**Problem Solving**

**Outline**
- Problem & problem solving
- 2-step process for problem solving
  - Model the problem
  - Derive the solution
- Guideline for modeling problems
- Guideline for finding solutions

**Problem & 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
  - A problem exists whenever one cannot go from the given situation to the desired situation simply by action
- What is Problem Solving?
  - Problem Solving is the process of working out or discovering how to reach such a goal
  - K. Dunker, On Problem Solving, (1945)

**Problem Solving Process**
- Solving real problems is a 2-step process
  - Step 1: Model the problem
    - Represent the problem in the proper way
  - Step 2: Find the solution
    - Come up with a creative solution to address the problem

**Archimedes' Puzzle**
- Archimedes was asked to determine whether silver has been substituted for pure gold by the goldsmith in the crown made for King Hiero II
- Gold & silver has different density, so the problem is to compare the volume of the crown with pure gold of same mass
  - The constraint is that he cannot damage the crown, so cannot melt it down into a regularly shaped body to measure its volume
- While taking a bath, Archimedes noticed that the water rose as he got in
  - Realized that this effect could be used to determine the volume of the crown
- The test was conducted successfully, proving that silver had been mixed in

**Guideline for Modeling Problems**
- Make sure you represent the problem in the right way
- Do not make unnecessary assumptions
  - Drop presuppositions that are not explicit in the original statement of the problem
- List all the facts & constraints
  - Represent everything explicit in the original statement of the problem
- Use priori knowledge
  - When representing a problem, look for structural similarities between this problem and one you know the answer to
DROP PRESUMPTIONS

- The 9 dot problem (Maier, 1931):
  - Connect all 9 dots with 4 straight lines
  - Cannot take your pen off the paper
  - The next line must start where the previous line finished
  - The dots are drawn on a flat, immovable surface
  - Cannot use a ridiculously big pen

REPRESENT EVERYTHING EXPLICITLY

- There are 3 houses, each of a different color, inhabited by men of different nationalities, with unique pets, drinks, & cars
  - The Englishman lives in the red house.
  - The Spaniard owns the dog.
  - The man in the green house drinks cocoa.
  - The Ukrainian drinks eggnog.
  - The green house is immediately to the right of the ivory house.
  - The owner of the Oldsmobile owns snails.
  - The owner of the Ford lives in the yellow house.
  - The man in the middle house drinks milk.
  - The Norwegian lives in the first house on the left.
  - The man who owns the Chevrolet lives in the house next to the house where the man owns a fox.
  - The Ford owner's house is next to the house where the horse is kept.
  - The Mercedes-Benz owner drinks orange juice.
  - The Japanese drives a Volkswagen.
  - The Norwegian lives next to the blue house.
  - Who owns the Zebra?

RELATE TO A KNOWN PROBLEM

- Can Fred know how old Ted's sons are based on this conversation?
  - Ted: All three of my sons celebrate their birthday today. Can you tell me how old each one is? (Ted is a bit weird)
  - Fred: Yes, but you have to tell me something about them...
  - Ted: The product of their ages is 36.
  - Fred: I need more info...
  - Ted: The sum of their ages is 13.
  - Fred: I need more info...
  - Ted: My oldest son has blue eyes.
  - Fred: That is sufficient!

GUIDELINE FOR FINDING SOLUTIONS

- Use two ways of thinking (Edward de Bono, 1967)
  - Employ creative (lateral) thinking to generate some novel ideas & alternative courses of action
  - Then employ critical (linear) thinking to evaluate them
- Techniques for generating of creative ideas:
  - Associative techniques
  - Analytic techniques (drill down)
  - Brainstorming
  - Role-playing
TECHNIQUES FOR GENERATING IDEAS

ANALYTIC DRILL DOWN
• Separate the problem into many smaller parts
• Linear thinking: go into the deep, analyze
• Try to really understand your problem: what is it about?
• This is what we are typically trained for

ASSOCIATIVE TECHNIQUES
• Compare something familiar to something unfamiliar:
  • Close analogy
  • Remote analogy
  • Forced analogy

WY SOLVING LOGIC PUZZLES BE IMPORTANT?
• An ability to solve logic puzzles is thought to be positively correlated with an ability to think creatively and solve problems of any kind
• Such a correlation is commonly believed to exist
• Whether or not it is truly exist is unproven
• Many universities & companies screen candidates on the basis of their ability to solve logic puzzles
• Employers care more about creative thinking & problem solving abilities in the workforce than any other general skill
• Creative thinking and problem solving abilities are among the most important skills sought after by universities

MICROSOFT INTERVIEW QUESTIONS
• You have 20 blue socks, 20 brown socks, & 2 black sock in a drawer in your room
• It is night time, and the room is completely dark
• How many would you have to take out to be sure you have 2 of the same colour?

• A mother sent her child to the lake and told him to bring back exactly 7 litres of water
• She gave him a 5 litre bucket & a 3 litre bucket
• How can the child measure out exactly 7 litres of water using nothing but the two buckets?