<table>
<thead>
<tr>
<th>Bootstrap Units</th>
<th>01</th>
<th>06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Videogames and Coordinate Planes</td>
<td>02</td>
<td>07</td>
</tr>
<tr>
<td>Contracts, Strings, and Images</td>
<td>03</td>
<td>08</td>
</tr>
<tr>
<td>Intro to Definitions</td>
<td>04</td>
<td>09</td>
</tr>
<tr>
<td>Design Recipe</td>
<td>05</td>
<td>10</td>
</tr>
<tr>
<td>Game Animation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Comparing Functions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conditional Branching</td>
<td></td>
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<tr>
<td>Collision Detection</td>
<td></td>
<td></td>
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<tr>
<td>Prepping for Launch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Additional Material</td>
<td></td>
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</tr>
</tbody>
</table>
01 Videogames and Coordinate Planes
### Lesson 1

#### Reverse-Engineering: How does NinjaCat work?

<table>
<thead>
<tr>
<th>Thing in the game...</th>
<th>What changes about it?</th>
<th>More specifically...</th>
</tr>
</thead>
<tbody>
<tr>
<td>cloud</td>
<td>position</td>
<td>x-coordinate</td>
</tr>
</tbody>
</table>

...
The coordinates for the PLAYER (NinjaCat) are: \(( \text{x-coordinate}, \text{y-coordinate} )\)

The coordinates for the DANGER (Dog) are: \(( \text{x-coordinate}, \text{y-coordinate} )\)

The coordinates for the TARGET (Ruby) are: \(( \text{x-coordinate}, \text{y-coordinate} )\)
# 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!

<table>
<thead>
<tr>
<th>Math</th>
<th>Circle of Evaluation</th>
<th>Racket Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>$5 \times 10$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$8 + (5 \times 10)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(8 + 2) - (5 \times 10)$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{5 \times 10}{8 - 2}$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
02 Contracts, Strings, and Images
<table>
<thead>
<tr>
<th>Rounds</th>
<th>Math</th>
<th>Circle of Evaluation</th>
<th>Racket Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td>(3 * 7) - (1 + 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 2</td>
<td>3 - (1 + 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 3</td>
<td>3 - (1 + (5 * 6))</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Round 4</td>
<td>(1 + (5 * 6)) - 3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
03 Intro to Definitions
### Fast Functions!

<table>
<thead>
<tr>
<th>name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>(EXAMPLE (_____  _____)  _________________________)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(EXAMPLE (_____  _____)  _________________________)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(define (_____ _____) ____________________________)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
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<td></td>
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<td></td>
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<tr>
<td>(define (_____ _____) ____________________________)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
## Fast Functions!

<table>
<thead>
<tr>
<th>name</th>
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<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td>(EXAMPLE</td>
<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
<tr>
<td>(EXAMPLE</td>
<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
<tr>
<td>(define</td>
<td>(_____  _____)</td>
<td>____________________________</td>
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<th>name</th>
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</thead>
<tbody>
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<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
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<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
<tr>
<td>(define</td>
<td>(_____  _____)</td>
<td>____________________________</td>
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</table>

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<td>____________________________</td>
</tr>
<tr>
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<td>____________________________</td>
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<tr>
<td>(define</td>
<td>(_____  _____)</td>
<td>____________________________</td>
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<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
<tr>
<td>(define</td>
<td>(_____  _____)</td>
<td>____________________________</td>
</tr>
</tbody>
</table>
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 ...

; function name : domain → range ;

what does the function do?

Examples

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

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

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

Definition

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

(define( function name variables )

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 size 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 ...

```
; function name domain range
```

### Examples

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

```
(EXAMPLE( ) )

(EXAMPLE( ) )
```

### Definition

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

```
(define( ) )
```

what the function does with those variables
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 ...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

what does the function do?

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

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

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

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

(define(          )
  function name  variables

  what the function does with those variables
)
Game Animation
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 ...

; function name : domain → range ;

what does the function do?

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

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

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

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

(define( function name variables )

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...

; function name : domain → range

; 

what does the function do?

**Examples**

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

(EXAMPLE( __________________________ ) )

function name input(s) what the function produces

(EXAMPLE( __________________________ ) )

function name input(s) what the function produces

**Definition**

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

(define( __________________________ )

function name variables

; ____________________________________________

what the function does with those variables
Comparing Functions

“safe-left?”
Protecting Sam

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...

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:

(> x -50)
**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 ...

; function name : domain → range

; what does the function do?

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

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

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

**Definition**
Write the definition, giving 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 690.

Contract and Purpose Statement
Every contract has three parts ...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

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

(define( function name )
 | variables | 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 ...

; function name : domain → range ;

what does the function do?

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

(EXAMPLE( function name input(s) )

what the function produces

(EXAMPLE( function name input(s) )

what the function produces

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

(define( function name variables )

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 Broccoli ($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 ...

; function name : domain → range

what does the function do?

