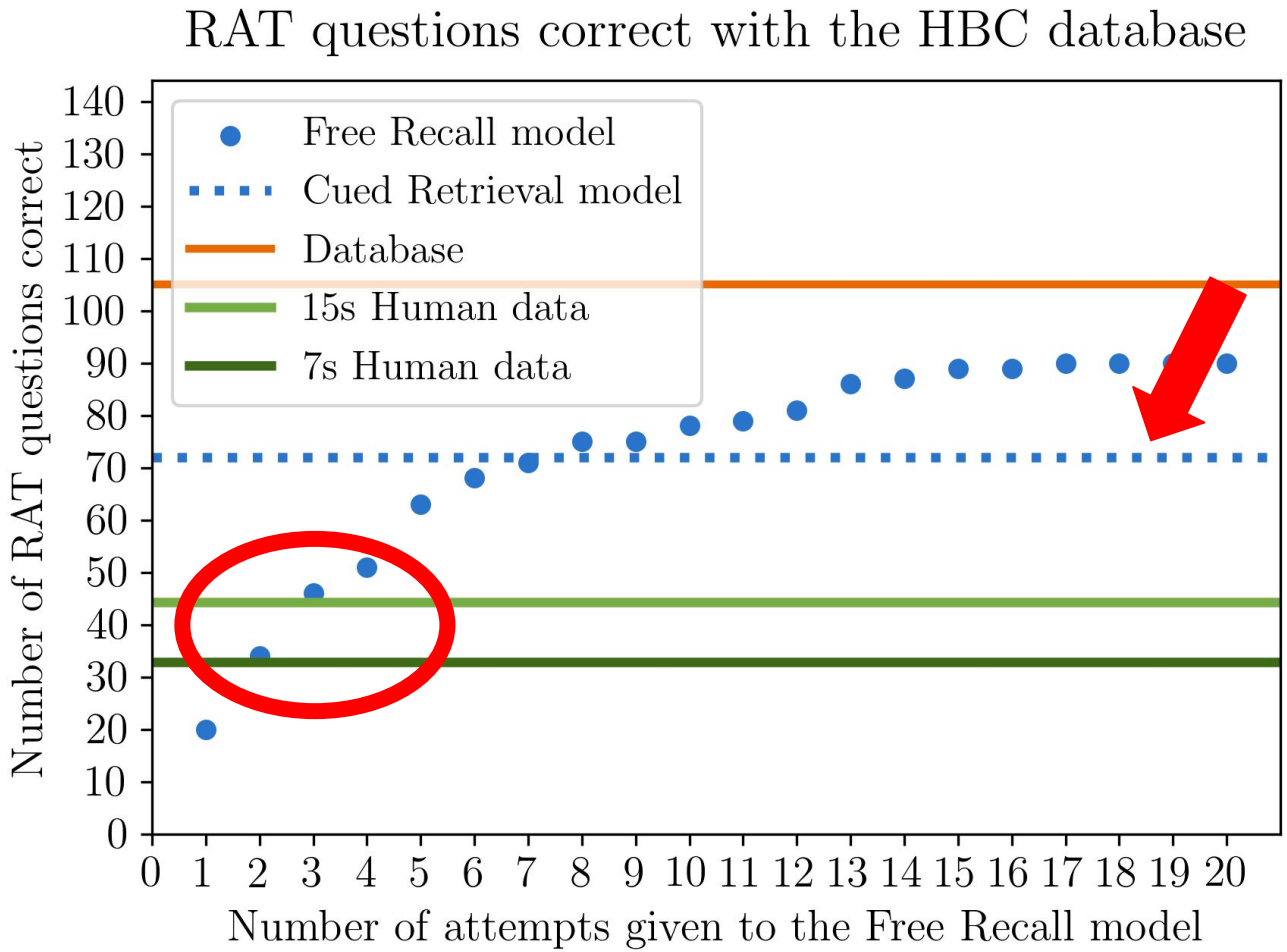
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- 144 questions into 12 bins based on human % correct

