

Thinking and Problem Solving

Thinking

Thought

- Cognition—mental activities involved in acquiring, retaining, and using knowledge
- Thinking—manipulation of mental representations to draw inferences and conclusions.
 - Mental processes directed at a goal or purpose.
 - 2 kinds of mental representations:
 1. Mental image—representation of objects or events that are not present
 2. Concepts – mental category we form to group objects, events, or situations that share common characteristics or features.

Mental Image

- Mental Image – mental representation of an object or event not physically present.
- Mental imaging works similar to actual visual imaging.
- Mental images are constructed and therefore subject to error.

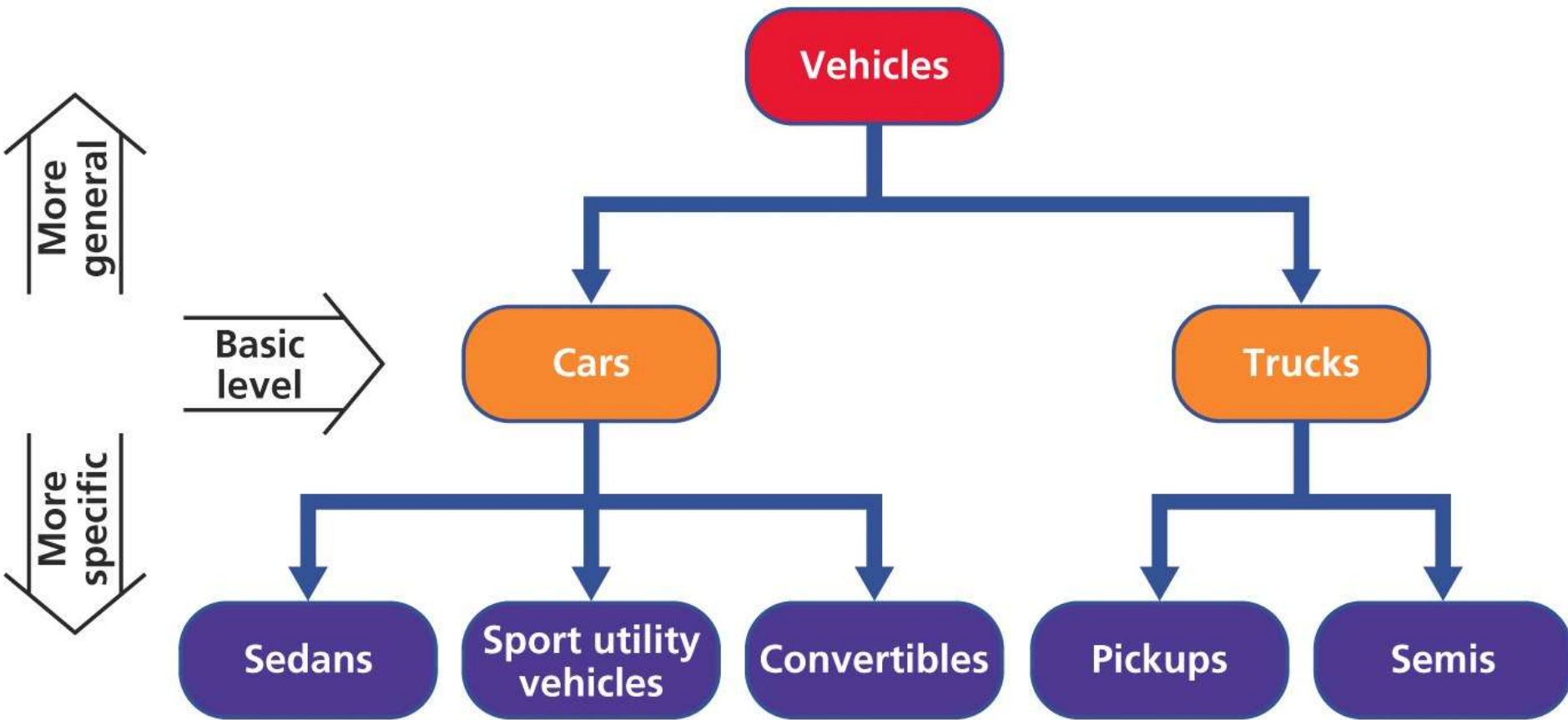
Concepts

- Concept—mental category we form to group objects, events, or situations that share common characteristics or features.
- Three Types of Concepts:
 1. Formal concept
 2. Natural concept
 3. Prototype

Concept Hierarchy

- A means to keep mental information organized from basic concepts to specific ones
- Move from basic category to more specific subordinate categories.

