Problem Solving Stages

Lesson VIII: Problem Solving
module 37

University of Idaho

- **Goals and operators**
  - When trying to solve a problem, the problem solver is trying to achieve a particular goal
  - Operators refer to all possible actions / paths a problem solver can take at each point in time

- **Well-structured problems**
  - Clear path to a solution
  - Goals and operators are known

- **Ill-structured problems**
  - Unclear path to a solution
  - Neither the goal, nor the operators, sometimes even the problem itself is clear

- **Well-structured problems**
  - 4 + 5 = ?
  - The ratio of blue socks to red socks is 5:1. How many socks do you have to pick blindfolded until you have at least one pair of the same color.
  - Cannibals and missionaries

- **Ill-structured problems**
  - Connect the following three points with four straight lines without moving the pen from the paper. **$10 challenge: can you do it with 3 straight lines (again, don't move the pen from the paper!)**

X   X   X

X   X   X

X   X   X

- **How do humans solve problems?**
  What are common problem-solving problems?

  – Stages in the problems-solving process
  – Problem solving strategies / heuristics
  – What is insight? Incubation?
  – Problems in problem solving:
    Mental set, functional fixedness, transfer
  – Analogies, problem structures
  – What makes an expert problem solver?

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- **Stage model according to Sternberg**
  - Problem identification
  - Problem definition and representation
  - Strategy formulation / implementation
  - Organization / interpretation of information
  - Resource allocation
  - Monitoring
  - Evaluation

- **The basic problem**
  - The ease of a solution often depends on
  - … how the problem is phrased (its surface structure)
  - … and what underlying assumptions are "imported"

- **Applied problems**
  - Most real problems are ill-defined
  - Sometime not even the outcome measure can be agreed upon (e.g., policy making)
  - Examples: how can we improve public education?

- **Identify the rule behind each sequence. What is the next number?**

- **What is the rule behind each sequence?**

1 2 3 4 5 6 7 _ ?

1 8 2 7 3 6 4 _ ?

8 5 4 9 1 7 6 _ ?

- **Deep structure vs. surface structure of a problem**
  - The deep structure of a problem refers to the the abstract form of the problem
  - The surface structure of a problem refers to the context and in which the problem is embedded

- **Isomorphic problems**
  - … are two problems which only differ in their surface structure, but are based on an identical deep structures
  - Example: An accountant can apply his business knowledge to all kinds of enterprises

- **Banana vs. milk example**
  - GOAL: you want to cut off a quarter of a banana
  - You first cut the banana in half
  - Then you cut one of the two halves
  - GOAL: you want to get a quarter of a gallon of milk and you only have two large, equal containers of which you don't know the volume
  - First step: you fill each of the containers so that they hold the same amount
  - Second step: you dump the content of one and distribute the remaining content between equally between the two containers

- **Accounting example**
  - An accountant can apply his business knowledge to all kinds of enterprises

- **Most well-defined problems can be represented in a problem space**
  - Define the current state
  - Define all possible transitions from one state to another state using the possible operators
  - Define the goal state

- **Problem solving then consists of …**
  - A path from the current state to the goal state
  - The transitions indicate the operators to be used
  - Computers can use algorithms to find possible paths by trying a huge number of paths

- **Humans often rely on heuristics**
  - *heuristic*: strategy that often works effectively

- **Analysis and hierarchical problem solving**
  - Breaking the problem up into sub-problems
  - Solve series of sub-problems until done

- **Heuristics**
  - Means-ends analysis: Reduce distance between current state and goal state
  - Working forward, backward
  - Generate and evaluate

- **Problem solving by analogy**
  - Try to find an analogous problem (isomorphic problem structure) that has been solved
  - Transform the solution to new problem

- **Which piece of information is relevant?**
  - Depending on the state of the problem solving process different parts of the given information are relevant or have to be sought out

- **Reinterpretation of information**
  - Value / interpretation of information can change:
  - Example: the series problem earlier in this module
  - The woman who married 20 men (textbook)

- **Strategic decisions - metacognition**
  - How to allocate time? Energy? Money?
  - Experts emphasize planning stage
  - Novices embark on "local" planning and execution

- **Monitoring**
  - State of the problem solving progress
  - Re-evaluation of problem solving approach
  - Evaluation of distance from goal
  - Estimate of problem completion

- **Is this solution a valid / workable solution?**
  - Checking solution against constraints
  - Reorganization of problem solving steps
  - Cleaning up

- **Feeling accompanying insight - "ah-ha" experience**
  - *Insight*: distinctive and sometimes seemingly sudden understanding of a problem or strategy to solve the problem. Often reconceptualizing a problem in a new way.
  - Pieces "fall into place" - Evaluation feels redundant.