Programming, Problem Solving, and Algorithms

CPSC 203, 2024 W2
(January – April 2025)
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Lecture 02

Today’s Plan…

1. Correctness isn’t everything…
2. Knitting
3. Work / effort / complexity
4. Simplicity / elegance / abstraction
5. Logistics
6. Color
7. Representing data on a computer

Let’s Go Shopping (version 1)

```
define shopping_trip1(grocery_list: List[food_item])
                      -> pantry_list: List[food_item]:

  # List of food in the pantry so far.
  pantry_list = []

  for item_on_grocery_list in grocery_list:
    # Take paper with single item to the store.
    item_at_store = go_to_store(item_on_grocery_list)
    # Get the item from the shelf.
    item_in_cart = pick_at_store(item_at_store)
    # Bring the item home.
    item_at_home = return_from_store(item_in_cart)
    # Put the item away.
    pantry_list.append(put_in_pantry(item_at_home))

  return pantry_list
```

```
(define shopping-trip1 grocery-list
  (cond [(empty? grocery-list) '()],
        [else
          (cons (put-in-pantry
                  (return-from-store
                    (pick-at-store
                      (go-to-store (first grocery-list)))))
                (shopping-trip1 (rest grocery-list)))]))
```

I am being sloppy here by assuming that the helper functions can accept (and will return) either a single item or a list of items

Let’s Go Shopping (version 2)

```
define shopping_trip2(grocery_list: List[food_item])
                      -> pantry_list: List[food_item]:

  # Take piece of paper with list to the store.
  grocery_list_at_store = go_to_store(grocery_list)

  # Get all items on the list into the cart.
  cart_list = []
  for item_at_store in grocery_list_at_store:
    cart_list.append(pick_at_store(item_at_store))

  # Bring the items home.
  grocery_bags_at_home = return_from_store(cart_list)

  # Put the items away.
  pantry_list = []
  for item_at_home in grocery_bags_at_home:
    pantry_list.append(put_in_pantry(item_at_home))

  return pantry_list
```

```
(define shopping-trip2 grocery-list
  (let ([grocery-list-at-store (go-to-store grocery-list)])
    (put-in-pantry
      (return-from-store
        (pick-at-store grocery-list-at-store)))))
```

I am being sloppy here by assuming that the helper functions can accept (and will return) either a single item or a list of items

Handcraft

Knitting

The language used to communicate patterns uses exactly the same fundamental constructs as Python!!

Sherbet Stripes

Notes: Bright, delicious stripes, vertical on the front and horizontal on the reverse side, make this dishcloth a welcome addition to your kitchen. A simple 4 row repeat of slip stitches creates a fun color work effect that is deceptively simple to work but must be done on double pointed needles to allow you to knit from either end of the work.

Slip Stitch Pattern (worked over four rows)

Row 1 (RS): With CC, *Sl1 WYIB, k1*, repeat between *'s until 1 st remains, Sl1 WYIB.

Row 2 (WS): Slide the work to the other end of the needle and pick up MC to work. *K1, Sl1 WYIB*, repeat between *'s until 2 st remains, K1. Turn work.

Row 3: With CC, *Sl1 WYIF, P1*, repeat between *s until 1 st remains, Sl1 WYIF.

Row 4: Slide the work to the other end of the needle and pick up MC to work. *P1, Sl1 WYIF*, repeat until 1 st remains, P1. Turn.

DIRECTIONS

With MC, CO 33 sts.

K 1 row.

Begin Slip Stitch Pattern and work 11 rep of the 4 row rep. (44 rows of patt.)

Break CC yarn.

K 1 row in MC.

BO all sts.

Finishing

Weave in ends, wash and block to dimensions.

About the Designer

Gillian Wynne Grimm lives in a little white cottage on a tree lined street in Portland, Oregon where she knits, sews and generally enjoys making all manner of crafty and creative things.
Follow along with her adventures at Birchhollowcottage.com.
For pattern support, please contact info@birchhollowcottage.com

Knitting






Quantifying the task...

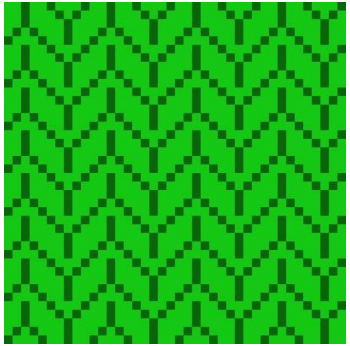
1. If we describe one dimension of a square rag by *n*, how much work is done by the knitter? ___________
2. If we have enough yarn for 36000000 stitches, what is the largest rag we could make? ___________
3. If each stitch takes a second, what is the largest rag we could make in one evening? ___________
4. If it takes an evening to make a 40x40 rag, how long will it take to make an 80x80 rag? ___________
5. If it takes time *t* to make an *n* by *n* rag, how long will it take to make a *3n* x *3n* rag? ___________

General idea: quantify the size of the problem (*n*) and consider the cost of our task *as that size increases*.

