Contracts

Applying Functions

Consider the math function $f(x)=x+4$

- What is the name of this function?
- The expression f(2) applies the function f to the number 2. What will it evaluate to?
- What will the expression f(3) evaluate to?
- The values to which we apply a function are called its ***arguments***. How many arguments does f expect?

Applying Functions

Open code.pyret.org (CPO) and click run.
Type `num-sqrt(16)` into the interactions area.

- What is the name of this function?
- How many arguments does the function expect?
- What type of argument does the function expect?
- Does the num-sqrt function produce a Number? String? Boolean?
- What did the expression evaluate to?

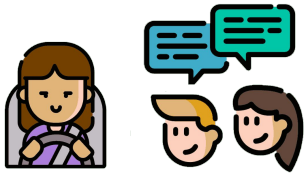
Applying Functions

Type `string-length("rainbow")` into the interactions area.

- What is the name of this function?
- How many arguments does the function expect?
- What type of argument does the function expect?
- What does the expression evaluate to?
- Does the `string-length` function produce a Number? String? Boolean?

Applying Functions

With your partner, complete Applying Functions.



When you finish answering the questions and identifying the bugs, explore the `triangle` function. Try using “outline” instead of “solid”. Then try changing the triangle’s color and size.

Note: This starter file says “include image”. You can enter that into the definitions area anytime you want pyret to access the image library.

Students browse: code.pyret.org/editor#share=12HvvQ1ik36_6bvG9jj0OoyNH-VVDHLKL&v=04...

Applying Functions

- What are the types of the arguments `triangle` was expecting?
- How does the output relate to the inputs?
- What kind of value was produced by that expression?
- Which error messages did you encounter?

Students, write your response!

Contracts

The `triangle` function created an example of a new ***data type***, called an *Image*.

The triangle function can make lots of different triangles! The size, style and color are all determined by the specific inputs provided in the code.

If we don’t provide the function with a number and two strings to define those parameters, we will get an error message instead of a triangle.

Contracts

We use **Contracts** to help keep track of all our functions.

Every Contract has three important parts:

1. The function's **name** - literally, what we type
2. **Domain** of the function - the type(s) of data we give it
3. **Range** of the function - the type of data the function produces

Contracts

Where else have you heard the word "contract"?

How can you connect that meaning to contracts in programming?

Students, write your response!

Contracts

Contracts are *general*. Expressions are *specific*!

Contract: `num-sqrt :: Number → Number`

Expression: `num-sqrt(16)`

Contracts

Here's a contract table for the functions we've already seen.

Name		Domain		Range
`# num-sqr`	`::`	`Number`	`->`	`Number`
`# num-sqrt`	`::`	`Number`	`->`	`Number`
`# string-contains`	`::`	`String, String`	`->`	`Boolean`
`# string-length`	`::`	`String`	`->`	`Number`
`# triangle`	`::`	`Number, String, String`	`->`	`Image`

When the input matches what the function consumes, the function produces the output we expect.

Contracts

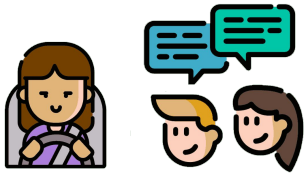
Here is an example of another function.

```
string-append("sun", "shine")
```

Type it into the editor. What is its contract?

Students browse: code.pyret.org/editor

Contracts



Complete

- Practicing Contracts: Domain & Range
- Matching Expressions and Contracts

Contracts

- What is the difference between a value like `17` and a type like `Number`?
- For each expression where a function is given inputs, how many outputs are there?

Exploring Image Functions

Suppose we had never seen star before.

How could we figure out how to use it, using the helpful error messages?

- Type `star` into the Interactions Area and hit "Enter".
- What did you get back? What does that mean?
- If it's a function, we know that it will need an open parentheses and at least one input.
- Try typing `star(50)`
- What error did we get? What *hint* does it give us about how to use this function?
- If I give star what it needs, what do I get in return?
- Be prepared to enter the contract for star on the next slide.

