95-864 Heuristic Problem Solving

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Heuristics are rules of thumb that let us simplify problem solving processes and make them more tractable. While there is no guarantee that a heuristic approach to solving a problem will find the best solution, or even any solution, they often do provide a practical useable solution. In this course we will study the use of heuristics in problem solving by people and programs.

The course will start off by examining puzzle-based learning (www.PuzzleBasedLearning.edu.au)—a new and emerging model of teaching critical thinking and problem solving by examining the solution process to a range of puzzles. For example, consider the following:

- Given two eggs, for a 100 storey building, what would be an optimal way to determine the highest floor, above which an egg would break if dropped?
- Suppose you buy a shirt at a discount. Which is more beneficial to us: apply the discount first and then apply sales tax to the discounted amount or apply the sale tax first and then discount the taxed amount? What do stores do?
- If you have a biased coin (say comes up heads 70% of the time and tails 30%), is there a way to work out a fair, 50/50 toss?
- A $10 gold coin is half the weight of a $20 gold coin. Which is worth more: a kilogram of $10 gold coins or half a kilogram of $20 gold coins?
- A farmer sells 100kg of mushrooms for $1 per kg. The mushrooms contain 99% moisture. A buyer makes an offer to buy these mushrooms a week later for the same price. However, a week later the mushrooms would have dried out to 98% of moisture content. How much will the farmer lose if he accepts the offer?

What is common to all of the above? Apart from being fun to ponder, solutions to these puzzles exemplify several problem solving strategies. During the course we will examine a range of puzzles, brainteasers, and games. What general problem solving strategies can we learn from the way we solve these puzzles? Puzzles, such as the above, are also often used in IT company hiring interviews to evaluate ones general problem solving skills.

While a learning goal of PBL is to distill domain independent transferable heuristics for tackling problems, in the learning continuum of project-based and problem-based learning, puzzle-based learning forms a foundation [1,2]:

- Real World
  - Abstract/Model World
    - Working in teams
      - Identifying the question
    - Acquisition of Domain Knowledge
    - Critical Thinking
      - Logical Reasoning
    - Dealing with uncertainty and changing conditions
    - Reasoning with domain-specific methods
    - Abstract Reasoning
      - Domain Independent

- Project-Based Learning
- Problem-Based Learning
- Puzzle-Based Learning


Interspersed with our discussion of puzzle-based learning we will study various methods for augmenting human decision making. We will focus on the key ideas of several business intelligence technologies and the value they can bring to an enterprise. Some of the technologies we will select to study include classic symbolic AI methods (rule-based systems, case-based reasoning), connectionist approaches (neural nets), evolutionary approaches (genetic algorithms), inductive approaches of machine learning (nearest neighbor, support-vector machines), data mining (constructing decision trees and association rules), and collective intelligence methods (collaborative filtering). Depending on time constraints and course participants’ interests we will selectively examine a subset of these modern heuristics for decision support in the enterprise. We will be using several software systems and libraries implementing these methods. By running experiments with these systems and libraries we will focus on how these technologies can support decision making in tasks such as design, classification, clustering, prediction, optimization, and recommendation.


**Learning Objectives**

- Examine a range of general problem solving strategies that transcend disciplines
- Introspection, transference, and meta-level reasoning of one’s problem solving process
- Principles of modern heuristics such as evolutionary methods, collective intelligence etc.
- The application of modern heuristics for decision support

**Assessment**

Performance in the course will be assessed using a combination and subset of classroom participation, assignments, quizzes, exams, and projects.

**References**

2. Gardner, Martin. Many of his works.