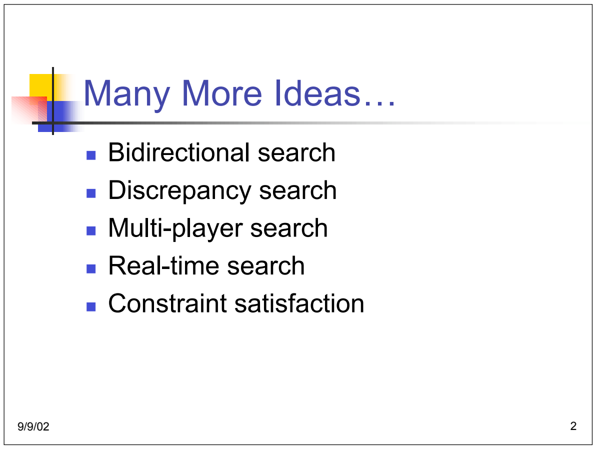
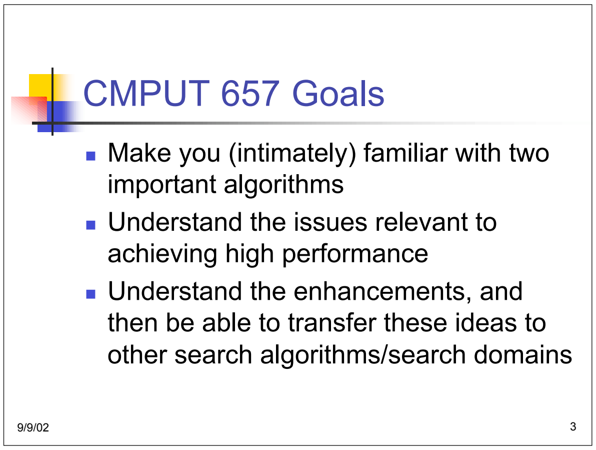
15. Perspectives

Jonathan Schaeffer
jonathan@cs.ualberta.ca
www.cs.ualberta.ca/~jonathan



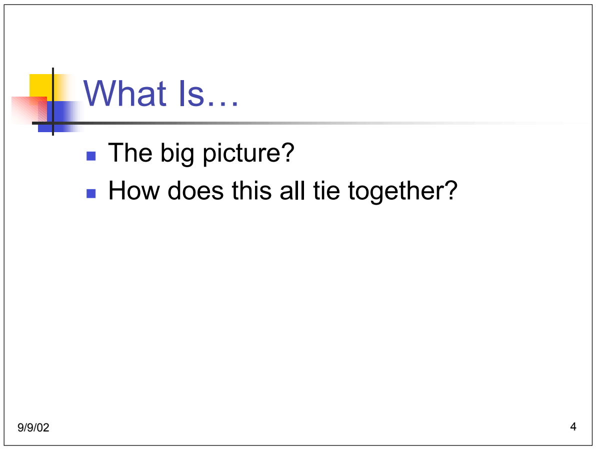
Many More Ideas…

- Bidirectional search
- Discrepancy search
- Multi-player search
- Real-time search
- Constraint satisfaction



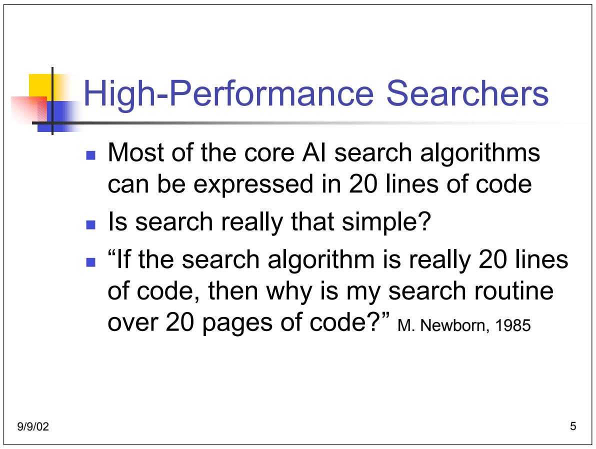
CMPUT 657 Goals

- Make you (intimately) familiar with two important algorithms
- Understand the issues relevant to achieving high performance
- Understand the enhancements, and then be able to transfer these ideas to other search algorithms/search domains



