

# Bootstrap Units

**01** Videogames  
and  
Coordinate  
Planes

**02** Contracts,  
Strings, and  
Images

**03** Intro to  
Definitions

**04** Design Recipe

**05** Game  
Animation

**06** Comparing  
Functions

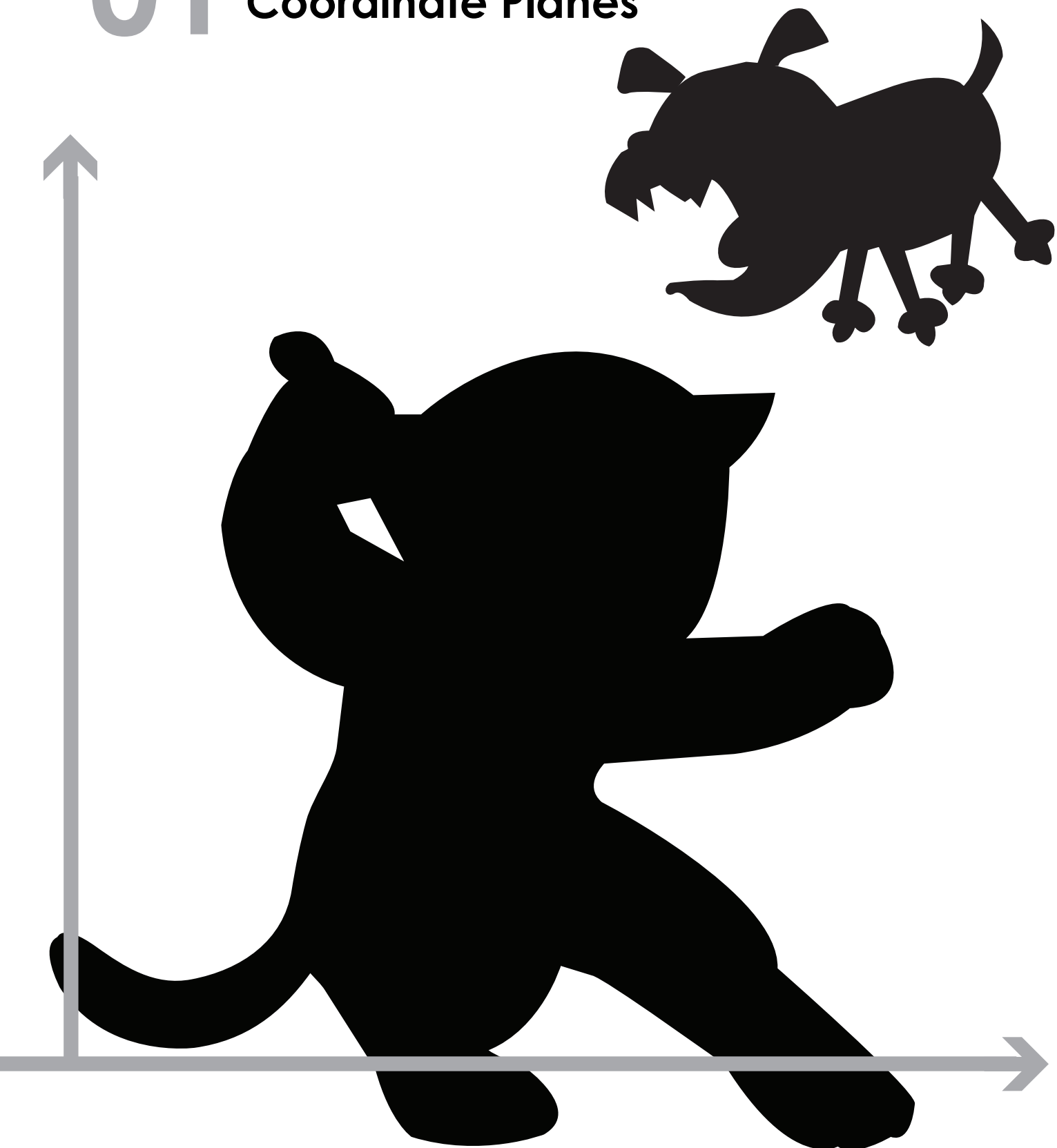
**07** Conditional  
Branching

**08** Collision  
Detection

**09** Prepping for  
Launch

**10** Additional  
Material

# 01 Videogames and Coordinate Planes



# Lesson 1

## Reverse-Engineering: How does NinjaCat work?

Thing in the game...	What changes about it?	More specifically...
<i>cloud</i>	<i>position</i>	<i>x-coordinate</i>

