Representation of knowledge

PSY 200

Greg Francis

Lecture 23

What is a shoe?

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Concepts

- What is the information in Long Term Memory?
  - May be several different types
- We have knowledge about the world
  - Due to personal experience
  - Or due to language
- Such information must be in some kind of format, which we call concepts
- But what are the concepts?
  - what is the concept of "dog," "walking," or "free-market capitalism"?

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Concepts

- We will look at three topics in concepts
  - Definitions (don't really work)
  - Prototypes (closer to how humans think)
  - Exemplars (more likely than prototypes)
- And then combinations of concepts
  - propositions

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Definitions

- Plato (and Socrates) spent a lot of effort trying to define terms like *virtue* and *knowledge*
  - they were largely unsuccessful
- the 20th century philosopher Wittgenstein wondered if definitions of even simple concepts were possible

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Definitions

- Consider the concept *shoe*, you might define it as Webster's Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
- Lots of shoes fit this definition

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Definitions

- Consider the concept *shoe*, you might define it as Webster's Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
- But now consider some situations and decide if they are really shoes
  - A shoe that is intended for display only

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Definitions

- Consider the concept *shoe*, you might define it as Webster's Dictionary does
  - A covering for the human foot, usually made of leather, having a thick and somewhat stiff sole and a lighter top.
  - Anything resembling a shoe in form, position, or use.
- But now consider some situations and decide if they are really shoes
  - a shoe filled with cement, which <u>cannot be worn</u>
  - a covering worn on the hands of a person without legs who walks on his hands
  - And this? →

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Definitions

- The difficulty is the same one that Plato and Socrates had trying to define *virtue*
  - for any definition you come up with, I can find examples that do not seem to fit the definition
- But we all know what a *shoe* is
  - so our knowledge of this concept must not be based on some precise definition
- Note, scientists can (sometimes) create precise definitions (e.g., a dog is defined by a DNA pattern or by mating abilities)
  - but the definition is somewhat arbitrary

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Prototypes

- Perhaps what defines a concept is similarity among its members
  - there may be no *absolutely necessary* characteristics
  - there may be no *absolutely sufficient* characteristics
- Prototype theory supposes that similarity is judged relative to a prototype example of the concept
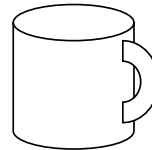 - e.g., an ideal, average, or most frequent version of the concept

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Prototypes

- In prototype theory it is possible for an object to be "more" or "less" a certain concept
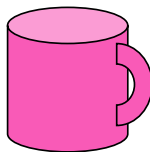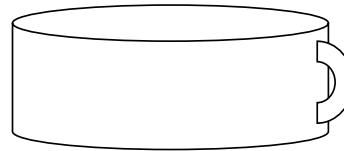- Consider the concept "coffee cup"
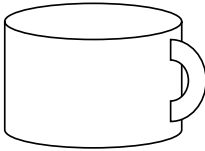
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Prototypes

- In prototype theory it is possible for an object to be "more" or "less" a certain concept
- Consider the concept "coffee cup"
  - and variations (some are "cup-ier" than others)

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Prototypes

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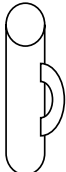 - and variations (some are "cup-ier" than others)

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Prototypes

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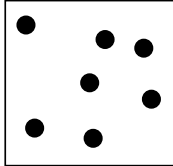
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Prototypes

- Lots of experiments suggest the role of prototypes
  - Posner & Keele (1968): learning category names for random dot patterns
  - Discriminate two sets of random dot patterns
  - Each pattern is a variation of one of two prototype patterns
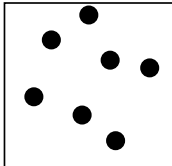
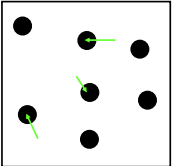*Purdue University*

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Prototypes
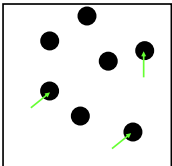
- Prototypes

A   B

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Prototypes

- variations are made by moving some of the dots

variant of A   variant of B

- subjects learn to classify many different variants
  - they never see the prototypes themselves

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Prototypes

- The key test is done after subjects learn to classify the variants
  - reaction time for judgment is recorded for stimuli they have never seen before
    - » new variants
    - » the prototypes
  - reaction time is faster for the prototypes
  - which suggests that the mental representation of the categories (concepts) are built to favor the prototype of the category

- Look at CogLab data

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Prototypes

- Results are based on data from 145 participants (39,285 for global).

