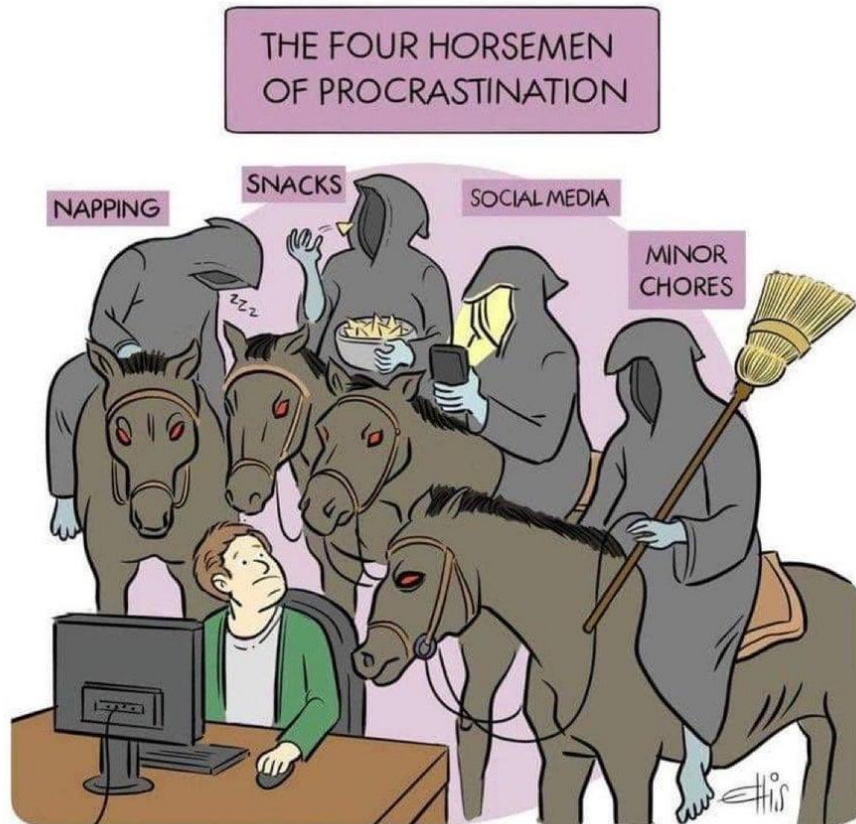


# CS 115, Autumn 2021

## Lecture 6: expressions; graphics



Thanks to Marty Stepp and Stuart Reges for parts of these slides

# Precedence

- **precedence:** Order in which operators are evaluated.

- Generally operators evaluate left-to-right.

$1 - 2 - 3$  is  $(1 - 2) - 3$  which is  $-4$

- But  $*$  /  $\%$  // have a higher level of precedence than  $+$  -

$1 + 3 * 4$  is  $13$

$6 + 8 // 2 * 3$

$6 + 4 * 3$

$6 + 12$  is  $18$

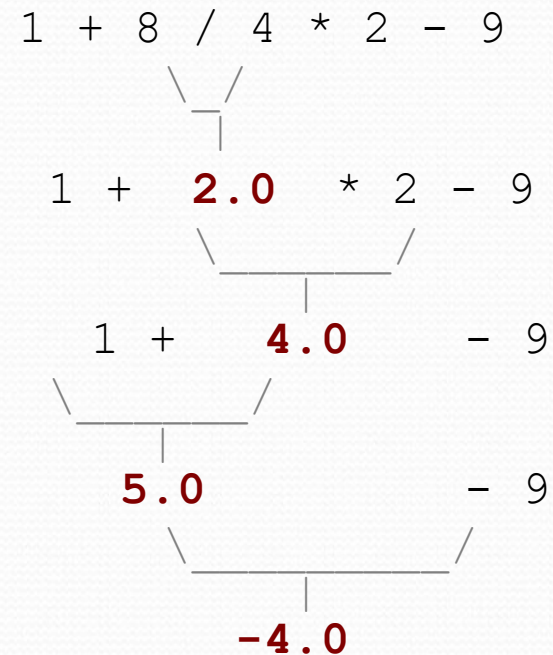
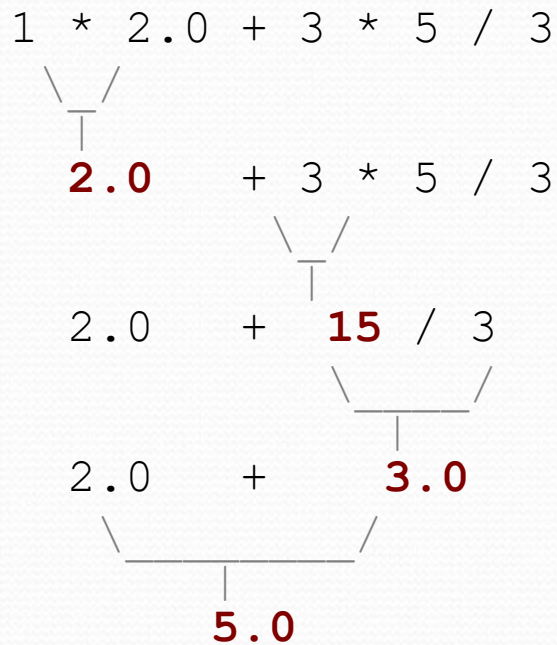
- Parentheses can force a certain order of evaluation:

$(1 + 3) * 4$  is  $16$

- Spacing does not affect order of evaluation

$1+3 * 4-2$  is  $11$

# Precedence examples



# Integer division with //

- When we divide integers with //, the quotient is also an integer.

- 14 // 4 is 3, not 3.5

$$\begin{array}{r} \underline{\quad 3} \\ 4 \ ) \ 14 \\ \underline{12} \\ 2 \end{array}$$

$$\begin{array}{r} \underline{\quad 4} \\ 10 \ ) \ 45 \\ \underline{40} \\ 5 \end{array}$$

$$\begin{array}{r} \underline{\quad 52} \\ 27 \ ) \ 1425 \\ \underline{135} \\ 75 \\ \underline{54} \\ 21 \end{array}$$

- More examples:

- 32 // 5 is 6

- 84 // 10 is 8

- 156 // 100 is 1

- Dividing by 0 causes an error when your program runs.

# Integer remainder with %

- The % operator computes the remainder from integer division.

- $14 \% 4$  is 2
- $218 \% 5$  is 3

$$\begin{array}{r} \phantom{4} \overline{) 14} \\ \underline{12} \\ 2 \end{array}$$

$$\begin{array}{r} \phantom{5} \overline{) 218} \\ \underline{20} \\ 18 \\ \underline{15} \\ 3 \end{array}$$

What is the result?

$$45 \% 6$$

$$2 \% 2$$

$$8 \% 20$$

$$11 \% 0$$

- Applications of % operator:

- Obtain last digit of a number:  $230857 \% 10$  is 7
- Obtain last 4 digits:  $658236489 \% 10000$  is 6489
- See whether a number is odd:  $7 \% 2$  is 1,  $42 \% 2$  is 0

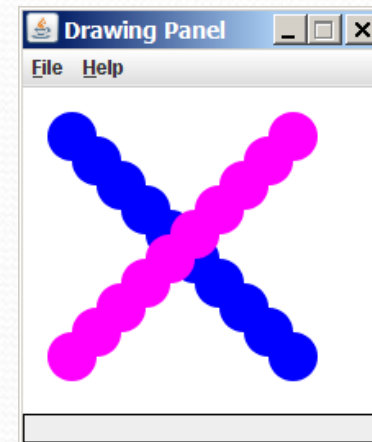
# Precedence questions

- What values result from the following expressions?
  - $9 // 5$
  - $695 \% 20$
  - $7 + 6 * 5$
  - $7 * 6 + 5$
  - $248 \% 100 / 5$
  - $6 * 3 - 9 // 4$
  - $(5 - 7) * 2 ** 2$
  - $6 + (18 \% (17 - 12))$

# Graphical objects

We will draw graphics in Python using a new kind of object:

- `drawing_panel`: A window on the screen.
  - Not part of Python; provided by the instructor. See class web site.
  - You will need `ECGUI.py`