Exploring Image Functions

What is the contract for `star`?

Students, write your response!

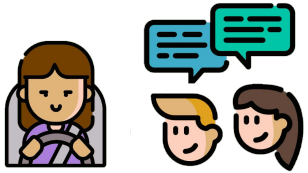
Exploring Image Functions

The contract for `star` and `square` both have:

- Number, String, String as the Domain
- Image as the Range

Does that mean the functions are the same?

Contracts



- Take the next 10 minutes to experiment with the image functions listed in the contracts pages at the back of your workbook.
- When you've got working expressions, record the contracts and example code or other notes!

You will be adding to these contract pages and referring back to them for the remainder of this Bootstrap class!

Students browse: code.pyret.org/editor#share=12HvvQ1ik36_6bvG9jj0OoyNH-VVDHLKL&v=04...

Exploring Image Functions

- `square` and `star` have the same Domain *(Number, String, String)* and Range *(Image)*. Did you find any other shape functions with the same Domain and Range?

- Does having the same Domain and Range mean that the functions do the same things?

Students, write your response!

Exploring Image Functions

A lot of the Domains for shape functions are the same, but some are different.

Why did some shape functions need more inputs than others?

Exploring Image Functions

- Was it harder to find contracts for some of the functions than others? Why?
- What error messages did you see?
- How did you figure out what to do after seeing an error message?

Students, write your response!

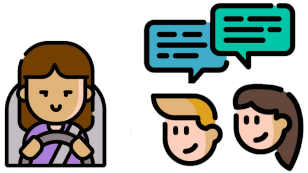
Contracts Help us Write Code

If you know the contract for a function before you start coding, writing an expression takes a lot less guessing and checking!

Contracts Help us write code!

Complete

- Using Contracts
- Using Contracts (continued)



Once you've discovered how to build a version of each image function, record the example code in your contracts table.

Students browse: code.pyret.org/editor#share=12HvvQ1ik36_6bvG9jj0OoyNH-VVDHLKL&v=04...

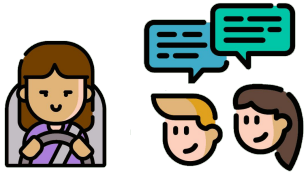
Contracts help us write code!

- What *kind* of triangle did `triangle` build?
- Only one of the inputs was a number. What did that number tell the computer?

Students, write your response!

Contracts help us write code!

Complete Triangle Contracts.



- Optional Triangle Contracts (SAS & ASA)
- Optional Radial Star
- Optional Star Polygon

Students browse: code.pyret.org/editor#share=1Lxea7lb_UBo7-oHo9vV7hO7aHq5lgaMH&v=04...

Exploring Image Functions

1. How was it different to code expressions for a shape function when you started with a contract?

2. Make sure you've written the Contracts for every image function you discovered in your Contracts Pages at the back.

Students, write your response!

Exploring Image Functions

For some of you, the word `ellipse` was new. How would you describe what an ellipse looks like to someone who'd never seen one before?

Students, write your response!

Exploring Image Functions

Why did the contract for `ellipse` require two numbers?

What happens when the two numbers are the same?

Students, write your response!

Exploring Image Functions

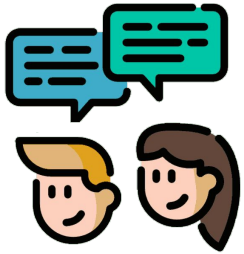
Which input determined the size of the Rhombus?

What did the other number determine?

Students, write your response!

Exploring Image Functions

How to diagnose and fix errors is a skill we will continue working on developing. Some of the errors are ***syntax errors***: a missing comma, an unclosed string, etc. All the other errors are ***contract errors***. If you see an error and you know the syntax is right, ask yourself these three questions:



What is the function that is generating that error?

What is the contract for that function?

Is the function getting what it needs, according to its Domain?

Additional Exercises

Matching Images to Code (Desmos)