Contracts

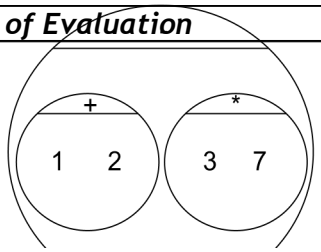
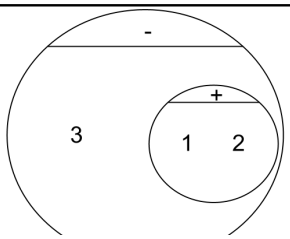
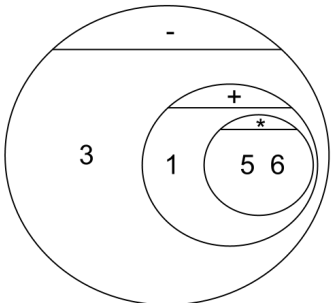
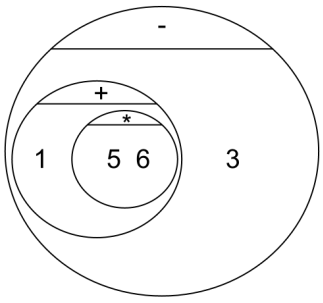
Name	Domain	Range	example
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	

Contracts

Name	Domain	Range	example
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	
;	:	→	

Lesson 1

Circles Competit… …e: 5 minutes

	Math	*Circle of Evaluation*	*Scheme Code*
Round 1	*(1 + 2) - (3 * 7)*		(- (+ 1 2) (* 3 7))
Round 2	*3 - (1 + 2)*		(- 3 (+ 1 2))
Round 3	*3 - (1 + (5 * 6))*		(- 3 (+ 1 (* 5 6)))
Round 4	*(1 + (5 * 6)) - 3*		(- (+ 1 (* 5 6)) 3)

Fast Functions!

Fill out the contract for each function, then try to write two examples and the definition by yourself.

; _double_____:__Number_____ -> _Number_____

name domain range

(EXAMPLE (_double_ __5__) _(* 2 5)_____)

(EXAMPLE (_double_ __7__) _(* 2 7)_____)

(define (__double_ _n____) _(* 2 n)_____)

; _triple_____ : __#_____ -> __#_____

name domain range

(EXAMPLE (triple_ 7____) __(* 3 7)_____)

(EXAMPLE (triple_ 9____) __(* 3 9)_____)

(define (_triple_ _n__) ___(* 3 n)_____)

; __plus1_____:__#_____ -> ___#_____

(EXAMPLE (plus1__ _4____) _(+ 1 4) _____)

(EXAMPLE (plus1 __13_____) (+ 1 13) _____)

(define (_plus1_ __n_____) _(+ 1 n) _____)

; __mystery_____:___#_____ -> ___#_____

(EXAMPLE (_mystery_ _5_) _(- 7 4)_____)

(EXAMPLE (_mystery_ _8_) _(- 7 8)_____)

(define (_mystery_ _x_) _(- 7 x)_____)

Lesson 2

DESIGN RECIPE: SAMPLE

State the problem:

Make a circle (spot) of size 100, with the provided color

Contract+Purpose Statement

Every contract has three parts:

; spot100 : String -> Image
name Domain Range

; Makes a size 100 circle in a color
What does the function do?

Give Examples

On the computer, write an example of your function in action, using EXAMPLE.

(EXAMPLE (spot100 "green")(circle 100 "solid" "green"))
the user types… …which should become

color

(EXAMPLE (spot100 "blue")(circle 100 "solid" "blue"))
the user types… …which should become

Function

Circle the changes in the EXAMPLEs, and name the variables.
Write the code, copying everything that isn't circled, and using names where you find variables!

(define (spot100 color) (circle 100 "solid" color))
function name variable names …and the computer does this

DESIGN RECIPE: DOUBLE-RADIUS

State the problem:

Write a function, double-radius, which takes in a radius and color, and makes an outline circle of the same color, but double the size

Contract+Purpose Statement

Every contract has three parts:

; _double-radius_____ : _Number String____ -> _Image_____
name Domain Range

; Doubles the radius, and draws a circle of that new size and color
What does the function do?