Pattern type	Reaction time (ms)	Global RT(ms)
Prototypes	798	969
Variants	843	1000

- Unanswered by this (and many other) experiments is what a prototype is:
    - a "thing" that resides in memory and contains information about the category features?
    - the result of processing information?
- A bit of thought suggests it is the result of processing information

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Prototypes

- Consider the types of concepts you can have
    - and how specific they can be
- things: bird, dog, chair, shoe,…
- actions: walking, running, sleeping,…
- goal-derived: "things to eat on a diet", "things to carry out of a house in case of a fire",...
- *ad hoc*: "things that could fall on your head", "things you might see while in Paris", "gifts to give one's former high school friend who has just had her second baby",...
- When studied, these concepts all seem to have prototype characteristics
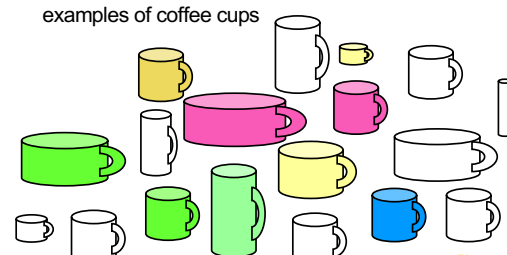
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Prototypes

- We can generate new concepts from old concepts
    - it's inconceivable that every possible prototype exists ready to be used
    - some must just be built as they are needed
    - perhaps even the prototypes for simple concepts like "bird" or "shoe" are also just built when they are needed
- A theory that can account for this processing approach is *exemplar theory*

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Exemplars

- A concept consists of lots of *examples* of the concept
    - e.g., a "coffee cup" concept might contain lots of examples of coffee cups

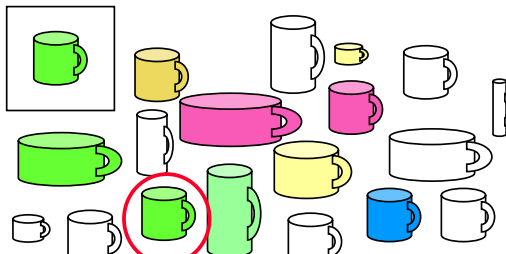
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Exemplars

- Comparing an object to see if it is a coffee cup involves comparing it to each example in memory and seeing if it matches anything well enough
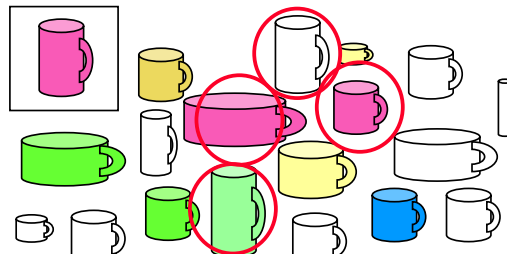

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Exemplars

- Even if it is a new object, it may match several exemplars well enough to generate an overall response to indicate it is a coffee cup

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Exemplars

- Some coffee cups seem prototypical because they match lots of exemplars
  - that's what defines a prototype

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Exemplars

- Unlike prototype theory, exemplar theory also contains information about the variability of examples within a concept
- Thus, we know that pizzas have an average size of 16 inches but can come in lots of different sizes
- And we know that foot-long rulers have an average size of 12 inches, but essentially no variability in size

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Complex associations

- How do we represent a concept that involves combinations of concepts?
  - e.g., "Dogs chase cats."
  - e.g., "Last Spring, Jacob fed the pigeons in Trafalgar Square."
- Need to identify the role of each concept

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Propositions

- Higher order ideas
  - things doing something
- Statement that is either true or false
  - things cannot be judged true or false
  - e.g., Book, Albert, Threw, Professor, Test, Gave
  - consists of an ordered list of concepts
    - e.g., (relation:X, Agent:Y, Object:Z)

  Albert threw the book.

