Problem solving

Chapter 12

Learning Objective Topics

- What is problem solving?
- The Gestalt Approach
- Problem Solving Strategies
- Expertise
- Creativity
What is the difference between problem solving and decision making?

- **Problem solving**
  - Goal-directed
  - Sequence of operations
  - Cognitive operations
  - Sub-goal decomposition
  - Overcome obstacles along the way

- **Decision making**
  - Evaluate options
  - Choose between alternatives

How to problem solve

- **Well defined vs. ill defined problems**
  - Stated goal and clear start/end points?
- **Take a goal that you have.**
- **Make your own example of an ill vs. a well defined problem.**
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### Gestalt Psychologists

- Gestalt psychologists: whole more than collection of parts
- How can we be good problem solvers?
  - Good representation of the problem in our minds
Insight

- Insight problems: requires to perceive problem as a whole
- A-ha moment
- *Have you or someone you know had one? What happened?*
- Wertheimer (1945): requires you to break away from existing associations – see problem in new way

Insight

- Kohler (1927): primates
  - Hang food out of reach, but provide objects to use
  - Trial and error; methods varied
  - [http://www.youtube.com/watch?v=fPz6uv1bWZE&playnext=1&list=PLD19D8BD54C65811&feature=results_video](http://www.youtube.com/watch?v=fPz6uv1bWZE&playnext=1&list=PLD19D8BD54C65811&feature=results_video)
- Is insight a gradual process or sudden solution?
Six pennies

Begin

GOAL

Show how to move only 2 pennies in left diagram to yield pattern on the right.

“Warmth” ratings: 0 = cold; 7 = solved

Six pennies

Begin

GOAL

Show how to move only 2 pennies in left diagram to yield pattern on the right.
**Insight**

Move 3 circles to get triangle to point down

Insight problems: not aware that near solution

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**Incubation effects**

- **Chain problem: Silveira (1971)**
  - Speak out loud during problem solving
  - Control grp (1 ½ hr): 55%
  - Expmt’ l 1 grp (15min, ½ break, 15min): 64%
  - Expmt’ l 2 grp (15min 4hr break, 15min): 85%

- **Smith & Blakenship (1989; 1991)**
  - Fixation grp: given incorrect mental set
  - Greater benefit of break

- **Why?**
  - Relax mental set
  - Forget unimportant details
  - Reconstruct information; new perspective
  - Low arousal increases attention span allowing more info to be access simultaneously
Sleep and insight

- Presented with difficult problem
- Groups:
  - Sleep: 8hr
  - Night: 8hr awake
  - Day: 8hr awake

Problem solving

- How do you organize your thoughts when solving a problem?
- Problem representation
  - Symbols
  - Matrix
  - Tree diagram
  - Graph
Representation

- Mary is 10 years younger than twice Susan’s age. Five years from now, Mary will be eight years older than Susan’s age at that time.
- How old are Mary and Susan?
- Which type of representation could you use?
- Answer: ???

Representation: Symbol

- Mary is 10 years younger than twice Susan’s age. Five years from now, Mary will be eight years older than Susan’s age at that time.
- How old are Mary and Susan?
- Representation: Use symbols = aka algebra!
- \[ M = 2S - 10 \]
- \[ M + 5 = S + 5 + 8 \]
- \[ 2s - 10 + 5 = s + 5 + 8 \]
- \[ 2s - 5 = s + 13 \]
- \[ 2s = s + 18 \]
- \[ S = 18 \]
- \[ M = 18 \times 2 = 36 - 10 = 26 \]
- \[ 18 + 5 = 23 \]
- \[ 26 + 5 = 31 \]
There are 5 women (Cathy, Debbie, Judy, Linda, and Sonya). Each as a different breed of dog (beagle, retriever, lab, Irish setter, sheepdog), and each has a different occupation (clerk, executive, lawyer, surgeon, teacher). Each also has a different number of kids (0, 1, 2, 3, 4). Given the information below, figure out how many kids the person who owns the sheepdog has.