Quantifying the task...

If we are solving a problem / writing an algorithm for an input of arbitrary size, we can parameterize the running time of the solution by the size of the input.

We *usually* denote this input size using the variable n.



Discussion:

1. We need to specify what n represents (in this case the length of each side of the square)
2. Sometimes we need multiple parameters to describe the size of the problem (such as n and m)
3. We pay attention to only the degree of n (so if a scarf takes $3n^2 + 12n$ time, we are only interested in the fact it is n^2)

Steve Jobs:

Simplicity is the ultimate sophistication. It takes a lot of hard work to make something simple, to truly understand the underlying challenges and come up with **elegant** solutions. [...] It's not just minimalism or the absence of clutter. It involves digging through the depth of complexity. To be truly simple, you have to go really deep. [...] You have to understand the essence of a product in order to be able to get rid of the parts that are not essential.

CPSC 203 Goal: Simplicity & Elegance

- To understand the work / effort / complexity of knitting a scarf
  - Assume that every stitch takes 1 unit of effort and moving to a new row takes no effort
  - Estimate the total effort by estimating the total number of stitches
- To design an algorithm to process a database of crime incidents
  - The database is a table, each row an incident, each column contains an element of information about that incident
  - We will store each row in a compound data type instance, and the whole database as a list (arbitrary size) of those compound instances
  - We will process the data one row at a time
- To (re)state a road trip planning problem
  - Each city is a node and each road between cities an edge in a graph
  - The shortest route which hits a given list of cities is the “Traveling Salesperson Problem”

Quantifying the task...

Suppose we can knit 1 (= 10^0) stitches per second....

time \ n	10	100	1000
$\log n$	~3 s	~6½ s	~10 s
n	10 s	10^2 s ~ 1½ min	10^3 s ~ 16½ min
$n \log n$	3(10) s ~ ½ min	$6(10^2)$ s ~ 10 min	10^4 s ~ 2½ hours
n^2	100 s ~ 1½ min	10^4 s ~ 2½ hours	10^6 s ~ 11½ days
n^3	1000 s ~ 16½ min	10^6 s ~ 11½ days	10^9 s ~ 31½ years
2^n	1024 s ~ 17 min	~10^{30} s	~10^{301} s
(Notes: log = $\log_2$ and the age of the universe: ~10^{18} s)			

The degree (in *n*) makes a **very** big difference!

Quantifying the task...

But computers are much faster. Suppose we can "knit" 10^{12} stitches / s

time \ n	10	100	1000	10^6	10^{12}
log n	~$3(10^{-12})$ s	~$6½(10^{-12})$ s	~$10(10^{-12})$ s	~$20(10^{-12})$ s	~$40(10^{-12})$ s
n	10^{-11} s	10^{-10} s	10^{-9} s	10^{-6} s	1 s
n log n	$3(10^{-11})$ s	$6(10^{-10})$ s	10^{-8} s	~$20(10^{-6})$ s	~40 s
n^2	10^{-10} s	10^{-8} s	10^{-6} s	1 s	10^{12} s
n^3	10^{-9} s	10^{-6} s	10^{-3} s	10^6 s	10^{24} s
2^n	~10^{-9} s	~10^{18} s	~10^{289} s		
(Notes: proteins fold in ~10^{-6} s and the age of the universe: ~10^{18} s)					

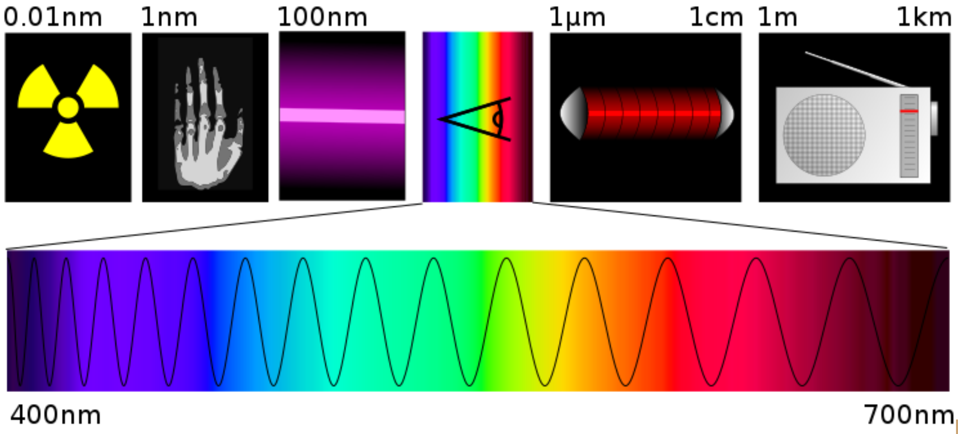
The amount of computation we do inside our algorithm actually matters!