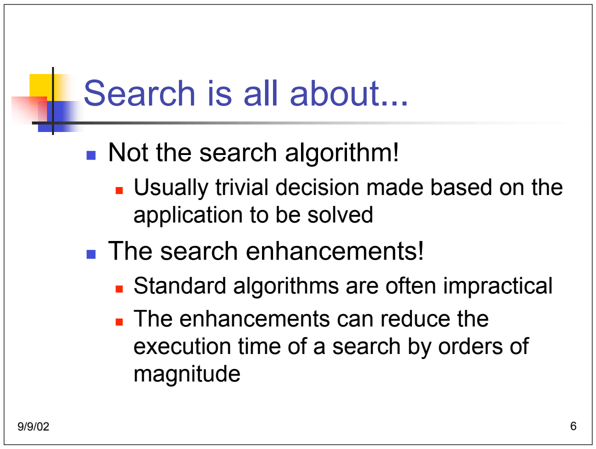
What Is…

- The big picture?
- How does this all tie together?



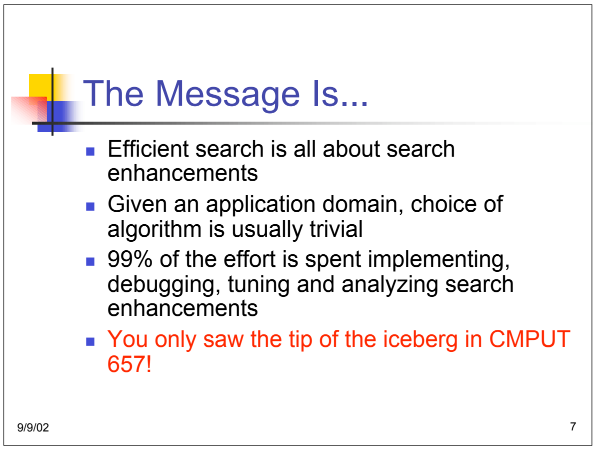
High-Performance Searchers

- Most of the core AI search algorithms can be expressed in 20 lines of code
- Is search really that simple?
- “If the search algorithm is really 20 lines of code, then why is my search routine over 20 pages of code?” M. Newborn, 1985



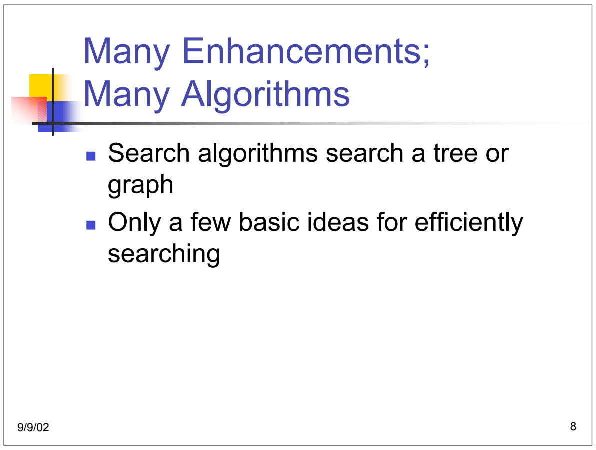
Search is all about...

- Not the search algorithm!
  - Usually trivial decision made based on the application to be solved
- The search enhancements!
  - Standard algorithms are often impractical
  - The enhancements can reduce the execution time of a search by orders of magnitude



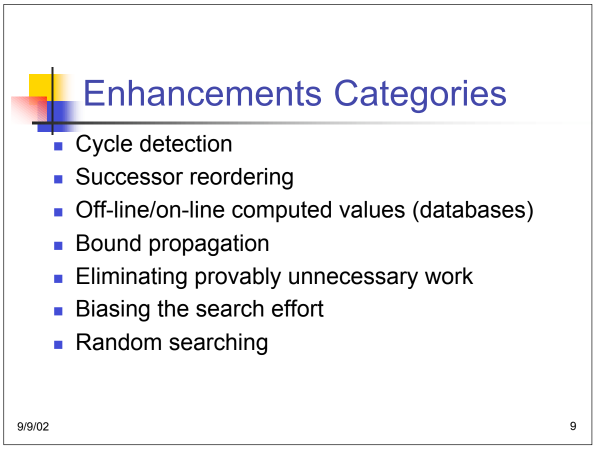
The Message Is...

- Efficient search is all about search enhancements
- Given an application domain, choice of algorithm is usually trivial
- 99% of the effort is spent implementing, debugging, tuning and analyzing search enhancements
- You only saw the tip of the iceberg in CMPUT 657!