- The executive owns a retriever.
- The owner of the lab is a surgeon.
- Linda does not own the sheepdog.
- The owner of the retriever has 4 kids.
- Debbie owns the beagle.
- The owner of the sheepdog doesn’t have 3 kids.
- The teacher has no kids.
- Sonya is a lawyer.
- Judy has 1 kid.
- Cathy is a clerk.
- Cathy owns the Irish setter.

<table>
<thead>
<tr>
<th>Dog</th>
<th>Cathy</th>
<th>Debbie</th>
<th>Judy</th>
<th>Linda</th>
<th>Sonya</th>
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- Sonya is a lawyer.
- Judy has 1 kid.
- **Cathy is a clerk.**
- **Cathy owns the Irish setter.**

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### Matriz

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<td>Kids</td>
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### Matriz: answer

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Buddhist Monk Problem

Exactly at sunrise, a Buddhist monk set out to climb a tall mountain. The narrow path was not more than a foot or 2 wide, and it wound around the mountain to a beautiful, glittering temple at the peak. The monk climbed the path at varying rates of speed. He stopped many times along the way to rest and to eat. He reached the temple just before sunset. At the temple he fasted and meditated for several days. Then he began his journey back along the same path, starting at sunrise, and walking as before at varying speeds with many stops along the way. However his average speed going down the hill was faster than his average climbing speed.

Show that there must be a spot along the path that the monk will pass on both trips at exactly the same time of day.
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Problem solving strategies

- Algorithms
  - Exhaustive search; step-by-step procedure
  - Always correct
- Heuristics
  - Selective search; educated guess
  - “Rule of thumb”
Algorithm or heuristic

Unscramble

S P L O Y O C H Y G

- Algorithm
  - 907,208 combinations
- Heuristic
  - Throw out all YY combinations
  - other heuristics?

Problem solving strategies

- Means-end
  - Goal directed
- Define the problem space (including initial state, goal state, and intermediate states) and any operators.
- Create sub-goals to navigate the way through the problem space.
- Discuss the efficiency of the path taken.
Solve the following problem through means-ends analysis:

- On 1 side of the river are 3 Hobbits and 3 Orcs. They have a boat on their side that can carry 2 creatures at a time across the river. At no point can Orcs out number Hobbits on either side of the river or they will eat the Hobbits. How do you get all 6 creatures across the river?

H H H O O O

Hobbits and Orcs: Means-end approach

- The problem can be solved in a minimum of 11 steps
- Means-end analysis: Use sub-goals
- Intermediate steps between initial and goal states
- Trick: have to bring 2 creatures back to original side of river – move away from goal-state.
Tower of Hanoi: *Means end analysis*


**Goal:** Move all three rings from the left peg to the right peg:

**Rules:**

1. You can only move one right at a time
2. You can move only the top ring on a peg
3. You cannot put a larger ring on a smaller ring

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**Problem solving strategies**

- Working backward
  - Start at goal
Solve this by working backward:

- Water lilies are growing on Blue Lake. The water lilies grow rapidly, so that the amount of water surface covered by the lilies doubles every 24 hours.
- On the first day of summer, there was just one water lily. On the 90th day of the summer, the lake was entirely covered. On what day was the lake half covered?

Water lilies: working backwards

- Use working backwards strategy!
- If doubles every day
  - 90th day 100%
  - 89th day 50%
- Answer: 89th day!
Problem solving strategies

- Analogies
  - Use similar ideas to get solution

Radiation problem

- Suppose you are a doctor faced with a patient who has a malignant tumor in his stomach. To operate on the patient is impossible, but if the tumor isn’t destroyed the patient will die. A kind of ray, at a sufficiently high intensity, can destroy the tumor. Unfortunately, at this intensity the healthy tissue that the rays pass through on the way to the tumor will also be destroyed. At lower intensities the rays are harmless to healthy tissue, but will not affect the tumor. How can the rays be used to destroy the tumor without injuring the healthy tissue?

- Only 10% of participants solve problem
The General story

Consider the following information to assist you with the answer for the above problem. A general who hoped to capture a fortress needed a large number of soldiers but all the roads leading to the fortress were planted with mines. Small groups of soldiers could travel to the fortress safely, since the mines would only be detonated by larger groups. By dividing the army into small groups and sending each group by a different path, the general was able to capture the fortress when the small groups converged from all directions onto the fortress.

