Search Problems

- a challenging topic
- all of you can do it
  - you have laid the foundation for this all term
- all of you will struggle with it some
  - the world has more difficult design problems than easy ones

- approach this topic knowing that, with work, you can do it

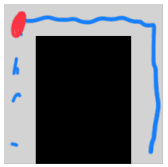
Search

- You know how to:
  - represent information of different forms
    - we have been doing information that “seemed clearly real”
  - design functions that do backtracking search on a tree
  - design functions that use generative recursion

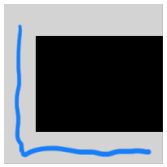
- One big difference today is we will represent “made up” information
  - a tree that we generate as we go
  - generative recursion
  - backtracking search

Solving Mazes

1



2

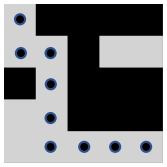


3

4

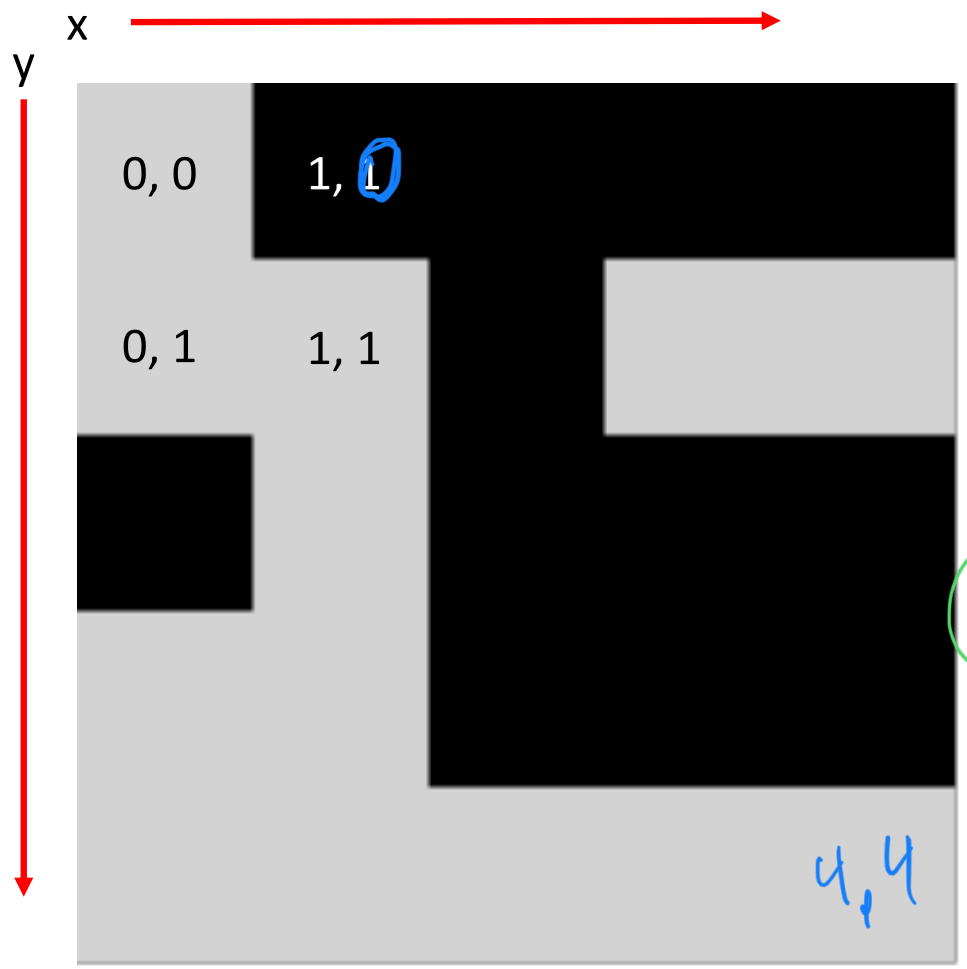
not solvable

NO down right (unless backtracking)



1

This maze is solveable, so will eventually reach 4, 4. Yay!



Notation and Assumptions

Each cell has a 0-based x, y position.