Give Examples

On the computer, write an example of your function in action, using EXAMPLE.

EXAMPLE (double-radius 6 "blue") (circle (* 2 6) "outline" "blue")
the user types... ...which should become

(EXAMPLE (double-radius 10 "red") (circle (* 2 10) "outline" "red")
the user types... ...which should become

Function

Circle the changes in the EXAMPLEs, and name the variables.
Write the code, copying everything that isn't circled, and using names where you find variables!

(define (double-radius radius color) (circle (* 2 radius) "outline" color))

DESIGN RECIPE: DOUBLE-WIDTH

State the problem:

Write a function, double-width, which takes in a height and a color, and makes a solid rectangle, where the width is twice the height

Contract+Purpose Statement

Every contract has three parts:

; _double-width_ : _Number String_____ -> _Image__
name Domain Range

; draws a rectangle where the width is twice the height, of the given color
What does the function do?

Give Examples

On the computer, write an example of your function in action, using EXAMPLE.

(EXAMPLE (double-width 3 "green") (rectangle 3 (* 2 3) "solid" "green"))
the user types... ...which should become

(EXAMPLE (double-width 7 "yellow") (rectangle 7 (* 2 7) "solid" "yellow"))
the user types... ...which should become

Function

Circle the changes in the EXAMPLEs, and name the variables.
Write the code, copying everything that isn't circled, and using names where you find variables!

(define (double-width h color) (rectangle h (* 2 h) "solid" color))

DESIGN RECIPE: PAINT-JOB

State the problem:

Write a function called paint-job that takes an auto and changes its color

Contract+Purpose Statement

```
; _paint-job_____ : __auto  string_________________ -> __auto_______
        name                                Domain                  Range
; takes in an auto and a color, and returns an auto with that color
                                What does the function do?
```

Give Examples

```
(EXAMPLE     (_paint-job____   ___car1   "green"_____________________)
                    (make-auto (auto-model car1)_____________________
                    _____________(auto-hp car1)_____________________
                    _____________(auto-rims car1)____________________
                    _____________"green"_____________________________
                    _____________(auto-value car1)_____________)_____________)
(EXAMPLE     (_paint-job____   ___car2   "black"_____________________)
                    (make-auto (auto-model car2)_____________________
                    _____________(auto-hp car2)_____________________
                    _____________(auto-rims car2)____________________
                    _____________"black"_____________________________
                    _____________(auto-value car2)_____________)_____________)
```

Function

```
(define      (_paint-job____   ___auto   color_____________________)
                    (make-auto (auto-model auto)_____________________
                    _____________(auto-hp auto)_____________________
                    _____________(auto-rims auto)____________________
                    _____________color_____________________________
                    _____________(auto-value auto)_____________)_____________)
```

DESIGN RECIPE: TURBO-CHARGE

State the problem:

Write a function called turbo-charge that takes an auto and adds 20 hp

Contract+Purpose Statement

; _turbo-charge_____ : _auto_____ -> __auto_____
name Domain Range

; takes in an auto and returns the same auto, with twenty more hp_____
What does the function do?

Give Examples

(EXAMPLE (_turbo-charge___ __car1_____)

(make-auto _(auto-model car1)_____

_(+ 20 (auto-hp car1))_____

_(auto-rims car1)_____

_(auto-color car1)_____

_(auto-value car1))_____)

(EXAMPLE (_turbo-charge___ __car2_____)

(make-auto _(auto-model car2)_____

_(+ 20 (auto-hp car2))_____

_(auto-rims car2)_____

_(auto-color car2)_____

_(auto-value car2))_____)

Function

(define (_turbo-charge___ __auto_____)

(make-auto _(auto-model auto)_____

_(+ 20 (auto-hp auto))_____

_(auto-rims auto)_____

_(auto-color auto)_____

_(auto-value auto))_____)

Lesson 3

DESIGN RECIPE: PIMP

State the problem:

+100 hp, red, +10000 value, 30" rims

Contract+Purpose Statement

; __pimp_____ : __auto_____ -> __auto_____
name Domain Range

; takes in an auto and makes it red, 30" rims, +100 hp and +10000 value
What does the function do?