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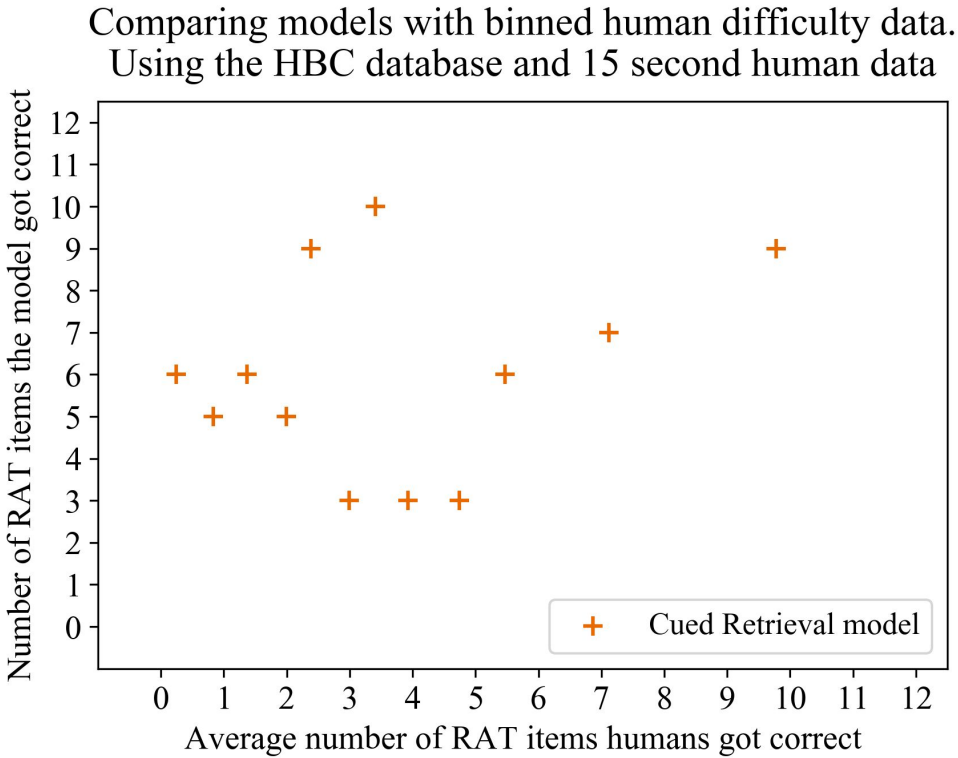

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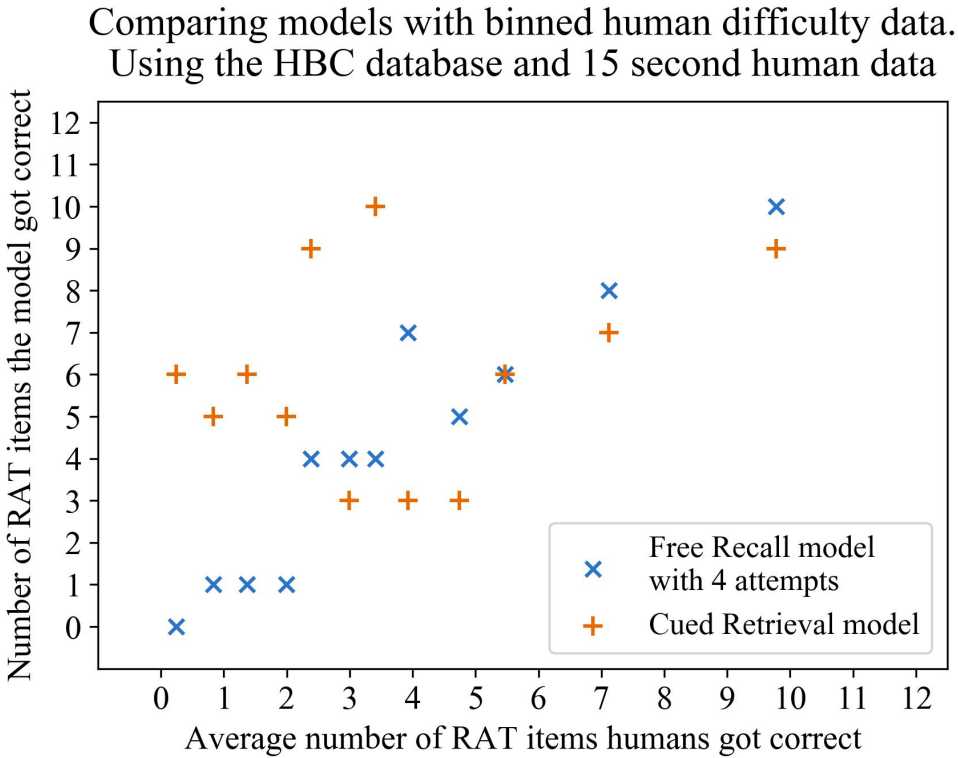