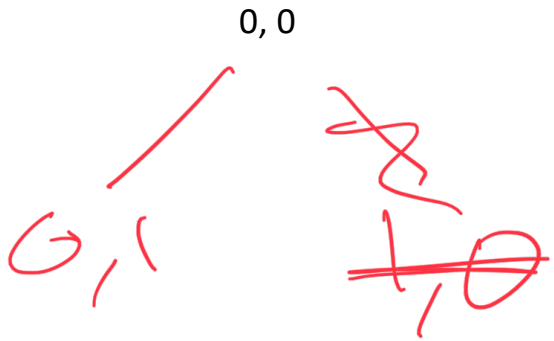
In this module, we restrict the problem so that at each step it is only possible to move down (y+1) or right (x+1).

Mazes are square.

width = height . so x is [0, WIDTH-1] y is in [0, WIDTH-1]

And, a maze does not seem to be a tree!

The big insight: We can generate a tree as we go.



Each position has up to 2 next positions: down and right.

But sometimes either of those may be invalid because they run into a wall or off the edge of the maze.

Do not assume each position can have only one valid next position. In general it is an arbitrary-arity tree. (Up to 2 in this module; up to 4 later.)

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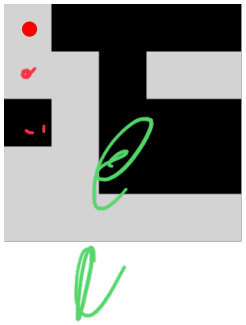

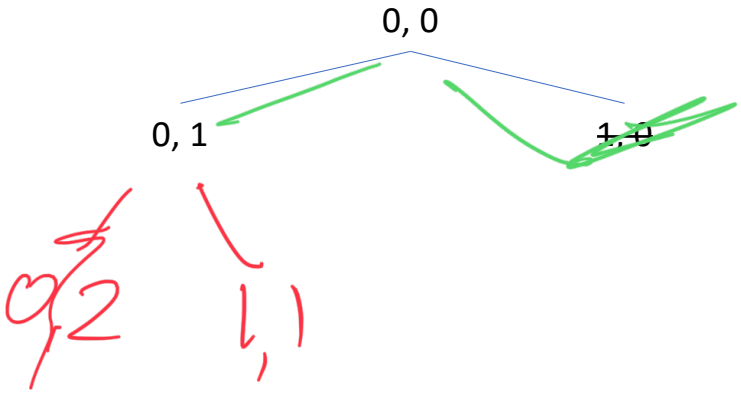

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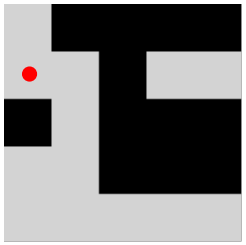

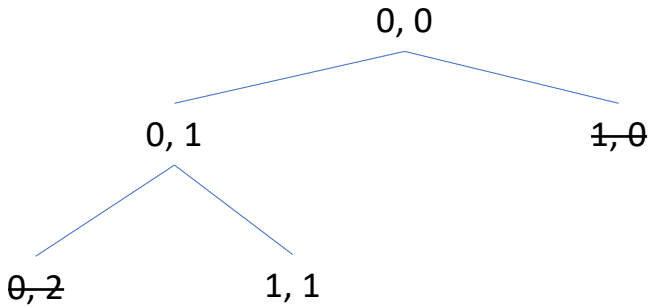

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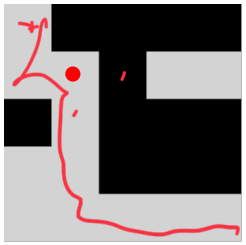