Give Examples

(EXAMPLE (__pimp_____ __car1_____)

_(make-auto (auto-model car1)_____

_____(+ 100 (auto-hp car1))_____

_____30_____

_____"red"_____

_____(+ 10000 (auto-value car1)))_____)

(EXAMPLE (__pimp_____ __car2_____)

_(make-auto (auto-model car2)_____

_____(+ 100 (auto-hp car2))_____

_____30_____

_____"red"_____

_____(+ 10000 (auto-value car2)))_____)

Function

(define (__pimp_____ __auto_____)

_(make-auto (auto-model auto)_____

_____(+ 100 (auto-hp auto))_____

_____30_____

_____"red"_____

_____(+ 10000 (auto-value auto)))_____)

DEFINE-STRUCT

Autos:

; an auto is a (make-auto string number number string number)

```
(define-struct auto   (model
                       hp
                       rims
                       color
                       value))
```

; a party is a (make-paty string string number)

```
(define-struct party   (location
                        theme
                        guests))
```

DESIGN RECIPE: RSVP

State the problem:

Add 1 to the # of guests

Contract+Purpose Statement

; __RSVP_____ : __party_____ -> _party_____
name Domain Range

; __Add 1 to the number of guests in the party_____
What does the function do?

Give Examples

(EXAMPLE (__RSVP_____ ___Halloween_____)

__(make-party (party-location Halloween)_____

_____(party-theme Halloween)_____

_____(+ 1 (party-guests Halloween)))_____)

(EXAMPLE (__RSVP_____ ___Summer_____)

__(make-party (party-location Summer)_____

_____(party-theme Summer)_____

_____(+ 1 (party-guests Summer)))_____)

Function

(define (__RSVP_____ ___party_____)

__(make-party (party-location party)_____

_____(party-theme party)_____

_____(+ 1 (party-guests party)))_____)

DESIGN RECIPE: RELOCATE

State the problem:

Write a function called relocate that takes in a location and moves the party there

Contract+Purpose Statement

; _relocate_____ : ____party string_____ -> __party_____
name Domain Range

; ___Moves a party to a new location_____
What does the function do?

Give Examples

On the computer, write an example of your function in action, using EXAMPLE.

(EXAMPLE (__relocate_____ __Halloween "home"_____)

__(make-party "home"_____

_____(party-theme Halloween)_____

_____(party-guests Halloween))_____)

(EXAMPLE (__relocate_____ __ Summer "backyard"_____)

__(make-party "backyard"_____

_____(party-theme Summer)_____

_____(party-guests Summer))_____)

Function

(define (__relocate_____ __ party place_____)

__(make-party place_____

_____(party-theme party)_____

_____(party-guests party))_____)

Dissecting a Demo: Ninja World

What changes?

_____the x coordinate of the dog _____

_____

_____

_____

Ninja World:

; a world is a __number_____

(define-struct world (_dogX_____))

My constructor function is:

1) (How do you make a world?)__make-world_____

What is its contract? ;make-world : number world_____

My accessor function is:

2) (How do you get the dogX out of the world?)

_____world-dogX_____

What is its contract? __ ; world-dogX : world number

DESIGN RECIPE: UPDATE-WORLD (NINJA WORLD)

State the problem:

Write a function called `update-world`, which adds 10 to the dogX

Contract+Purpose Statement

; _update-world__ : __world_____ -> __world_____
name Domain Range

;__adds 10 to a world_____
What does the function do?

Give Examples

On the computer, write an example of your function in action, using EXAMPLE.