Concept Hierarchy



Examples of Concepts

- **Formal concept**— rigid rules or features that define a particular concept.
 - All or nothing categorization process
 - Categories for solid, liquid, or gas
- **Natural concept**—Eleanor Rosch said these form from everyday experience and do not have boundaries that are sharply defined
 - Members of these share a kind of “family resemblance” that helps us to recognize items that belong in the same category, even if they are not identical.
 - Example: space shuttle & hot air balloon are both examples of the natural concept “aircraft”

Prototype

- A **prototype** is an early sample, model.
- A typical best example of a particular thing
- The closer a new object is to our concept prototype the easier it is to categorize it
 - If an object has four wheels and doors it probably fits our prototype for...



Types of Thinking

- Convergent Thinking – focused on finding a particular answer to a problem
- Divergent Thinking – Thinking Creatively to generate as many possible answers to a question or problem as you can.
“Brainstorming”
- Incubation – Leave the problem for a time, allowing their minds to work on it without conscious effort. (Can led to Insight)

More Faulty Thinking

Hindsight Bias

- “Knew it all Along”
- When we learn the outcome of an event or solution to a problem, we are convinced the answer was quite obvious.
- Understanding of a situation or event only after it has happened or developed.



Dunning-Kruger Effect

- “Illusory Superiority”
- People who are bad at something often think they are good at it.
- Their incompetence keeps them from realizing they are incompetent.



Problem Solving



Problem Solving

What is a Problem?

A problem arises when a living creature has a goal but does not know how this goal is to be reached.

What is Problem Solving?

Problem Solving is the process of working out or discovering how to reach such a goal.



Ways of Problem Solving

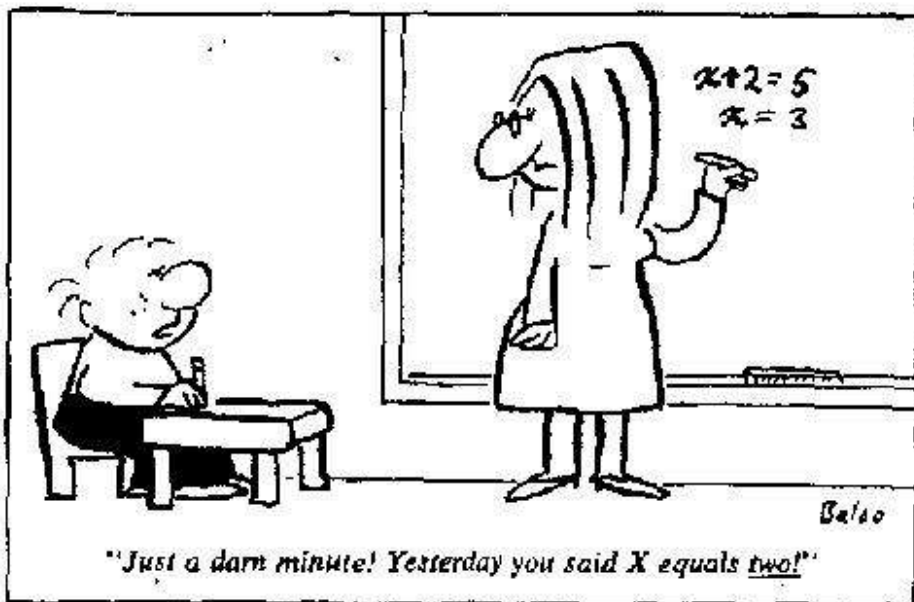
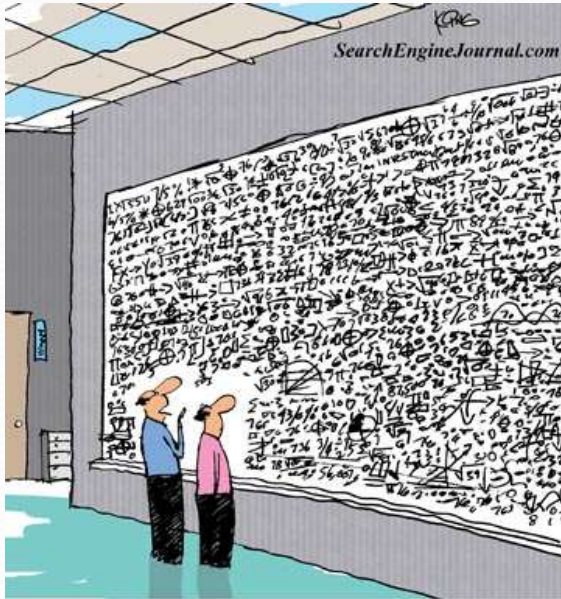
- Trial & Error
- Algorithms
- Heuristics

Trial & Error

- Trying a variety of solutions and eliminating those that don't work.