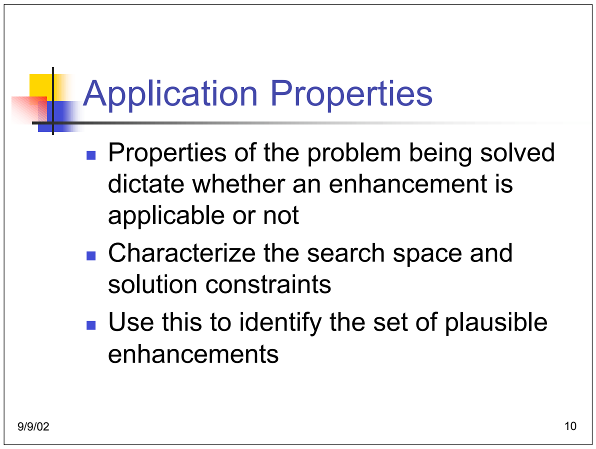
Many Enhancements; Many Algorithms

- Search algorithms search a tree or graph
- Only a few basic ideas for efficiently searching



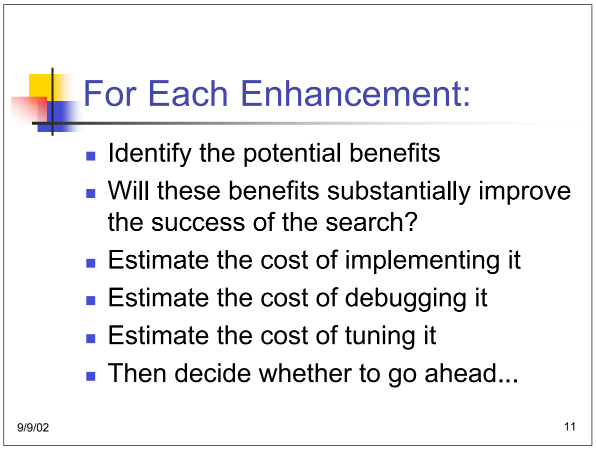
Enhancements Categories

- Cycle detection
- Successor reordering
- Off-line/on-line computed values (databases)
- Bound propagation
- Eliminating provably unnecessary work
- Biasing the search effort
- Random searching



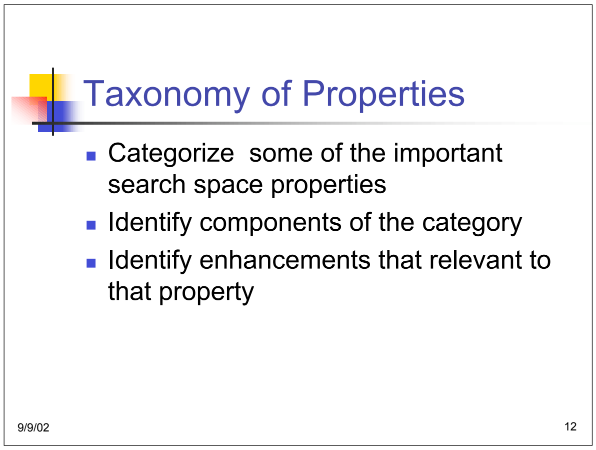
Application Properties

- Properties of the problem being solved dictate whether an enhancement is applicable or not
- Characterize the search space and solution constraints
- Use this to identify the set of plausible enhancements



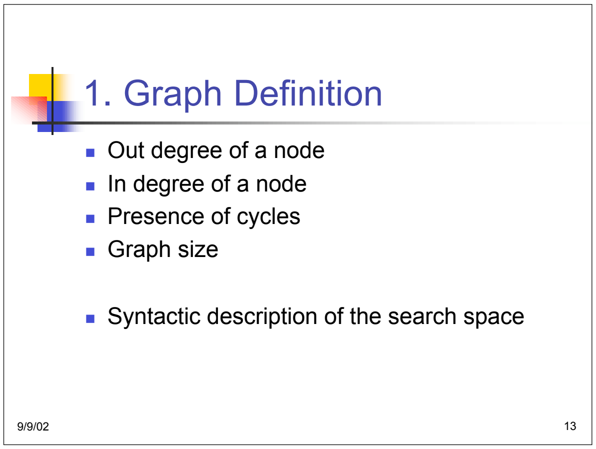
For Each Enhancement:

- Identify the potential benefits
- Will these benefits substantially improve the success of the search?
- Estimate the cost of implementing it
- Estimate the cost of debugging it
- Estimate the cost of tuning it
- Then decide whether to go ahead...