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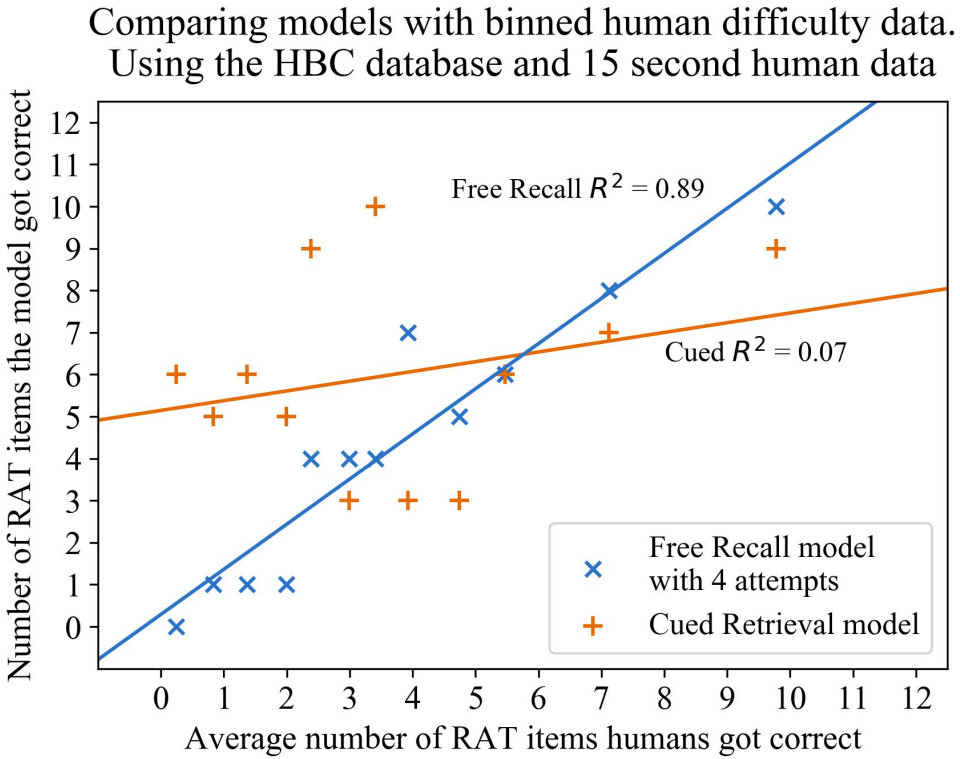

Which model provides a better explanation of human difficulty on the RAT?

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Relies on queries with hard constraints

$R^2 = 0.07$

Free Recall Model

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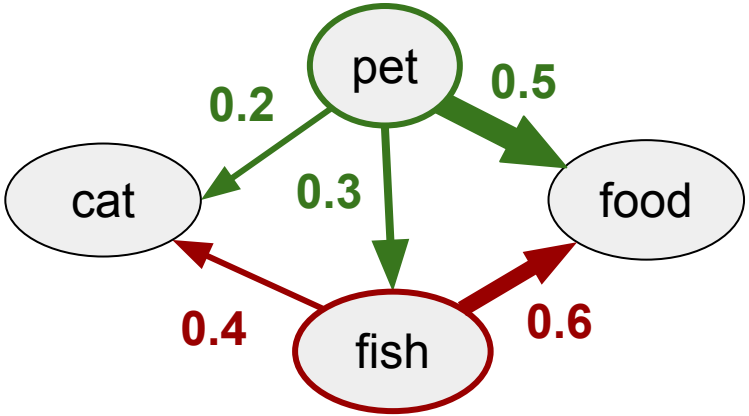
- Removing the effect from fan
- Reversing direction of spreading
- Initializing base-level activation with word frequency data



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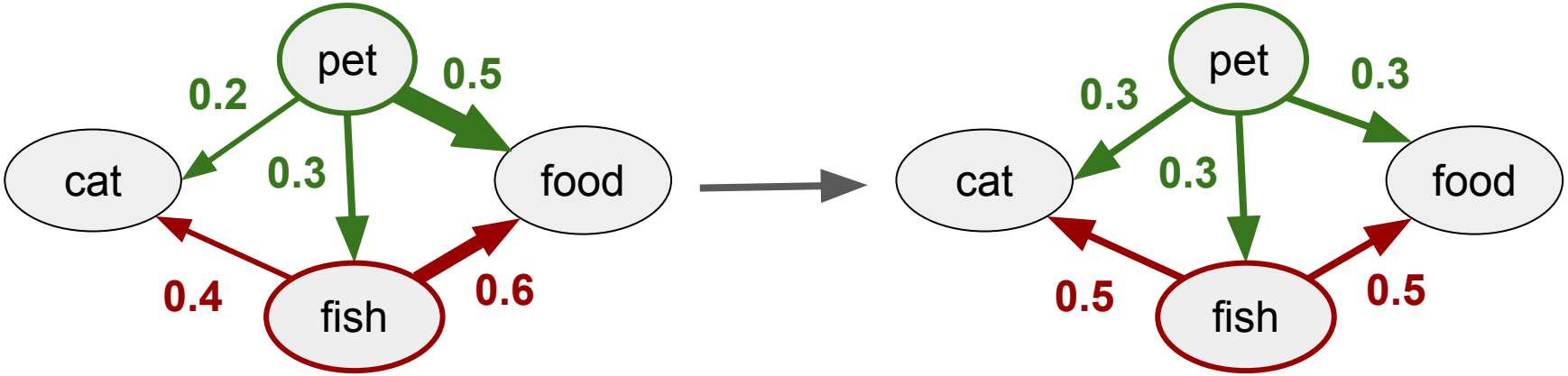