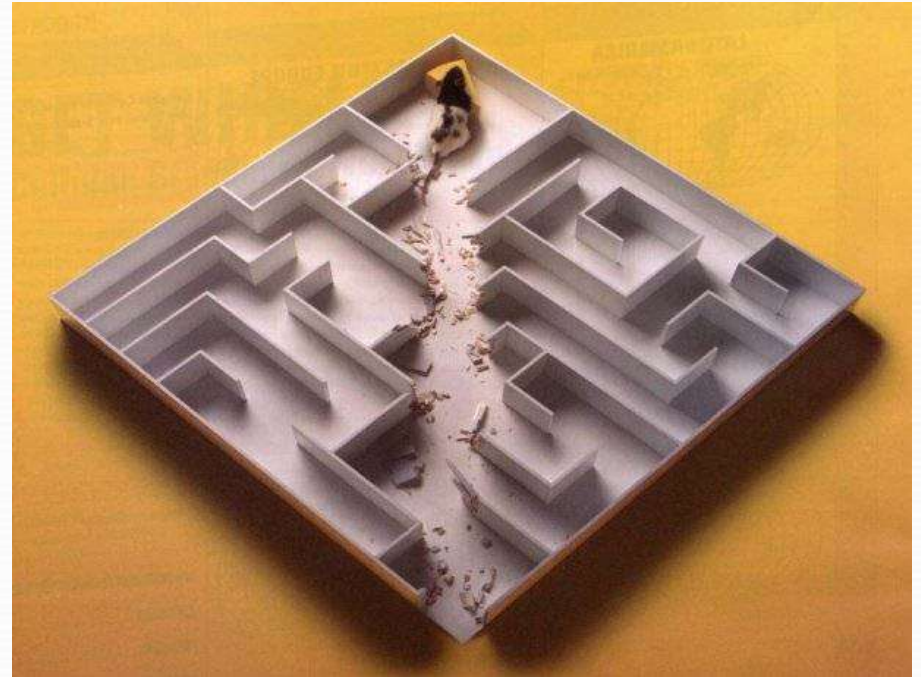
Algorithms

- A rule that guarantees the right solution to a problem.
- Usually by using a formula.
- They work but are sometimes impractical.



Heuristics

- A rule of thumb that generally, but not always, can be used to make a judgment to solve a problem.
- It is fast, but is...
- Prone to errors



Two ways we use Heuristics

- Subgoals – divide the problem into to smaller more manageable parts
 - As you solve each subproblem you get closer to solving the larger problem.
- Working Backward – determine the steps to reach your goal starting from the end point. (i.e. making a budget).



Heuristics can lead to Overconfidence...



- Our confidence is not a good indicator of how right we are.
- **Belief Perseverance**- maintaining a belief even after it has been proven wrong.
- **Belief Bias**- People will tend to accept any and all conclusions that fit in with their systems of belief, without challenge or any deep consideration of what they are actually agreeing with.

