Expressions, Values, & Names

CMPU 101 – Problem Solving and Abstraction

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Programs

- A program (or script) instructs a computer to do something.
- These instructions must be very specific for the computer to carry them out.
    - Recall my National Engineers week comments
- But programs also need to be understood by people, i.e. they must be readable!

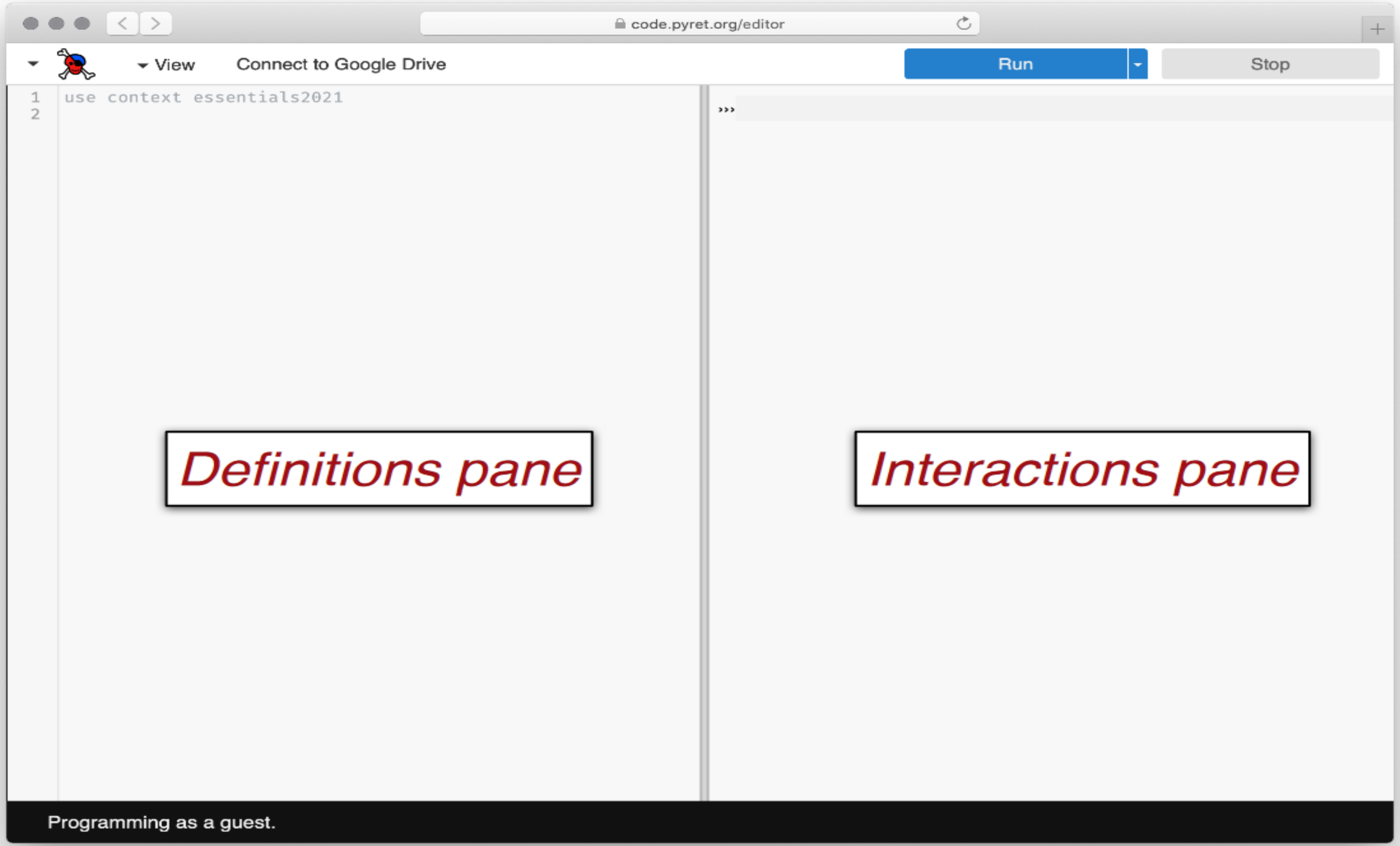
More Basics

- To write a program, we need to use a programming language
  - We could write the 1's and 0's (apologies to Elle King) in a way that the computer can understand the input stream… that's what assembly language is for, btw
- and programming environment. Also known as an Interactive Development Environment, IDE

- We write our computation in the (specified) programming language.
- We run the program in the environment.
  - There's more to the story, but this will suffice for now.

