CS/ENGRD 211
Spring 2006

Lecture 1: Overview

http://www.cs.cornell.edu/courses/cs211

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Course Staff

- Instructors:
  - Professor Andrew Myers
  - Professor David Schwartz
- Administrative Assistant:
  - Kelly Patwell
- Locations, office hours, contact info?
  - See Staff on website

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Student Course Staff

- Teaching Assistants:
  - TAs lead recitation sections (starting today)
  - TAs are your main contact point
- Consultants:
  - In Upson 360, hours TBA online
  - “Front line” for answering questions
- More info?
  - See Staff on website

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Lectures

- TR 10:10-11am, Olin 155
- Attendance is mandatory
- Lecture notes will be online—print them before class and bring them to class
- We will occasionally make small last minute changes to the notes, so don’t print them too far in advance
- Readings will be posted online together with lecture notes

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Sections

675-396	SEC 01	T	1220-0110P	HO	320
675-445	SEC 02	T	0125-0215P	UP	111
675-482	SEC 03	T	0230-0320P	HO	110
675-493	SEC 04	W	1220-0110P	HO	314
675-624	SEC 05	W	0125-0215P	HO	401
675-679	SEC 06	R	0230-0320P	HO	306
675-708	SEC 07	T	1220-0110P	HO	401
675-777	SEC 08	T	0125-0215P	UP	109
675-929	SEC 09	W	1220-0110P	UP	109
676-076	SEC 10	W	0125-0215P	SE	1120

- Attendance is mandatory
- Usually review, help on homework
- Sometimes new material

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CS212

- ***CS 212: Java Practicum***
- 1 credit project course
- Substantial project
- 1 lecture per week
- Required for CS majors; recommended for others
- Take 211 and 212 in same semester?

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Online resources

- Course web site
  http://www.cs.cornell.edu/Courses/cs211
  - Watch for announcements
- Course newsgroup
  cornell.class.cs211
  - Good place to ask questions (carefully)
- Textbook: Weiss, "Data Structures and Problem Solving Using Java"

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Obtaining Java

- We do not require an IDE
  - But we generally use Eclipse
- See **Help & Software** under **Java Resources** on website

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Java Help

- CS 211 assumes basic Java knowledge:
  - control structures
  - arrays, strings
  - classes (fields, methods, constructors)
- Need review?
  - Tutorials, links on website (**Help & Software**)
  - ***Java Refresher/Bootcamp***:
    - self-guided tutorial—material on website
    - You can also work with staff on it: 7:30-10:30pm on both Thu 1/26 and Tue 1/31 in Upson B7
    - Same material on both days

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Academic Excellence Workshops

- Two-hour labs in which students work together in cooperative setting
- One credit S/U course based on attendance
- ENGRG 210, 745-791, Fridays, 2:30-4:25, ACCEL
- See CS211 web site for more info

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Course Work

- 6 assignments involving both programming and written answers
  - We A.I. check each homework assignment
- Two prelims and final exam
- Course evaluation

Assignments (44%)						Exams (55%)			Eval
A1	A2	A3	A4	A5	A6	P1	P2	F	
6	7	7	7	7	10	15	15	25	1

Assignments

- Assignments may be done by teams of two students (except A1)
- You can do them by yourself if you like
- Finding a partner: choose your own or contact your TA. Newsgroup may be helpful.
- Monogamy is strongly encouraged, polygamy is strongly discouraged, and divorces are permitted in case of irreconcilable differences
- See website course info and Code of Academic Integrity

CS211 Objectives

An introduction to computer science and software engineering

- Concepts in modern programming languages:
  - recursive algorithms and data structures
  - data abstraction, subtyping, generic programming
  - frameworks and event-driven programming
- Analyzing, designing for efficiency
  - asymptotic complexity, induction
- Data structures and algorithms: arrays, lists, stacks, queues, trees, hash tables, graphs
- Organizing large programs

Using Java, but not a course on Java!

