

CompSci 101

Introduction to Computer Science



Oct 31, 2017

Prof. Rodger

compsci 101, fall 2017

1

Announcements

- Next Reading and RQ due Thursday
- Assignment 6 due Thursday
- APT 5 due tonight, APT 6 due Nov 7
- APT Quiz2 Sun-Wed next week
- Lab this week - images
- Today:
 - Nested loops, tuples, images

compsci 101, fall 2017

2

ACM Programming Contest

Need Volunteers

Saturday, Nov 11 at Duke

- Over 120 teams, 8 university sites
- Team:
 - 3 people, 1 computer
 - 8 problems, 5 hours
- Need volunteers to deliver printouts, etc
 - 8:15am-12:30 OR 11:20am-6pm
 - Get tshirt and meals!



compsci 101, fall 2017

3

It's Halloween

- What is Prof. Rodger's Halloween costume, from long ago....

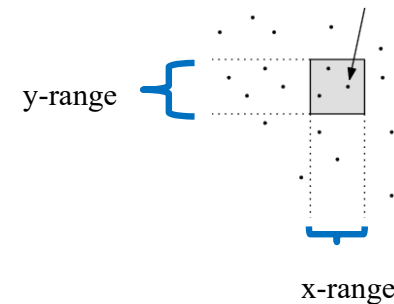


YARN,
in the
shape
binary
Subtree
made
mole
ki
What is it?

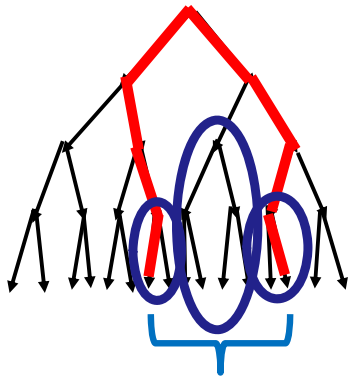


2D-range tree

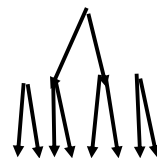
- Search in x-y plane
- Main tree organized by x-values
- Subtree organized by y values



Binary Search tree of points in the plane – sorted by X-value



In the x-range



Each subtree organized by y-value

Search each subtree by y-value

Problem: Given list of words, find word with most vowels

- Example:
 - Given ['dog', 'cat', 'gerbil', 'elephant']
 - 'elephant' has 3 vowels, the most
- To solve – nested loops:
 - Loop over words in list
 - For each word: Loop over characters in word

Bit.ly/101f17-1031-1

```
def wordWithMostVowels(words):
    maxcnt = 0
    maxword = ""
    cnt = 0
    for word in words:
        for letter in word:
            if isVowel(letter):
                cnt += 1
        if cnt > maxcnt:
            maxcnt = cnt
            maxword = word
    return maxword
```

comp sci 101, fall 2017

9

Problem – Given two lists of names, print a list of pairs of names in which the two names are the same length

- A = ['mo', 'ted', 'bill']
- B = ['billie', 'jes', 'bo']

mo, bo

ted, jes

- To solve
 - for name in A:
 - for name in B:
 - Check length
 - print pair

comp sci 101, fall 2017

10

Bit.ly/101f17-1031-2

```
for aname in A:
    for bname in B:
        if len(aname) == len(bname):
            print aname + ", " + bname
print
for bname in B:
    for aname in A:
        if len(aname) == len(bname):
            print aname + ", " + bname
```

comp sci 101, fall 2017

11

APT - UniqueZoo

```
filename: UniqueZoo.py

def numberUnique(zoos):
    """
    Parameter zoos is a list of strings, each string is the
    types of animals the zoo has, separated by blanks.
    Return the number of zoos that have at least one unique
    animal that does not appear at any other zoo
    """

    # you write code here
```

