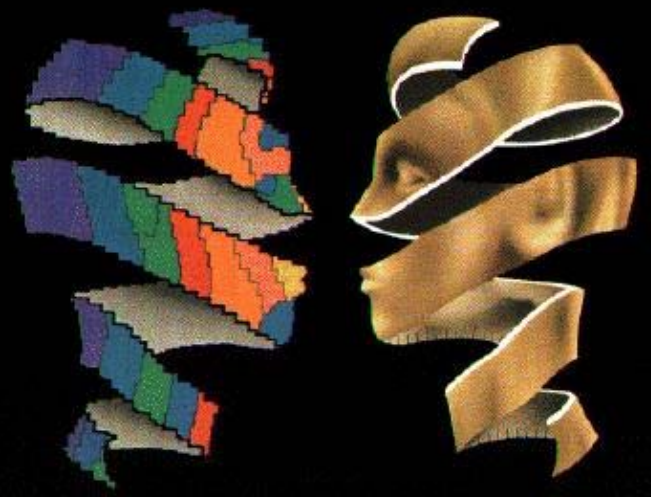
Problem Solving

- Overview.
- The Process of Problem Solving.
- The Role of Memory in Problem Solving.
- Problems in Problem Solving.
- Creativity.



Problem Solving

The processes involved in transforming one situation into another to obtain a goal.

- **Always involves three components:**

1. **Initial State.**
   - ***The*** **problem; a given set of information.**
2. **Goal State.**
   - **The solution (or a general description thereof).**
     - **Subgoals - smaller problems; useful 'stepping stones'.**
3. **Operators.**
   - **The specific actions that allow one to go from initial state to goal state.**

Problem Solving

- The *Tumor Problem…*

Problems

- **Always come in one of two forms:**

1. **Well-defined (structured) - initial state, goal state, and operators are all clearly defined.**
   - ***Chess; Crossword puzzles; Math problems*.**

2. **Ill-defined (open-ended) - states and operators are *not* clearly defined.**
   - ***Getting dinner; impressing boss; choosing career*.**

- **Most interesting real-world problems are ill-defined. Scientists have thus spent most of their time studying well-defined problems....**

Problems

- **Well-defined problems are of three types:**

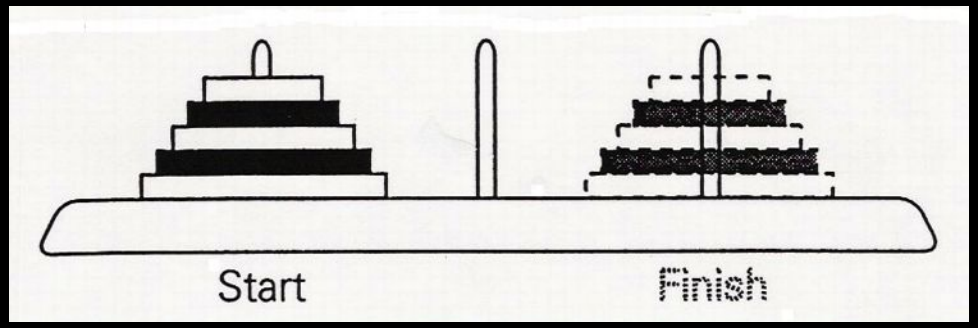
1. **Arrangement - reorganizing parts so as to obtain some pre-defined criteria.**
   - ***Anagrams; setting-up furniture in a new house*.**