  (relation:*Threw*, Agent:*Albert,* Object:Book)

  (Threw, Albert, Book)

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Proposition

- Network Representation
  - The proposition connects the appropriate concept nodes

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Proposition

- Network Representation
  - The proposition connects the appropriate concept nodes

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Proposition
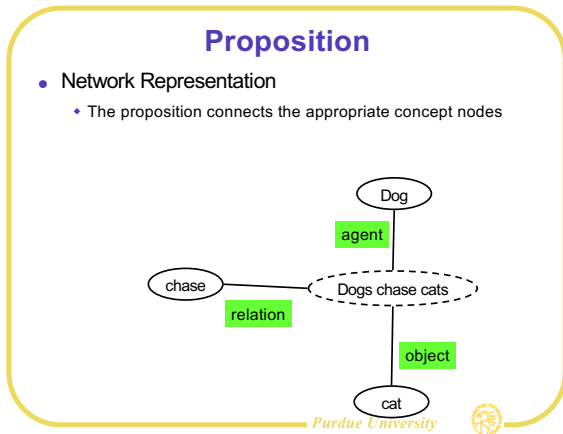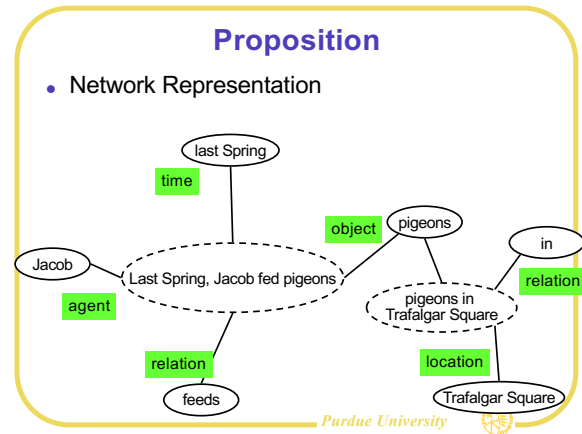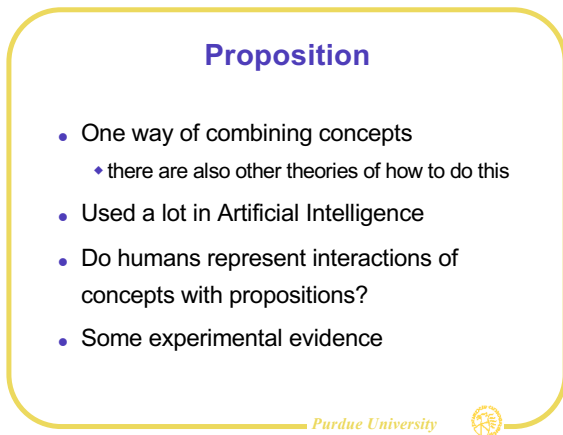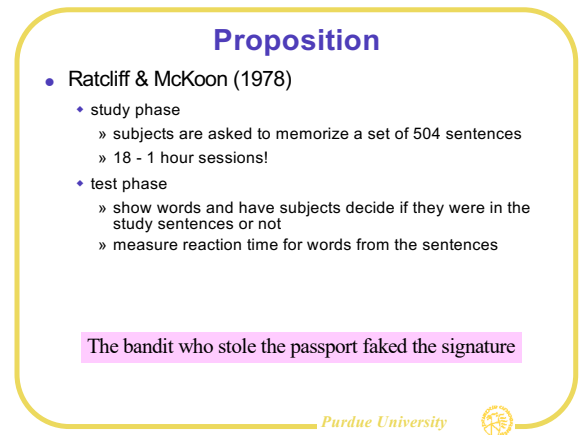
- Network Representation
  - The proposition connects the appropriate concept nodes

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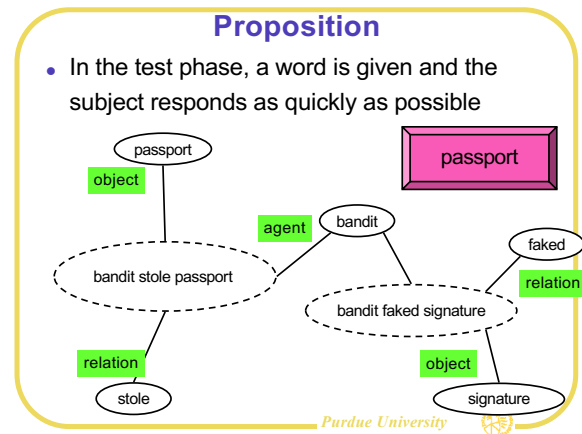### Proposition

- Network Representation

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Proposition

- One way of combining concepts
  - there are also other theories of how to do this
- Used a lot in Artificial Intelligence
- Do humans represent interactions of concepts with propositions?
- Some experimental evidence