Hurdles to problem solving

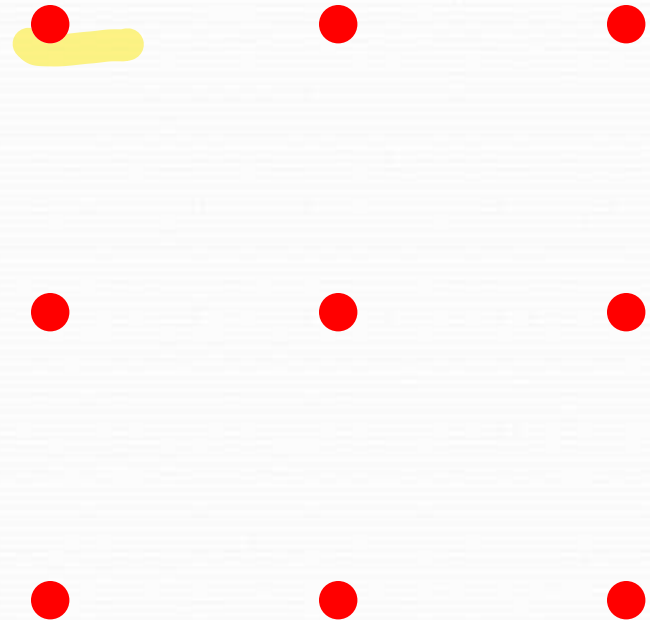


Mental Set

- A tendency to approach a problem in a particular way that has worked in the past
- A well-established habit of perception or thought
- The set may or may not be helpful in solving a new problem

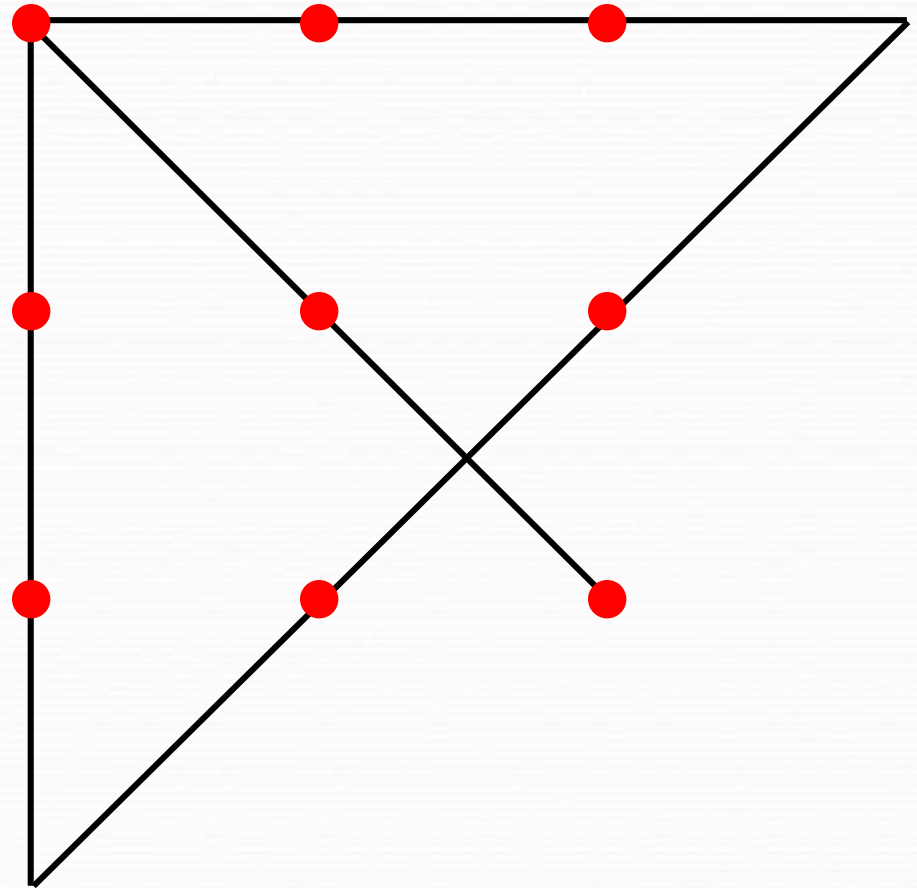
Nine dots problem

- Without lifting your pencil or re-tracing any line, draw four straight lines that connect all nine dots

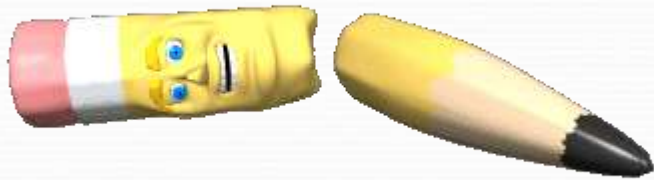


Nine dots mental set

- Most people will not draw lines that extend from the square formed by the nine dots
- To solve the problem, you have to break your mental set & the implicit assumption you have to stay within the dots.



Functional Fixedness



Think of as many uses as
you can for a

- The inability to see a new use for an object.



MACGYVER

All he needed was a ball-point pen and a paper clip.

