Variables & Datatypes

CSE 120 Winter 2019

Instructor: Justin Hsia

Teaching Assistants: Ann Shan, Eunia Lee, Pei Lee Yap, Sam Wolfson, Travis McGaha

Feds Can't Force You To Unlock Your iPhone With Finger Or Face, Judge Rules

"Judge Westmore declared that the government did not have the right, even with a warrant, to force suspects to incriminate themselves by unlocking their devices with their biological features. Previously, courts had decided biometric features, unlike passcodes, were not 'testimonial.' That was because a suspect would have to willingly and verbally give up a passcode, which is not the case with biometrics.

"The magistrate judge decision could, of course, be overturned by a district court judge, as happened in Illinois in 2017 with a similar ruling."

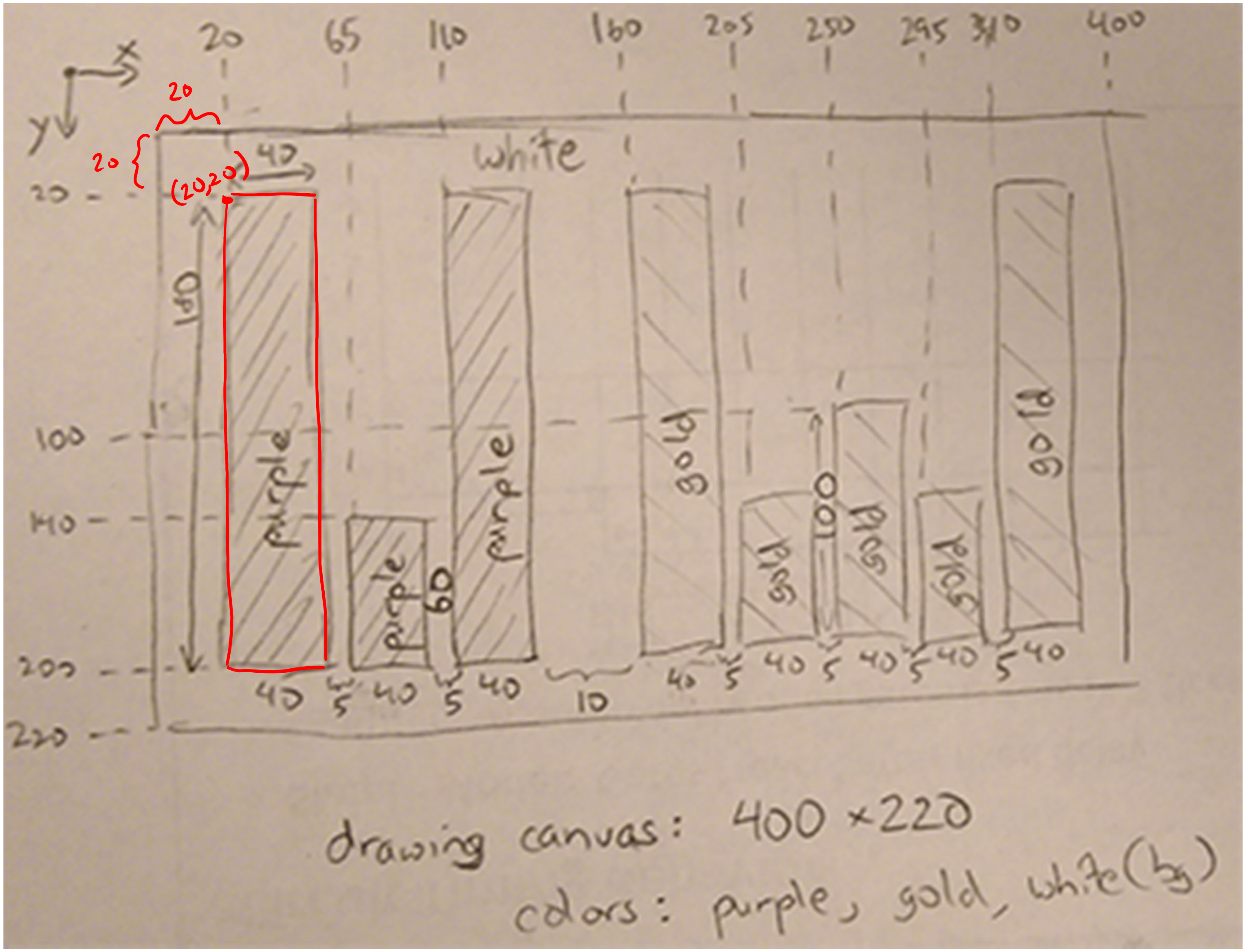
- https://www.forbes.com/sites/thomasbrewster/2019/01/14/feds-cant-force-you-to-unlock-your-iphone-with-finger-or-face-judge-rules/

Administrivia

- Assignments:
  - Taijitu [checkoff] due Thursday (1/17)
  - Reading Check 2 due Thursday by 3:30 pm (1/17)
  - Logo Design due Friday (1/18)