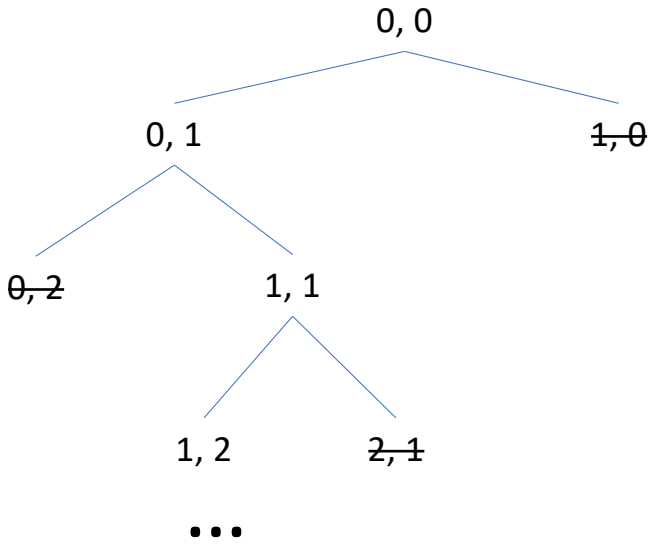

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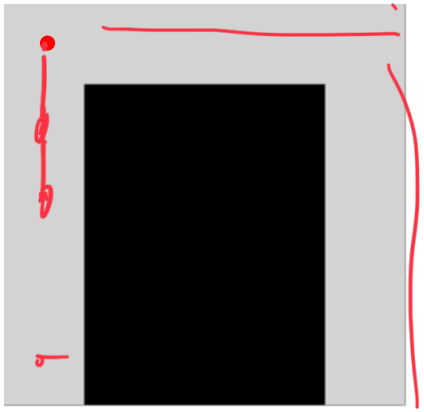
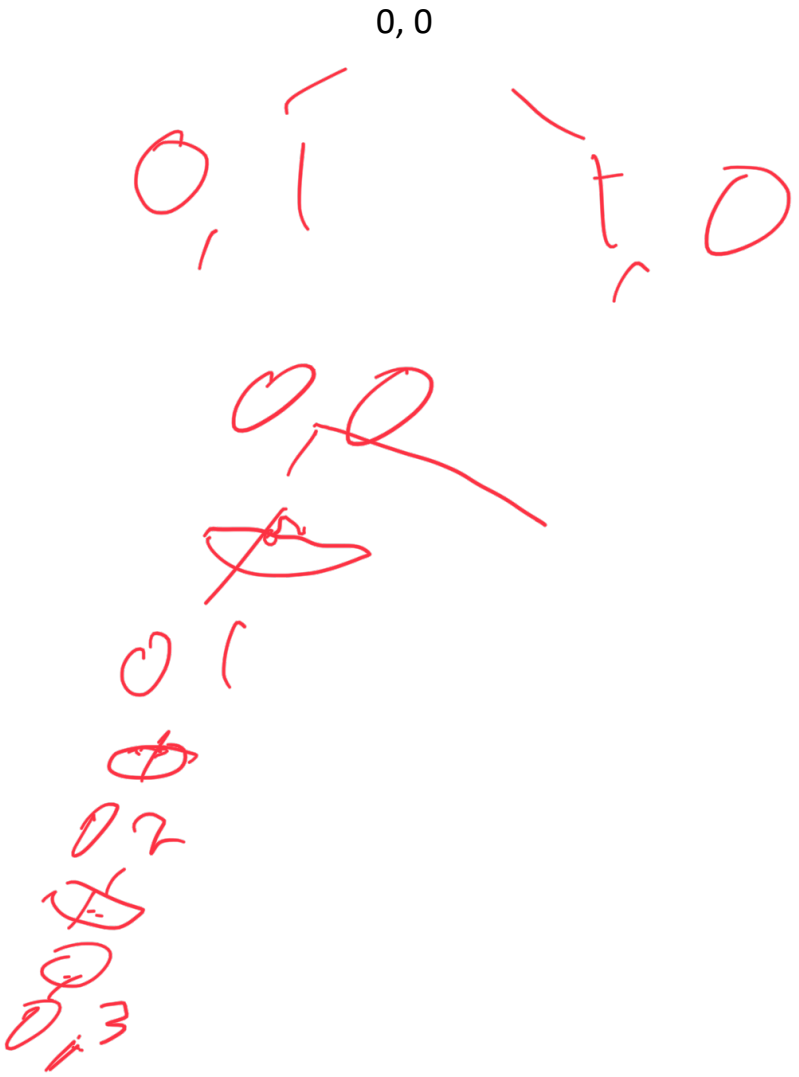
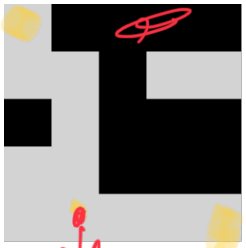
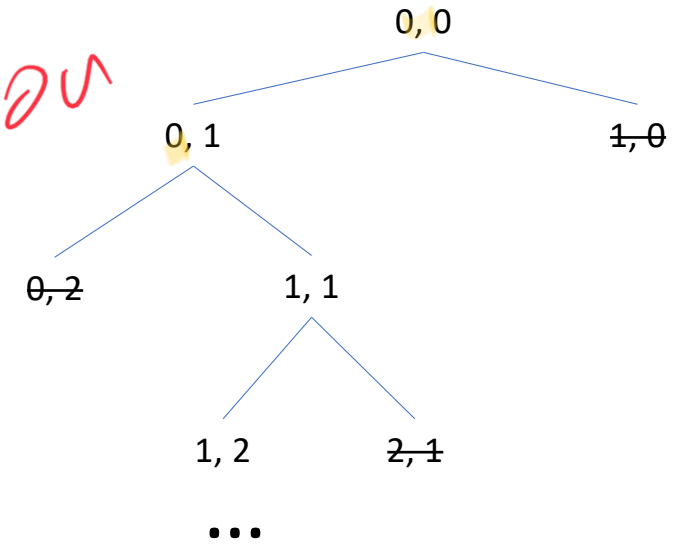