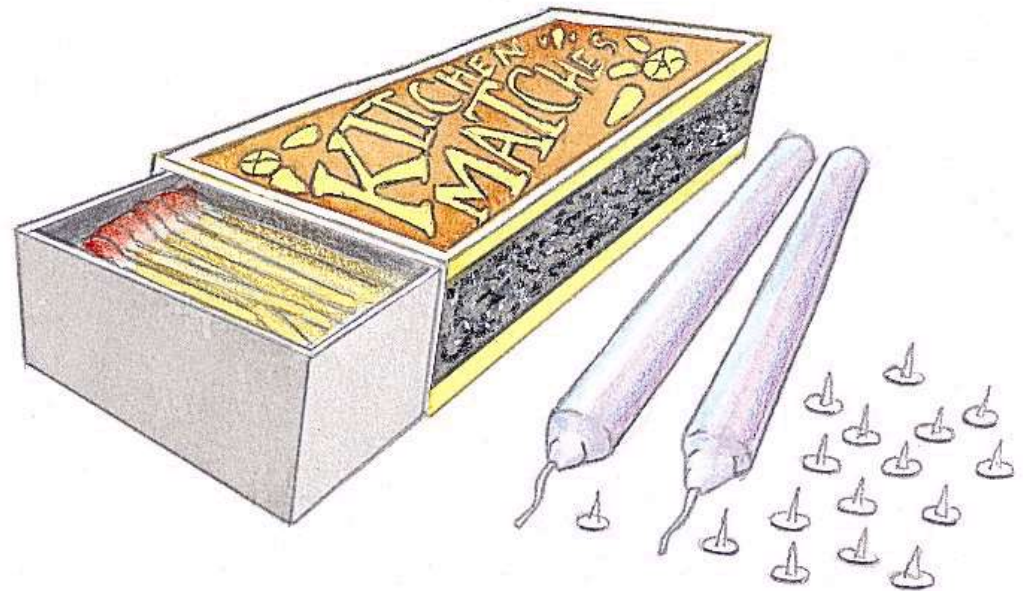
Functional Fixedness

- Type of mental set
- Inability to see an object as having a function other than its usual one
- Have to unlock the door?
 - Use a credit card.
- Tighten a screw without a screwdriver?
 - Use a coin!