(EXAMPLE (_update-world_ _START_____)

_(make-world (+ 10 (world-dogX START))_____)

(EXAMPLE (_update-world_ _NEXT_____)

_(make-world (+ 10 (world-dogX NEXT))_____)

Function

(define (_update-world_ _w_____)

_(make-world (+ 10 (world-dogX w))_____)

Lesson 4

Review: define-struct

Last week we talked about a function that created new structs. For the structs below, what function would you use for each of the following?

```
; an auto is a String _Number_ Number _String_ Number
(define-struct auto (model  hp  rims  color  value))
```

Make an auto? __make-auto_____

Get the model out of an auto? _auto-model_____

Get the hp out of an auto? _auto-hp_____

```
; a party is a _String_ String Number
(define-struct team (location  theme  guests))
```

Make a party? __make-party_____

Get the location out of the party? _party-location_____

Get the theme out of the party? _party-theme_____

Get the guests out of the party? _party-guests_____

```
; a world is a Number
(define-struct world (dogX))
```

What function would you use to:

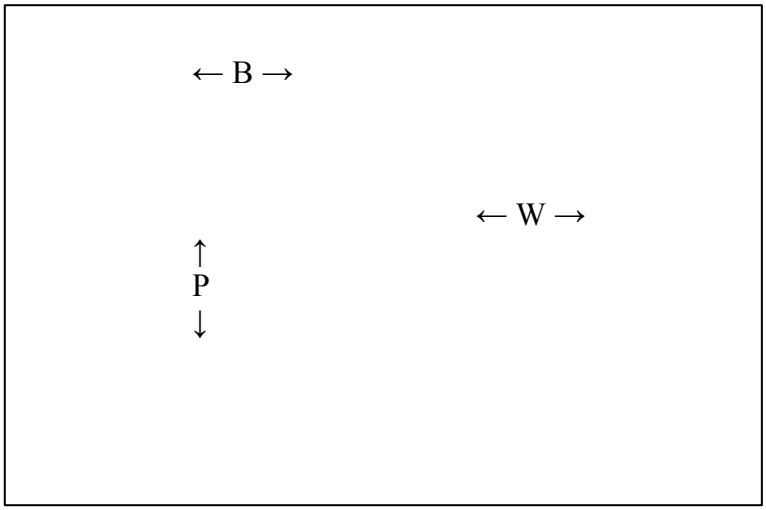
Make a world? _make-world_____

Get the dogX out of the world? __world-dogX_____

GAME DESIGN

"Start Simple, Get Complex"

Draw a rough sketch of your game in action



What images will you need for your game?

Background	cave
player	archer
danger	bats
projectile	arrow
danger	wumpus

List everything that has changed, and the datatype you will use to represent it

Changed (position? score? color? costume?)	**Datatype** (number? string? image? boolean?)
Wumpus status	String
archer y	Number
Wumpus x	Number
Bat x	Number
Arrow x	Number

; a world is a _string number number number number____

(define-struct world (__wstatus_____

__archerY_____

__wumpusX_____

__batX_____

__arrowX_____))

My constructor function is…

; make-world : _string number number number number__ → World

My accessor functions are…

; world-wstatus : world → string

; world-archerY : world → number

; world-wumpusX : world → number

; world-batX : world → number

; world-arrowX : world → number

Lesson 5

(0, 480) **START** (640,480)

(0, 0) (640, 0)

At the start of my game, this is where everything is:

Object (top to bottom of stack)	Position (x, y)
Bats	(620, 440)
archer	(50, 40)
arrow	(800, 25)
wumpus	(600, 210)
Background	

(define START(make-world _ "asleep" _____

___ 40 _____

___ 210 _____

___ 620 _____

___800_____))

(0, 480) **NEXT** (640,480)

(0, 0) (640, 0)

A split second later, this is where everything is:

Object (top to bottom of stack)	Position (x, y)
Bats	(580, 440)
archer	(50, 40)
arrow	(820, 25)
wumpus	(600, 210)
Background	

(define NEXT (make-world _ "asleep" _____

___ 40 _____

___ 210 _____

___ 580 _____

___820_____))

DRAW-WORLD

Contract

```
; _draw-world____ : __world_____________________________ -> __image_________
```

Using put-image

```
(define (_draw-world____  _w_____________________________________)

 (put-image _FLOCK_____________________

            _(world-batX w) 440_____________________

           (put-image __PLAYER_____________________

                      __50 (world-archerY w)____

                      (put-image __ARROW_____________

                                 (world-arrowX w) (+ 5 (world-archerY w))___

                                 (put-image _DANGER_____________________

                                            _(world-wumpusX w) 210___

                                            BACKGROUND _)))))__
```

DESIGN RECIPE: UPDATE-WORLD

State the problem (What changes?):