Introducing our IDE

- …Both sides now

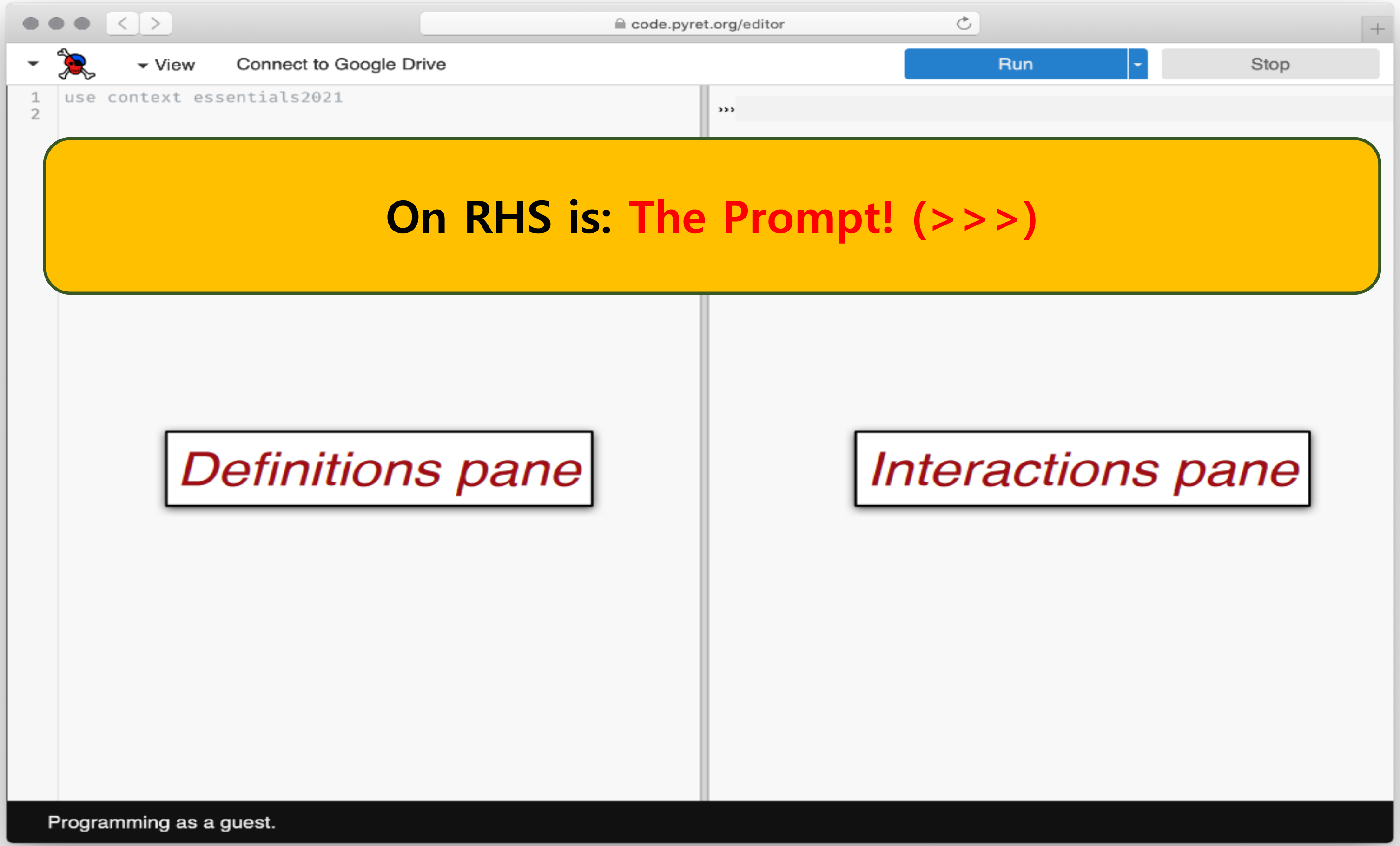


```
use context essentials2021
```

code.pyret.org

Introducing our IDE

- From up and down



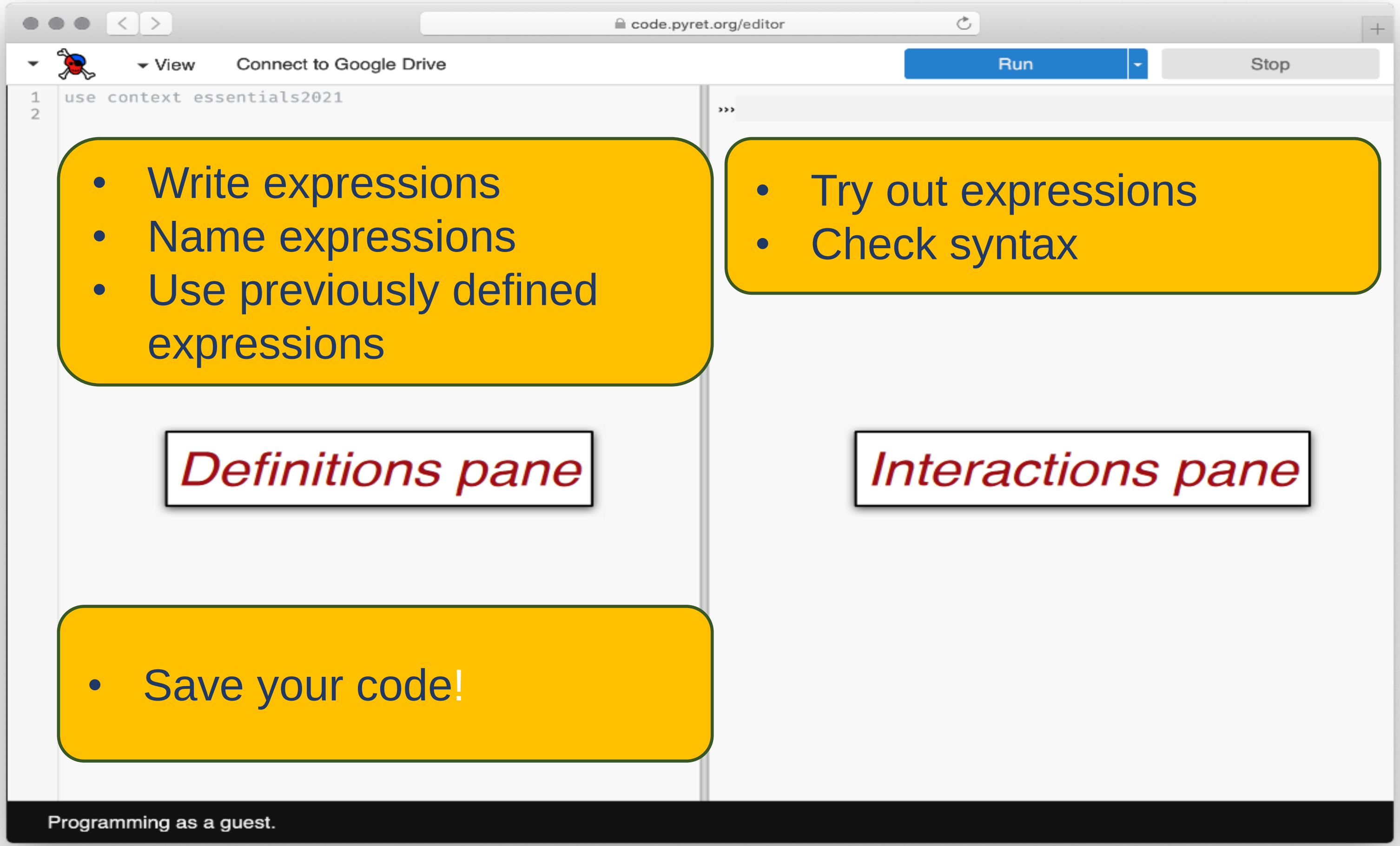
```
use context essentials2021
```

On RHS is: The Prompt! (>>>)

code.pyret.org

Things you can do LHS/RHS

- And still somehow



```
use context essentials2021
```

- Write expressions
- Name expressions
- Use previously defined expressions

Definitions pane

- Save your code!

- Try out expressions
- Check syntax

Interactions pane

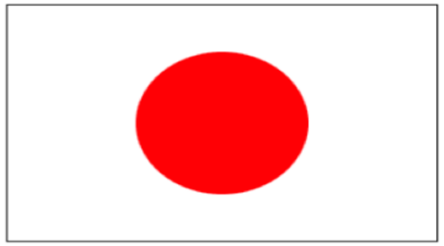
code.pyret.org

Pop Quiz!

Which pane would I use if...

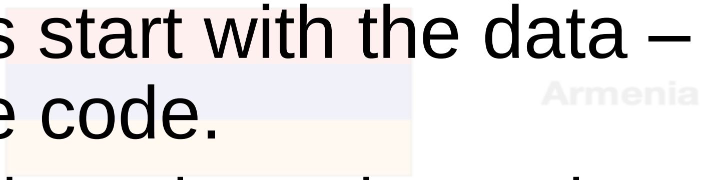
1. I want to see if I can make a blue circle?
2. I want to define `my-shape` as a blue circle and use it later in my code?
3. I want to see if Pyret will accept this: `print "5"`?
4. I want to start my assignment now and finish it later?