## Finding Coordinates



The coordinates for the PLAYER (NinjaCat) are:  $( \quad , \quad )$   
x-coordinate y-coordinate

The coordinates for the DANGER (Dog) are:  $( \quad , \quad )$

The coordinates for the TARGET (Ruby) are:  $( \quad , \quad )$

# Our Videogame

Created by (write your names): \_\_\_\_\_

## Background

Our game takes place in: \_\_\_\_\_  
(space? the desert? a mall?)

## The Player

The player is a \_\_\_\_\_.

The player moves only up and down.

## The Target

*Your player GAINS points when they hit the target.*

The Target is a \_\_\_\_\_.

The Target moves only to the left and right.

## The Danger

*Your player LOSES points when they hit the danger.*

The Danger is a \_\_\_\_\_.

The Danger moves only to the left and right.

# Circle of Evaluation Practice

**Time: 5 minutes**

Don't forget to use the computer's symbols for things like multiply and divide!

<b>Math</b>	<b>Circle of Evaluation</b>	<b>Racket Code</b>
$5 \times 10$		
$8 + (5 \times 10)$		
$(8 + 2) - (5 \times 10)$		
$\frac{5 \times 10}{8 - 2}$		

## 02 Contracts, Strings, and Images



# Circles Competition

Time: 5 minutes

	<b>Math</b>	<b>Circle of Evaluation</b>	<b>Racket Code</b>
Round 1	$(3 * 7) - (1 + 2)$		
Round 2	$3 - (1 + 2)$		
Round 3	$3 - (1 + (5 * 6))$		
Round 4	$(1 + (5 * 6)) - 3$		



# 03 Intro to Definitions



## Fast Functions

`; _____ : _____ -> _____`  
name domain range

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(define ( \_\_\_\_\_ ) \_\_\_\_\_)

`; _____ : _____ -> _____`  
name domain range

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(define ( \_\_\_\_\_ ) \_\_\_\_\_)

`; _____ : _____ -> _____`  
name domain range

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(define ( \_\_\_\_\_ ) \_\_\_\_\_)

`; _____ : _____ -> _____`  
name domain range

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_)

(define ( \_\_\_\_\_ ) \_\_\_\_\_)

# Fast Functions

$f: \text{domain} \rightarrow \text{range}$

name domain range

(EXAMPLE ( ) )

(EXAMPLE ( ) )

(define ( ) )

$f: \text{domain} \rightarrow \text{range}$

name domain range

(EXAMPLE ( ) )

(EXAMPLE ( ) )

(define ( ) )

$f: \text{domain} \rightarrow \text{range}$

name domain range

(EXAMPLE ( ) )

(EXAMPLE ( ) )

(define ( ) )

$f: \text{domain} \rightarrow \text{range}$

name domain range

(EXAMPLE ( ) )

(EXAMPLE ( ) )

(define ( ) )

# 04 Design Recipe

1 Contract

2 Example

3 Definition



Word Problem: rocket-height

Directions: A rocket blasts off, traveling at 7 meters per second. Write a function called 'rocket-height' that takes in the number of seconds that have passed since the rocket took off, and which produces the height of the rocket at that time.

Contract and Purpose Statement

Every contract has three parts...

1

function name

:

arguments

→

output

2

3

what does the function do?

Examples

Give some examples, show how it and what value it outputs...

(EXAMPLE ( 

function name

arguments

 ) 

what the function produces

 )

(EXAMPLE ( 

function name

arguments

 ) 

what the function produces

 )

Definition

Write the definition, given variable names to all your input values...

(define ( 

function name

arguments

 ) 

what the function does with the arguments

 )

Word Problem: lawn-area

Directions: Use the Design Recipe to write a function "lawn-area", which takes in the width and length of a lawn, and returns the area of the lawn. (Don't forget: area = length \* width!)

Contract and Purpose Statement

Every contract has three parts...

2

function name

parameters

return

output

2

(what does the function DO?)

