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

Definitions pane  Interactions pane

code.pyret.org
Introducing our IDE

• From up and down

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

Definitions pane

Interactions pane

code.pyret.org
Things you can do LHS/RHS

- And still somehow

- Write expressions
- Name expressions
- Use previously defined expressions

- Try out expressions
- Check syntax

- Save your code!
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?

- Armenia
- Austria
- Colombia
- Zambia
- Japan
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 \((3 + 4) \times (5 + 1)\) is a computation that produces an answer.
  • A program – any program - consists of one or more computations
  • Question: what about \(3 + 4 \times 5 + 1\)?
    • WWJD?
Numbers

• Consider
  • An individual number like 5 is a value – it can’t be computed any further.
  • An expression like $(3 + 4) \times (5 + 1)$ is a computation that produces an answer.
  • A program – any program - consists of one or more computations.
  • Question: what about $3 + 4 \times 5 + 1$?
    • WWJD? See...
      https://introcs.cs.princeton.edu/java/11precedence/
In pyret...

```python
>>> 3 + 4 * 5
Reading this expression errored:

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

```
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 though we can’t predict the output?

Consider this thingy on the right to be a “black box”

Have you heard the term before?

It’s not always a number.

It can be other types, not just numbers!
More On Evaluations

• An expression of the form
  \( \langle \text{name} \rangle = \langle \text{expression} \rangle \)
  tells Pyret to associate the value of
  \( \langle \text{expression} \rangle \) with \( \langle \text{name} \rangle \).
  Every time you type \( \langle \text{name} \rangle \), 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.
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 бонny_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.
Let’s try drawing an eyeball

```python
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)
```
Let's try drawing something—an eyeball! 2 eyeballs!

```python
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)
overlay-xy(pupil, eyeball)
```

This application expression errored:

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...)

8/31/2022
Whoops! Whoopsie! Don’t forget documentation!

define 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)

    #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 emoji

```python
use context essentials2021

# 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)

# Put the face on the head

emoji = overlay-align("center", "center", face, head)

emoji
```
This also makes a smiley emoji!

```python
# Create the head: a yellow circle with black border
base = circle(50, "solid", "yellow")
head = overlay(base, circle(53, "solid", "black"))

# Create a pair of eyes, using a square as a spacer
eye = circle(9, "solid", "blue")
eyes = beside(eye, 
    beside(square(12, "solid", "yellow"), # eye spacer
    eye))

# Add a mouth to the eyes to make a face
mouth = ellipse(30, 15, "solid", "red")

# Make the face above the eyes
face = above(
    eyes, 
    above(
    rectangle(30, 15, "solid", "yellow"), # mouth spacer
    mouth))

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

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

- \(\text{pupil} = \text{ellipse}(15, 25, "solid", "black")\)
- \(\#\text{overlay}(\text{pupil}, \text{eyeball})\)

- \(\#\text{overlay-xy}(\text{pupil}, -35, -60, \text{eyeball})\)
- \(\text{left-eyeball} = \text{overlay-xy}(\text{pupil}, -35, -60, \text{eyeball})\)
- \(\text{right-eyeball} = \text{flip-horizontal}(\text{left-eyeball})\)
- \(\text{beside}(\text{left-eyeball}, \text{right-eyeball})\)
2nd set of emoji code: Copy From

```python
# Create the head: a yellow circle with black border
base = circle(50, "solid", "yellow")
head = overlay(base, circle(53, "solid", "black"))

# Create a pair of eyes, using a square as a spacer
eye = circle(9, "solid", "blue")
eyes =
  beside(
eye,
  beside(
square(12, "solid", "yellow"), # eye spacer
eye))

# Add a mouth to the eyes to make a face
mouth = ellipse(30, 15, "solid", "red")
face =
  above(
eyes,
  above(
    rectangle(30, 15, "solid", "yellow"), # mouth spacer
    mouth))

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