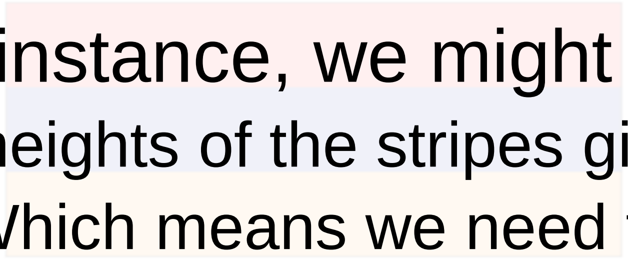
Let's start to program by considering… Flags ?

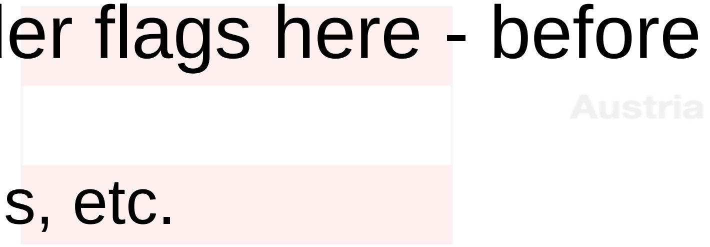


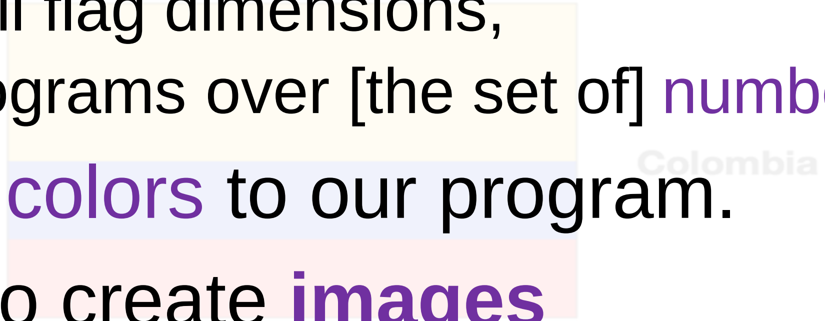
OK, we want to print some flags…

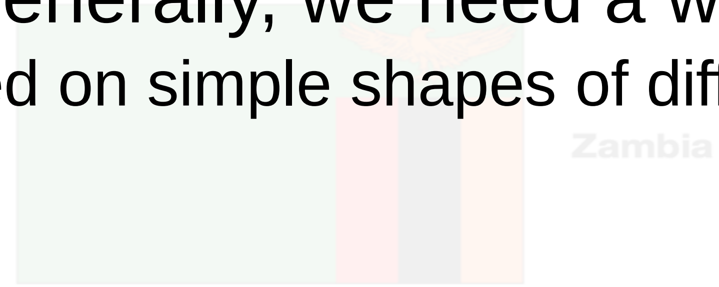
- Let’s start with the data – consider flags here - before we dive in and write code.
  - Dimensions, shapes, juxtapositions, etc.
- For instance, we might want to compute
  - heights of the stripes given: overall flag dimensions,
  - ➢Which means we need to write programs over [the set of] numbers.
- We also need a way to describe colors to our program.
- More generally, we need a way to create **images**
  - based on simple shapes of different colors.

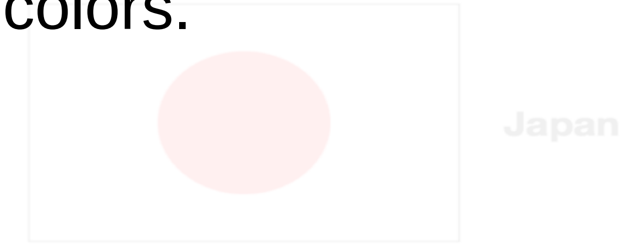












Numbers

- Consider
  - An individual number like `5` is a value – it can’t be computed any further.

  - An expression like **`(3 + 4) * (5 + 1)`** is a computation that produces an answer.
  - A program – any program - consists of one or more computations
  - Question: what about **`3 + 4 * 5 + 1`** `?`
    - `WWJD?`

Numbers

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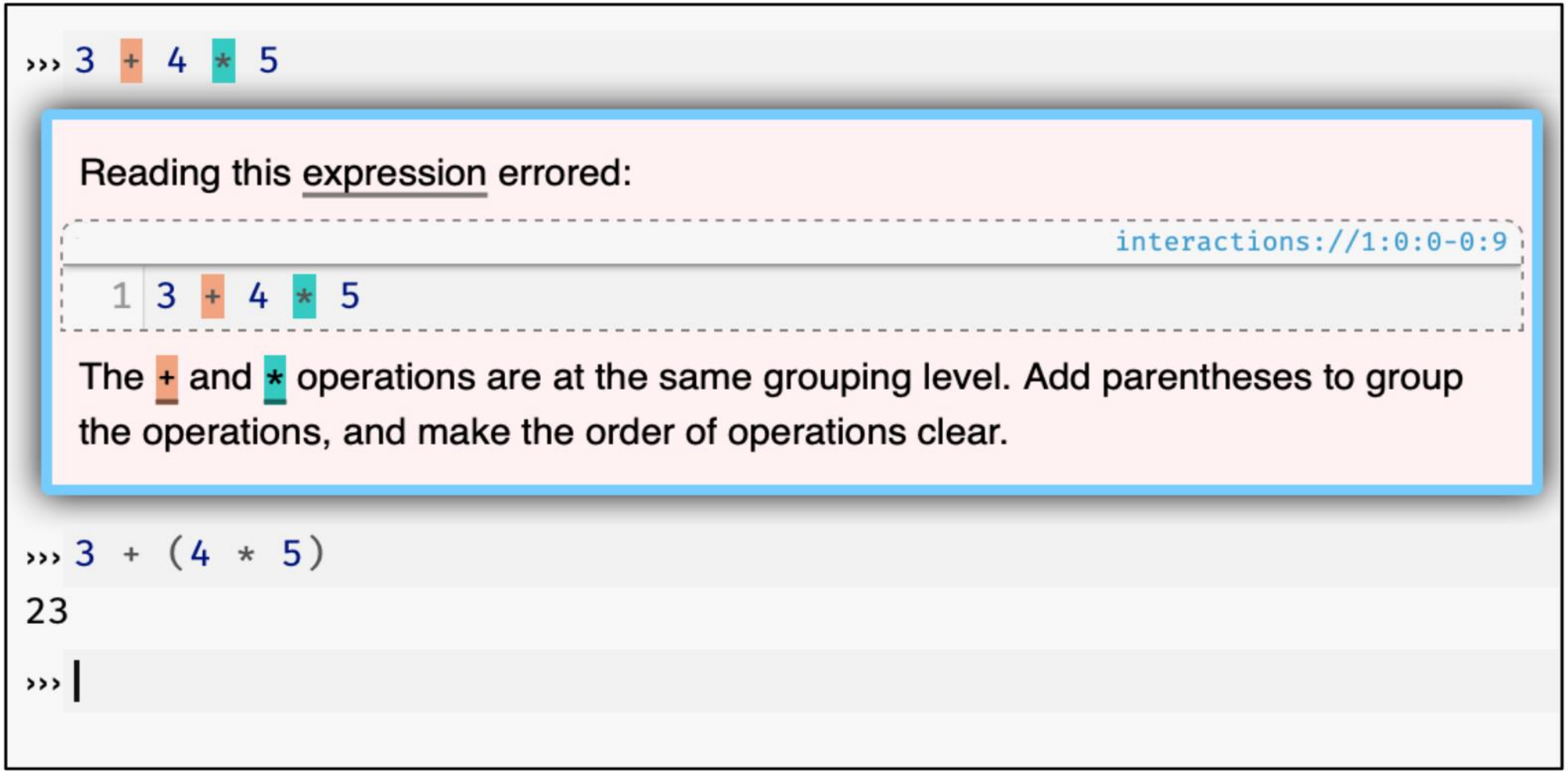
  - An individual number like `5` is a value – it can’t be computed any further.