Examples

Write some examples, then circle and label what changes...

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

Definition

Write the definition, given variable names in all your input values...

(define ( 

function name

parameters

 ) 

what the function does with those variables

 )

Word Problem: red-square

Directions: Use the Design Recipe to write a function "red-square", which takes in a number (the length of each side of the square) and outputs a solid red rectangle whose length and width are the same size.

Contract and Purpose Statement

Every contract has three parts...

2

function name

parameters

what

why

2

What does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

Definition

Write the definition, given variable names in all your input values...

(define ( 

function name

parameters

 )  )

what the function does with those variables

# target



# danger



## 05 Game Animation



Word Problem: update-danger

Directions: Use the Design Recipe to write a function 'update-danger', which takes in the danger's x-coordinate and produces the next x-coordinate, which is 50 pixels to the left.

Contract and Purpose Statement

Every contract has three parts...

1  
function name      arguments      →      return type

2  
\_\_\_\_\_

(what does the function do?)

Examples

Write some examples, then circle and label what changes...

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_ )

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_ )

(EXAMPLE ( \_\_\_\_\_ ) \_\_\_\_\_ )

Definition

Write the definition, given variable names in all your input values...

(define ( \_\_\_\_\_ ) \_\_\_\_\_ )

\_\_\_\_\_

(what the function does with those variables)

Word Problem: update-target

Directions: Write a function 'update-target', which takes in the target's x-coordinate and produces the next x-coordinate, which is 50 pixels to the right.

Contract and Purpose Statement

Every contract has three parts...

1  
function name  
parameters  
return  
output

2  

what does the function do?

Examples

Write some examples, draw circles and label what changes...

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

(EXAMPLE ( 

function name

parameters

 ) 

what the function produces

 )

Definition

Write the definition, given variable names in all your input values...

(defLine ( 

function name

parameters

 )  

what the function does with those variables

 )



***“safe-left?”***

## **06** Comparing Functions

## DESIGN RECIPE

Sam is in a 640 x 480 yard. How far he can go to the left and right before he's out of sight?

1. A piece of Sam is still visible on the left as long as...  $( > \frac{x}{-50} )$  \_\_\_\_\_
2. A piece of Sam is still visible on the right as long as... \_\_\_\_\_
3. Draw the Circle of Evaluation for these two expressions in the circles below:



**Word Problem: safe-left?**

**Directions:** Use the Design Recipe to write a function 'safe-left?', which takes in an x-coordinate and checks to see if it is greater than -50

## Contract and Purpose Statement

Every contract has three parts...

The diagram illustrates the relationship between a function name, its domain, and its range. It consists of a horizontal line divided into three segments. The first segment is labeled 'function name', the second 'domain', and the third 'range'. An arrow points from the 'function name' segment to the 'domain' segment, and another arrow points from the 'domain' segment to the 'range' segment.

---

what does the function do?

## Examples

Write some examples, then circle and label what changes...

(EXAMPLE ( function name ( input(s) ) what the function produces )

function name	#input	what the function produces
<b>(EXAMPLE ( ) )</b>		

#### Definition

Write the definition, given variable names to all your input values...

```
(define( function name variables )
```

---

what the function does with those variables

Word Problem: safe-right?

Directions: Use the Design Recipe to write a function "safe-right", which takes in an x-coordinate and checks to see if it is less than 0.00.

Contract and Purpose Statement

Every contract has three parts...

2

function nameparametersreturn type

2

what does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE (function nameparameters) what the function produces)

(EXAMPLE (function nameparameters) what the function produces)

Definition

Write the definition, given variable names in all your input values...

(define (function nameparameters)

what the function does with those variables

## and / or

**Write the Circles of Evaluation for these statements, and then convert them to Racket**

1. Two is less than five, and zero is equal to six.



2. Two is less than four or four is equal to six.



Word Problem: onscreen?

Directions: Use the Design Recipe to write a function "onscreen?", which takes in the x-coordinate and checks to see if Sam is safe on the left AND safe on the right.

Contract and Purpose Statement

Every contract has three parts...

2

function name

parameters

→

return

output

2

What does the function do?

Examples

Write some examples, then circle and label what changes...

(EXAMPLE ( 

function name

parameters

 )

what the function produces

(EXAMPLE ( 

function name

parameters

 )

what the function produces

Definition

Write the definition, given variable names to all your input values...