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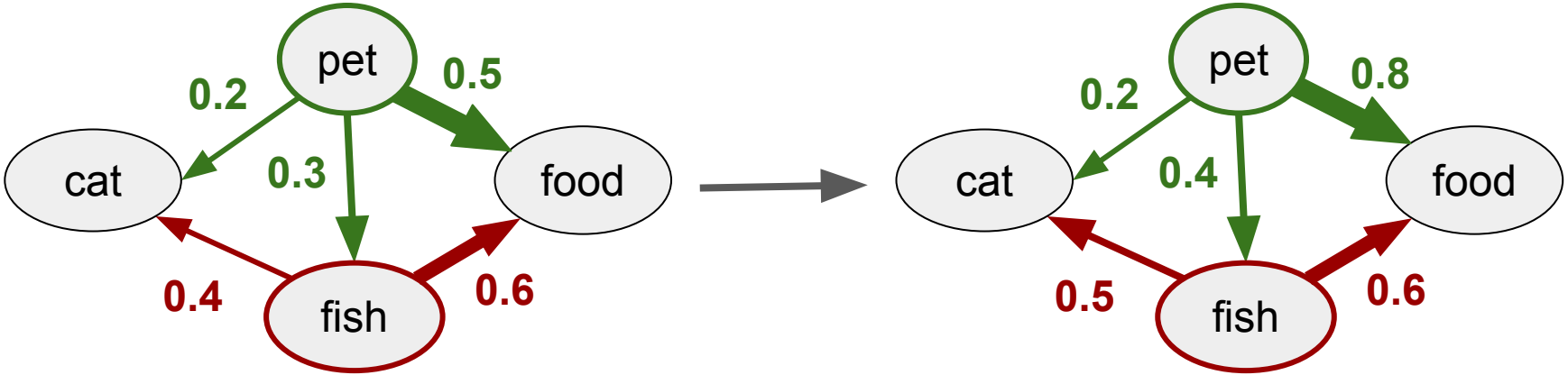

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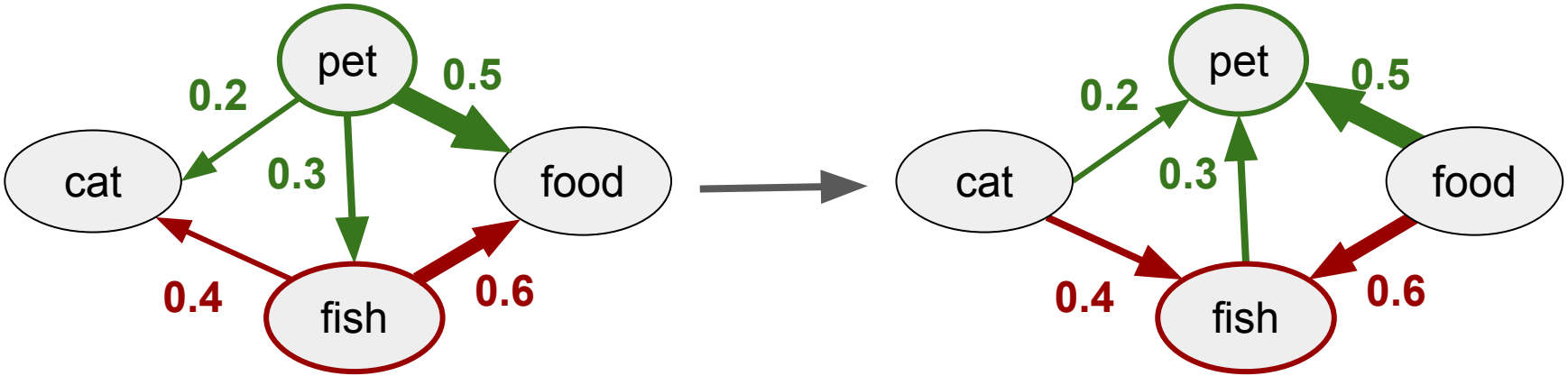
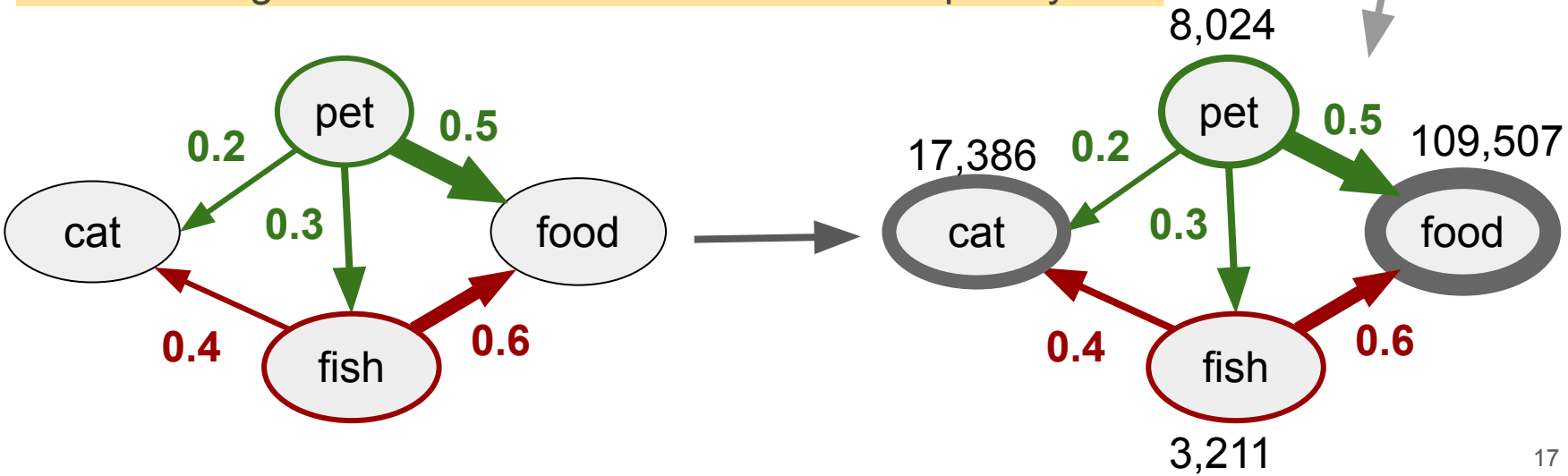