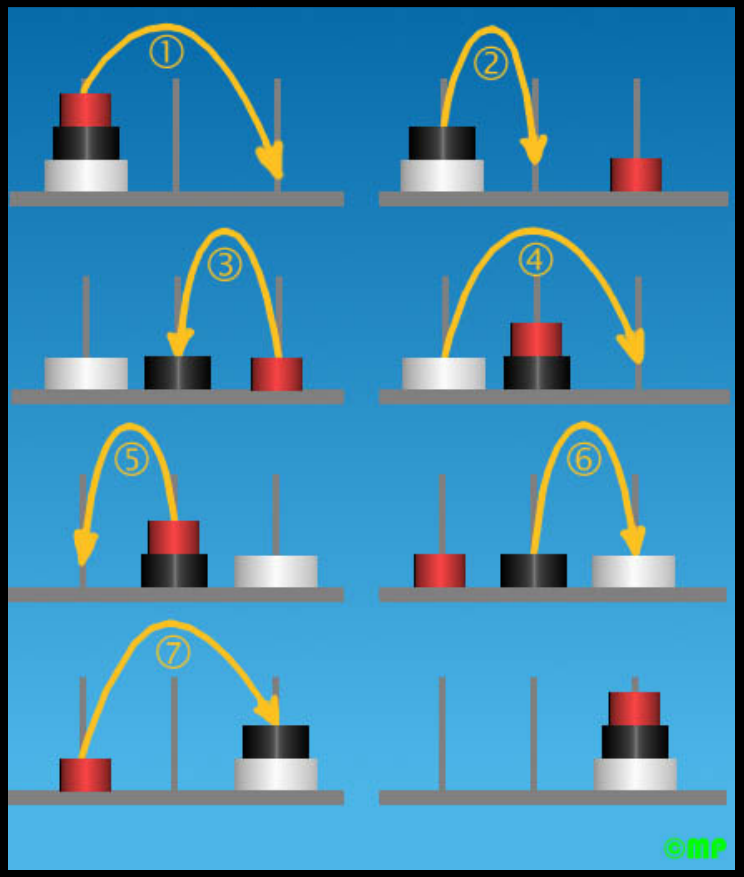
2. **Inducing Structure - here, the arrangement is fixed and problem is to discover the underlying structure.**
   - ***Series completion: 1, 2, 3, 5, 7, 11, 13, ?*.**
   - ***Analogies: Gangs are to Cops as Terrorists are to ?***
   - ***Discovering the structure of DNA.***

3. **Transformation - reaching a specific goal in a problem space using pre-specified operators.**
   - ***Learning to drive; Solving the Tower of Hanoi…***

Transformation

- **Tower of Hanoi:**





- **The goal of the puzzle is to reconstruct the tower on the peg on the right while respecting two rules of only moving one disk at a time and never placing a bigger disk on top of a smaller one.**

The Process of Problem Solving

Three steps: (1) Framing The Problem; (2) Generating Solutions; (3) Evaluating Solutions.

- **Framing / Understanding.**
  - **The most important step! This is "the box"!**
  - **Identifying the critical aspects of the problem, as well as the non-critical aspects.**
  - **How a problem is defined will determine if you solve it, and how you'll solve it.**

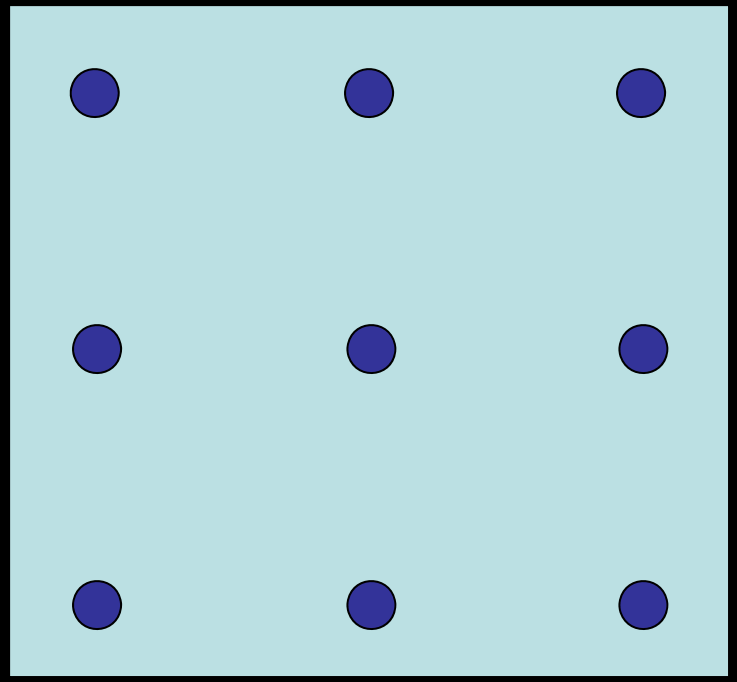
- Getting rid of a fly in your room.

- The nine-dot problem....

- The monk problem....

The Nine-Dot Problem

Connect all nine dots with 4 straight lines, without lifting your pencil.



The Monk Problem

A monk has decided to climb a mountain near his monastery. He starts his climb promptly at sunrise, but hikes at varying speeds, and stops at several points in his journey to rest and to meditate. He reaches the mountain top just as the sun is setting.

The next day, he begins his descent, again starting just at sunrise. Once again, though, he hikes at varying speeds, stopping several times to rest and meditate. His descent is somewhat faster, however, than his climb, and he reaches the monastery again at 3:30 P.M.