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Proposition

- Ratcliff & McKoon (1978)
  - study phase
    » subjects are asked to memorize a set of 504 sentences
    » 18 - 1 hour sessions!
  - test phase
    » show words and have subjects decide if they were in the study sentences or not
    » measure reaction time for words from the sentences

The bandit who stole the passport faked the signature

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Proposition

- Network Representation

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Proposition

- In the test phase, a word is given and the subject responds as quickly as possible

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Proposition

- In the test phase, a word is given and the subject responds as quickly as possible

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Proposition

- The expectation is that activation will flow through the entire proposition that includes this word

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Proposition

- So, if the next word is part of the same proposition, a subject will respond even faster

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Proposition

- If words are from different propositions, no priming

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Proposition

- In the test phase, a word is given and the subject responds as quickly as possible

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Proposition

- Activation will flow through the entire proposition that includes this word

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Proposition

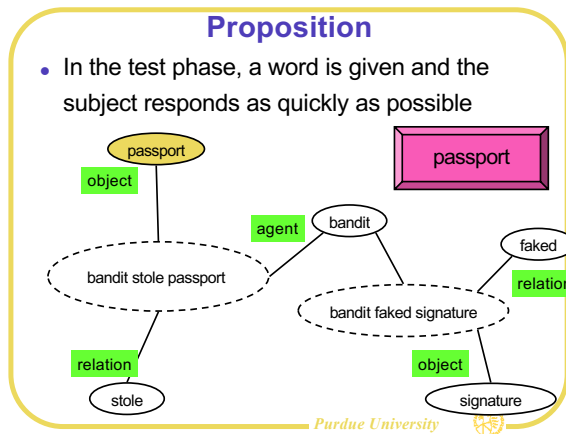- When the next word is shown, its node has not been primed, so it responds more slowly

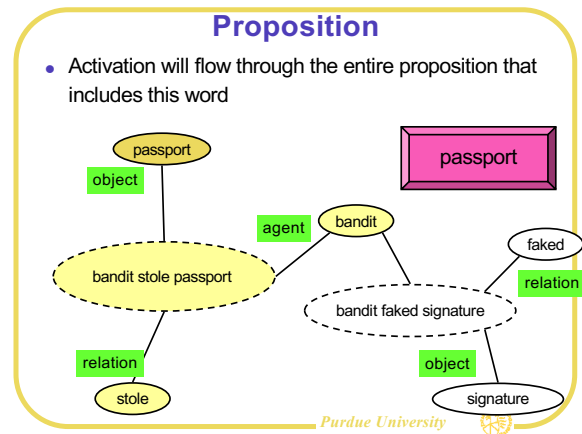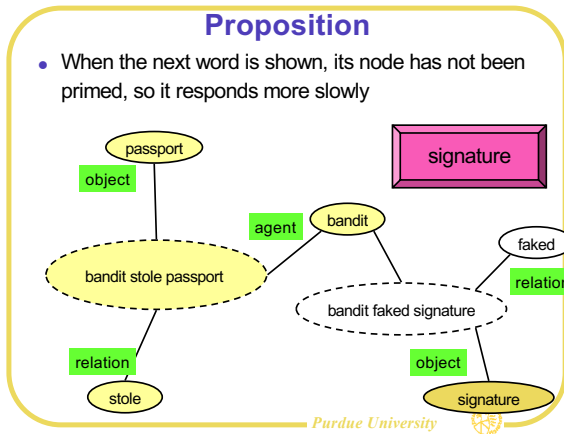*43*

Proposition

- Test Phase : Priming Task
  - ◆ compare RTs for second in a pair of words
  - ◆ within a common proposition (bandit -- passport)
  - ◆ between propositions (passport -- signature)
  - ◆ not related in sentence (horizon -- signature)
  - ◆ interested in RT to *second* word in each pair
- Ratcliff & McKoon (1978)
  - ◆ results
    - » within same proposition words: 561 msec
    - » between proposition words: 581 msec
    - » unrelated: 671
  - ◆ evidence of priming by propositional activation
- We *think* in propositions!

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Conclusions

- Concepts
  - ◆ definitions
  - ◆ prototypes
  - ◆ exemplars
- Propositions
  - ◆ Evidence we think in terms of propositions

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Next time

- Other types of knowledge
- Mental images
  - ◆ mental rotation
  - ◆ mental scaling
  - ◆ limitations of

- CogLab on Mental rotation due!
- *Is a picture in your head like a picture in the world?*

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