Add 20 to arrowX, subtract 40 from batX

Contract+Purpose Statement

; _update-world_____ : __world_____ -> __world_____
name Domain Range

; __Add 20 to arrowX, subtract 40 from batX

Give Examples

(EXAMPLE (_update-world___ _START_____)

_(make-world (world-wstatus START)_____

_____(world-archerY START)_____

_____(world-wumpusX START)_____

_____(- (world-batX START) 40)_____

_____(+ 20 (world-arrowX START)))_____)

(EXAMPLE (_update-world___ _NEXT_____)

_(make-world (world-wstatus NEXT)_____

_____(world-archerY NEXT)_____

_____(world-wumpusX NEXT_____

_____(- (world-batX NEXT) 20)_____

_____(+ 40 (world-arrowX NEXT)))_____)

Function

(define (_update-world___ _w_____)

_(make-world (world-wstatus w)_____

_____(world-archerY w)_____

_____(world-wumpusX w)_____

_____(- (world-batX w) 40)_____

_____(+ 40 (world-arrowX w)))_____)

Lesson 6

When the user presses…	*this* part...	Changes by…
"up"	archerY	20
"down"	archerY	20

DESIGN RECIPE

State the Problem

For each keypress in the Ninja World game, show how (keypress START <key>) should change your world.

Contract+Purpose Statement

; keypress : world string -> world

name Domain Ranges

Give Examples

(EXAMPLE (keypress START "up")

(make-world (world-dogX w)

(world-rubyX w)

(+ 10 (world-catY w))

))

(EXAMPLE (keypress START "down")

(make-world (world-dogX w)

(world-rubyX w)

(- (world-catY w) 10)

))

```
(define (_keypress_____ _w key_____)
  (cond
  [(_string=? key "up"_____)

    __(make-world (world-dogX w)_____

                  __(world-rubyX w)_____

                  __(+ (world-catY w) 10)))_____

                        _____]

  [(_string=? key "down"_____)

    __(make-world (world-dogX w)_____

                  __(world-rubyX w)_____

                  __(- (world-catY w) 10)))_____

                  _____]))
```

DESIGN RECIPE

State the Problem

For each keypress in your game, show how (keypress START <key>) should change your world.

Contract+Purpose Statement

; keypress : world string -> world

name Domain Range

Give Examples

```
(EXAMPLE (keypress START "up")

         (make-world (world-wstatus w)
                     (+ (world-archerY w) 10)
                     (world-wumpusX w)
                     (world-batX w)
                     (world-arrowX w)))
```

```
(EXAMPLE (keypress START "down")

         (make-world (world-wstatus w)
                     (- (world-archerY w) 10)
                     (world-wumpusX w)
                     (world-batX w)
                     (world-arrowX w)))
```

```
(EXAMPLE  (keypress START _____)
          (make-world     _____
                          _____
                          _____
                          _____
                          _____))
```

```
(define      (_keypress_____  __w key_____)
     (cond
     [(_____string=? key "up"_____)
     (make-world      __(world-wstatus w)_____
                           _(+ (world-archerY w) 10)_____
                           _(world-wumpusX w)_____
                           _(world-batX w)_____
                           _(world-arrowX w)_____)]
     [(_____string=? key "down"_____)
     (make-world      __(world-wstatus w)_____
                           _(- (world-archerY w) 10)_____
                           _(world-wumpusX w)_____
                           _(world-batX w)_____
                           _(world-arrowX w)_____)]

     [(____string=? key "  "_____)
     (make-world      __"awake"_____
                           _(world-archerY w) _____
                           _(world-wumpusX w)_____
                           _(world-batX w)_____
                           _50_____)]
```

Lesson 7

Extended update-world:

; __off-right?___:___number_____ -> __boolean_____

name domain range

(EXAMPLE (_off-right?__ _800_____) _(> 800 640)_____)

(EXAMPLE (_off-right?__ _150_____) __(> 150 640)_____)

(define (_off-right?_____ _x_____) __(> x 640)_____)

; _off-left?___:__number_____ -> __boolean_____

(EXAMPLE (_off-left?___ __-100____) __(< -100 0)_____)