Taxonomy of Properties

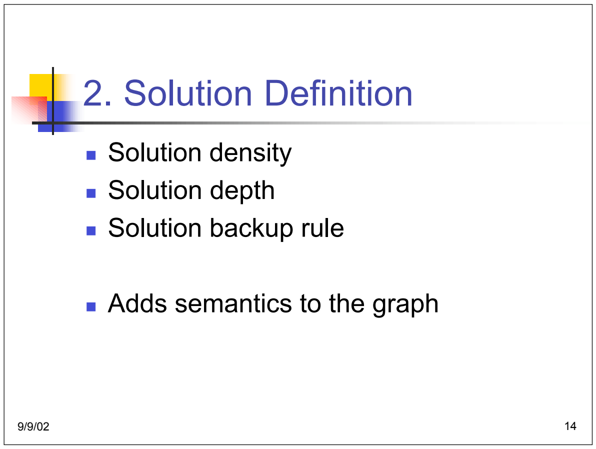
- Categorize some of the important search space properties
- Identify components of the category
- Identify enhancements that relevant to that property



1. Graph Definition

- Out degree of a node
- In degree of a node
- Presence of cycles
- Graph size

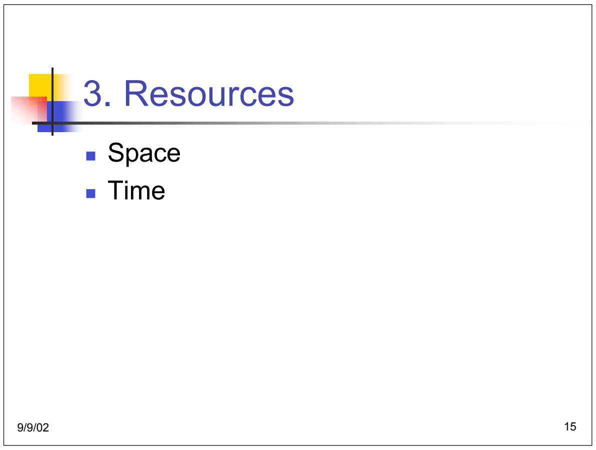
- Syntactic description of the search space



2. Solution Definition

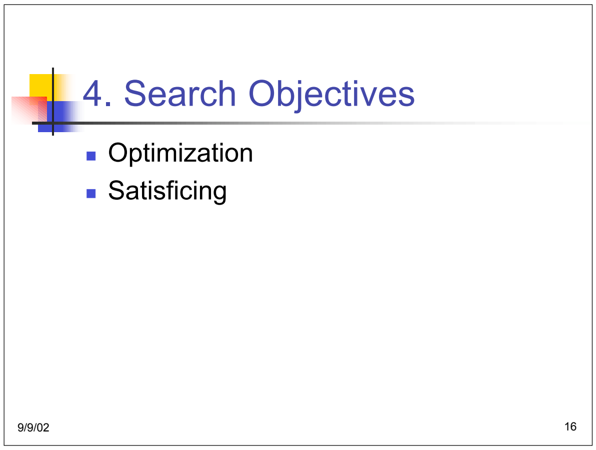
- Solution density
- Solution depth
- Solution backup rule