Homework: Logo Design

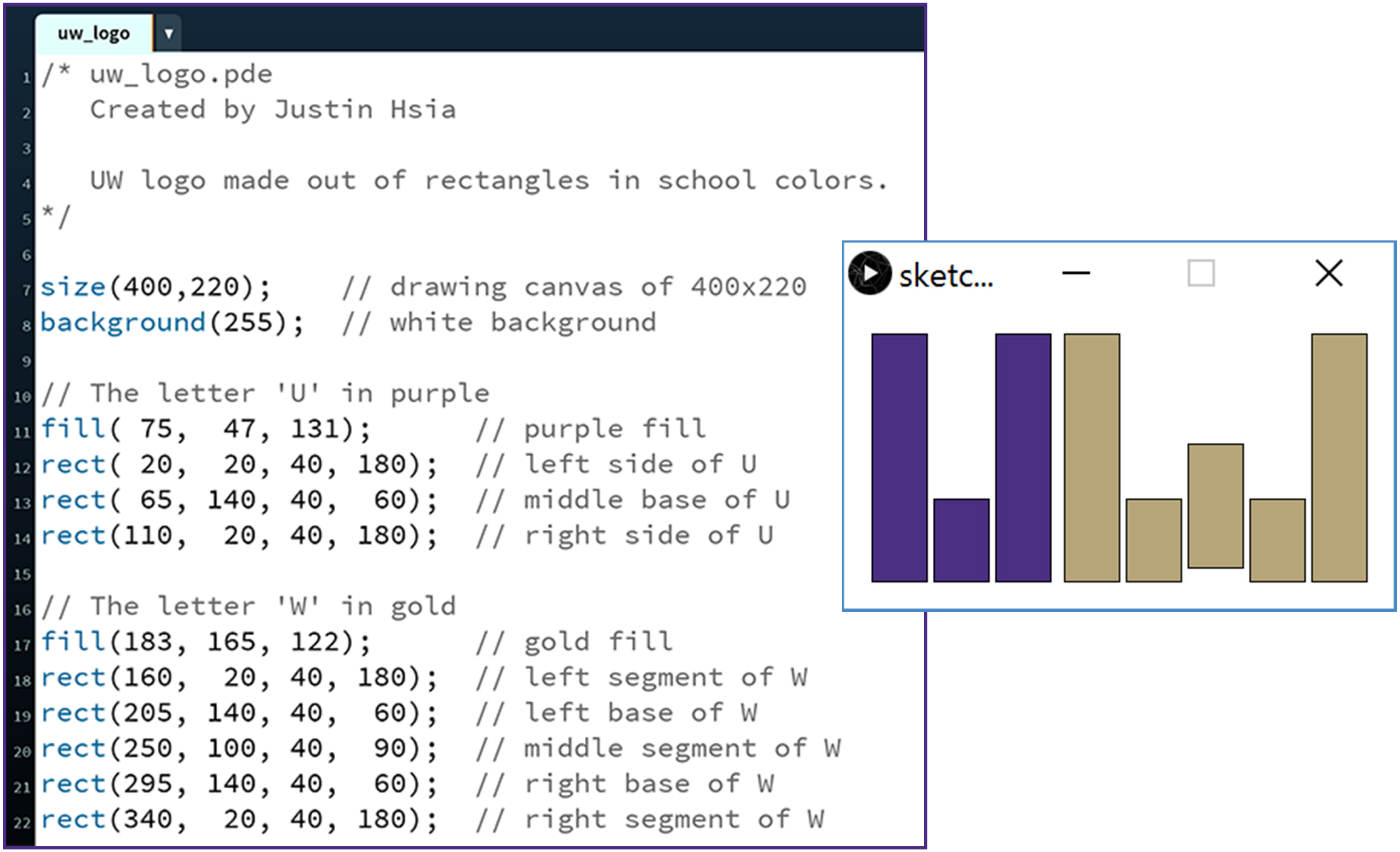
Cuordinate system reminder



drawing canvas: 400 × 220

colors: purple, gold, white(bg)

Homework: Logo Design



```
/* uw_logo.pde
   Created by Justin Hsia

   UW logo made out of rectangles in school colors.
*/

size(400,220);    // drawing canvas of 400x220
background(255);  // white background

// The letter 'U' in purple
fill( 75,  47, 131);      // purple fill
rect( 20,  20, 40, 180);  // left side of U
rect( 65, 140, 40,  60);  // middle base of U
rect(110,  20, 40, 180);  // right side of U

// The letter 'W' in gold
fill(183, 165, 122);      // gold fill
rect(160,  20, 40, 180);  // left segment of W
rect(205, 140, 40,  60);  // left base of W
rect(250, 100, 40,  90);  // middle segment of W
rect(295, 140, 40,  60);  // right base of W
rect(340,  20, 40, 180);  // right segment of W
```

Drawing a House

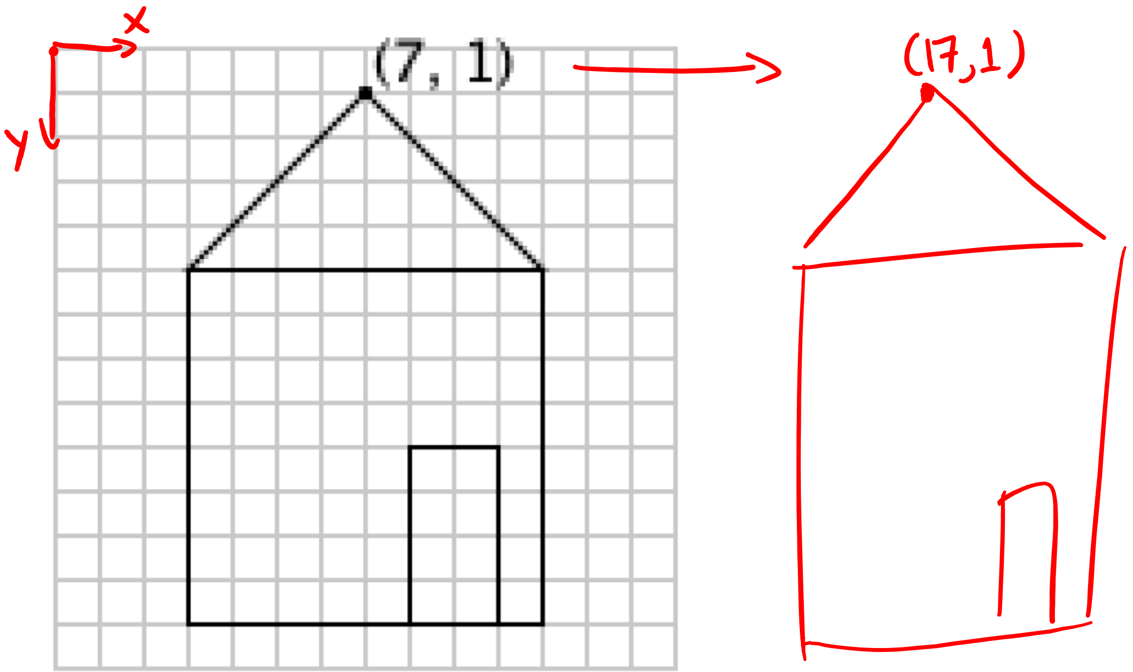
- One solution from worksheet:

triangle(~~7~~ 17,1, ~~3~~ 13,5, ~~11~~ 21,5);
x_1 y_1 x_2 y_2 x_3 y_3

rect(~~3~~ 13, 5, 8, 8);
x y w h

rect(~~8~~ 18, 9, 2, 4);
x y w h

  - What if we wanted to move the house? 5 changes to our code!