(define ( 

function name

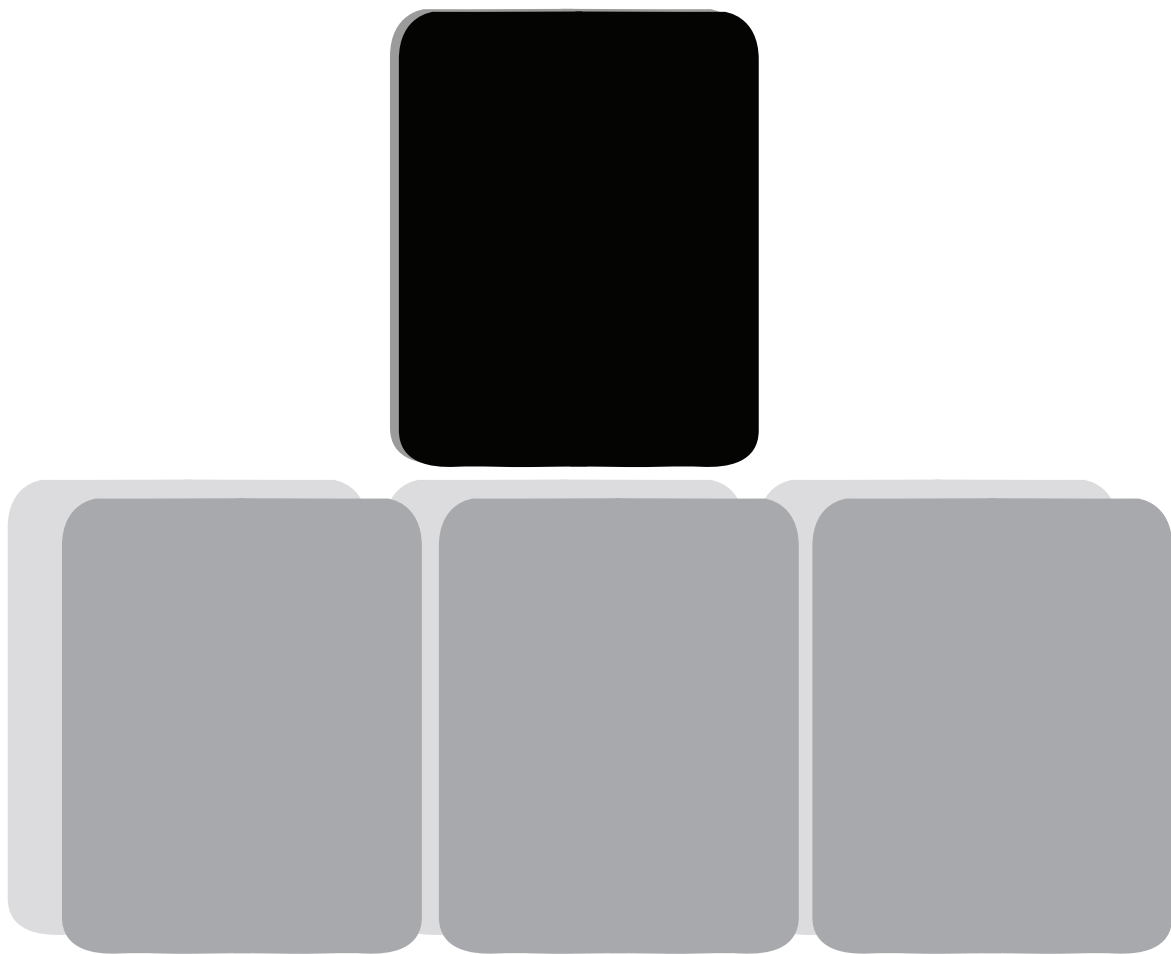
parameters

 )

what the function does with those variables



# 07 Conditional Branching



Word Problem: cost

Directions: Luigi's Pizza has hired you as a programmer. They offer Pepperoni (\$10.50), Cheese (\$9.00), Chicken (\$11.25) and Brat-o-let (\$10.25). Write a function called cost which takes in the name of a topping and outputs the cost of a pizza with that topping.

Contract and Purpose Statement

Every contract has three parts...