  - An expression like **`(3 + 4) * (5 + 1)`** is a computation that produces an answer.
  - A program – any program - consists of one or more computations
  - Question: what about **`3 + 4 * 5 + 1`** ?
    - `WWJD? See… https://introcs.cs.princeton.edu/java/11precedence/`

In pyret…



```
››› 3 + 4 * 5
```

Reading this expression errored:

```
interactions://1:0:0-0:9
3 + 4 * 5
```

The + and * operations are at the same grouping level. Add parentheses to group the operations, and make the order of operations clear.

```
››› 3 + (4 * 5)
23
›››
```

Colors

- Consider
  - Names can be given as text strings, e.g., “`purple`"
  - Pyret will understand what “`purple`“ means in the context of a color, i.e. if pyret is expecting a text string that represents a color. Let’s clarify…

Shapes

- Consider

  -
    ```
    >>> include image
    >>> circle(50, "solid", “purple")
    ```
  - We’re asking pyret to create an image, specifically a solid purple circle with some dimension of 50.

Shapes

- Like numbers, we can manipulate images…
  - Numbers can be added, subtracted, etc.
  - Similarly, Images can overlaid, rotated, flipped, etc.

Moving On To Evaluations

How does something like `(4 + 2) / 3` work?

- What is the operator `/` dividing?
- Shouldn't `/` expect two numbers?

Even though `(4 + 2)` isn't a number, it's an expression that *evaluates* to a number.

- This works for all data types, not just numbers!

Moving On To Evaluations

How does something like `(4 + 2) / 3` work?

What is the operator `/` dividing?

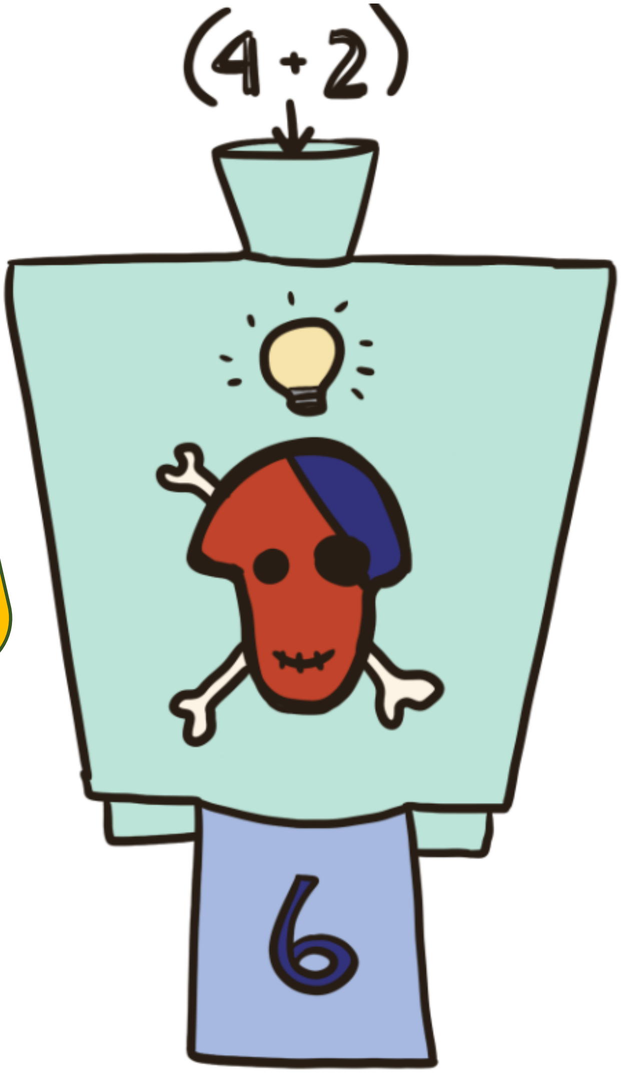
Shouldn't `/` expect two numbers?

Even th

umber.

types, not just numbers!

Consider this thingy on the right to be a "black box"
Have you heard the term before?



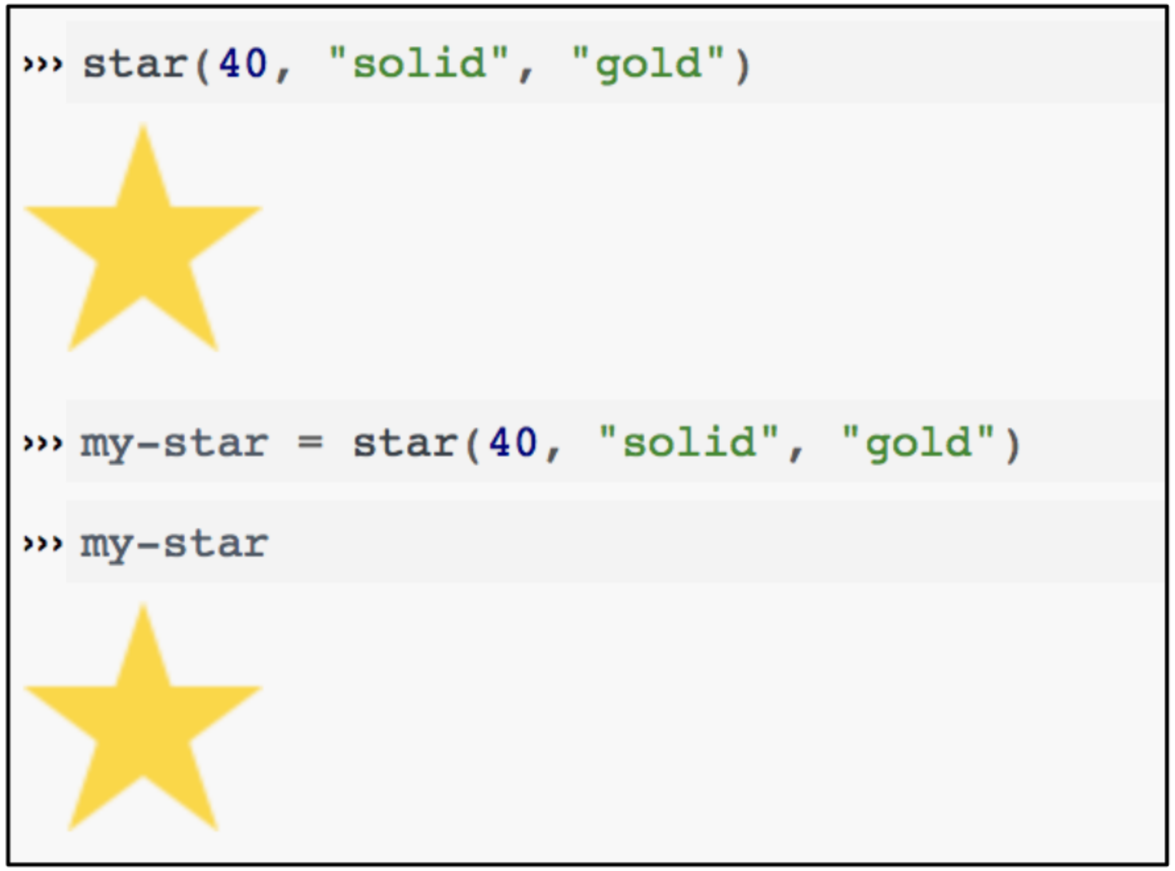
More On Evaluations

- An expression of the form
  `⟨name⟩ = ⟨expression⟩`
  tells Pyret to associate the value of
  `⟨expression⟩` with `⟨name⟩`.
  Every time you type `⟨name⟩`, Pyret will substitute the value for you:
  ```
  x = 5
  x + 4
  ```
  will evaluate to 9.

Creating a definition…

Note there's no output from entering a definition.

It only has a side effect of telling Pyret to associate the name with the value.