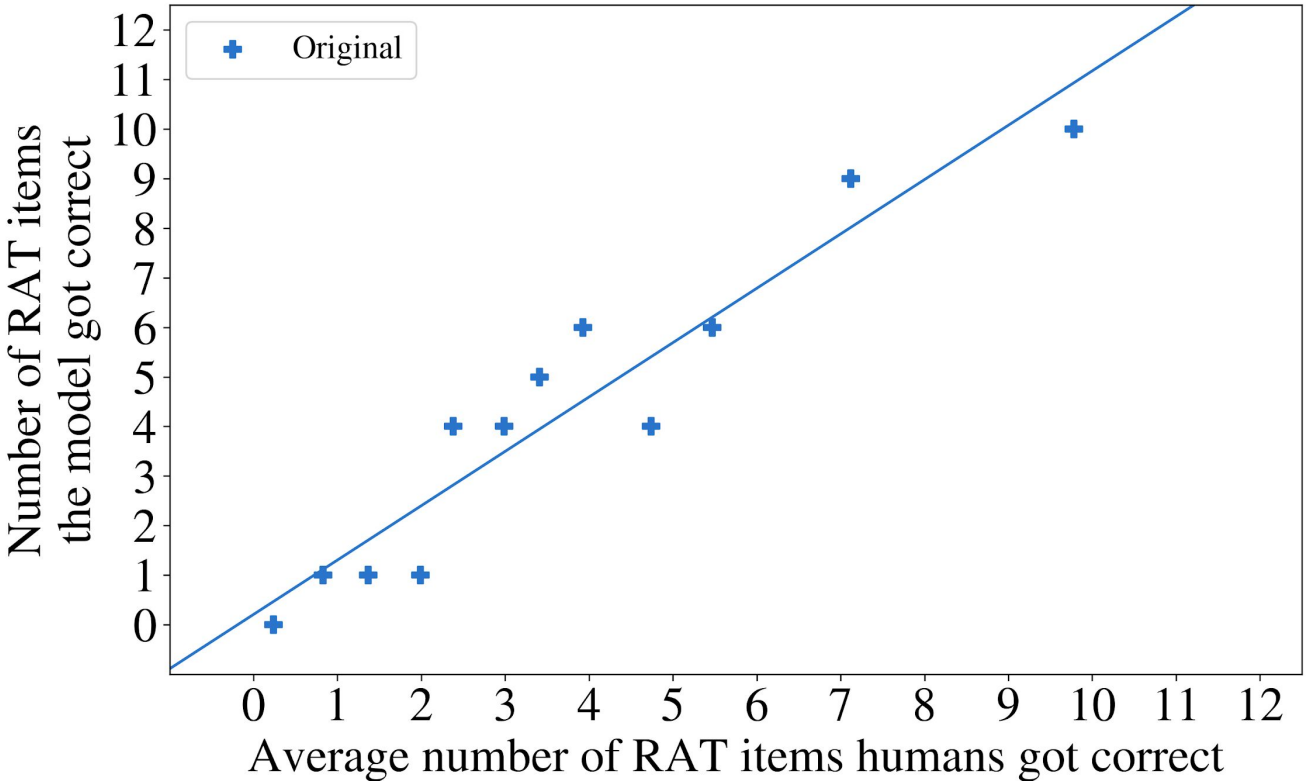
Modifications

- Removing the effect from association strength
- Removing the effect from fan
- Reversing direction of spreading
- Initializing base-level activation with word frequency data