Variables

- Piece of your program that holds the value of something storage space, like a box
  - Every variable must be given a *name* and a *data type*

    identifier (which box?) "shape" of box
- The values of these variables can change (*i.e.* vary) during the execution of your program
  - Warning: Not like a variable in Algebra (*i.e.* an unknown)

    5x=20 implies x=4
- Assignment/Write: give a variable a specific value
  - *e.g.* `x ⇐ 12;` "put value 12 into the box x"

    x $\boxed{12}$

Variables

- Piece of your program that holds the value of something storage space, like a box
  - Every variable must be given a *name* and a *data type*

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    "shape" of box
- The values of these variables can change (*i.e.* vary) during the execution of your program
  - Warning: Not like a variable in Algebra (*i.e.* an unknown)

- Read: use the current value of a variable x 12
  - *e.g.*

    12+1

    ```
    ellipse(x+1, 50, 20, 20);
    ```

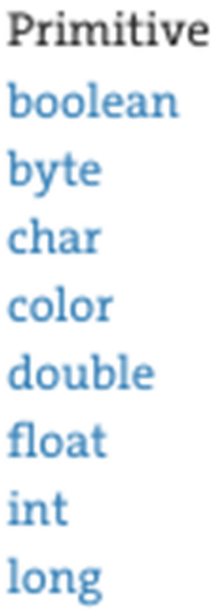
    look in box x and use its current value

    draws an ellipse with center at (13,50)

Datatypes

`int`	integers	(*e.g.* `12` or `-3`)
`float`	decimal/real numbers	(*e.g.* `3.14`)
`color`	RGB	(*e.g.* `color(0)`)
`char`	characters	(*e.g.* `'J'`)
`boolean`	true or false	(*e.g.* `true`)

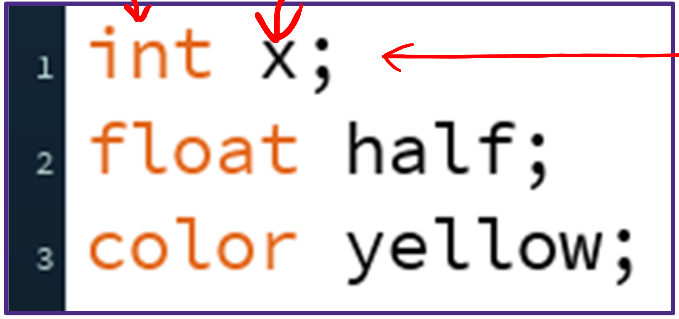
- Many more exist and can be found in the Processing Reference:



Primitive
boolean
byte
char
color
double
float
int
long

Declarations

- We declare a variable by telling Processing the variable's datatype, followed by the variable's name:

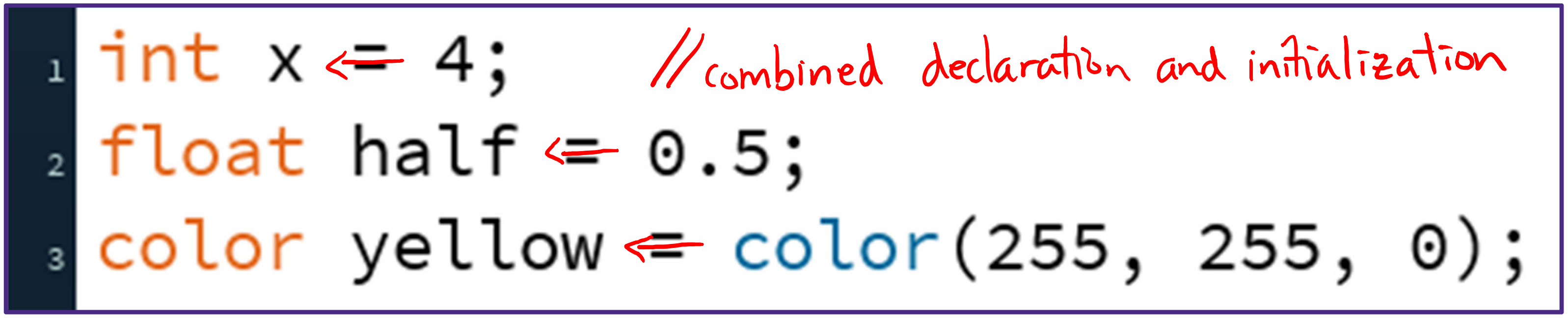


```
int x;
float half;
color yellow;
```

```
x = 4;
```

separate declaration and initialization

- You can also give a variable a starting value (initialization) in the same line as the declaration:



```
int x = 4;      //combined declaration and initialization
float half = 0.5;
color yellow = color(255, 255, 0);
```

Variable Manipulation

- Executed sequentially, just like other statements
- For variable assignments, compute right-hand side *first*, then store result in variable
- Example:

```
① int x = 4;     //initialize x to 4
② x = x + 1;     // increment x by 1
```

1) Read the current value of x (4) for the right-hand side
2) Add 1 to the current value of x
3) Store the result (5) back into x

x $\boxed{\cancel{4}5}$

Drawing a House with Variables

int houseX = 7;