1

function name

→

2

parameters

→

3

return

4

what does the function do?

Examples

Write your examples, show the input and what value it outputs...

(EXAMPLE ( cost "pepperoni" ) )

function name (parameters) value the function produces

(EXAMPLE ( ) )

function name (parameters) value the function produces

(EXAMPLE ( ) )

function name (parameters) value the function produces

(EXAMPLE ( ) )

function name (parameters) value the function produces

(EXAMPLE ( ) )

function name (parameters) value the function produces

Definition

Write the definition, gives variable names to all your input values...

(define (

function name

parameters

)

(cond

{

{

}

{

}

{

}

{

}

{

}

}

)

25

Word Problem: update-player

Directions: Write a function called update-player, which takes in the player's y-coordinate and the name of the key pressed, and returns the new y-coordinate.

Contract and Purpose Statement

Every contract has three parts...

2

function nameparametersreturn type

2

(what does the function do?)

Examples

Write some examples, show inputs and labels what it changes...

(EXAMPLE( update-player320 "up" ) )

(EXAMPLE( update-player100 "up" ) )

(EXAMPLE( ) )

(EXAMPLE( ) )

Definition

Write the definition, given variable names to all your input values...

(define( ) )

{ }

{ }

{ }

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# 08 Collision Detection

collision



distance

Word Problem: line-length

Directions: Write a function called "line-length" which takes in two numbers and returns the "positive difference" between them. It should always subtract the smaller number from the bigger one, and if they are equal it should return zero.

Contract and Purpose Statement

Every contract has three parts...

1

function name

2

arguments

3

return

1

2

return value (the data that is returned)

Examples

Give some examples, show how it works and what value it returns...

(EXAMPLE( line-length 10 5 ) (- 10 5) )

function name arguments return value (the data that is returned)

(EXAMPLE( line-length 2 8 ) (- 8 2) )

function name arguments return value (the data that is returned)

Definition

Write the definition, given variable names to all your input values...

(define (

function name

)

(cond

{

{

}

}

)

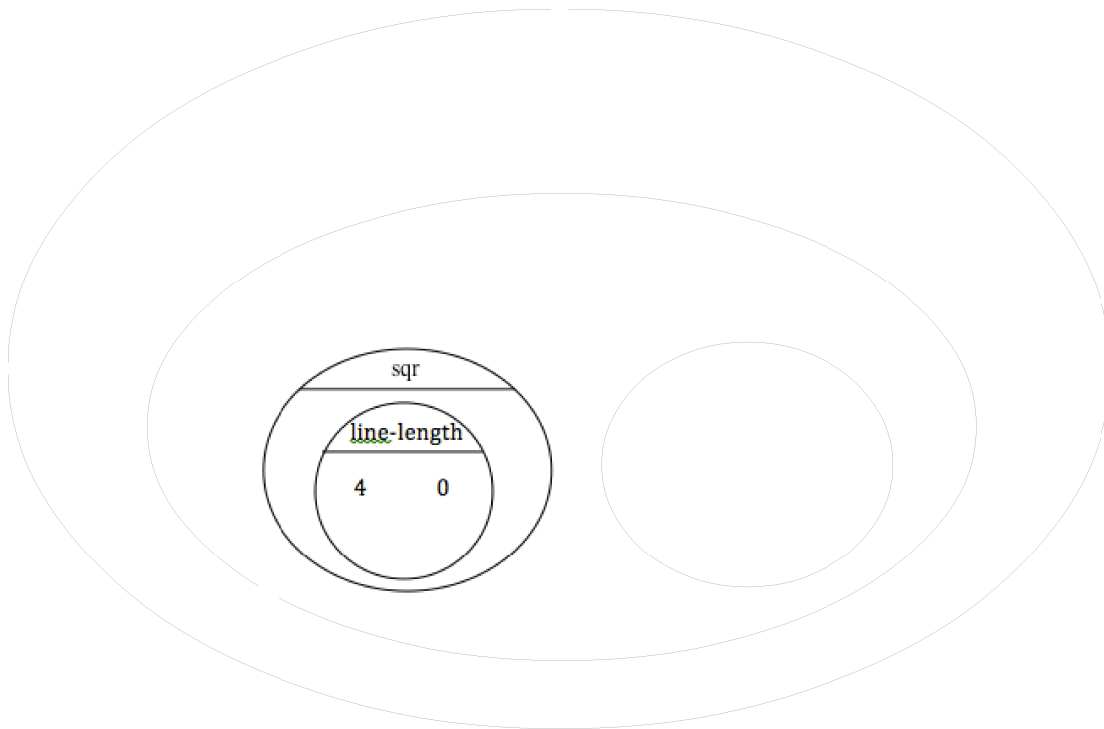
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## The Distance Formula (an example)