Word	Frequency
pet	8,024
food	109,507
cat	17,386
fish	3,211



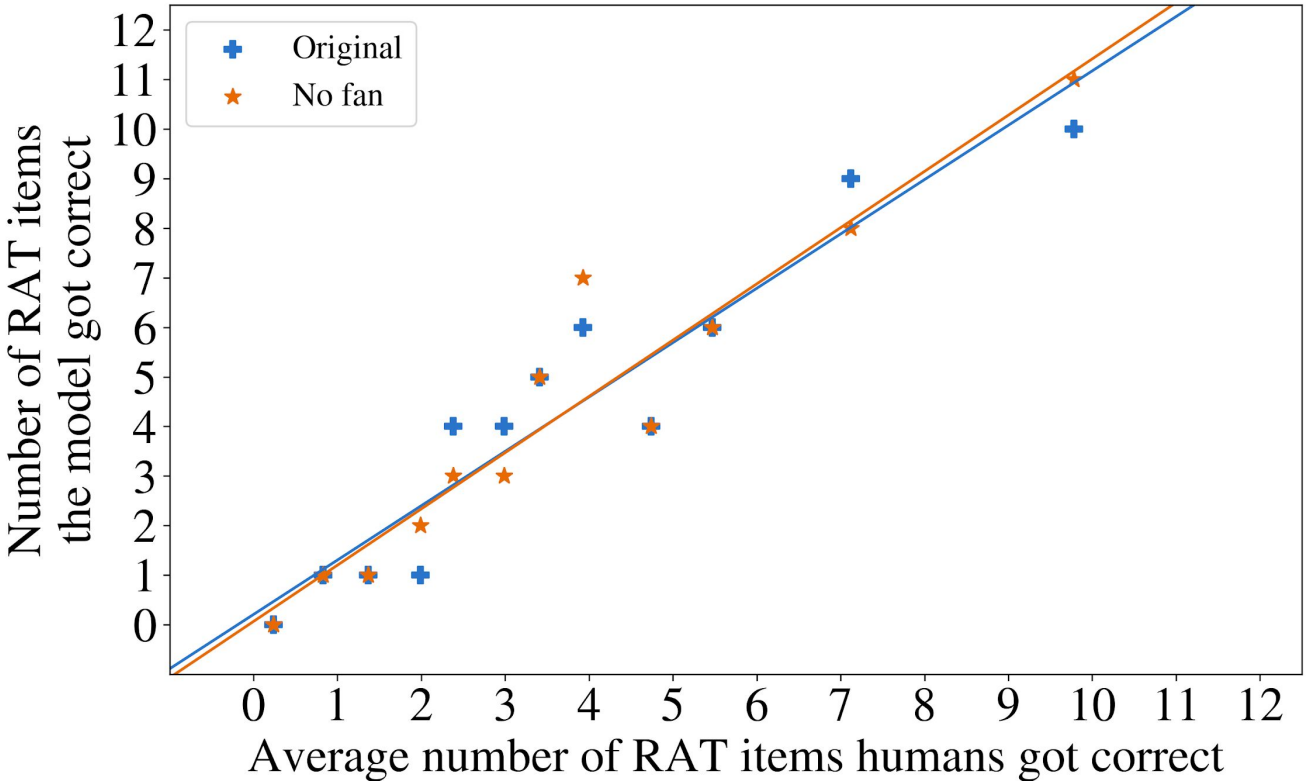
Comparing models with binned human difficulty data.
Using the HBC database and 15 second human data



R^2 Values

Orignal: 0.92

Comparing models with binned human difficulty data.
Using the HBC database and 15 second human data