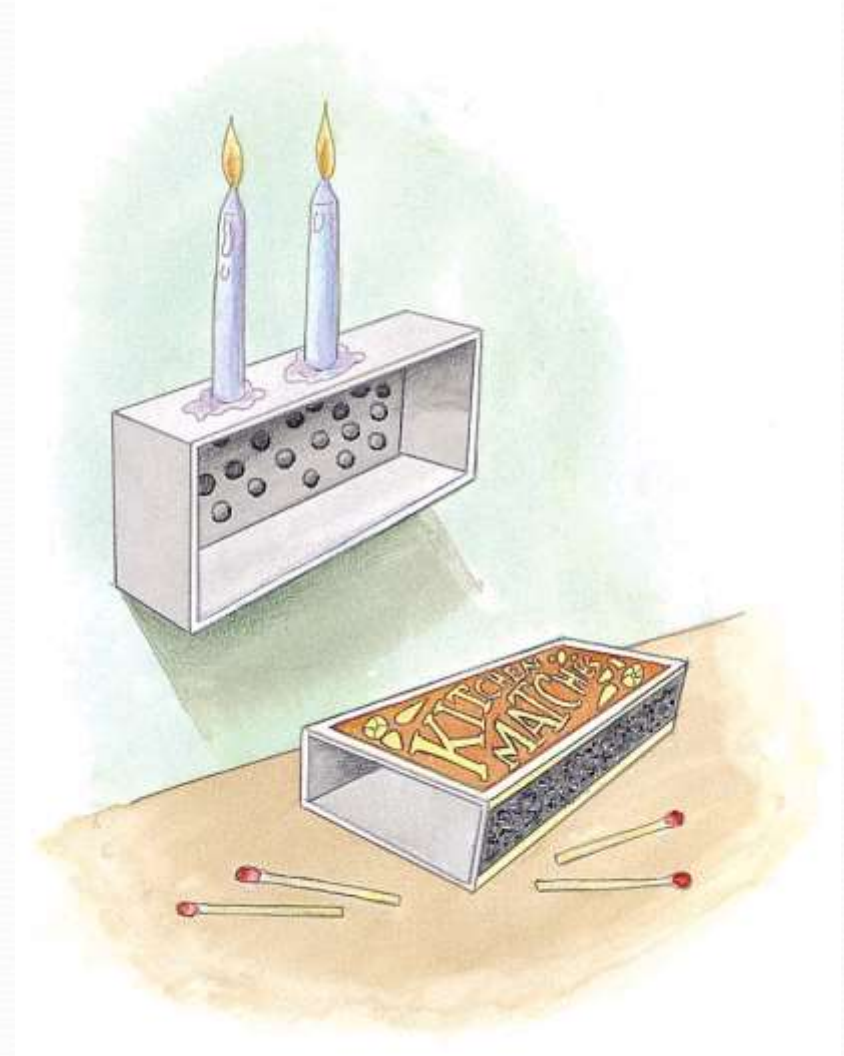
Mounting candle problem

- Using only the objects present on the right, attach the candle to the bulletin board in such a way that the candle can be lit and will burn properly



Answer to candle problem

- Most people do not think of using the box for anything other than its normal use (to hold the tacks)
- To solve the problem, you have to overcome functional fixedness



Confirmation Bias

- Tendency to search for, interpret, favor, and recall information in a way that confirms one's preexisting beliefs or hypotheses.
- We look for evidence to confirm our beliefs and ignore evidence that contradicts them.

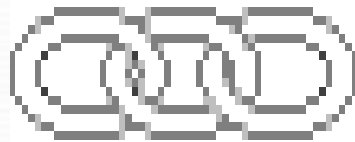
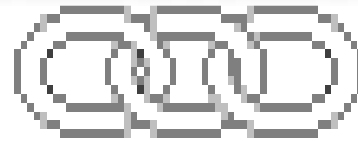
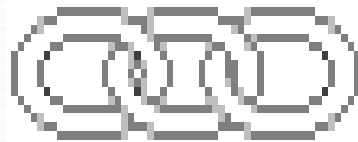
Framing

- The way a problem is presented can drastically effect the way we view it.

Strategies for solving problems

1. Break mental sets – be creative!
2. Find useful analogy
3. Represent information efficiently
4. Find shortcuts
5. Establish sub-goals
6. Turn ill-defined problems into well-defined problems

Rs 2 for breaking Rs 3 for joining total: Rs 15





- H L A C K

- M R E A F

- R W T E A

- E R G E N

- T H I N G

Problem space theory by Newell and Simon

- People solve problems by searching in a *problem space*. The problem space consists of the initial (current) state, the goal state, and all possible states in between. The actions that people take in order to move from one state to another are known as *operators*.
- Consider the eight puzzle. The problem space for the eight puzzle consists of the initial arrangement of tiles, the desired arrangement of tiles (normally 1, 2, 3....8), and all the possible arrangements that can be arrived at in between.

Problem space theory by Newell and Simon


- However, problem spaces can be very large so the key issue is how people navigate their way through the possibilities, given their limited working memory capacities. In other words, how do they choose operators? For many problems we possess domain knowledge that helps us decide what to do. But for novel problems Newell and Simon proposed that operator selection is guided by cognitive short-cuts, known as heuristics.

Problem space theory by Newell and Simon

- The simplest heuristic is *repeat-state avoidance* or *backup avoidance*¹, whereby individuals prefer not to take an action that would take them back to a previous problem state. This is unhelpful when a person has taken an inappropriate action and actually needs to go back a step or more.
- Another heuristic is *difference reduction*, or *hill-climbing*, whereby people take the action that leads to the biggest similarity between current state and goal state.

- A more sophisticated heuristic is means-ends analysis. Like difference reduction, the means-ends analysis heuristic looks for the action that will lead to the greatest reduction in difference between the current state and goal state, but also specifies what to do if that action cannot be taken. Means-ends analysis can be specified as follows:

1. Compare the current state with the goal state. If there is no difference between them, the problem is solved.

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2. If there is a difference between the current state and the goal state, set a goal to solve that difference. If there is more than one difference, set a goal to solve the largest difference.
 3. Select an operator that will solve the difference identified in Step 2.
 4. If the operator can be applied, apply it. If it cannot, set a new goal to reach a state that would allow the application of the operator.
 5. Return to Step 1 with the new goal set in Step 4.

CREATIVITY



What Is Creativity? (1 of 9)



Describable and Satisfying:

- ✓ Novel: *unique, new, innovative, different, imaginative, non-typical, unusual.*
- ✓ Useful: *responds to a need, has some utility or value, answers a question.*
- ✓ Understandable: *not the result of chance, reproducible.*

Through novel, creativity is describable and satisfying.