Is there any point, anywhere on the monk's path, that he reached at precisely the same time of day on his ascent and on his descent?

Generating Solutions

Two general ways to generate solutions.

- **Algorithms - Specific rules or procedures that *guarantee* a solution.**
- **Heuristics - Short-cuts that are fast and easy, but *don't* guarantee a solution.**

- **Hill Climbing.**
- **Generate-and-Test (Trial and Error).**
- **Means/end analysis.**
- **Working backwards.**
- **Using Imagery & Analogies.**

Heuristics

- **Hill Climbing: Choosing any available option that moves you closer to your goal.**
  - ***Finding a bad smell in your house.***
- **Generate-and-Test (trial-and-error): Generate a possible solution and test it.**
  - ***Arranging the furniture in your den.***
- **Means/end analysis: Identify (1) your current state, (2) where you want to be (your goal state), and (3) the means that will get you there.**
  - ***Getting a particular job, writing a class paper.***

Heuristics

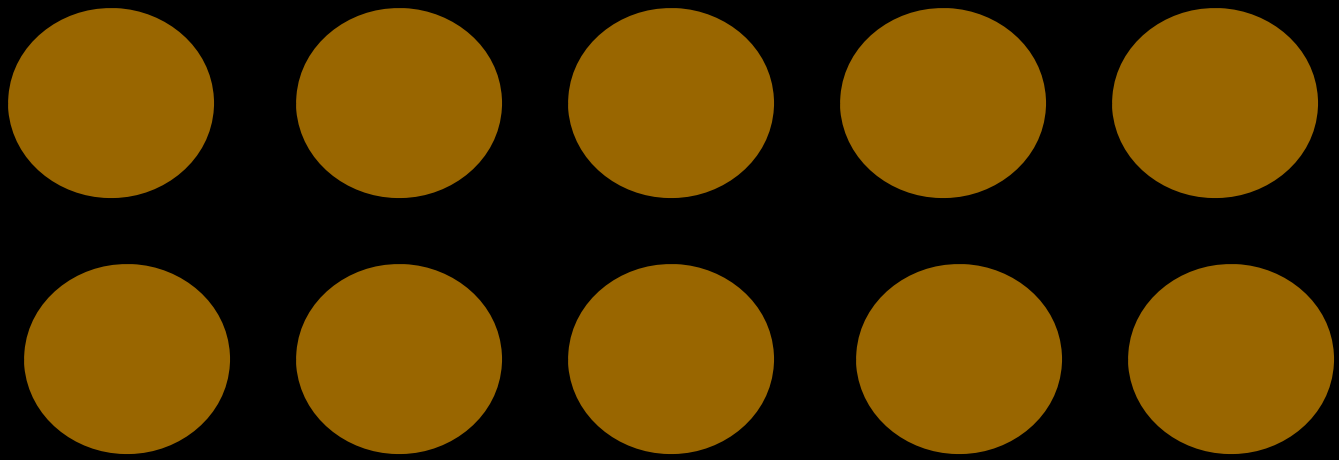
- **Working backwards: Similar to means/end. Reducing the difference between initial and goal states by working from both ends.**
  - ***Finding lost keys; the pennies problem.***

- **Using Imagery: Translating a problem into concrete (e.g., visual) terms.**
  - ***The Monk problem; taking another's perspective to describe a location or the appearance of something.***

