

CMSC 330: Organization of Programming Languages

Project 1 – Maze Solver

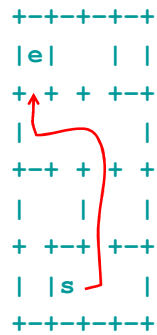
Overview

- Write Ruby program to process maze files
 - Parse & store simple maze file
 - Analyze & process maze
 - Parse standard maze file
- Goals
 - Learn Ruby data structures
 - Learn basic text processing

Maze

- 2D square maze with walls separating cells
- Start & end located anywhere in maze
- Examples

```
+--+--+--+
|e|  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|s|  |  |
+--+--+--+
```

A 10x10 maze grid. The start 'e' is at row 2, column 2. The end 's' is at row 9, column 3. A red path starts at 'e', goes right to column 4, then down to row 5, then left to column 2, and finally down to 's'.

Solvable

```
+--+--+--+
|e|  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|  |  |  |
+--+--+--+
|s|  |  |
+--+--+--+
```

Unsolvable

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Parts of Project

- Read in maze from simple maze file, then
 1. Find maze properties
 2. Rank paths by cost
 3. Pretty-print maze
 4. Decide whether maze is solvable
- Parse standard maze file
 1. Find & report invalid lines, if any
 2. Else translate into simple maze file

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Maze Specification

- Maze
 - An $n \times n$ array of **cells**
 - With specified starting & end cell
 - May include **paths**
- Cells
 - May have openings in walls
 - Specified as **udlr** → up, down, left, right
 - Each opening has a weight
- Paths
 - Sequence of directions (**udlr**) from starting cell

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Simple Maze File Format

- Comprised of
 - Header (size, start, end)
 - Cell (location, openings, weights)
 - Path (pathname, start, directions)
- Items separated by spaces
- Example
 - 16 0 2 13 11 16 × 16, start(0,2), end(13,11)
 - 0 1 **udlr** 4.3 5.1 2.0 5.0 (0,1), openings→**udlr**, wts → 4.3,...
 - path p** 0 2 **drlr** Path **p**, start(0,2), directions →**drlr**
- May assume always valid & in correct format

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Simple Parser Using String.split

```
line = file.gets
sz, sx, sy, ex, ey = line.split(/\s/)      # maze header
while line = file.gets do
  if line[0...4] == "path"
    p, name, x, y, ds = line.split(/\s/)    # path spec
  else
    x, y, ds, w = line.split(/\s/,4)        # cell spec
    ws = w.split(/\s/)
    ws.each {|w| ... }
  end
end
```

Parser is provided, but still need maze data structures

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Analyze & Process Maze

- Find maze properties
 - Number of closed cells
 - Number of openings of each type (udlr)
- Rank paths by cost
 - Cost of path = sum of weight of each opening on path
- Pretty-print maze
- Decide whether maze is solvable
 - Find any path from start cell to end cell

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Standard Maze File Format

- Comprised of header, cells, paths
- Items separated by spaces, commas, colons, etc.
- Example
 - maze: 16 0:2 -> 13:11 16 × 16, start(0,2), end(13,11)
 - 0,1: uldr 4.3,5.1,2.0,5.0 (0,1), openings→uldr, wts → 4.3,...
 - “p:(0,2),d,r,l,r”, “q...” Path p, start(0,2), dirs →drlr, Path q

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Parse Standard Maze File

- Parse standard maze file
- Use Ruby regular expressions
- Invalid maze file if any lines not in proper format
 - Helpful to use ^ and \$ to match entire line
 - line =~ /^expr\$/ # true only if entire line matches expr
- If invalid maze file
 - Output “invalid maze”
 - Followed by list of invalid lines
- Else
 - Output maze in simple format

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Ruby Program

- Code in maze.rb
- Invoked with two arguments
 - Mode command to execute
 - Filename name of maze file
- Print output to console
 - Using puts, print, etc...
- Examples
 - ruby maze.rb print <name of simple maze file>
 - ruby maze.rb solve <name of simple maze file>
 - ruby maze.rb parse <name of standard maze file>

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Project Tasks

- Handle command line arguments
 - ARGV[0], ARGV[1]
- Open & read text files
 - file = File.new(<filename>, "r")
- Processing data
 - Count, compare, add, sort...
- Recognizing text patterns
 - Regular expressions (e.g., /s/)
- Etc...

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Administration

- Project description & files
 - [Download from class web page](#)
- Due midnight Wed, Feb 19th
 - 10% penalty for 1 day late
- Submit maze.rb to submit server
 - submit.cs.umd.edu
- Public test cases provided
 - [Sample inputs & outputs available](#)