# Named colors

Named colour chart												
snow	deep sky blue	gold	seashell3	SlateBlue2	LightBlue3	SpringGreen2	DarkGoldenrod1	brown4	pink3	purple1	gray26	gray64
ghost white	sky blue	light goldenrod	seashell4	SlateBlue3	LightBlue4	SpringGreen3	DarkGoldenrod2	salmon1	pink4	purple2	gray27	gray65
white smoke	light sky blue	goldenrod	AntiqueWhite1	SlateBlue4	LightCyan2	SpringGreen4	DarkGoldenrod3	salmon2	LightPink1	purple3	gray28	gray66
gainsboro	steel blue	dark goldenrod	AntiqueWhite2	RoyalBlue1	LightCyan3	green2	DarkGoldenrod4	salmon3	LightPink2	purple4	gray29	gray67
floral white	light steel blue	rosy brown	AntiqueWhite3	RoyalBlue2	LightCyan4	green3	RosyBrown1	salmon4	LightPink3	MediumPurple1	gray30	gray68
old lace	light blue	indian red	AntiqueWhite4	RoyalBlue3	PaleTurquoise1	green4	RosyBrown2	LightSalmon2	LightPink4	MediumPurple2	gray31	gray69
linen	powder blue	saddle brown	bisque2	RoyalBlue4	PaleTurquoise2	chartreuse2	RosyBrown3	LightSalmon3	PaleVioletRed1	MediumPurple3	gray32	gray70
antique white	pale turquoise	sandy brown	bisque3	slate2	PaleTurquoise3	chartreuse3	RosyBrown4	LightSalmon4	PaleVioletRed2	MediumPurple4	gray33	gray71
papaya whip	dark turquoise	dark salmon	bisque4	slate3	PaleTurquoise4	chartreuse4	IndianRed1	orange2	PaleVioletRed3	thistle1	gray34	gray72
blanched almond	medium turquoise	salmon	PeachPuff2	DodgerBlue2	CadetBlue1	OliveDrab1	IndianRed2	orange3	PaleVioletRed4	thistle2	gray35	gray73
bisque	turquoise	light salmon	PeachPuff3	DodgerBlue3	CadetBlue2	OliveDrab2	IndianRed3	orange4	maroon1	thistle3	gray36	gray74
peach puff	cyan	orange	PeachPuff4	DodgerBlue4	CadetBlue3	OliveDrab4	IndianRed4	DarkOrange1	maroon2	thistle4	gray37	gray75
navajo white	light cyan	dark orange	NavajoWhite2	SteelBlue1	CadetBlue4	DarkOliveGreen1	sienna1	DarkOrange2	maroon3		gray38	gray76
lemon chiffon	cadet blue	coral	NavajoWhite3	SteelBlue2	turquoise1	DarkOliveGreen2	sienna2	DarkOrange3	maroon4		gray39	gray77
mint cream	medium aquamarine	light coral	NavajoWhite4	SteelBlue3	turquoise2	DarkOliveGreen3	sienna3	DarkOrange4	VioletRed1		gray40	gray78
azure	aquamarine	tomato	LemonChiffon2	SteelBlue4	turquoise3	DarkOliveGreen4	sienna4		coral1	VioletRed2	gray42	gray79
alice blue	dark green	orange red	LemonChiffon3	DeepSkyBlue2	turquoise4	khaki1	burlywood1	coral2	VioletRed3		gray43	gray80
lavender	dark olive green	red	LemonChiffon4	DeepSkyBlue3	cyan2	khaki2	burlywood2	coral3	VioletRed4		gray44	gray81
lavender blush	dark sea green	hot pink	cornsilk2	DeepSkyBlue4	cyan3	khaki3	burlywood3	coral4	magenta2		gray45	gray82
misty rose	sea green	deep pink	cornsilk3	SkyBlue1	cyan4	khaki4	burlywood4	tomato2	magenta3		gray46	gray83
dark slate gray	medium sea green	pink	cornsilk4	SkyBlue2	DarkSlateGray1	LightGoldenrod1	wheat1	tomato3	magenta4		gray47	gray84
dim gray	light sea green	light pink	ivory2	SkyBlue3	DarkSlateGray2	LightGoldenrod2	wheat2	tomato4	orchid1		gray48	gray85
slate gray	pale green	pale violet red	ivory3	SkyBlue4	DarkSlateGray3	LightGoldenrod3	wheat3	OrangeRed2	orchid2		gray49	gray86
light slate gray	spring green	maroon	ivory4	LightSkyBlue1	DarkSlateGray4	LightGoldenrod4	wheat4	OrangeRed3	orchid3		gray50	gray87
gray	lawn green	medium violet red	honeydew2	LightSkyBlue2	aquamarine2	LightYellow2	tan1	OrangeRed4	orchid4		gray51	gray88
light grey	medium spring green	violet red	honeydew3	LightSkyBlue3	aquamarine4	LightYellow3	tan2	red2	plum1		gray52	gray89
midnight blue	green yellow	medium orchid	honeydew4	LightSkyBlue4	DarkSeaGreen1	LightYellow4	tan4	red3	plum2		gray53	gray90
navy	lime green	dark orchid	LavenderBlush2	SlateGray1	DarkSeaGreen2	yellow2	chocolate1	red4	plum3		gray54	gray91
cornflower blue	yellow green	dark violet	LavenderBlush3	SlateGray2	DarkSeaGreen3	yellow3	chocolate2	DeepPink2	plum4		gray57	gray92
dark slate blue	forest green	blue violet	LavenderBlush4	SlateGray3	DarkSeaGreen4	yellow4	chocolate3	DeepPink3	MediumOrchid1		gray18	gray56
slate blue	olive drab	purple	MistyRose2	SlateGray4	SeaGreen1	gold2	firebrick1	DeepPink4	MediumOrchid2		gray19	gray57
medium slate blue	dark khaki	medium purple	MistyRose3	LightSteelBlue1	SeaGreen2	gold3	firebrick2	HotPink1	MediumOrchid3		gray20	gray58
light slate blue	khaki	thistle	MistyRose4	LightSteelBlue2	SeaGreen3	gold4	firebrick3	HotPink2	MediumOrchid4		gray21	gray59
medium blue	pale goldenrod	snow2	azure2	LightSteelBlue3	PaleGreen1	goldenrod1	firebrick4	HotPink3	DarkOrchid1		gray22	gray60
royal blue	light goldenrod yellow	snow3	azure3	LightSteelBlue4	PaleGreen2	goldenrod2	brown1	HotPink4	DarkOrchid2		gray23	gray61
blue	light yellow	snow4	azure4	LightBlue1	PaleGreen3	goldenrod3	brown2	pink1	DarkOrchid3		gray24	gray62
dodger blue	yellow	seashell2	SlateBlue1	LightBlue2	PaleGreen4	goldenrod4	brown3	pink2	DarkOrchid4		gray25	gray63