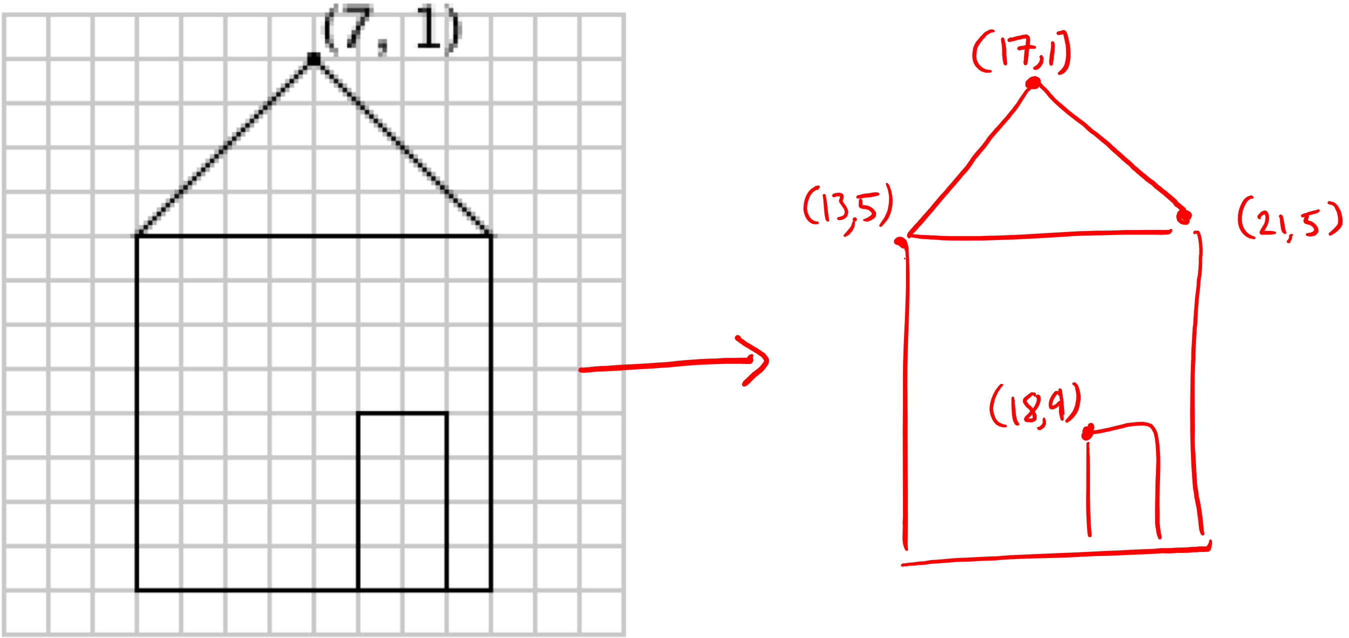
changing this to 17 moves the whole house right by 10!

- Initial solution:

triangle(~~7~~ houseX,1, ~~3~~ houseX-4,5, ~~11~~ houseX+4,5);
rect(~~3~~ houseX-4, 5, 8, 8);
rect(~~8~~ houseX+1, 9, 2, 4);

- What properties might be useful to store in variables?

houseX
houseY
size



Variable Rules & Guidelines

- Variable naming rules:

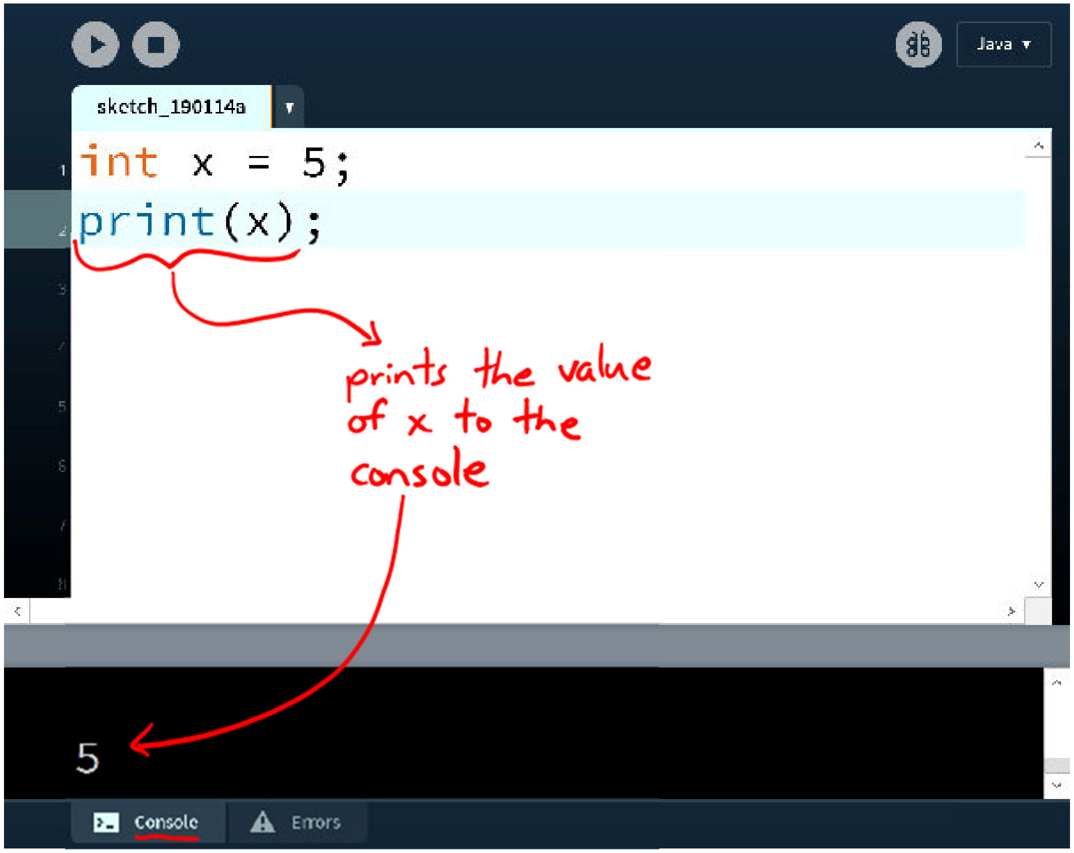
  different variables
  - Variables are case-sensitive (e.g. `myx` vs. `myX`)
  - Numbers allowed, but not at beginning (e.g. `k9` ✓ vs. `9k` ✗)
  - Generally avoid symbols other than underscore (e.g. `my_x` ✓)

- Variable names are meaningless to computers, but meaningful to humans
  - Choosing informative names improves readability and reduces confusion ☆

- In this class, most of our variables will be declared and initialized at the very top of our programs

