Notes for Meeting 15
Creative Problem Solving

The Nature of Creativity

One distinguishing characteristic of human intelligence is the ability to exhibit creativity.

Creativity is the generation of some novel structure or behavior that achieves some goal or objective.

This capability comes into play in many fields: art, literature, architecture, science, and engineering.

For millenia, philosophers assumed that creativity was a mystical process that we cannot understand in rational terms.

But the definition above suggests that creative activity may be closely related to problem solving.

Creativity and Problem Solving

Recall that creativity is both goal-oriented and involving some form of novelty.

This has led Simon (1966) to hypothesize that:

- The same mechanisms that underlie everyday problem solving also support creativity.
- This suggests that creativity involves heuristic search through some problem space.

This is an empirical claim that could be false, but it has much to recommend it.

Weisberg (1993) presents historical and experimental evidence that normal problem solving accounts for creativity.

Creativity in Design

One broad area in which creativity has received substantial attention concerns DESIGN.

We can formulate the abstract task of design as:

- Given: A specification for some desired artifact;
- Given: A set of possible components or structures that can be used in the artifact;
- Given: A set of operations for extending, elaborating, or revising candidate structures;
- Generate: One or more structures that satisfy the specification for the artifact.

Although some work on design assumes basic problem-space search, other analyses give analogy a central role.

Also, studies of creative design suggest that problem FORMULATION is very important.

Insight in Problem Solving

Human problem solvers find some tasks, like the nine-dots puzzle or matchstick problems, to be inherently difficult.

In some cases, they cannot solve such problems without an external hint that suggests a solution they could not see before.

- These are often called INSIGHT problems because, when a person finds a solution, it arrives quite suddenly.

The Gestalt paradigm in psychology studied human behavior on such insight problems and attempted to explain it.

- Their account posited that insight involved SEEING a problem in a different way that enabled a solution.

This explanation seems related to the notion of problem formulation in information-processing models.

Problem Solving vs. Problem Formulation

Traditional work on problem solving assumes the availability of a problem space, but it does not explain its origin.

When humans are given a problem, they must move beyond the task specifications to CONSTRUCT a problem space.

- This step seems better viewed as problem UNDERSTANDING than as problem solving.

- Although one can formulate a problem in different ways, this seems more like INFERENCE than problem-space search.

- We can think of problem formulation as interpreting or parsing the task statement to produce a problem space.

This view is consistent with both the Gestalt treatment of insight problems and studies of creativity in design.

An Earlier Account of Insight

After reviewing examples of insight in mathematics and science, Hadamard (1945) proposed a four-stage theory:

- Preparation: Attempting to solve a problem by normal means but giving up after expending too much effort;

- Incubation: Temporarily abandoning the problem consciously, but continuing to consider it unconsciously;

- Illumination: Becoming aware of a potential solution when unconscious search finds a promising candidate; and

- Verification: Checking the candidate solution to ensure that it actually solves the problem.

These four stages reflect empirical regularities observed in science, but they posit implausible psychological mechanisms.

Alternative Accounts of Insight

Cognitive scientists have proposed more plausible explanations of creative insights:

- Simon (1966) explained incubation as selective forgetting and illumination as searching a new space enabled by acquired chunks;

- Langley and Jones (1988) explained illumination as problem-space search enabled by analogical spread of activation;

- Ohlsson (1990) proposed that insight involved problem space restructuring based on elaboration, reencoding, or relaxing of constraints.

The third alternative is most closely aligned with Gestalt theory and analyses of creativity in design.

Assignments for Meeting 16
Icarus Review and Practice Midterm

- Review the course notes in preparation for the practice midterm on 3/21/2001.

- Work on the fourth exercise (due 11:59 PM on 3/21/2011) and bring questions about it to class.