(EXAMPLE (_off-left?_____ _500_____) _(< 500 0)_____)

(define (_off-left?_____ _x_____) _(< x 0)_____)

; _____:_____ -> _____

(EXAMPLE (_____ _____) _____)

(EXAMPLE (_____ _____) _____)

(define (_____ _____) _____)

; _____:_____ -> _____

(EXAMPLE (_____ _____) _____)

(EXAMPLE (_____ _____) _____)

(define (_____ _____) _____)

TEST	RESULT
(off-left? (world-batX w))	(make-world _(world-wstatus w)_____ _(world-archerY w)_____ _(world-wumpusX w)_____ _800_____ ___(world-arrowX w)_____)
(off-left? (world-wumpusX w))	(make-world _(world-wstatus w)_____ _(world-archerY w)_____ _800_____ _(world-batX w)_____ __(world-arrowX w)_____)
	(make-world _____ _____ _____ _____ _____)
	(make-world _____ _____ _____ _____ _____)

Lesson 8

Design Recipe: line-length

Write a function called line-length, which takes in two numbers and returns the difference between them. It should always subtract the smaller number from the bigger one.

Contract+Purpose Statement

Every contract has three parts:

; _line-length___ : ___number number_____ -> __number_____
name Domain Range

Give Examples

(EXAMPLE (_line-length_____ _2 7__) _(- 7 2)_____)

(EXAMPLE (_line-length___ _7 2_____) _(- 7 2)_____)

Function Header

Write the Function Header, giving variable names to all your input values that change.

(define (_line-length_____ ___a b_____)
function name variable names

__(cond_____

[(> a b)	(- a b)]
[else	(- b a)]

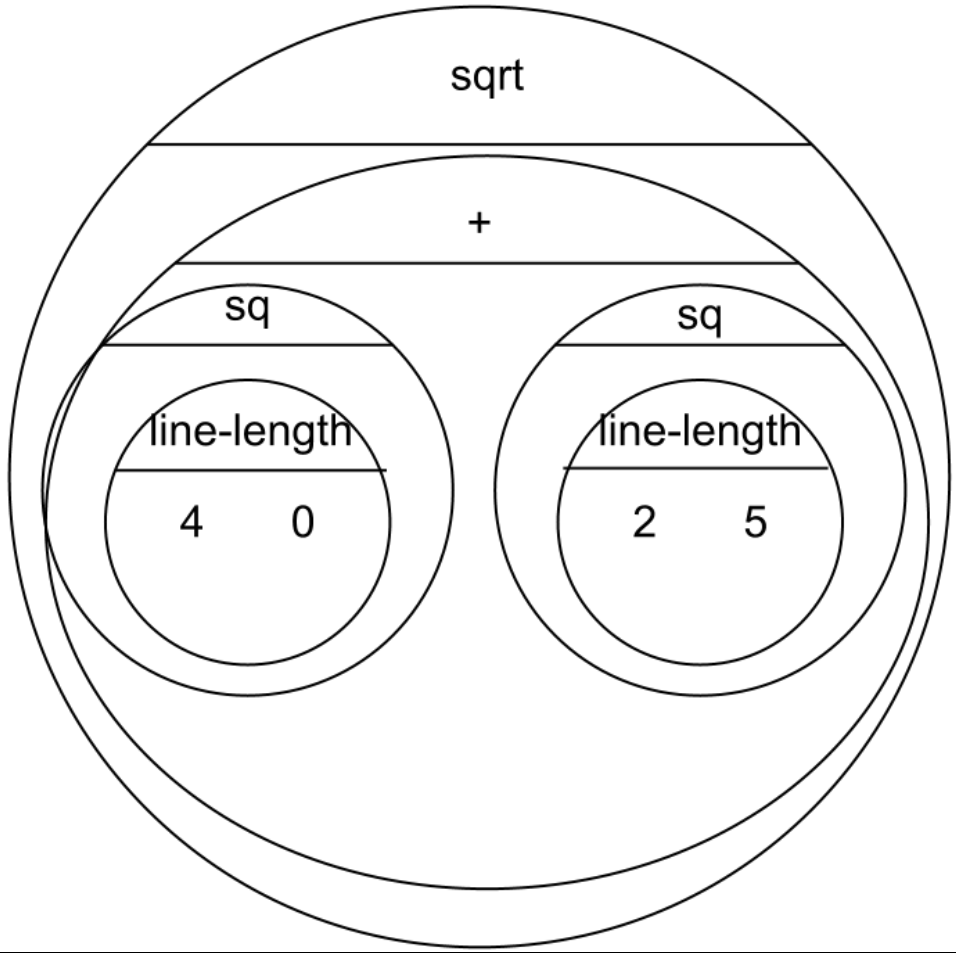
))