Variable Worksheet

- New functions: `print()`, `println()`



```
int x = 5;
print(x);
```

prints the value of x to the console

```
5
```

System Variables

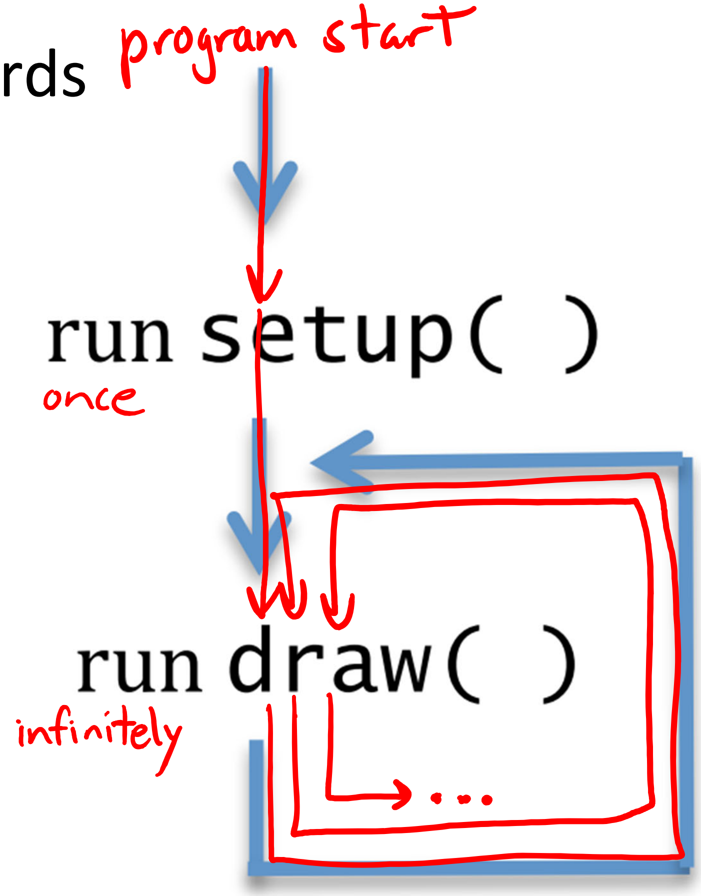
- Special variables that hold values related to the state of the program, often related to user input
  - You don't need to declare these variables
  - These variables will update automatically as the program runs
  - Colored **pink/magenta-ish** in the Processing environment

- Examples: `width` and `height` hold the value of the width and height of the drawing canvas, respectively

Active Mode in Processing

- We enter active mode by creating the functions **`setup`**`()` and **`draw`**`()` in our program
  - **`setup`**`()` automatically executes once at the start
  - **`draw`**`()` executes infinitely afterwards

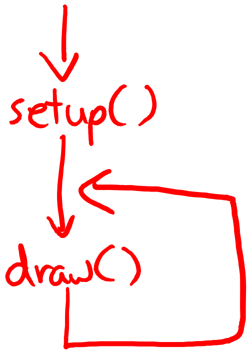
- Each time **`draw`**`()` executes, it is called a new *frame*



Drawing and Frames

- System variable `frameCount` returns the number of frames since the start of the program

frameCount
0
~~1~~,~~2~~,3,...



  - Starts at 0 in **`setup`**`()`

- `frameRate()` changes the desired number of frame updates there are *per second*
  - Larger argument is faster
  - Default is `frameRate(60)`

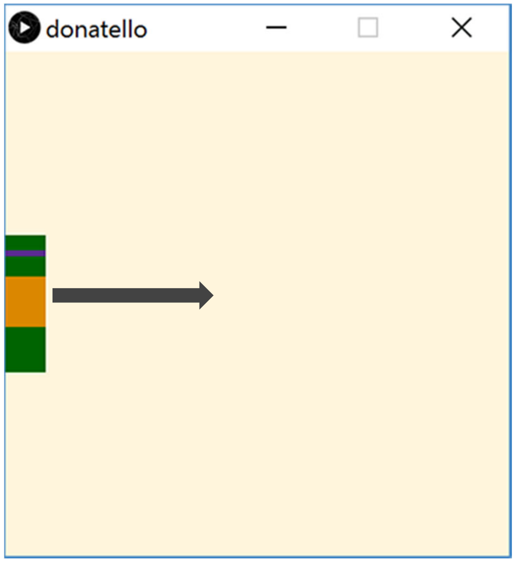
frame Rate (30) refreshes half as frequently