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Lecture Sequence

- Introduction and Review
- Recursion and induction
- Object-oriented concepts: data abstraction, subtyping
- Data structures: Lists and trees
- Grammars and parsing
- Inheritance and frameworks
- Algorithm analysis
  - Asymptotic Complexity
- Searching and Sorting

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More Lecture Topics

- Generic Programming
- Abstract Data Types
  - Sequence Structures: stacks, queues, heaps, priority queues
  - Search Structures: binary search trees, hashing
  - Graphs and graph algorithms
- Graphical user interface frameworks
  - Event-driven programming
  - Concurrency and simple synchronization

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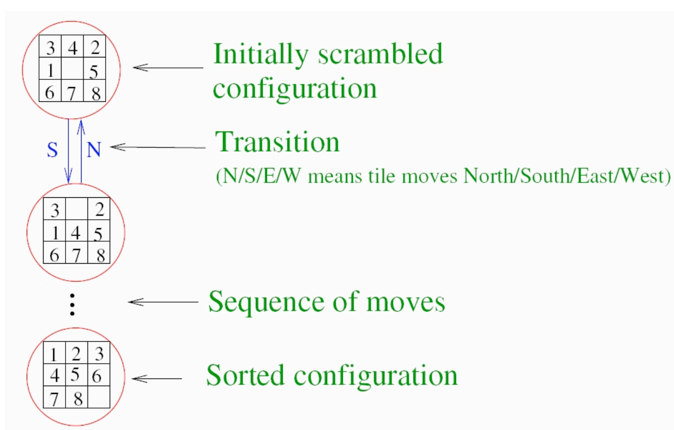
Sam Loyd's 8 Puzzle



Goal: Given an initial configuration of tiles, find a sequence of moves that will lead to the sorted configuration.

A particular configuration is called a ***state*** of the puzzle.

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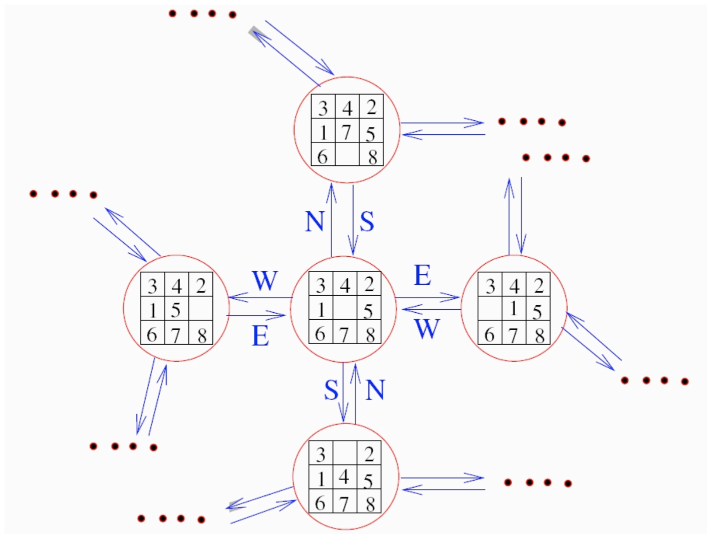
State Transition Diagram of 8-Puzzle



State Transition Diagram: picture of adjacent states.
A state Y is ***adjacent*** to state X if Y can be reached from X in one move.