Be Creative!

- Choose the goal of creativity
- Reinforce creative behavior
- Engage in problem finding
- Acquire relevant knowledge
- Try different approaches
- Exert effort and expect setbacks

How to solve problems creatively:

- Make sure you represent the problem in the right way!
 - i. Don't assume restrictions that aren't stipulated
 - ii. Do represent everything explicit in the question
 - iii. Do compare the structure of the problem with similar ones
- Then generate lots of creative ideas with:
 - i. Associative techniques
 - ii. Analytic techniques
 - iii. Brainstorming
 - iv. Role Playing



Association: There are three types of associative thinking. This type of thinking is basically a linking process either through similarity, difference, or contiguity. For example, contiguity finds solutions from things that are connected through proximity, sequence, and cause and effect.

Analytical Thinking: This thinking method is based on analysis. It is the most conventional and logical of all the methods and follows a step by step pattern.

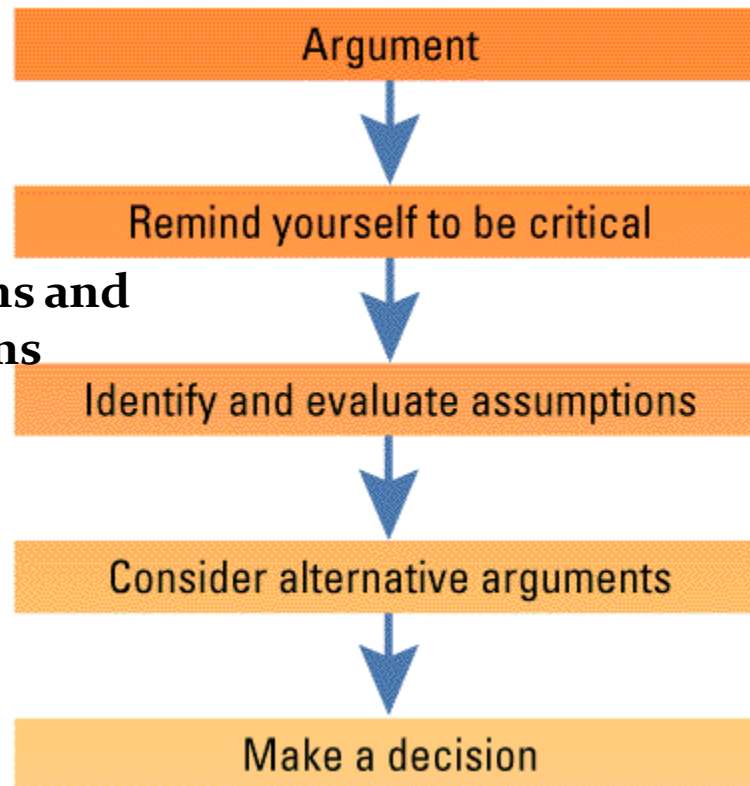
- a. Examine each cause of the problem. Then for each cause, based on your direct knowledge and experience, list the solutions that logically would seem to solve the problem.
- b. Check the possible solutions you arrive at with the research you have compiled on how the problem was solved by others.

Solving Problems and Making Judgments

Steps in Critical Thinking

§ Critical Thinking

The process of solving problems and making decisions through careful evaluation of evidence



Q1. Which of the following is the best example of a well-defined problem?

- a. creating a guest list for a party
- b. finding a detour around a traffic problem
- c. **constructing a proof in algebra**
- d. writing a paper for your cognition class
- e. figuring out how to tell your mother that you eloped

Q2. A tendency to adopt a certain framework, strategy, or procedure, which can become an obstacle to successful problem solving, is called:

- a. **mental set.**
- b. functional fixedness.
- c. well-defined thinking.
- d. ill-defined thinking.
- e. procrastination.

Q3. The string problem often generates _____ when participants do not think to use the screwdriver as a pendulum.

- a. **functional fixedness**
- b. mental set
- c. incomplete representations
- d. reasoning by analogy
- e. means-end analysis

Q4. _____ involves appropriate novelty in generating solutions.

- a. Intelligence
- b. Genius
- c. **Creativity**
- d. Mental disorder
- e. Bizarre thinking

Q5. _____ is defined as “going beyond the information given.”

- a. Problem-solving
- b. Reasoning
- c. Decision making
- d. Remembering
- e. **Thinking**