```
››› star(40, "solid", "gold")
```

```
››› my-star = star(40, "solid", "gold")
››› my-star
```

Naming Conventions

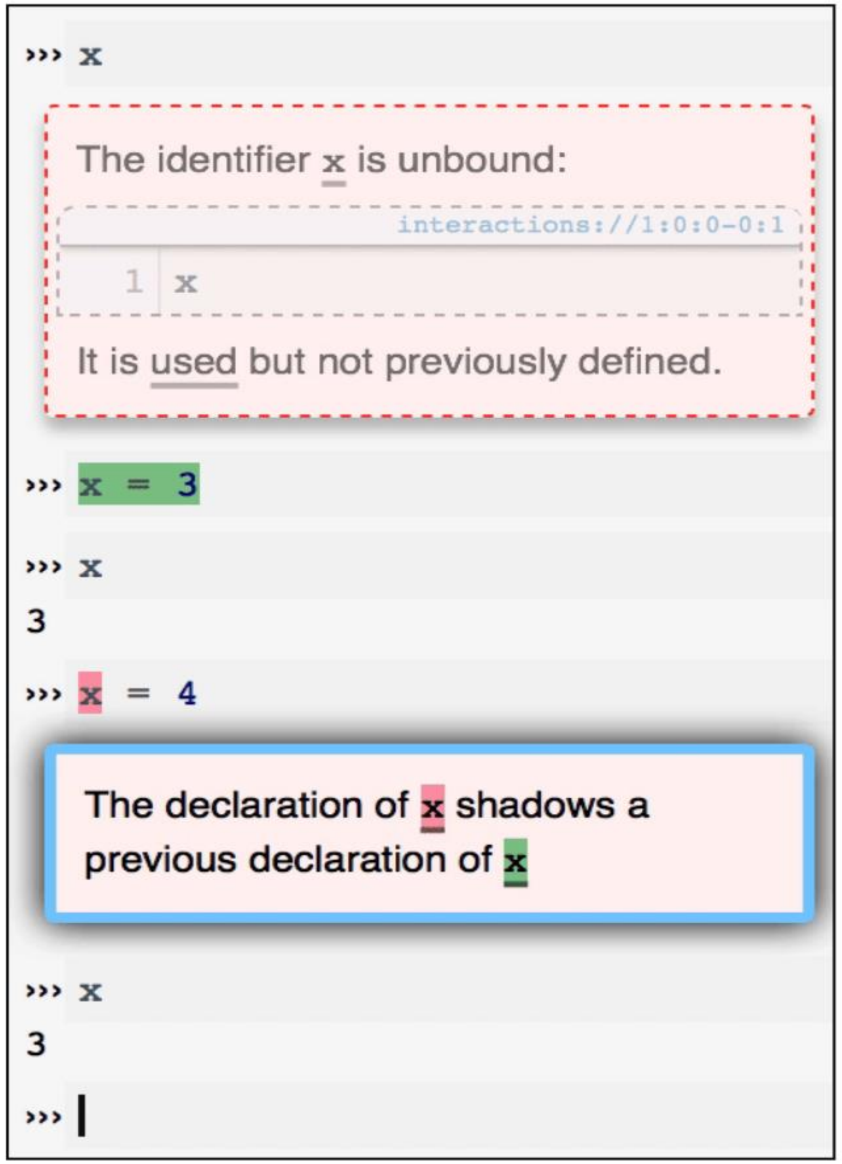
- Every programming language has its own conventions for names.
- In Pyret, names are lowercase with words joined by hyphens, e.g.,

```
this-is-a-good-name
this_makes_bonny_cry
thisIsACrimeAgainstPyret
```

Naming Conventions (2)

Names must be given a value before being used.

In Pyret, names are *immutable*, which means they can only be defined once.



```
››› x
```

The identifier x is unbound:

```
interactions://1:0:0-0:1
x
```

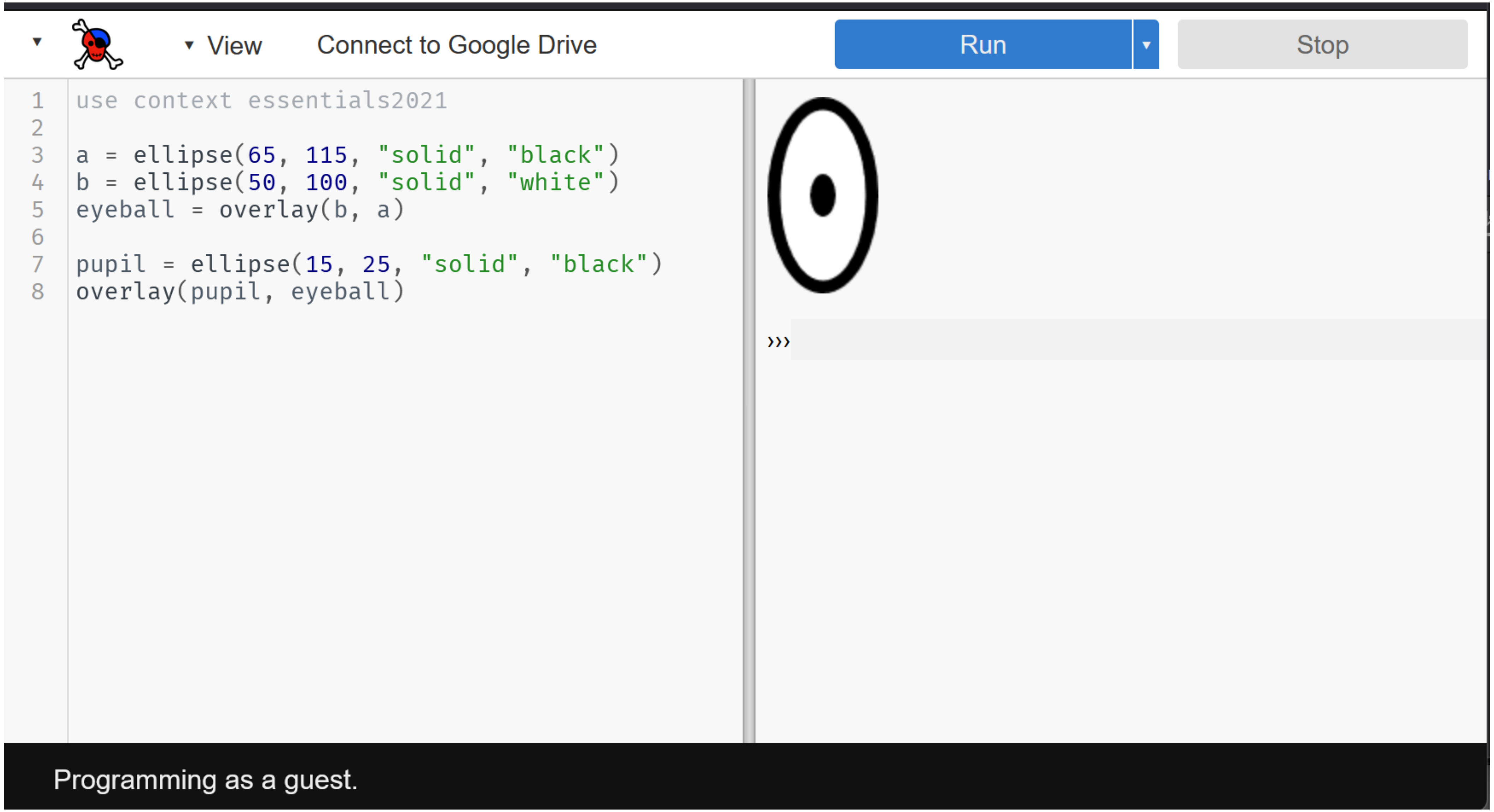
It is used but not previously defined.

```
››› x = 3
››› x
3
››› x = 4
```

The declaration of x shadows a previous declaration of x

```
››› x
3
›››
```

Let's try drawing ~~something~~ an eyeball

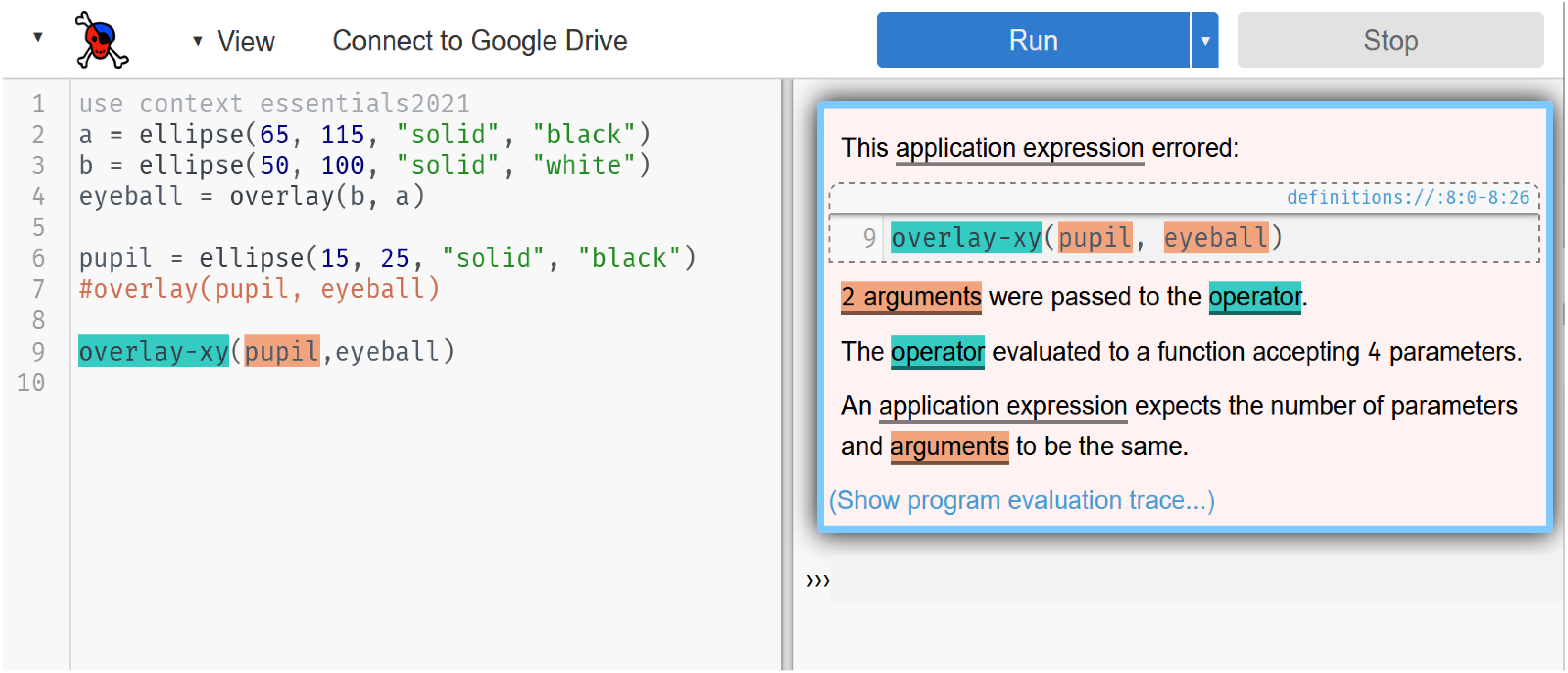


```
use context essentials2021

a = ellipse(65, 115, "solid", "black")
b = ellipse(50, 100, "solid", "white")
eyeball = overlay(b, a)

pupil = ellipse(15, 25, "solid", "black")
overlay(pupil, eyeball)
```

```
›››
```

Programming as a guest.

Let's try drawing ~~something an eyeball~~ 2 eyeballs!



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b = ellipse(50, 100, "solid", "white")
eyeball = overlay(b, a)

pupil = ellipse(15, 25, "solid", "black")
#overlay(pupil, eyeball)

overlay-xy(pupil,eyeball)
```

This application expression errored:

```
                                        definitions://:8:0-8:26
9 overlay-xy(pupil, eyeball)
```

2 arguments were passed to the operator.