Logistics (and a breather)

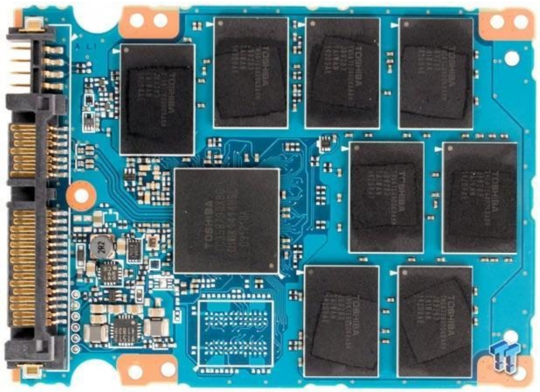
- Labs:
- Prairie Learn:
    - Examlet
    - Lab
    - POTW
    - Class Activity
- CBTF & Website: stay tuned…
- Getting to know Terminal
- Still on the waitlist?

Color Interpretation

- How does light wavelength become color?
  - Biological: https://en.wikipedia.org/wiki/Color_vision
- What's your favorite color?
  - Psychological: http://www.playbuzz.com/jon10/what-color-matches-your-personality
- Does that color influence your dress/decor/purchases?
  - Cultural: http://markedbydesign.net/blog/meaning-in-color/



Representing numbers



Why do humans represent numbers in base 10?

How do computers represent numbers?

Is that enough?

ref: http://arstechnica.com/information-technology/2012/06/inside-the-ssd-revolution-how-solid-state-disks-really-work/2/

Number Representation

Can we use bits to represent integers?

3	1	5	7
10^3	10^2	10^1	10^0

=

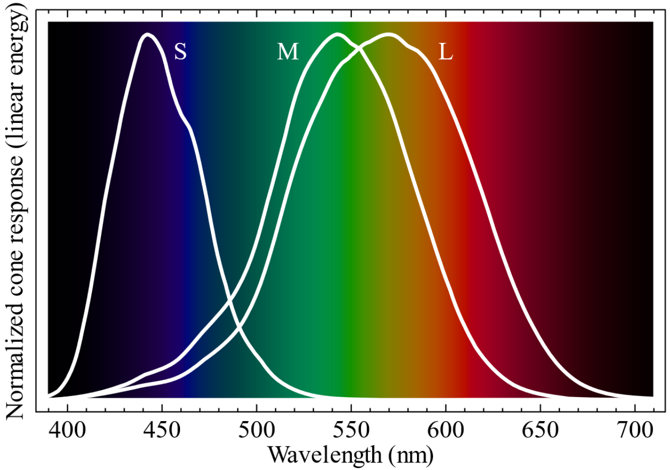
1	0	1	1
3	2	1	0

=

=

Color - Representation

- Human color vision has three channels
  - Our brain experiences color based on the intensity of light detected by “red”, “green” and “blue” cone cells in our retinas
- If we are shown a yellow wavelength
  - L cones will respond strongly
  - M cones will respond almost as strongly
  - S cones will respond weakly
- To fake a yellow wavelength (for a human)
  - Show a lot of a red wavelength
  - Show a little less of a green wavelength
  - Show little or no blue wavelength
- So we only need to figure out how to manage blends of three colors!



Color - Representation

Step 1: Build a screen with lots of little red, green and blue bulbs.
Step 2: Use integers to represent colors?

RGB - (red, green, blue), where each “component” is in range 0 through 255.

ex. (255, 0, 127) == 

fun calculator for color values: http://colorizer.org

How many bits for 256 values?

(Step 3: Profit!)

Color - Representation

RGB - (red, green, blue), where each “component” is in range 0 through 255, with 8 bits for each component = 24 bit color

What color is

0 1 0 1 1 0 1 1 0 1 0 1 1 0 1 1 0 1 0 1 1 0 1 1

(stretch) Easier to read if we use “hexadecimal” representation:

Each component is represented by 2 hex digits 0123456789abcdef

ex. #674ea7 ==