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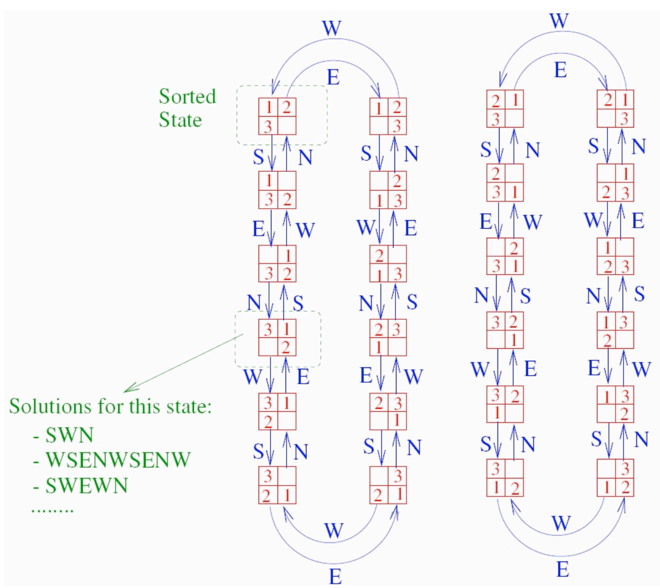
State Transition Diagram for a 2x2 Puzzle



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Graphs

- State Transition Diagram in previous slide is an example of a ***graph:*** a mathematical abstraction
  - ***vertices*** (or ***nodes***): (e.g., the puzzle states)
  - ***edges*** (or ***arcs***): connections between pairs of vertices
  - vertices and edges may be labeled with some information (name, direction, weight, cost, …)
- Other examples of graphs: airline routes, roadmaps, . . .
  - A common vocabulary for problems

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Path Problems in Graphs

- Is there a path from node A to node B?
  - Solve the 8-puzzle
- What is the shortest path from A to B?
  - 8-puzzle (efficiently), Mapquest, …
- Traveling salesman problem
- Hamiltonian cycles
- . . . will see later

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Simulating 8-puzzle

- What operations should puzzle objects support?
- How do we represent states?
- How do we specify an initial state?
- What algorithm do we use to solve a given initial configuration?
- What kind of GUI should we design?
- How to structure the program so it can be maintained, fixed, upgraded?

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SaM

- ***SaM*** is a simple StAck Machine:
  - Similar to the Java Virtual Machine (JVM)
  - and to the machine code understood by processor hardware
  - Use it to understand how compilers work
- Download it from course homepage
- Used extensively in CS212

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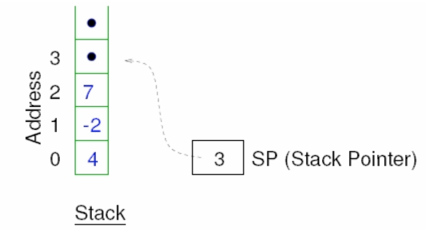
SaM's Stack



Note: For now, assume only integers can be pushed on stack. SaM actually allows floats, characters, etc. to be pushed, and it tracks type of data. GUI displays type (I:integer,F:float,. . .), but ignore this for now.

Stack: an array of integers
- Stack grows when integer is "pushed" on top.
- Stack shrinks when integer is "popped" from top.
- Stack starts at address 0 and grows to larger addresses.

Stack pointer (SP):
- first "free" address in stack
- stores integer address
- initialized to 0

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Some SaM Commands

- All arithmetic/logical operations pop values from stack, perform operation, push result, and move SP to first free address
- Some commands:

PUSHIMM *int*
// push integer *int* onto top of stack
ADD
// pops two values from top of stack
// adds them and pushes result
SUB
// pops two values (say top and below)
// and pushes result of doing (below - top)
TIMES
// works like **ADD**
GREATER
// Boolean values are simulated using 0/1 (false/true)
AND
// logical AND
STOP
// terminate execution of program

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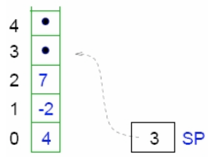
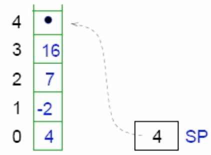
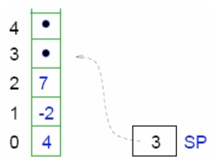
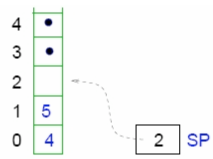
Demonstrate SaM Commands