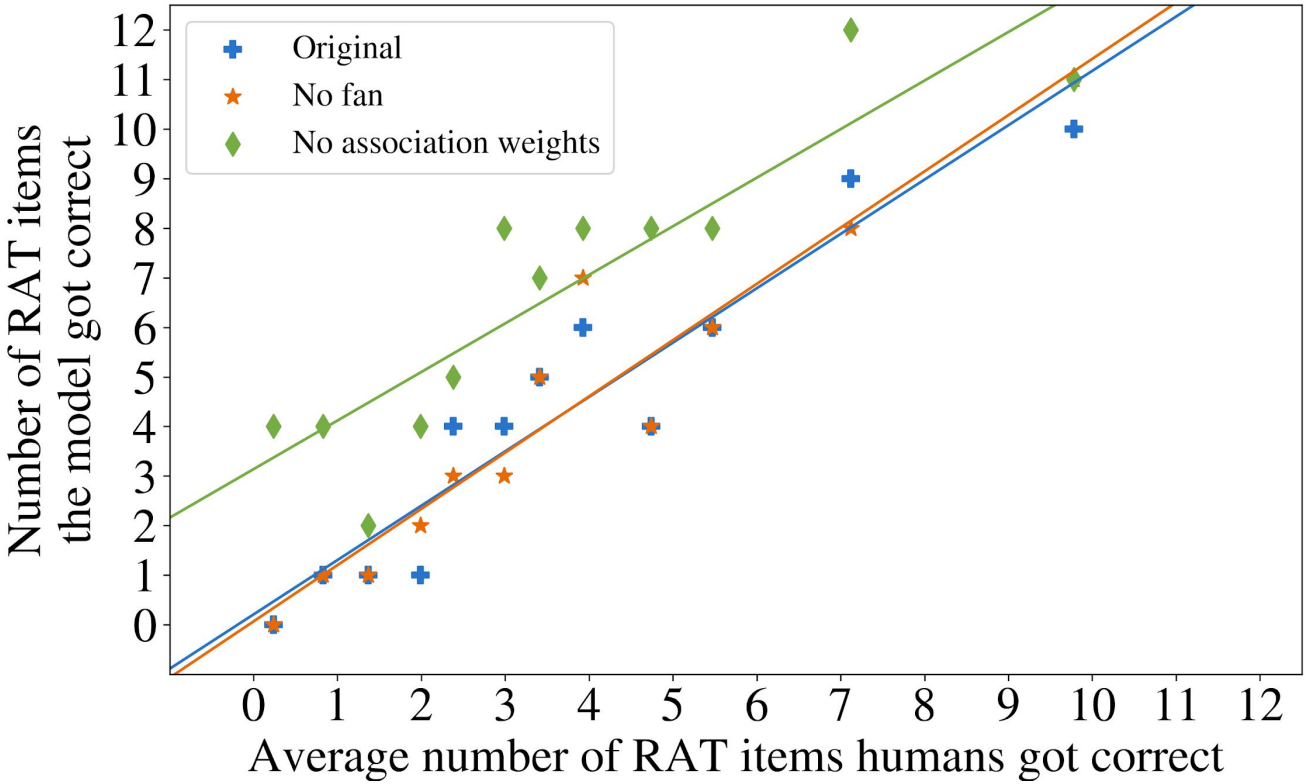


R^2 Values

Orignal: 0.92

No Fan: 0.89

Comparing models with binned human difficulty data. Using the HBC database and 15 second human data