Examples

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

(EXAMPLE(cost"pepperoni") )

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

(EXAMPLE( ) )

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

(EXAMPLE( ) )

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

(EXAMPLE( ) )

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

(EXAMPLE( ) )

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

Definition

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

(define( ____________ ____________ )

(function name variables)

(cond ____________

[ ____________ ]

[ ____________ ]

[ ____________ ]

[ ____________ ]

[ ____________ ]

[ ____________ ]

[ ____________ ]))))
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 ...

; function name : domain → range ;

; ____________________________________________________________________________________________ ;

what does the function do?

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

(EXAMPLE( update-player function name 320 "up" input(s) what the function produces ))

(EXAMPLE( update-player function name 100 "up" input(s) what the function produces ))

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

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

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

(define( function name variables )

( ________________ )

[ ________________ ]

[ ________________ ]

[ ________________ ]

[ ________________ ]))
Directions: 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 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 (line-length 10 5 ) (- 10 5 ) )
function name input(s) what the function produces

(EXAMPLE (line-length 2 8 ) (- 8 2 ) )
function name input(s) what the function produces

Definition

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

(define (line-length )

function name variables

(cond

[__________________________ ]

[__________________________ ]))
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:

- 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. (HINT: look at what you did on the previous page!)

Contract and Purpose Statement

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
<th>what does the function do?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples

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

(EXAMPLE( function name      input(s) )

what the function produces

(EXAMPLE( function name      input(s) )

what the function produces

Definition

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

(define( function name      variables )

what the function does with those 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 ( function name input(s) what the function produces )

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

Definition

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

(define ( function name variables )

what the function does with those variables)
09 Presentation Preparation
Lesson 9

Catchy Intro:

________________________________________
________________________________________
________________________________________

Name, Age, Grade:

________________________________________
________________________________________
________________________________________

Game Title:

________________________________________
________________________________________
________________________________________

Back Story:

________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

Characters:

________________________________________
________________________________________
________________________________________
________________________________________
________________________________________

Explain a piece of your code:

________________________________________
________________________________________
________________________________________
________________________________________
________________________________________
## Presentation Feedback

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

<table>
<thead>
<tr>
<th>Question</th>
<th>No way!</th>
<th>A little.</th>
<th>Definitely!</th>
</tr>
</thead>
<tbody>
<tr>
<td>Was the introduction catchy?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they talk about their characters?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they explain the code well?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they speak slowly enough?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they speak loudly enough?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Were they standing confidently?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did they make eye contact?</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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 ('circle', 'triangle', 'star', or 'rectangle'), and draws that shape. All shapes should be solid and red, and can be whatever size you choose.

Contract and Purpose Statement

Every contract has three parts ...

<table>
<thead>
<tr>
<th>function name</th>
<th>domain</th>
<th>range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

what does the function do?

Examples

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

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

(EXAMPLE( ) )

(EXAMPLE( ) )

(EXAMPLE( ) )

(EXAMPLE( ) )

Definition

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

(define( )

  (cond
    [ (circle 50 "solid" "red") ]
    [ ]
    [ ]
    [ ]
    [ ]
    [ ]
)))
### Translating into Algebra

#### Values: Translate the Racket Code into Algebra

<table>
<thead>
<tr>
<th>Racket Code</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>(define x 10)</code></td>
<td><code>x = 10</code></td>
</tr>
<tr>
<td><code>(define y (* x 2))</code></td>
<td><code>y = x*2</code></td>
</tr>
<tr>
<td><code>(define z (+ x y))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define age 14)</code></td>
<td></td>
</tr>
<tr>
<td><code>(define months (* age 12))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define days (* months 30))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define hours (* days 24))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define minutes (* hours 60))</code></td>
<td></td>
</tr>
</tbody>
</table>

#### Functions: Translate the Racket Code into Algebra

<table>
<thead>
<tr>
<th>Racket Code</th>
<th>Algebra</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>(define (double x) (* x 2))</code></td>
<td><code>double(x) = x*2</code></td>
</tr>
<tr>
<td><code>(define (area length width) (* length width))</code></td>
<td><code>area(length, width) = length * width</code></td>
</tr>
<tr>
<td><code>(define (circle-area radius) (* pi (sq radius)))</code></td>
<td></td>
</tr>
<tr>
<td><code>(define (distance x1 y1 x2 y2) (sqrt (+ (sq (- x1 x2)) (sq (- y1 y2)))))</code></td>
<td></td>
</tr>
</tbody>
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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:

; $D$ : ___________________________ -> ____________

name         Domain                  Range

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.

$D( ) =$
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

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.


Word Problem

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

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.

= 


I. Contract+Purpose Statement
Every contract has three parts:

; __________________ : __________________ --> ____________

name : Domain --> Range

II. Give Examples
Write an example of your function for some sample inputs

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Use the function here What should the function produce?

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Use the function here What should the function produce?

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Use the function here What should the function produce?

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Use the function here What should the function produce?

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

= }

42
I. Contract+Purpose Statement
Every contract has three parts:

; __________________ : __________________ -> ____________
  name       Domain               Range

II. Give Examples
Write an example of your function for some sample inputs

  =
  Use the function here What should the function produce?

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  Use the function here What should the function produce?

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  Use the function here What should the function produce?

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  Use the function here What should the function produce?

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

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## Contracts

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