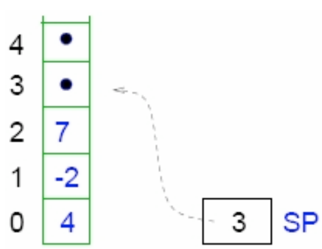
PUSHIMM 16

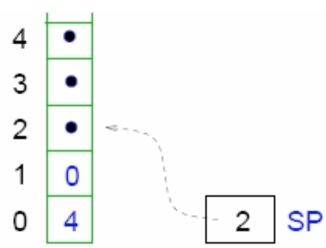




ADD:
- Pop 7
- Pop -2
- Determine 7 + (-2)
- Push result

Booleans and SaM





Booleans are simulated in SaM with integers:
- False → 0
- True → any int except 0 (usually 1)

GREATER:
- Pop two values (V_{top} and V_{below}) from stack (V).
- So, V_{top} = 7 and V_{below} = -2.
- If $V_{below} > V_{top}$ push 1; else push 0.
- In example, we would push 0.

SaM Programs

- Example 1:

```
PUSHIMM 5
PUSHIMM 4
PUSHIMM 3
PUSHIMM 2
TIMES
TIMES
TIMES
STOP // should leave 120 on top of stack
```

- Example 2:

```
PUSHIMM 5
PUSHIMM 4
GREATER
STOP //should leave 1 on top of stack
```

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SaM Simulator

- What operations must SaM objects support?
- How do we represent the internal state of SaM?
- How do we load programs from a file?
- How do we write code to interpret each of the opcodes?
- How do we turn a high-level language like Java into SaM code?
- See “Chapter 1” in CS212 lecture notes

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Why you need CS 211

You will be able to design and write moderately large, well-structured programs to simulate such systems. *Useful because:*

1. Computer systems are complex. Need CS to make them work; can't just hack it
   - Selected software disasters:
     - CTAS air traffic control system 1991-present
     - Ariane 5 ex-rocket
     - Denver airport automated baggage handling

Why you need CS211, cont'd

2. Fun and intellectually interesting: cool math ideas meet engineering and make a difference.
   - Recursion, induction, logic, discrete structures, …
3. Crucial to any engineering or science career
   - Good programmers are >10x more productive
   - Leverages knowledge in other fields, makes new possibilities
   - Where will you be in 10 years?

Moore's Law

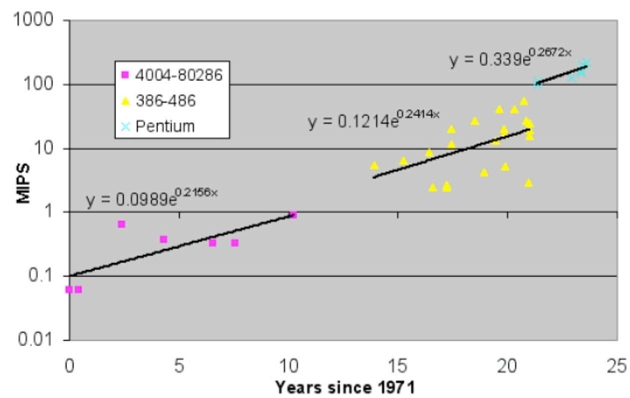

Figure 5: Processor performance in millions of instructions per second (MIPS) for Intel processors, 1971-1995.

From *Lives and death of Moore's Law*, Ilkka Tuomi, 2002

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Grandmother's Law

- Brain takes about 0.1 second to recognize your grandmother
  - About 1 second to add two integers (e.g. 3+4=7)
  - About 10 seconds to think/write statement of code
- Your brain is not getting any faster!

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Motivation

- Computers double in speed every 18 months
  - Software doubles in size every M Years
  - Data doubles in size every N Years
  - Your brain never doubles in speed
  - But we do get smarter, and can work in teams
- Computer science is increasingly important
  - Better algorithms
  - Better data structures
  - Better programming languages
  - Better understanding of what is (and is not) possible

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