Distance:

The Player is at (4, 2) and the Target is at (0, 5).
Distance takes in the player-x, player-y, character-x and character-y.

Use the formula below to fill in the EXAMPLE:

$$\sqrt{(line-length\ \ 4\ \ 0\ )^2\ +\ (line-length\ \ 2\ \ 5\ )^2}$$



Convert it into Racket code:

(EXAMPLE (_distance ___ _4 2 0 5_____)

(sqrt (+ (sq (line-length 4 0)) (sq (line-length 2 5))))_____)

Design Recipe: distance

Write a function `distance`*,which takes FOUR inputs:*

- *px: The x-coordinate of the player*
- *py: The y-coordinate of the player*
- *cx: The x-coordinate of* another game character
- *cy: The y-coordinate of another game character*

It should return the distance between the two, using the Distance formula:

$$\text{Distance} = ((\text{line-length px cx})^2 + (\text{line-length py cy})^2)$$

Contract+Purpose Statement

; __distance____ : _number number number number_____ -> __number_____
name Domain Range

; _____
What does the function do?

Give Examples

(EXAMPLE (_distance 4 2 0 5_____)

(sqrt (+ (sq (line-length 4 0)) (sq (line-length 2 5))))_____)

(EXAMPLE (_____distance 7 8 9 1_____)

(sqrt (+ (sq (line-length 7 9)) (sq (line-length 8 1))))_____)

Function Header

(define (__distance____ _px py cx cy_____)
function name variable names

__(sqrt (+ (sq (line-length px cx)) (sq (line-length py cy))))_____)

DESIGN RECIPE: COLLIDE?

Write a function `collide?`*,which takes FOUR inputs:*

- *px: The x-coordinate of the player*
- *py: The y-coordinate of the player*
- *cx: The x-coordinate of* another game character
- *cy: The y-coordinate of another game character*

It should return `true` if the coordinates of the player are within **75 pixels** of the coordinates of the other character. Otherwise, `false`.

Contract+Purpose Statement

; __collide?__ : ___number number number number_____ -> __boolean_____
name Domain Range

; _____
What does the function do?

Give Examples

(EXAMPLE (_collide?____1 3 234 91_____)

____(< (distance 1 3 234 91) 75)_____)

(EXAMPLE (__collide?__543 25 24 431_____)

____(< (distance 543 25 24 431) 75)_____)

Function Header

(define (__collide?__ __px py cx cy_____)

____(< (distance px py cx cy) 75)_____)

TEST	RESULT
(collide? (world-wumpusX w) 210 50 (world-archerY w))	(make-world (world-wstatus w)_____ 0_____ 1000_____ (world-batX w)_____ (world-arrowX w))_____)
(collide? (world-batX w) 440 50 (world-archerY w))	(make-world (world-wstatus w)_____ 0_____ (world-wumpusX w)_____ 1500_____ (world-arrowX w))_____)
(collide? (world-wumpusX w) 210 (world-arrowX w) (+ 25 (world-archerY w)))	(make-world "asleep"_____ (world-archerY w)_____ 800_____ (world-batX w)_____ 900)_____)
	(make-world _____ _____ _____ _____ _____)

Supplemental

The *Teacher Game* file contains a fully working game up to this point. As you can see, while the game works it is not fully fleshed out. Additional code, which could be completed in a couple more hours of small group work, is implemented in *Teacher Game 2*.

Changes include the following:

- **Adding a "Game Over" screen**
- **Implementing the wumpus status: awake/asleep/dead**
- **Writing a second collide function, with decreased range**
- **Providing fine resolution player mvmt**