↑ faster
↓ slower

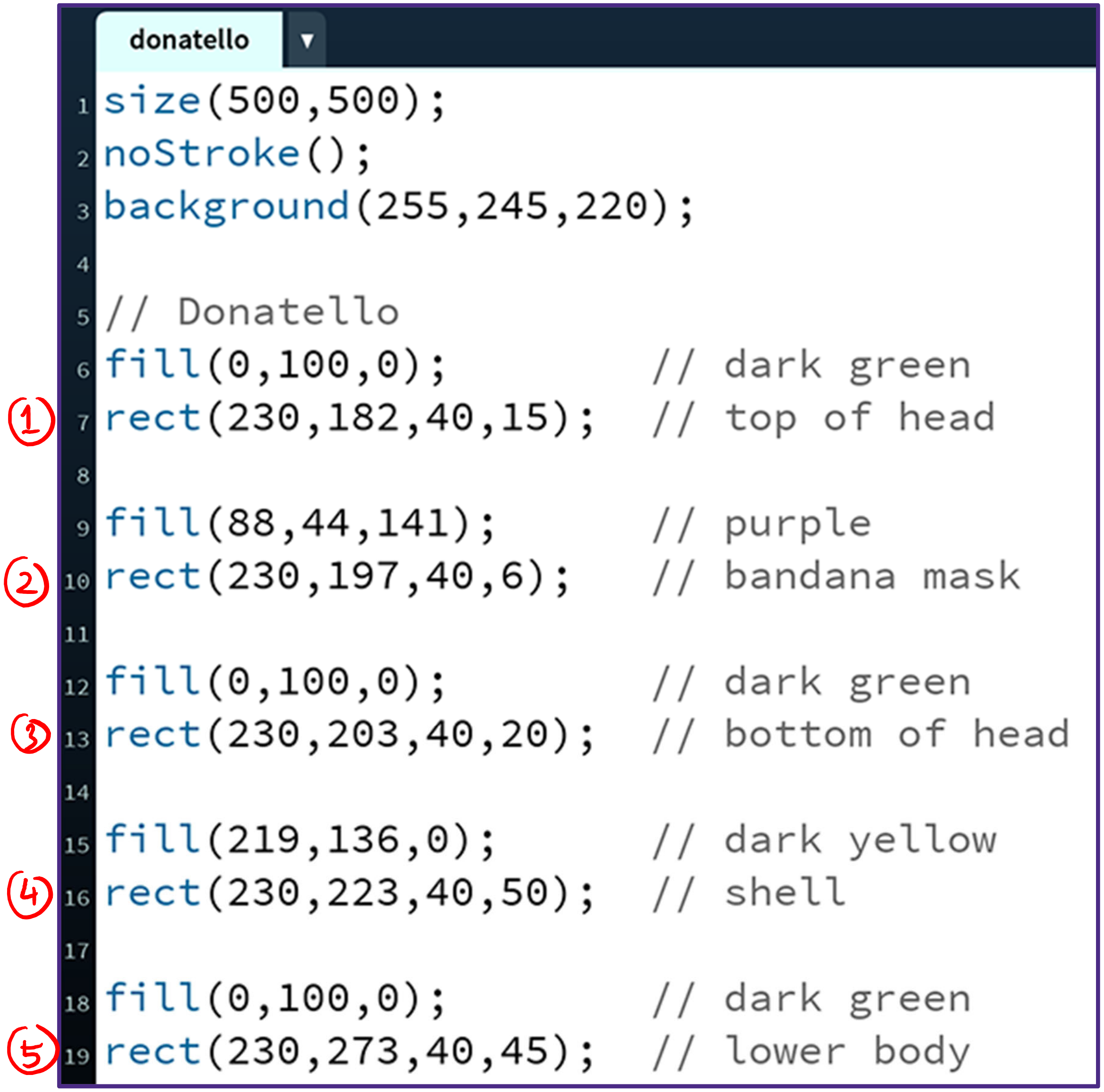
- `noLoop()` stops **`draw`**`()` from being continuously executed
  - Can restart using `loop()`

Motion with Variables

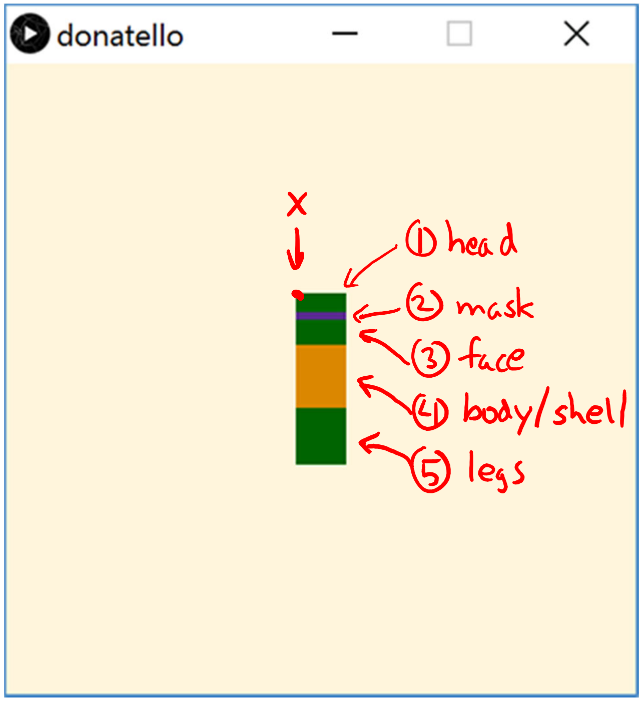
1) Create your drawing
2) Introduce a variable
3) Substitute values in your drawing with expressions that use the new variable
4) Change the variable value in-between frames
   - Use `background()` to cover old frames