What are the valid next positions of 0,0 in this maze?



Search Domain Analysis MUST HAVE Search Tree





And answers to 3 questions:

What is changing information? current x,y position

How to form next next search search states? down and right, UNLESS hit wall or edges

How to tell when done? solved if reach lower right corner
can also run out of moves

Expect it to take a while to get this worked out!

```
;; genrec
(define (genrec d)
  (cond [(trivial? d) (trivial-answer d)]
        [else
         [... d
              (genrec (next-problem d))]]))


;; arb-tree  (of Pos) -> Pos and (listof Pos)
(define (fn-for-pos p)
  (... p
       (fn-for-lop (POS-SUBS p)))) ;pos-subs doesn't really exist!!!


(define (fn-for-lop lop)
  (cond [(empty? lop) (...)]
        [else
         (... (fn-for-pos (first lop))
              (fn-for-lop (rest lop)))]))


;; try-catch
     (local [(define try <one-option>)]
       (if (not (false? try))
           try
           <other-option>))
```

```
(define (fn-for-pos p)
  (cond [(trivial? p) (trivial-answer p)]
        [else
         (... p
              (fn-for-lop (next-problem p)))]))


(define (fn-for-lop lop)
  (cond [(empty? lop) false]
        [else
         (local [(define try (fn-for-pos (first lop)))]
           (if (not (false? try))