Working Backwards

The Pennies Problem

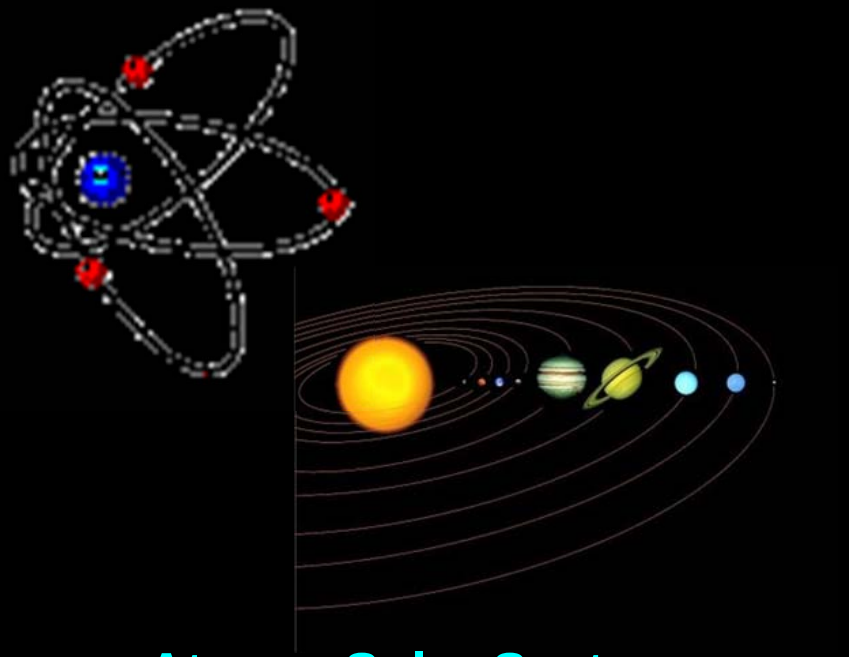
- Ten pennies are placed on a table. Two players pick up one, two, or three pennies on each turn. The goal is to make the other player pick up the last penny. Is there a strategy that will guarantee that you will win if you go first?



Using Analogies in Problem Solving

- **Using a familiar problem to understand a novel problem. Requires one to ignore the surface structure of the two problems and instead map the deep structure of the familiar problem onto the novel problem.**

Human Brain ~ Computer



Atom ~ Solar System

The Role of Memory in Problem Solving

- Using Analogies.
- Lessons from the study of chess.
- The problem of *inert knowledge*.
- Conditionalizing knowledge.

The Role of Memory in Problem Solving

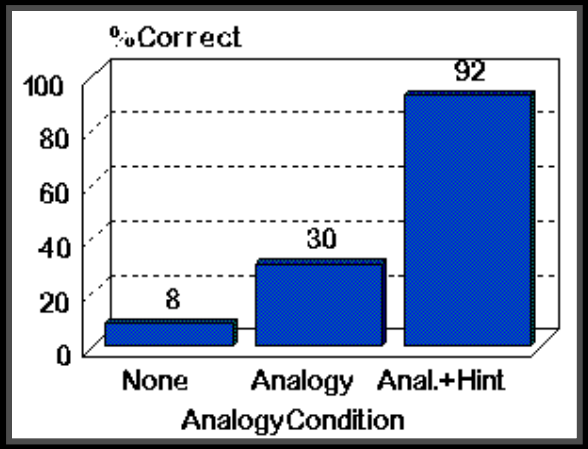
➢ Lessons from the study of chess:

- **Masters show better memory for real board configurations, but not non-meaningful configurations.**
  - **Masters create larger, more meaningful chunks than novices.**
  - **Chunks free up mental resources that can be used to consider relevant moves.**
- **Masters don't always consider more moves than novices, but do usually consider *better* moves.**
- **Situations (and thus solutions) are best stored in memory as *condition-action pairs*.**

The Role of Memory in Problem Solving

- A General wants to attack a fortress that has many roads leading to it.
- The Enemy has planted mines on the roads that will be triggered by large groups.
- However, large numbers of soldiers are necessary to capture the fortress.

- The problem of ***inert knowledge***:
  People often have appropriate solutions in memory (either directly or via analogies) yet fail to access that info when confronted with a problem.



The Role of Memory in Problem Solving

- **Conditionalizing knowledge: Getting around the problem of inert knowledge (and thus increasing spontaneous access) by acquiring knowledge in the form of condition-action (if-then) pairs.**
- **Adams et al. (1988):**
  - **"Uri Fuller, the famous Israeli superpsychic, can tell you the score of any baseball game before it begins. What's his secret?"**
  - **Fact-oriented: "Before any game is played, there is no score".**
  - **Problem-oriented: "You can tell the score of any game before it is played; because there is no score.**
  - **Problem-oriented > Fact-oriented on later problems.**

Problems in Problem Solving

- **Inert Knowledge** (the answer is in memory but it's not retrieved when the problem is presented).
- **Problem Presentation.**
- **Conceptual Blocks.**
  - **Persistence of set.**
  - **Functional fixedness.**

Problems in Problem Solving

- **Problem presentation: The way a problem is presented often has a large influence on whether, or how quickly, it's solved.**

E.g., Anagrams are more difficult to solve when presented as separate words:

***A psychological condition*:**

txaneyi vs. taxi yen

a rich zone ship vs. aishiezhrcpn

- **Problem solving is difficult when irrelevant information (*surface structure*) is emphasized and relevant information (*deep structure*) is difficult to identify.**

Problems in Problem Solving

- **Conceptual Blocks:** **Psychological factors that make problem solving difficult.**

1. **Persistence of (mental) set:** **The use of certain strategies or assumptions that, while appropriate for one type of problem, are not appropriate for the current problem and thus thwart its successful solution.**

What is the next letter in the sequence?