TMNT: Donatello

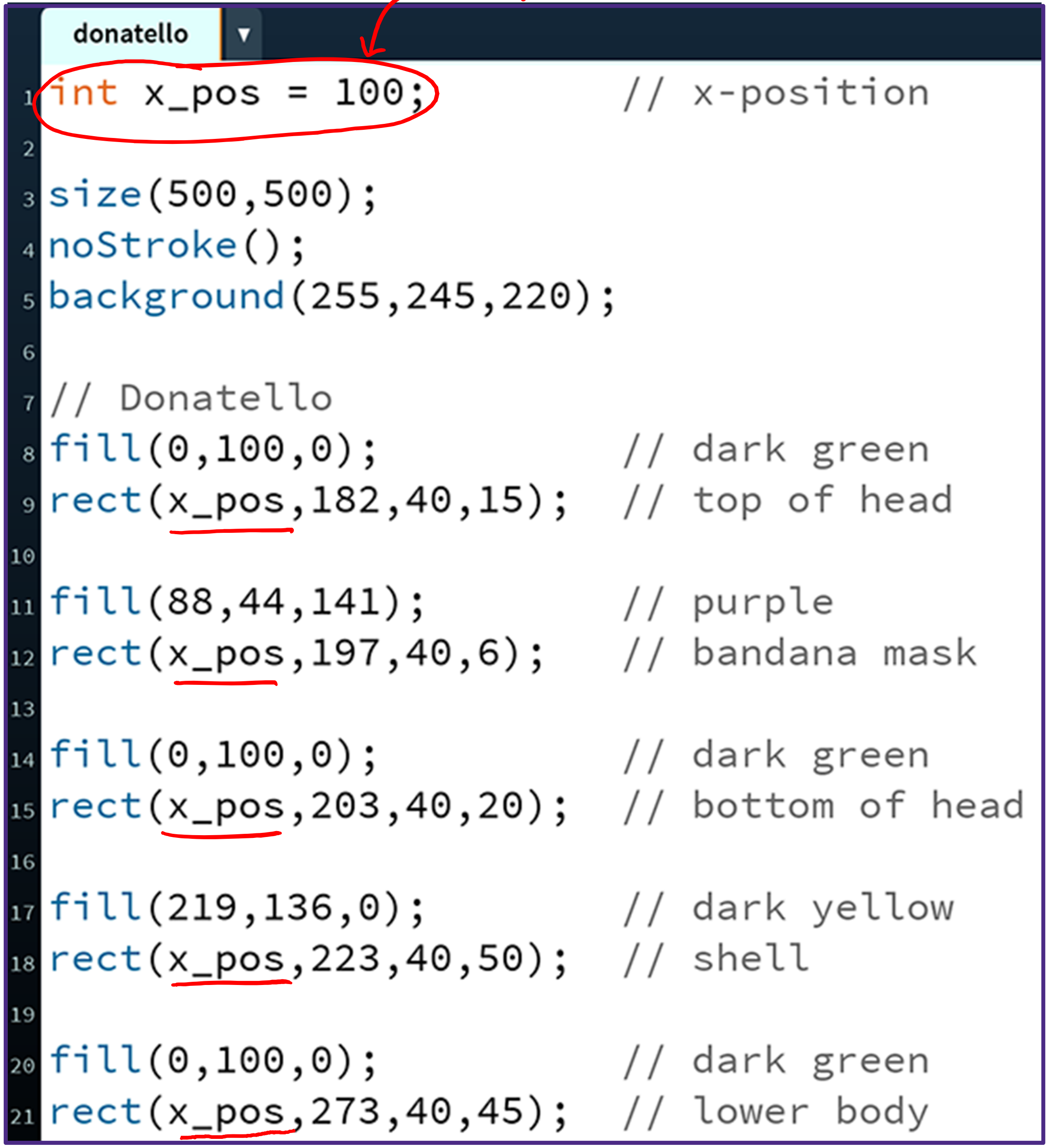


```
size(500,500);
noStroke();
background(255,245,220);

// Donatello
fill(0,100,0);          // dark green
rect(230,182,40,15);    // top of head

fill(88,44,141);        // purple
rect(230,197,40,6);     // bandana mask

fill(0,100,0);          // dark green
rect(230,203,40,20);    // bottom of head

fill(219,136,0);        // dark yellow
rect(230,223,40,50);    // shell

fill(0,100,0);          // dark green
rect(230,273,40,45);    // lower body
```



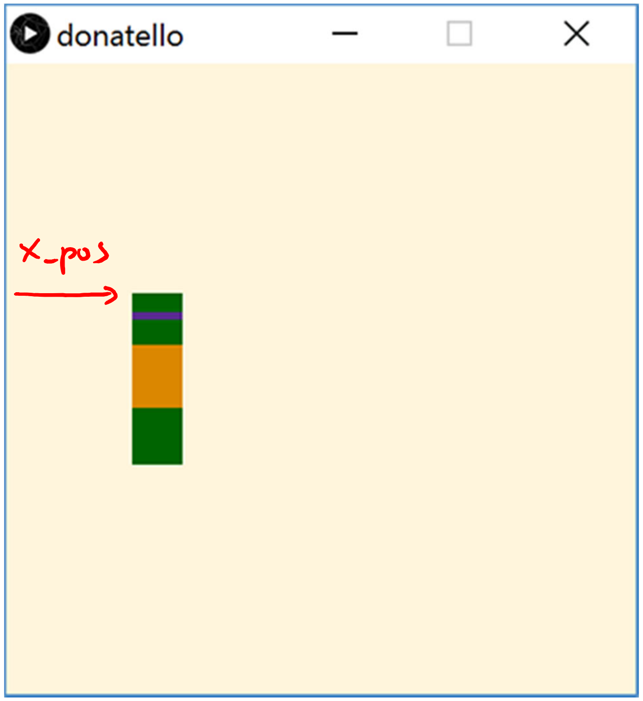
Donatello with a Variable

new variable



```
int x_pos = 100;        // x-position

size(500,500);
noStroke();
background(255,245,220);

// Donatello
fill(0,100,0);          // dark green
rect(x_pos,182,40,15);  // top of head

fill(88,44,141);        // purple
rect(x_pos,197,40,6);   // bandana mask

fill(0,100,0);          // dark green
rect(x_pos,203,40,20);  // bottom of head

fill(219,136,0);        // dark yellow
rect(x_pos,223,40,50);  // shell

fill(0,100,0);          // dark green
rect(x_pos,273,40,45);  // lower body
```

x_pos moves entire drawing!



Stopping Motion

- Stop Donatello from running off the *right* side of the screen:

returns minimum of these two numbers

```
x_pos = min(x_pos + 1, width-40);
```

// sets maximum x-pos of width-40=460

- Stop Donatello from running off the *left* side of the screen:

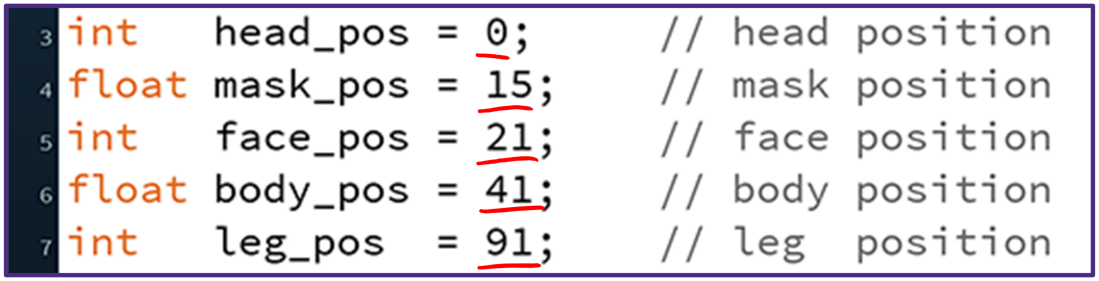
returns maximum of these two numbers

```
x_pos = max(x_pos - 1, 0);
```