               try
               (fn-for-lop (rest lop))))]))
```

```
(define (fn-for-pos p)
  (cond [(solved? p) true]
        [else
         (fn-for-lop (valid-next-positions p))]))
```

```
(define (fn-for-lop lop)
  (cond [(empty? lop) false]
        [else
         (local [(define try (fn-for-pos (first lop)))]
           (if (not (false? try))
               try
               (fn-for-lop (rest lop))))]))
```

```
;; genrec
(define (genrec d)
  (cond [(trivial? d) (trivial-answer d)]
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```

genrec

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;; arb-tree  (of Pos) -> Pos and (listof Pos)
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(define (fn-for-lop lop)
  (cond [(empty? lop) (...)]
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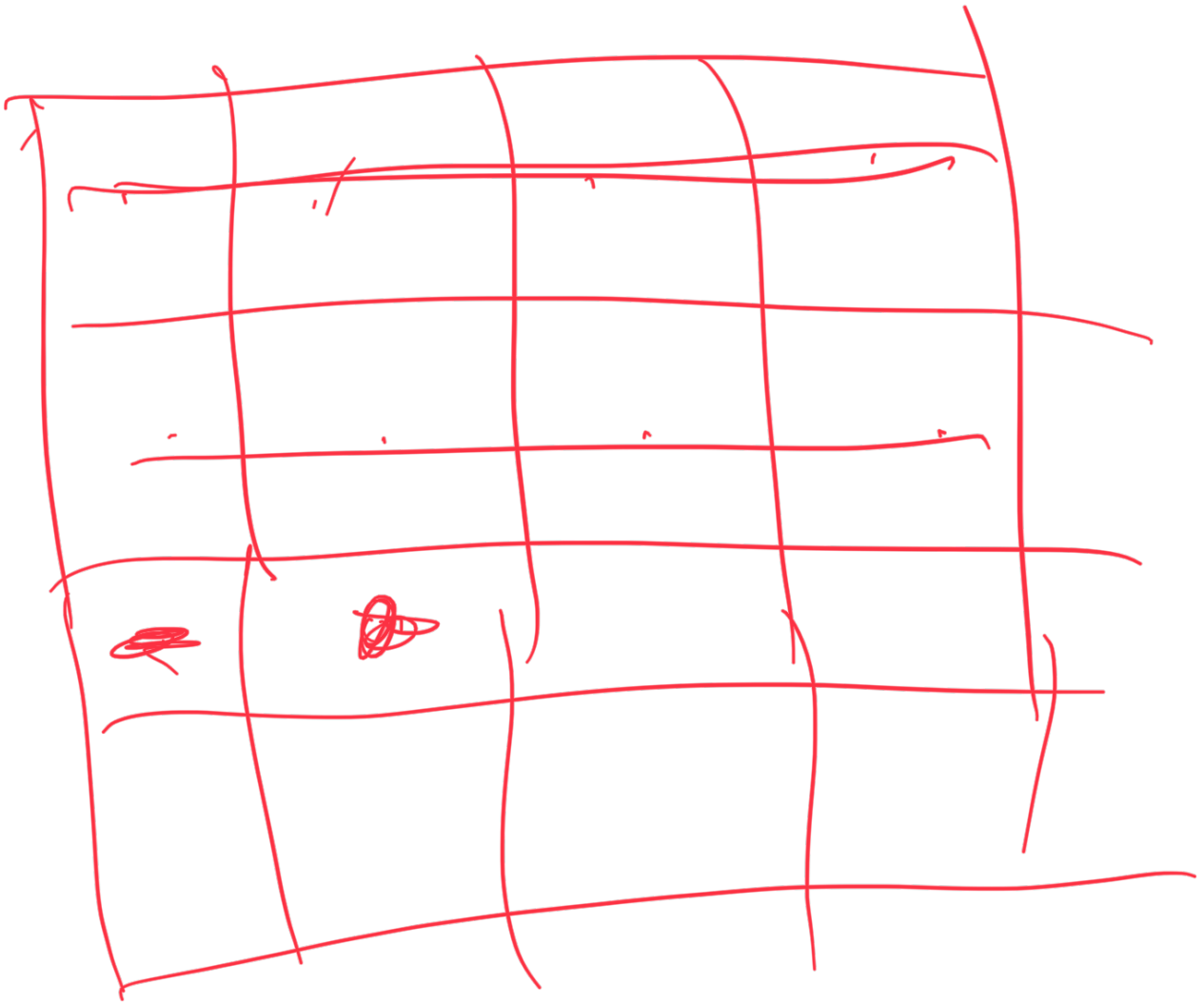
```

arb-tree

```
;; try-catch
    (local [(define try <one-option>)]
      (if (not (false? <one-option>))
          <one-option>
          <other-option>))
```

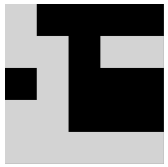
try-catch

$2 \times 4 + 1 = 9$

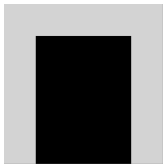


0, 2

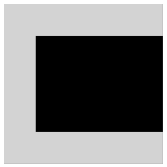
Solving Mazes



1

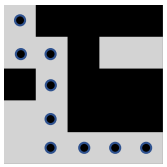


2



3

4



1