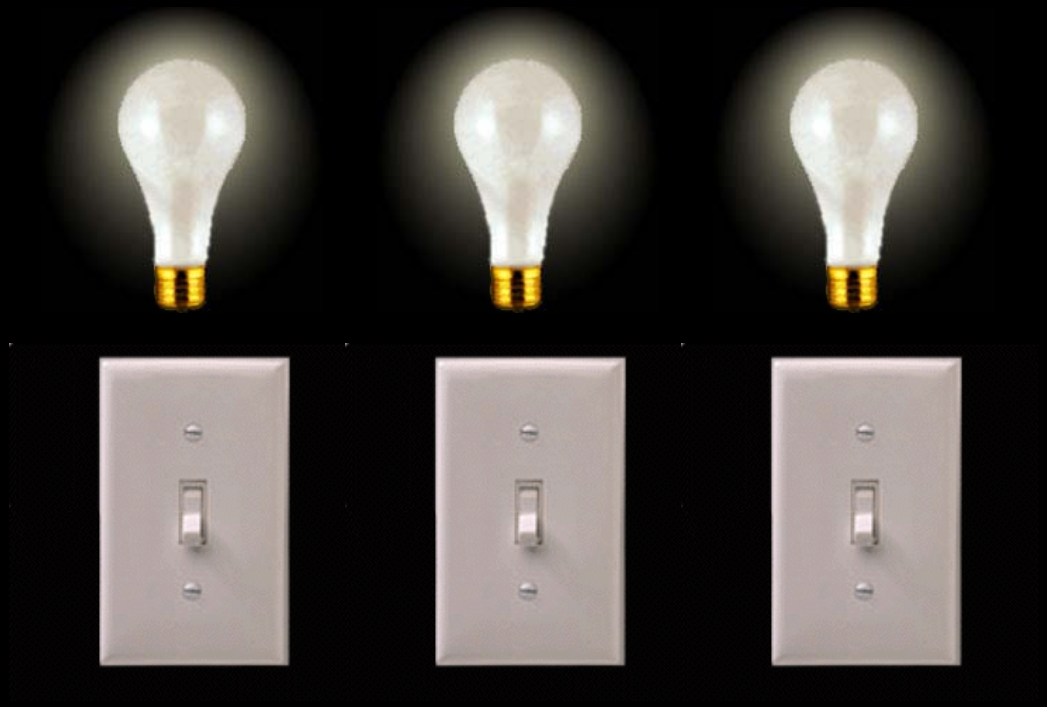
A, C, E, G, I, K …

J, F, M, A, M …

Problems in Problem Solving

- **Conceptual Blocks:** **Psychological factors that make problem solving difficult.**

2. **Functional fixedness:** **The tendency to rigidly think about an object as having only a limited set of uses.**



Creativity

- **Wallas' (1926) four stages of creative problem solving:**
  - **Preparation:** intense work on a problem; requires much prior training.
  - **Incubation:** putting the problem aside for a while.
  - **Illumination:** insight; when the solution suddenly "pops" to mind.
  - **Verification:** checking the validity of a solution.

Incubation

- **Why are problem solutions facilitated by a break?**

1. **Recovery from fatigue.**
2. **Forgetting inappropriate solutions, strategies, or assumptions.**
3. ***Consciously* working on the problem during the break.**
4. ***Unconsciously* working on the problem.**
   - **encountering relevant info during the break.**
   - **unconscious processing as allowing multiple interpretations of the same information.**

Review

- 3 Components to any problem: Initial State, Goal State, & Operators.
- 2 main kinds of problems: Well defined & Ill defined.
- 3 steps/processes in solving any problem: Framing, generating solutions, evaluating solutions.
- 6 heuristic strategies often used to solve problems: Hill climbing, generate-test, mean/end analysis, working backwards, using imagery & analogies.
- 3 major difficulties in solving problems: Inert knowledge, problem presentation, & conceptual blocks (persistent of set & functional fixedness).
- 4 stages involved in creative problem solving: Preparation, Incubation, Illumination, & Verification.

The End of PSY410!

Good Luck with your Posters, Papers, the Final Exam, and the Rest of Your Life!