The distance between the points (0, 0) and (4, 3) is given by:

$$\sqrt{(\text{line-length } 4 \ 0)^2 + (\text{line-length } 3 \ 0)^2}$$

Convert the formula above into a Circle of Evaluation. (We've already gotten you started!)



Convert the Circle of Evaluation into Racket code:

# Word Problem: distance

Directions: Write a function distance, which takes FOUR inputs:

- $p_x$ : The  $x$ -coordinate of the player
- $p_y$ : The  $y$ -coordinate of the player
- $c_x$ : the  $x$ -coordinate of another game character
- $c_y$ : the  $y$ -coordinate of another game character

It should return the distance between the two, using the Distance formula. (HINT: look at what you did on the previous page)

## Contract and Purpose Statement

Every function has two parts...

```
1  def distance(x1, y1, x2, y2):  
2      # your code here  
3      return
```

(What does the function do?)

## Examples

Write some examples, show calls to and label what changes...

```
(EXAMPLE) def distance(x1, y1, x2, y2):  
1      # your code here  
2      return  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
13  
14  
15  
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90  
91  
92  
93  
94  
95  
96  
97  
98  
99  
100
```

(What does the function do?)

## Definition

Write the definition, given variable names to all your input values...

```
(defLine) def distance(x1, y1, x2, y2):  
1      # your code here  
2      return  
3  
4  
5  
6  
7  
8  
9  
10  
11  
12  
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96  
97  
98  
99  
100
```

(What does the function do with these variables?)

**Word Problem: collide?**

*Directions: 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

Are the coordinates of the player within 50 pixels of the coordinates of the other character?

### Contract and Purpose Statement

Every contract has three parts...

*function name*      *domain*      *range*

*what does the function do?*

### Examples

Write some examples, then circle and label what changes...

(EXAMPLE(	)	)
<i>function name</i>	<i>input(s)</i>	<i>what the function produces</i>
(EXAMPLE(	)	)
<i>function name</i>	<i>input(s)</i>	<i>what the function produces</i>

## Definition

Write the definition, given variable names to all your input values...

```
(define ( function name variables )  
  when the function does with these variables )
```





## 09 Presentation Preparation



# Lesson 9

Catchy Intro:

---

---

---

Name, Age, Grade:

---

Game Title:

---

Back Story:

---

---

---

---

Characters:

---

---

---

---

---

Explain a piece of your code:

---

---

---

---

[illegible]

## Presentation Feedback

*For each question, circle the answer that fits best.*

Was the introduction catchy?      No way!      A little.      Definitely!

Did they talk about their characters?      No way!      A little.      Definitely!

Did they explain the code well?      No way!      A little.      Definitely!

Did they speak slowly enough?      No way!      A little.      Definitely!

Did they speak loudly enough?      No way!      A little.      Definitely!

Were they standing confidently?      No way!      A little.      Definitely!

Did they make eye contact?      No way!      A little.      Definitely!

## Presentation Feedback

*For each question, circle the answer that fits best.*

Was the introduction catchy?      No way!      A little.      Definitely!

Did they talk about their characters?      No way!      A little.      Definitely!

Did they explain the code well?      No way!      A little.      Definitely!

Did they speak slowly enough?      No way!      A little.      Definitely!

Did they speak loudly enough?      No way!      A little.      Definitely!

Were they standing confidently?      No way!      A little.      Definitely!

Did they make eye contact?      No way!      A little.      Definitely!

Word Problem: red-shape

Directions: Write a function called red-shape, which takes in the name of a shape and draws that shape (solid and red). Add an else clause that produces a sensible output.

Contract and Purpose Statement

Every contract has three parts...

2

function nameparametersreturn type

2

(what does the function do?)

Examples

Write some examples, then circle it and label what it changes...