Analogy approach

- **Mappings**
  - Attack → Radiation
  - Fortress → Tumor
  - Attacking troops → Rays
  - Small bodies of men → Weak rays
  - Multiple roads → Multiple paths
  - Destroy villages → Damage healthy tissue

- **Holyoak & Thagard (1997)**
  - *Multiconstraint theory*
  - Problem similarity
  - Problem structure (mappings below)
  - Purpose of analogy (goals match)
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Expertise: Chase & Simon (1973)

Participants shown board then asked to recreate after all pieces were removed.

Chess masters remember more if it makes sense in the game.
When I say go write down the following sentence.

Why are experts faster problem solvers in their field?

- Expertise allows for:
  - More knowledge
  - Meaningful organization
    - Store more information
  - More time analyzing problems
    - Lesgold (1988): Think-aloud protocol
    - Experts spent more time understanding problem and less time implementing a strategy for solution
- Automaticity of certain operations
- No benefit for problems outside of area of expertise
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What could you use this for?

Should have less functional fixedness for less common object.
Influencing factors and bias

- Functional fixedness
  - Tendency to use objects in typical ways

Candle problem

- Given: box of tacks, book of matches, candle
- Goal: Attach the candle to the wall and light so it can burn properly
Candle problem

- Functional fixedness: “fixated” on box’s normal function
- Use tacks to attach box to wall

What is creativity?

- How would you get a message to a friend across campus? (you don’t have a cell phone)
- What defines a creative answer?
Creativity

- How can we define creativity as a single construct that covers Leonardo da Vinci to Stephen Hawking?
- 1 Definition: Production of something original and worthwhile; insightful
- Is creativity a special trait?
  - Or just expertise and commitment?
- Divergent thinking: unique way to think; solve open-ended problems

Activity 3: Add lines to the incomplete figures to make pictures out of them. Try to tell complete stories with your pictures. Give your pictures titles. You have 3 minutes.
Torrance test of creative thinking

- 3 parts to test:
  - Thinking Creatively with Pictures
  - Figural TTCT (abstract pictures and the examinee asked to state what the image might be)
  - The Verbal TTCT (presents a situation)
    - “If you could fly, what problems would it create for society?”
- Scoring:
  - Originality (More points if answer by 5% or less of Ss)
  - Fluency (# of responses)
  - Flexibility (More points if different categories)
  - Elaboration (More points for greater detail)

Torrance Tests of Creative Thinking

- **Activity 1**: Try to improve this stuffed toy rabbit so that it will be more fun to play with. You have 3 minutes.
- **Activity 2**: Just suppose that people could transport themselves from place to place with just a wink of the eye or a twitch of the nose. What might be some things that would happen as a result? You have 3 minutes.
- **Activity 4**: Add details to diamonds to make pictures out of them. Make the diamond a part of any picture you make. Try to think of pictures no one else will think of. Add details to tell complete stories with your pictures. Give your pictures titles. You have 3 minutes.
What might this be?

Expertise & Creativity

- What would be the advantages and disadvantages of having a novice vs an expert redesign the new iPhone?
- How would the following apply:
  - functional fixedness
  - creative cognition
  - surface feature vs. structural feature analysis
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Use different mental representations</td>
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<tr>
<td>Problem solving strategies</td>
</tr>
<tr>
<td>• Systematic plan</td>
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<tr>
<td>• Make inferences</td>
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<tr>
<td>• Create sub-goals</td>
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<tr>
<td>• Work backwards</td>
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<tr>
<td>• Search for contradictions</td>
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<td>• Search for relations (analogies)</td>
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<td>Overcome obstacles</td>
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<tr>
<td>• Functional fixedness</td>
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<td>• Negative or mental set</td>
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<tr>
<td>Utilize expertise and creativity</td>
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<tr>
<td>• Increase domain knowledge</td>
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<tr>
<td>• Increase automaticity to reduce memory load</td>
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<tr>
<td>Practice!</td>
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