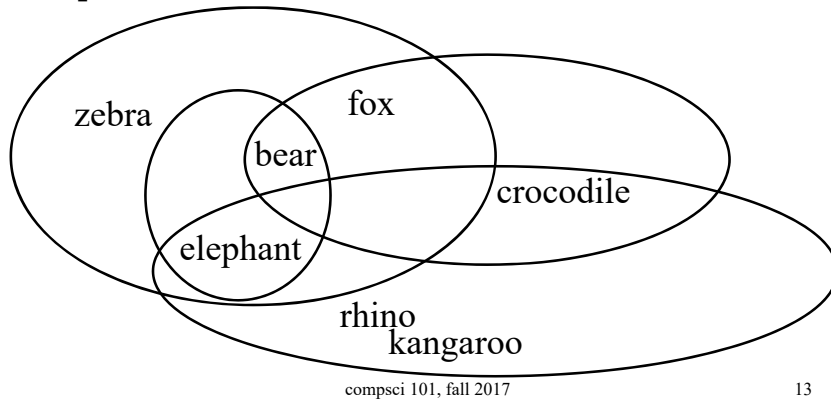
- How do you solve this problem?
- How is it similar to the problem we just solved

comp sci 101, fall 2017

12

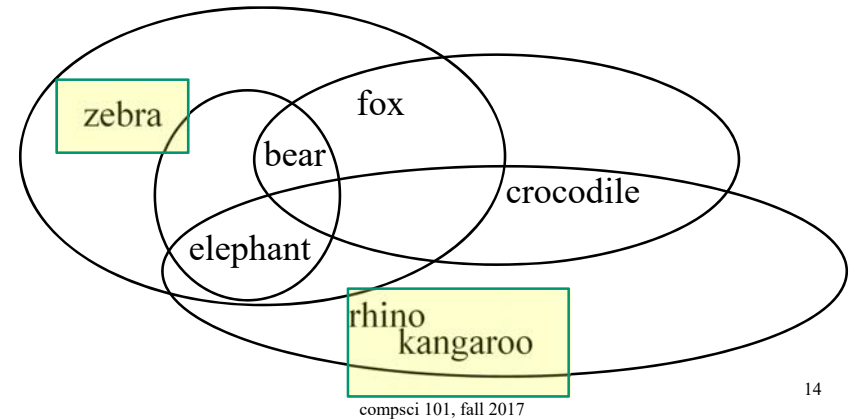
Example Data for UniqueZoo

["zebra bear fox elephant", "bear crocodile fox", "rhino elephant crocodile kangaroo", "elephant bear"]



13

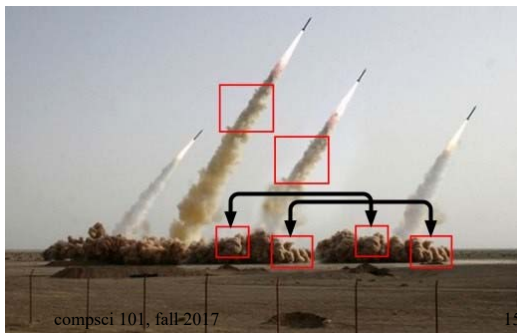
UniqueZoo – two zoos have unique animals



14

Image Processing

- What's real, what's Photoshopped
 - <http://bit.ly/1Kj0Kn6> from 2008
 - Learn more at <http://bit.ly/1Psi0hG>, we'll do very basic stuff in class and lab, next assignment too!



15

Example: convert color to gray scale



*Process each pixel
Convert to gray*



compsci 101, fall 2017

16

Example: convert blue to green



Process each pixel
Convert blue ones to green

Is this like red-eye removal?



compsci 101, fall 2017

17

Lab 8

- You'll create new images
 - Invert
 - Solarize
 - Darken
 - Brighten
 - etc

compsci 101, fall 2017

18

Need new concepts and Image library

- Red, Green, Blue color model
 - Triples of (R,G,B) are processed as Python tuples.
 - *Let's study tuples!*
- Images can be very big, what's 4K display?
 - $4,096 \times 2,160 = 8,847,360$ pixels, 8Mb at least
 - Creating huge lists takes up memory
 - Sometimes only need one pixel at-a-time
 - *Let's study generators!*



compsci 101, fall 2017

19

Need new concepts and Image library

- Red, Green, Blue color model
 - Additive model, each pixel specified by (r,g,b) triple, values of each between 0-255
 - https://en.wikipedia.org/wiki/RGB_color_model
 - White is (255,255,255) and Black is (0,0,0)
- Images stored as sequence of (r,g,b) tuples, typically with more data/information too
 - 256 values, represented as 8 bits, $2^8 = 256$
 - 32 bits per pixel (with alpha channel)
 - In Python we can largely ignore these details!