- Adds semantics to the graph



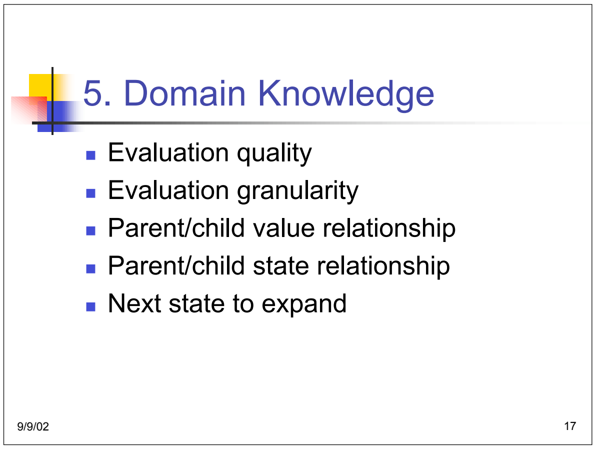
3. Resources

- Space
- Time



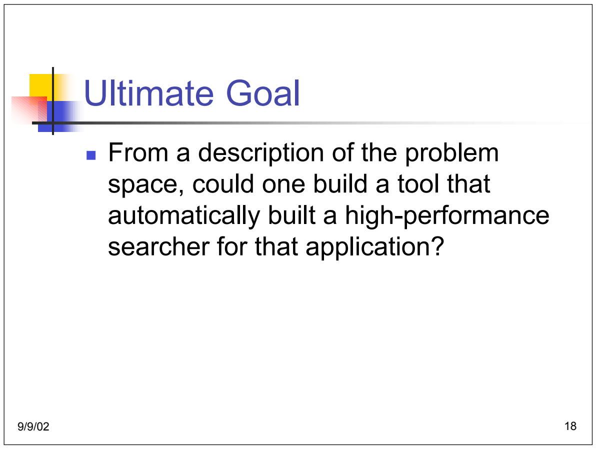
4. Search Objectives

- Optimization
- Satisficing



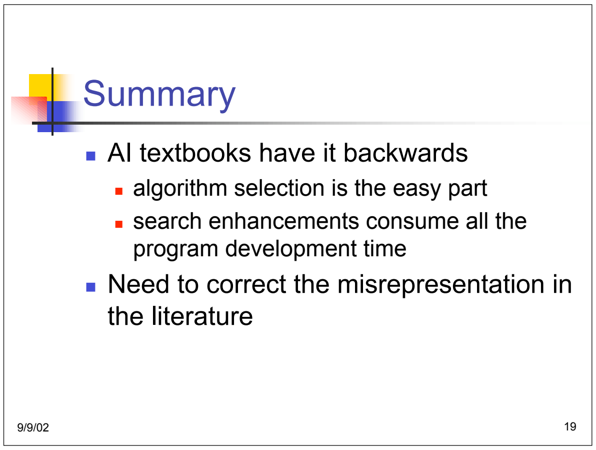
5. Domain Knowledge

- Evaluation quality
- Evaluation granularity
- Parent/child value relationship
- Parent/child state relationship
- Next state to expand



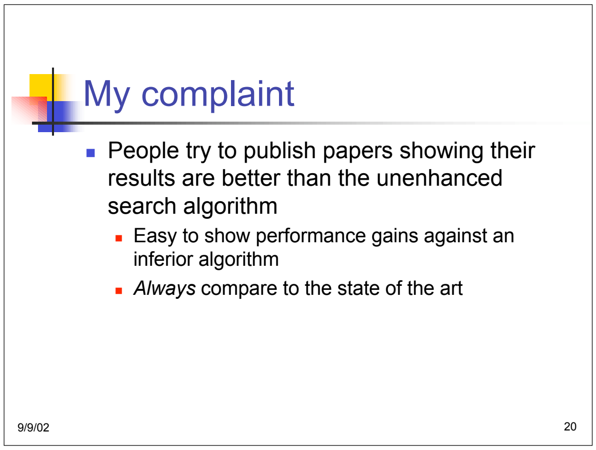
Ultimate Goal

- From a description of the problem space, could one build a tool that automatically built a high-performance searcher for that application?



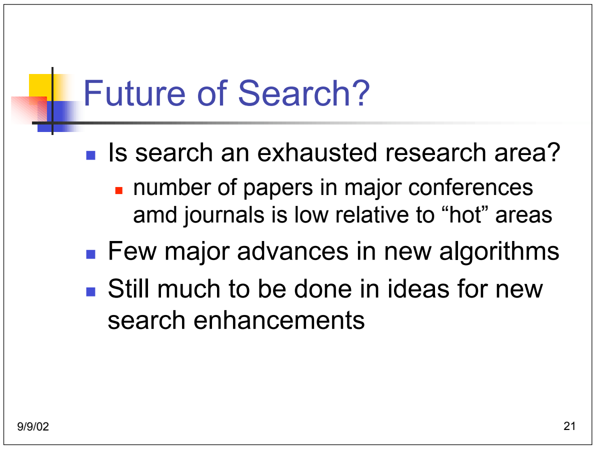
Summary

- AI textbooks have it backwards
  - algorithm selection is the easy part
  - search enhancements consume all the program development time
- Need to correct the misrepresentation in the literature



My complaint

- People try to publish papers showing their results are better than the unenhanced search algorithm
  - Easy to show performance gains against an inferior algorithm
  - *Always* compare to the state of the art



Future of Search?

- Is search an exhausted research area?
  - number of papers in major conferences amd journals is low relative to “hot” areas
- Few major advances in new algorithms
- Still much to be done in ideas for new search enhancements

9/9/02

21