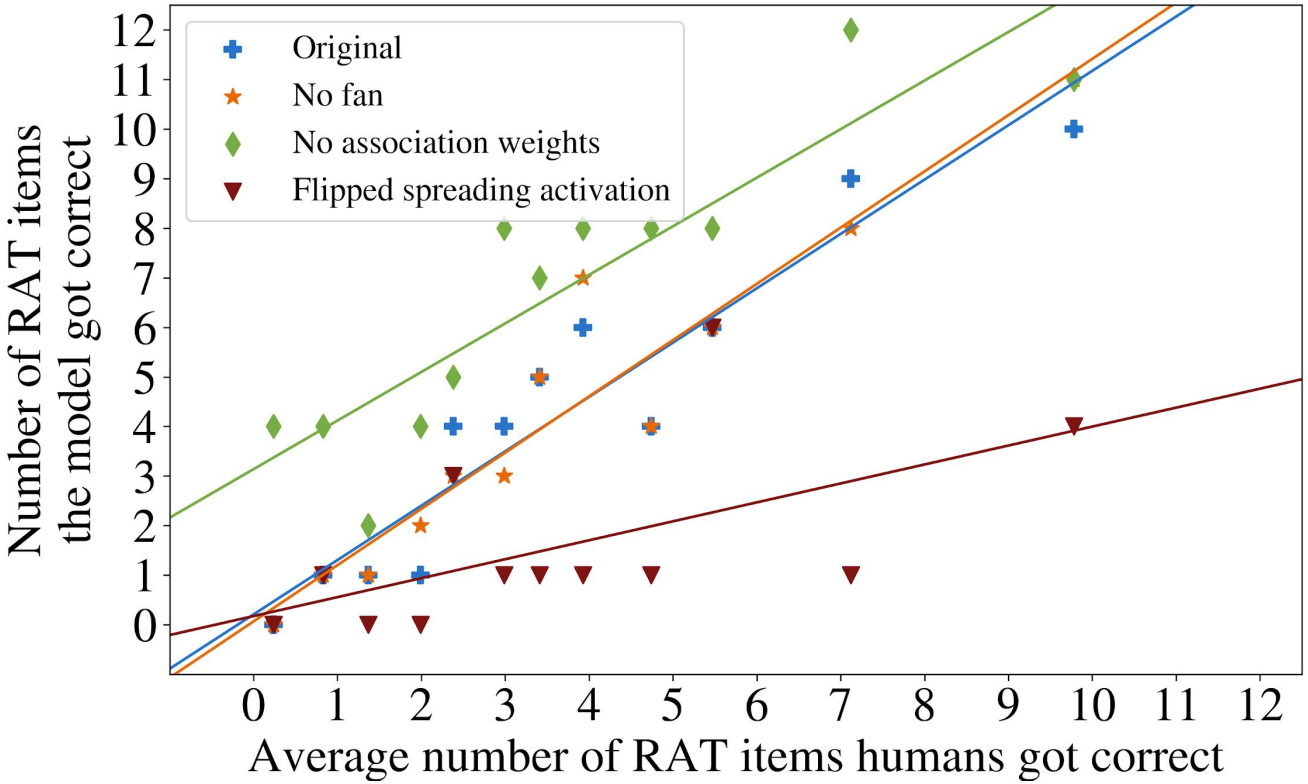
R^2 Values

Orignal: 0.92

No Fan: 0.89

No Weights: 0.83

Comparing models with binned human difficulty data. Using the HBC database and 15 second human data



R^2 Values

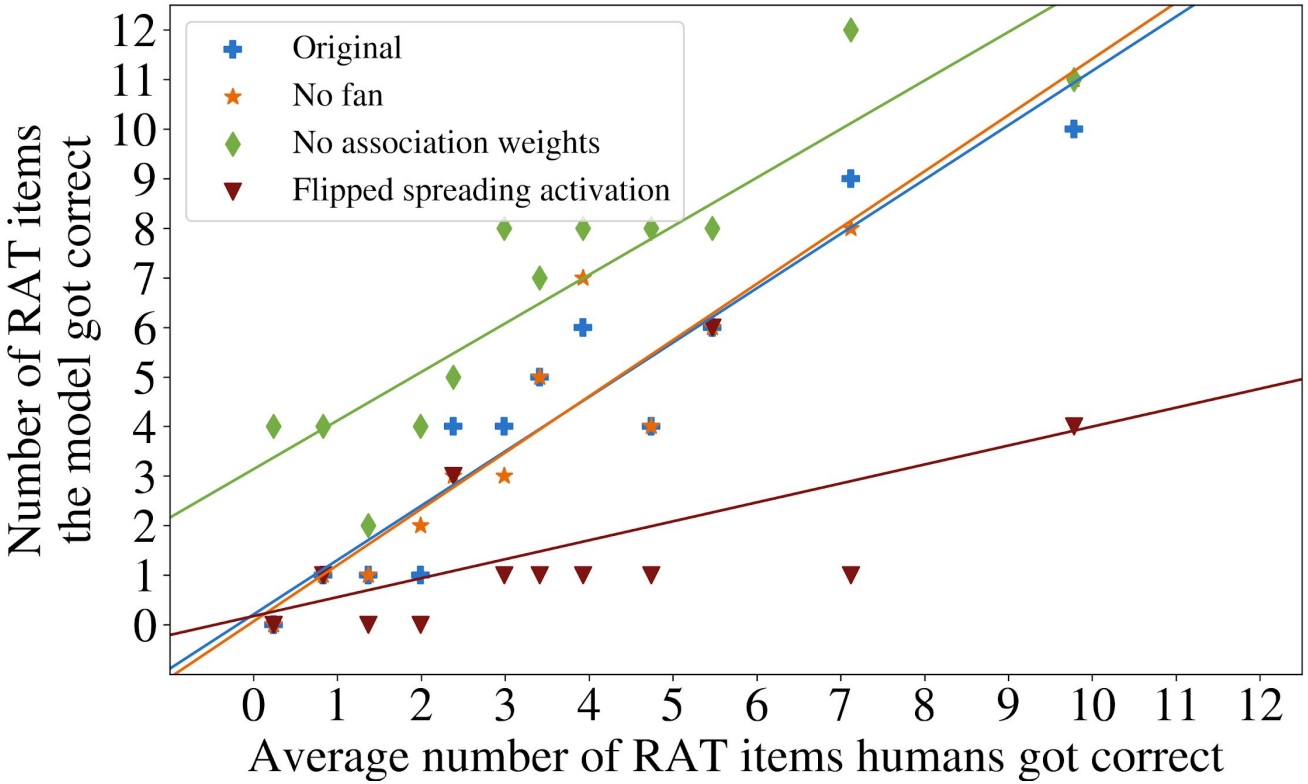
Orignal: 0.92

No Fan: 0.89

No Weights: 0.83

Flipped Spread: 0.19

Comparing models with binned human difficulty data. Using the HBC database and 15 second human data



R^2 Values

Orignal: 0.92

No Fan: 0.89

No Weights: 0.68

Flipped Spread: 0.19

Word Frequency Initialization: 0.92

Questions or Comments?

Gold Nugget

Consistent results with spreading activation

Coal

Removing fan doesn't impact results