compsci 101, fall 2017

20

Image library: Two ways to get pixels

- Each pixel is a *tuple* in both models
 - Like a list, indexable, but *immutable*
 - `pix = (255, 0, 0)`
 - What is `pix`?, `pix[0]`? What is `pix[5]`?
- Invert a pixel: by subscript or named tuple
 - Access by assignment to variables!

```
npx = (255-pix[0],255-pix[1],255-pix[2])
```

```
(r,g,b) = pix  
npx = (255-r,255-g,255-b)
```

compsci 101, fall 2017

21

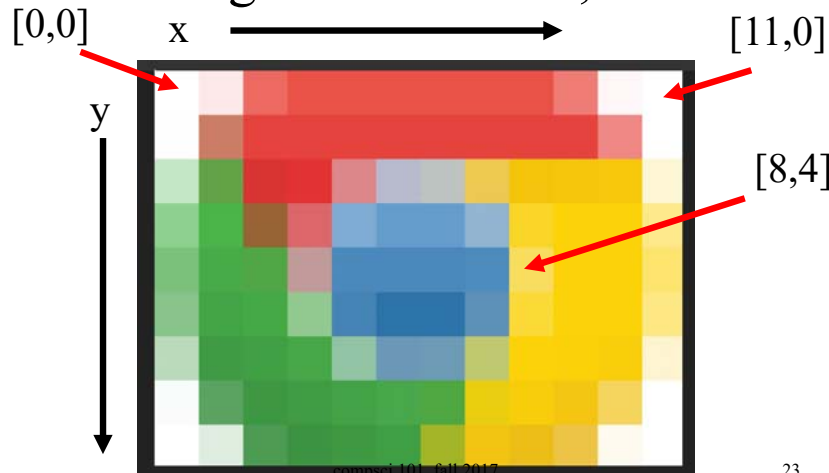
Let's look at GrayScale.py

- Key features we see
 - Import Image library, use API by example
 - `Image.open` creates an image object
- Image functions for Image object `im`
 - `im.show()`, displays image on screen
 - `im.save("xy")`, saves with filename
 - `im.copy()`, returns image that's a copy
 - `im.load()`, `[x,y]` indexable pixel collection
 - `im.getdata()`, iterable pixel collection
- Let's look at two ways to process pixels!

22

Pixels in an image

Background is black, 12x9



compsci 101, fall 2017

23

Image Library: open, modify, save

- `Image.open` can open most image files
 - .png, .jpg, .gif, and more
 - Returns an image object, so store in variable of type Image instance
 - Get pixels with `im.getdata()` or `im.load()`
- `Image.new` can create a new image, specify color model "RGB" and size of image
 - Add pixels with `im.putdata()`
- These belong to Image package

24

`im.getdata()`, accessing pixels

- Returns something *like* a list
 - Use: `for pix in im.getdata():`
 - Generates pixels on-the-fly, can't slice or index unless you use `list(im.getdata())`
 - Structure is called a Python generator!
 - Saves on storing all pixels in memory if only accessed one-at-a-time
- See usage in `GrayScale.py`, note how used in list comprehension, like a list!

compsci 101, fall 2017

25

Questions bit.ly/101f17-1031-3

```
def makeGray(pixel):
    (r,g,b) = pixel
    gray = (r+g+b)/3
    return (gray,gray,gray)

def grayit2(picname):
    im = Image.open(picname)
    im.show()
    pixels = [makeGray(pix) for pix in im.getdata()]
    nim = Image.new("RGB",im.size)
    nim.putdata(pixels)
    nim.show()
    nim.save("gray"+picname)
```

compsci 101, fall 2017

26

Alternate : Still Tuples and Pixels

- The `im.getdata()` function returns list-like iterable
 - Can use in list comprehension, see code
 - Use `.putdata()` to store again in image

```
pixels = [makeGray(pix) for pix in im.getdata()]
```

```
def makeGray(pixel):
    r,g,b = pixel
    gray = (r+g+b)/3
    return (gray,gray,gray)
```

compsci 101, fall 2017

27

Making Tuples and Generators

- Overuse and abuse of parentheses
 - To create a tuple, use parentheses
- To create a generator use parentheses as though creating a list comprehension!

```
for pix in im.getdata():
    (r,g,b) = pix
    npx = (255-r,255-g,255-b)
```

```
[2*n for n in range(10000)]
(2*n for n in range(10000))
```

- See this in PyDev console

compsci 101, fall 2017

28