// sets minimum x-pos of 0

Falling Into Place

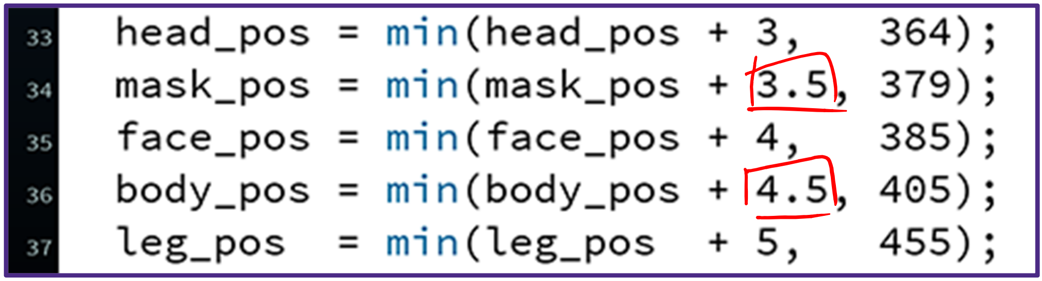
- Introduce variables for each body segment:



```
int   head_pos = 0;     // head position
float mask_pos = 15;    // mask position
int   face_pos = 21;    // face position
float body_pos = 41;    // body position
int   leg_pos  = 91;    // leg  position
```

initial y-positions for each body segment

- Update each variable at different speeds:



```
  head_pos = min(head_pos + 3,    364);
  mask_pos = min(mask_pos + 3.5,  379);
  face_pos = min(face_pos + 4,    385);
  body_pos = min(body_pos + 4.5,  405);
  leg_pos  = min(leg_pos  + 5,    455);
```

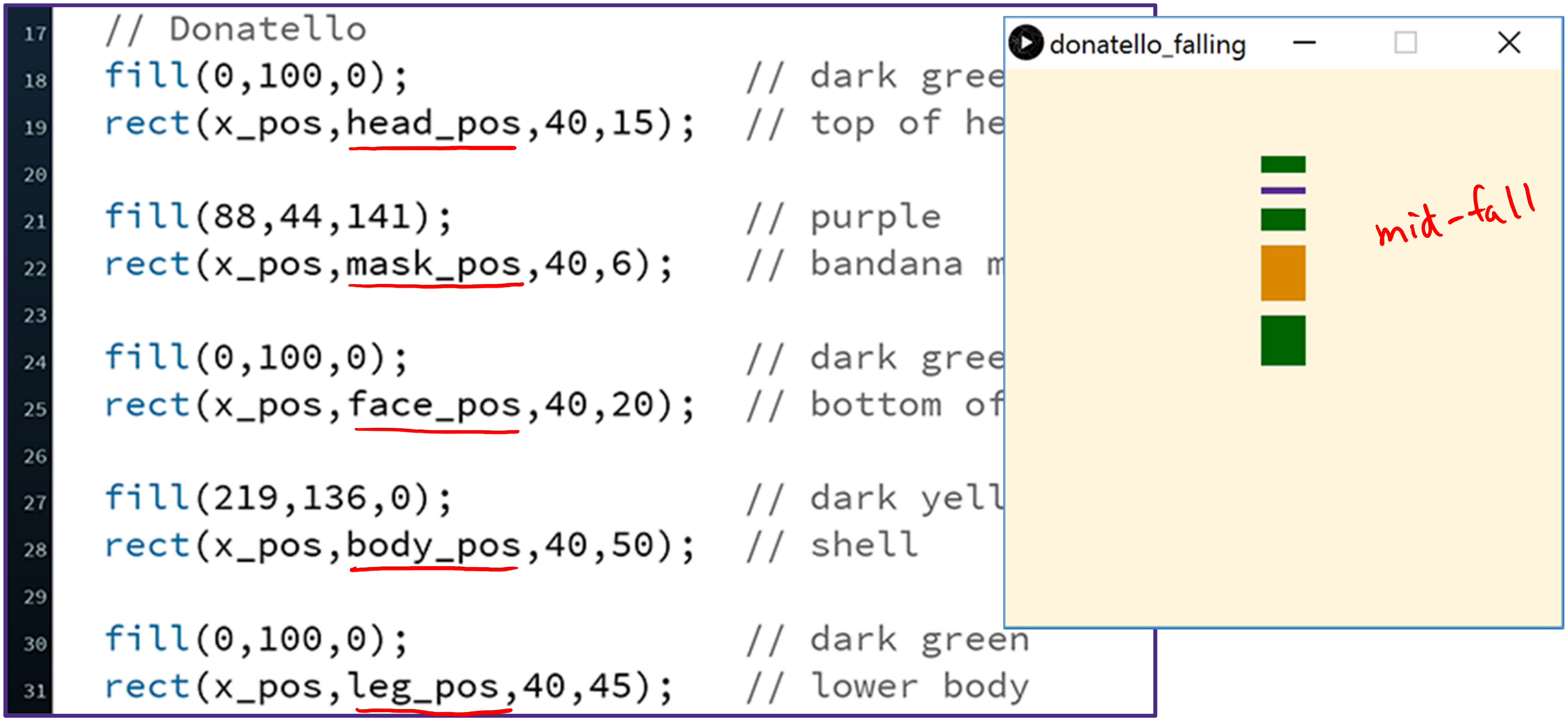
← higher segments fall slower

← lower segments fall faster

variables that use decimals need to be declared as float

Falling Into Place

- Update y-positions of drawing based on new variables:



```
// Donatello
fill(0,100,0);                  // dark gree
rect(x_pos,head_pos,40,15);     // top of he

fill(88,44,141);                // purple
rect(x_pos,mask_pos,40,6);      // bandana m

fill(0,100,0);                  // dark gree
rect(x_pos,face_pos,40,20);     // bottom of

fill(219,136,0);                // dark yell
rect(x_pos,body_pos,40,50);     // shell

fill(0,100,0);                  // dark green
rect(x_pos,leg_pos,40,45);      // lower body
```

mid-fall

Summary

- Variables are named quantities that can vary during the execution of a program
  - Datatypes specific different forms of data
    - *e.g.* `int`, `float`, `color`, `Boolean`
  - Variable *declarations* specify a variable datatype and name to the program
    - Generally occur at top of program
- Active mode uses **`setup`**`()` and **`draw`**`()`
  - Motion can be introduced by changing the values of variables used in drawing commands in-between frames
- `min()` and `max()` functions can be used to limit or stop change in a variable value