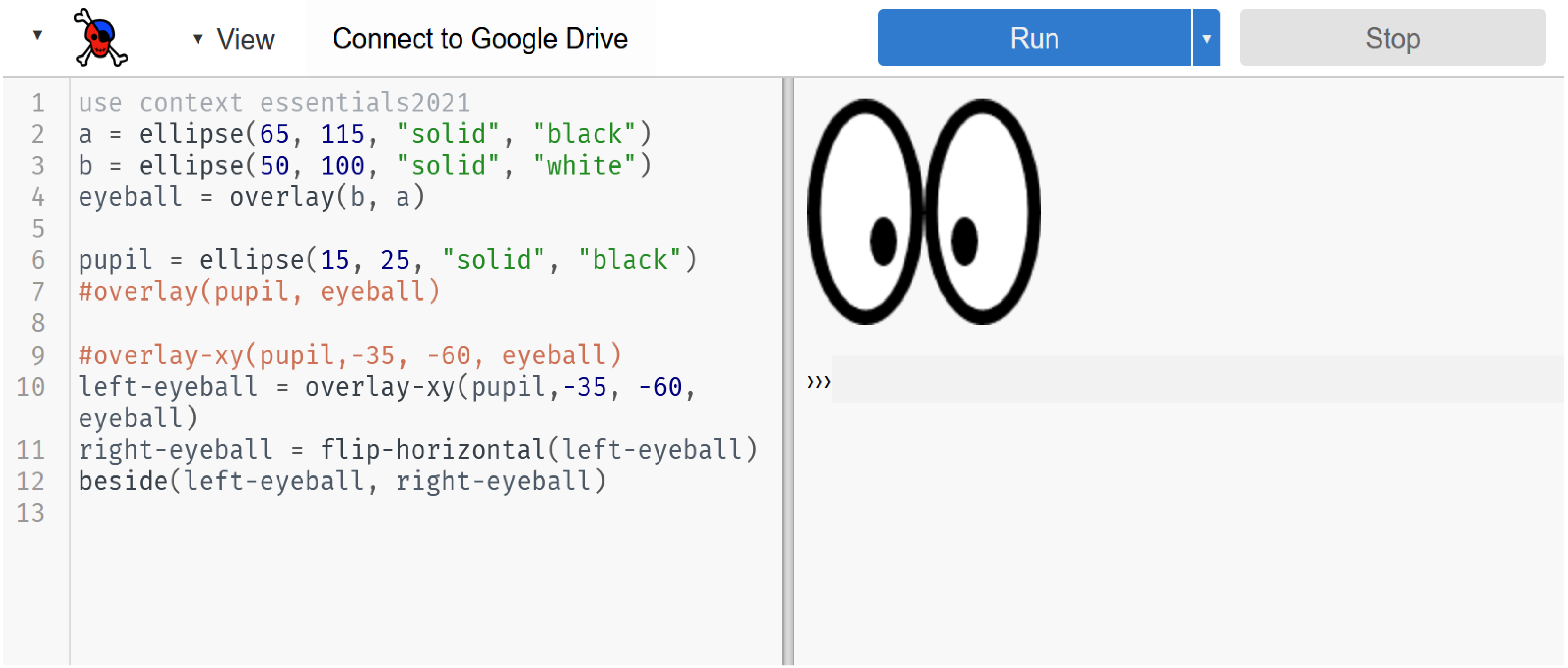
The operator evaluated to a function accepting 4 parameters.

An application expression expects the number of parameters and arguments to be the same.

(Show program evaluation trace...)

›››

Whoops! Whoopsie! Don’t forget documentation!



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a = ellipse(65, 115, "solid", "black")
b = ellipse(50, 100, "solid", "white")
eyeball = overlay(b, a)

pupil = ellipse(15, 25, "solid", "black")
#overlay(pupil, eyeball)

#overlay-xy(pupil,-35, -60, eyeball)
left-eyeball = overlay-xy(pupil,-35, -60,
eyeball)
right-eyeball = flip-horizontal(left-eyeball)
beside(left-eyeball, right-eyeball)

```