# Custom colors

- You can construct custom colors using hex.
  - # followed by six numbers 0 – 9 and letters A – F
    - A is 10, B is 11 and so on
    - #000000 is black
    - #FFFFFF is white
    - Colors get darker as the number gets lower
    - The first two digits are the amount of red, the next two green, the last two blue

```
panel = drawing_panel(80, 50, background="#3367D3")
```

# Drawing shapes

Function name	Description
<code>p.draw_line(x1, y1, x2, y2)</code>	line between points $(x1, y1)$ , $(x2, y2)$
<code>p.draw_oval(x, y, width, height)</code>	outline largest oval that fits in a box of size $width * height$ with top-left at $(x, y)$
<code>p.draw_rect(x, y, width, height)</code>	outline of rectangle of size $width * height$ with top-left at $(x, y)$
<code>p.draw_string("text", x, y)</code>	text with upper-left at $(x, y)$
<code>p.fill_oval(x, y, width, height)</code>	fill largest oval that fits in a box of size $width * height$ with top-left at $(x, y)$
<code>p.fill_rect(x, y, width, height)</code>	fill rectangle of size $width * height$ with top-left at $(x, y)$
<code>p.set_color("color")</code>	set the default color to "color"

- You can pass an additional "color" to any shape as a last parameter

```
p.draw_rect(50, 100, 60, 60, "red")
```

# Coordinate system

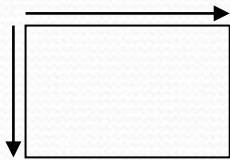
- Each  $(x, y)$  position is a *pixel* ("picture element").
- $(0, 0)$  is at the window's top-left corner.
  - $x$  increases rightward and the  $y$  increases downward.
- The rectangle from  $(0, 0)$  to  $(200, 100)$  looks like this:

$(0, 0)$

$x+$

$(200, 100)$

$y+$



# Superimposing shapes

- When two shapes occupy the same pixels, the last one drawn is seen.

```
from ECGUI import *

def main():
    p = drawing_panel(200, 100, background="gray77")
    p.fill_rect(10, 30, 100, 50, "black")
    p.fill_oval(20, 70, 20, 20, "red")
    p.fill_oval(80, 70, 20, 20, "red")
    p.fill_rect(80, 40, 30, 20, "cyan")

main()
```