(EXAMPLE( red-shape "circle" ) (circle 50 "solid" "red") )

parametersreturn

what the function produces

(EXAMPLE( ) )

parametersreturn

what the function produces

(EXAMPLE( ) )

parametersreturn

what the function produces

(EXAMPLE( ) )

parametersreturn

what the function produces

(EXAMPLE( ) )

parametersreturn

what the function produces

Definition

Write the definition, given variable names to all your input values...

(define(

function nameparameters)

(cond

{

(circle 50 "solid" "red")

}

{

}

{

}

{

}

{

}

)

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## Translating into Algebra

### Value Definitions

Racket Code	Algebra
<code>(define x 10)</code>	$x = 10$
<code>(define y (* x 2))</code>	$y = x \cdot 2$
<code>(define z (+ x y))</code>	
<code>(define age 14)</code>	
<code>(define months (* age 12))</code>	
<code>(define days (* months 30))</code>	
<code>(define hours (* days 24))</code>	
<code>(define minutes (* hours 60))</code>	

### Function Definitions

Racket Code	Algebra
<code>(define (area length width)   (* length width))</code>	$\text{area}(\text{length}, \text{width}) = \text{length} \cdot \text{width}$
<code>(define (circle-area radius)   (* pi (sqr radius)))</code>	
<code>(define (distance x1 y1 x2 y2)   (sqrt (+ (sqr (- x1 x2))            (sqr (- y1 y2)))))</code>	

## Design Recipe

A rocket is flying from Earth to Mars at 80 miles per second. Write a function that describes the **distance**  $D$  that the rocket has traveled, as a function of **time**  $t$ .

## I. Contract+Purpose Statement

Every contract has three parts:

;

<u>D</u>	:		->	
name		Domain		Range

;

---

*What does the function do?*

## II. Give Examples

Write an example of your function for some sample inputs

D(1) = \_\_\_\_\_

Use the function here                      What should the function produce?

**D( 2 )=** \_\_\_\_\_  
 Use the function here                      What should the function produce?

**D( )** = \_\_\_\_\_

Use the function here                      What should the function produce?

	=
Use the function here	What should the function produce?

### III. Definition

Write the formula, giving variable names to all your input values.

$$D(\quad) =$$



# Design Recipe

A rocket is traveling from Earth to Mars at 80 miles per second. Write a function that describes the time the rocket has been traveling, as a function of distance.

## I. Contract+Purpose Statement

Every contract has three parts:

;  
: \_\_\_\_\_ -> \_\_\_\_\_  
name Domain Range  
;  
\_\_\_\_\_  
What does the function do?

## II. Give Examples

Write an example of your function for some sample inputs

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

## III. Definition

Write the Formula, giving variable names to all your input values.

\_\_\_\_\_  
= \_\_\_\_\_

# Design Recipe

A rocket leaves Earth, headed for Mars at 80 miles per second. **At the exact same time**, an asteroid leaves Mars traveling towards Earth, moving at 70 miles per second. If the distance from the Earth to Mars is 50,000,000 miles, how long will it take for them to meet?

## I. Contract+Purpose Statement

Every contract has three parts:

;  
name : Domain -> Range  
;  
What does the function do?

## II. Give Examples

Write an example of your function for some sample inputs

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

## III. Definition

Write the Formula, giving variable names to all your input values.

=

# Design Recipe

## I. Contract+Purpose Statement

Every contract has three parts:

;  
name : Domain -> Range  
;  
What does the function do?

## II. Give Examples

Write an example of your function for some sample inputs

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

=  
Use the function here What should the function produce?

## III. Definition

Write the Formula, giving variable names to all your input values.

=

# Design Recipe

## I. Contract+Purpose Statement

Every contract has three parts:

;  
; \_\_\_\_\_ : \_\_\_\_\_ -> \_\_\_\_\_  
name Domain Range  
;  
; \_\_\_\_\_  
What does the function do?

## II. Give Examples

Write an example of your function for some sample inputs

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

\_\_\_\_\_  
= \_\_\_\_\_  
Use the function here What should the function produce?

## III. Definition

Write the Formula, giving variable names to all your input values.

\_\_\_\_\_  
= \_\_\_\_\_

# Contracts

[illegible]

# Contracts

[illegible]