```
›››
```

Final Thoughts on the eyeballs

- As you build up more complex images from simpler ones, you're following a core idea called:

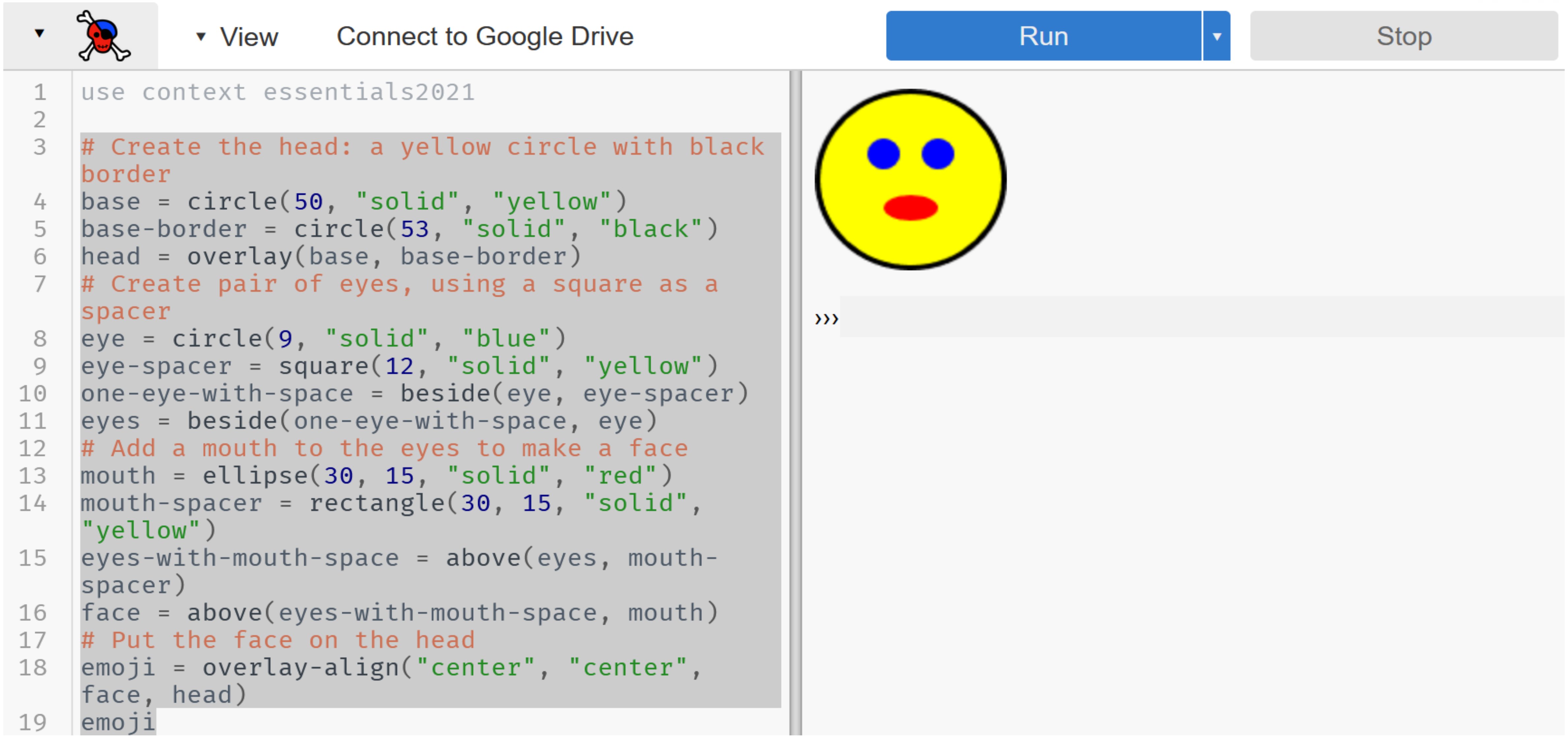
COMPOSITION.

- Programs are always built of smaller programs that do parts of the larger task you want to perform.
- We'll use composition throughout this course

Next: What does this code do?

- # Create the head: a yellow circle with black border
- base = circle(50, "solid", "yellow")
- base-border = circle(53, "solid", "black")
- head = overlay(base, base-border)
- # Create pair of eyes, using a square as a spacer
- eye = circle(9, "solid", "blue")
- eye-spacer = square(12, "solid", "yellow")
- one-eye-with-space = beside(eye, eye-spacer)
- eyes = beside(one-eye-with-space, eye)
- # Add a mouth to the eyes to make a face
- mouth = ellipse(30, 15, "solid", "red")
- mouth-spacer = rectangle(30, 15, "solid", "yellow")
- eyes-with-mouth-space = above(eyes, mouth-spacer)
- face = above(eyes-with-mouth-space, mouth)
- # Put the face on the head
- emoji = overlay-align("center", "center", face, head)
- emoji

Too slow: This code makes a smiley emojii



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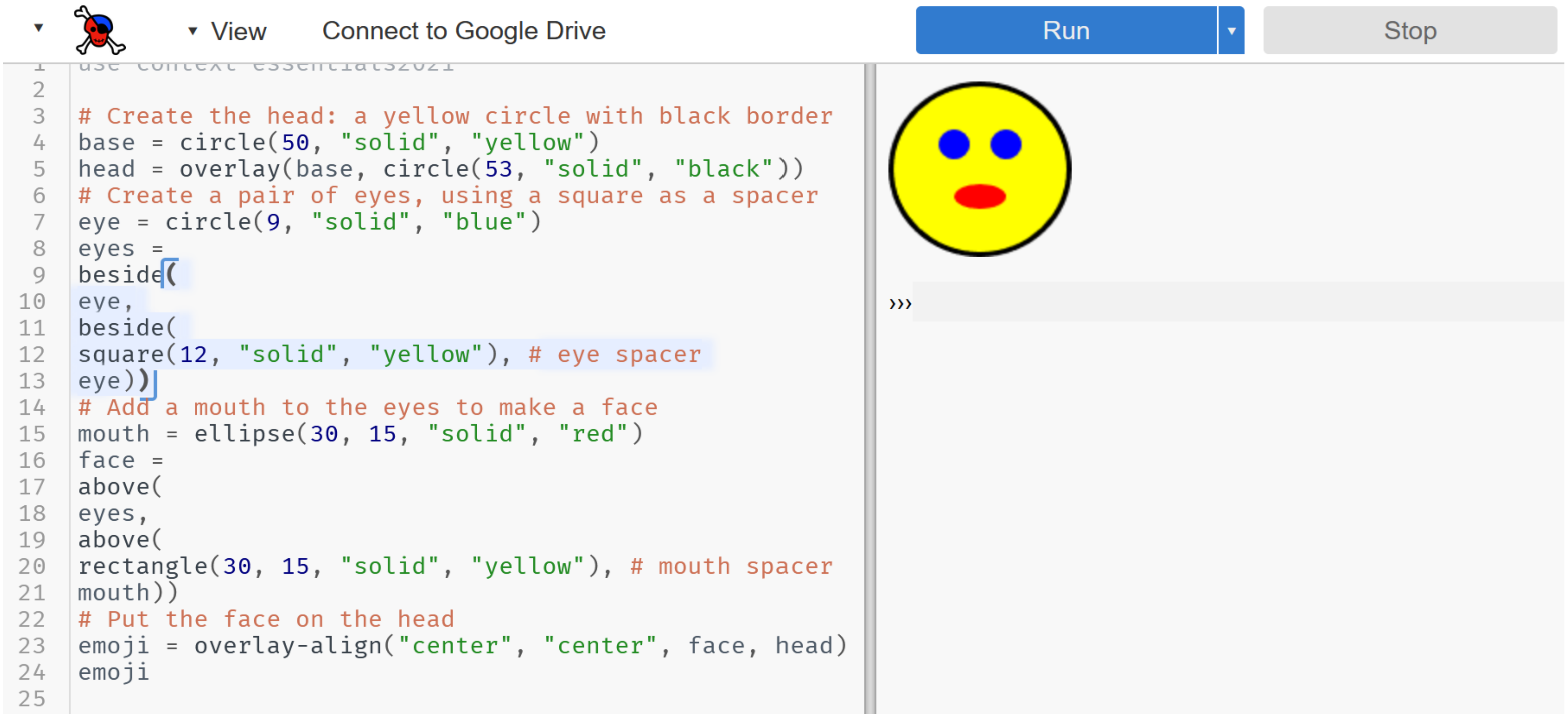
# Put the face on the head
emoji = overlay-align("center", "center", face, head)
emoji
```

```
›››
```

This also makes a smiley emojii



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eyes =
beside(
eye,
beside(
square(12, "solid", "yellow"), # eye spacer
eye))
# Add a mouth to the eyes to make a face
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face =
above(
eyes,
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rectangle(30, 15, "solid", "yellow"), # mouth spacer
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# Put the face on the head
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emoji
```

```
›››
```

Which version is “better?”

- The first set of code may seem easier to understand. At first.
- As we get more involved working with structured data, writing code like the second slide will be more useful:
  - The structure of well written program tends to reflect the structure of the data you are working with.

Eyeball code: Copy From

- a = ellipse(65, 115, "solid", "black")
- b = ellipse(50, 100, "solid", "white")
- eyeball = overlay(b, a)

- pupil = ellipse(15, 25, "solid", "black")
- #overlay(pupil, eyeball)

- #overlay-xy(pupil,-35, -60, eyeball)
- left-eyeball = overlay-xy(pupil,-35, -60, eyeball)
- right-eyeball = flip-horizontal(left-eyeball)
- beside(left-eyeball, right-eyeball)

2nd set of emoji code: Copy From

```
# Create the head: a yellow circle with black border
base = circle(50, "solid", "yellow")
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```