CS101, Spring 2015

Image Processing

Lecture #7

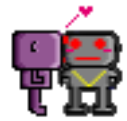
Roadmap

Last time we learned

- Sequences
  - Lists
  - Strings
  - Tuples

This week we will learn

- Default parameters
- Named parameters
- Formatting
- String methods
- Image processing



Function arguments

We have learnt about parameters and function arguments:

```
def create_sun(radius, color):
    sun = Circle(radius)
    sun.setFillColor(color)
    sun.setBorderColor(color)
    sun.moveTo(100, 100)
    return sun


sun = create_sun(30, "yellow")
```

Arguments are mapped to parameters one-by-one, left-to-right.

Default parameters

We can provide default parameters:

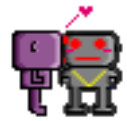
```
def create_sun(radius = 30, color = "yellow"):
  # as before
```

Now we can call it like this:

```
sun = create_sun()
star = create_sun(2)
moon = create_sun(28, "silver")
```

But not like this:

```
moon = create_sun("silver")
```

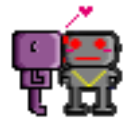


Normal and default parameters

Default parameters have to follow normal parameters:

```
def avg(data, start = 0, end = None):
  if not end:
    end = len(data)
  return sum(data[start:end]) / float(end-start)


>>> d = [ 1, 2, 3, 4, 5 ]
>>> avg(d)
3.0
>>> avg(d, 2)
4.0
>>> avg(d, 1, 4)
3.0
```

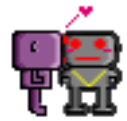


Named parameters

We can include the name of the parameter in the function call to make the code clearer. Then the order of arguments does not matter:

```
moon = create_sun(color = "silver")
moon = create_sun(color = "silver", radius = 28)
```

```
>>> avg(d, end=3)
2.0
>>> avg(data=d, end=3)
2.0
>>> avg(end=3, data=d)
2.0
>>> avg(end=3, d)
SyntaxError: non-keyword arg after keyword arg
```



Formatting

We often want to produce nicely formatted output:

```
print "Max between " + str(x0) + " and " +
      str(x1) + " is " + str(val)
```

The string formatting operator % makes this much easier:

```
print "Max between %d and %d is %g" % (x0, x1, val)
```

Formatting operator:

```
format_string % (arg0, arg1, .... )
```

Tuple has one element for each place holder in the `format_string`. Place holders are:

- `%d` for integers in decimal,
- `%g` for `float`,
- `%.2f` for `float` with fixed precision (2 digits after period),
- `%s` for anything (like `str(x)`).

Formatting

If there is only one place holder, tuple is not necessary:

```
print "Maximum is %g" % val
```

We can align tables by using field width:

```
print "%3d ~ %3d : %10g" % (x0, x1, val)
```

A value can be left-aligned in its field:

```
print "%3d ~ %-3d : %-12g" % (x0, x1, val)
```

Strings

Strings are sequences:

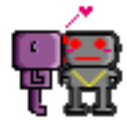
```
def is_palindrome(s):
  for i in range(len(s) / 2):
    if s[i] != s[len(s) - i - 1]:
      return False
  return True
```

Strings are immutable.

The `in` operator for strings:

```
>>> "abc" in "01234abcdefg"
True
>>> "abce" in "01234abcdefg"
False
```

Different from the `in` operator for lists and tuples, which tests whether something is equal to an element of the list or tuple.



String methods

String objects have many useful methods:

- `upper()`, `lower()`, and `capitalize()`
- `isalpha()` and `isdigit()`
- `startswith(prefix)` and `endswith(suffix)`
- `find(str)`, `find(str, start)`, and `find(str, start, end)`
  (return -1 if `str` is not `in` the string)
- `replace(str1, str2)`
- `rstrip()`, `lstrip()` and `strip()` to remove white space on the right, left, or both ends.

String methods for converting between lists and strings:

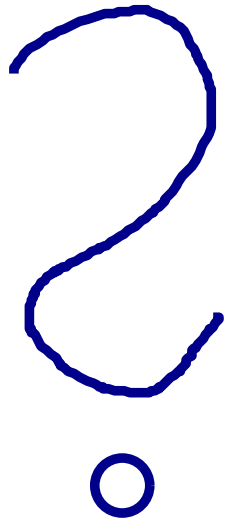
- `split()` splits with white space as separator
- `split(sep)` splits with given separator `sep`
- `join(l)` concatenates strings from a list `l`

Copy and paste

Let's put the KAIST statue on a nice background:

+

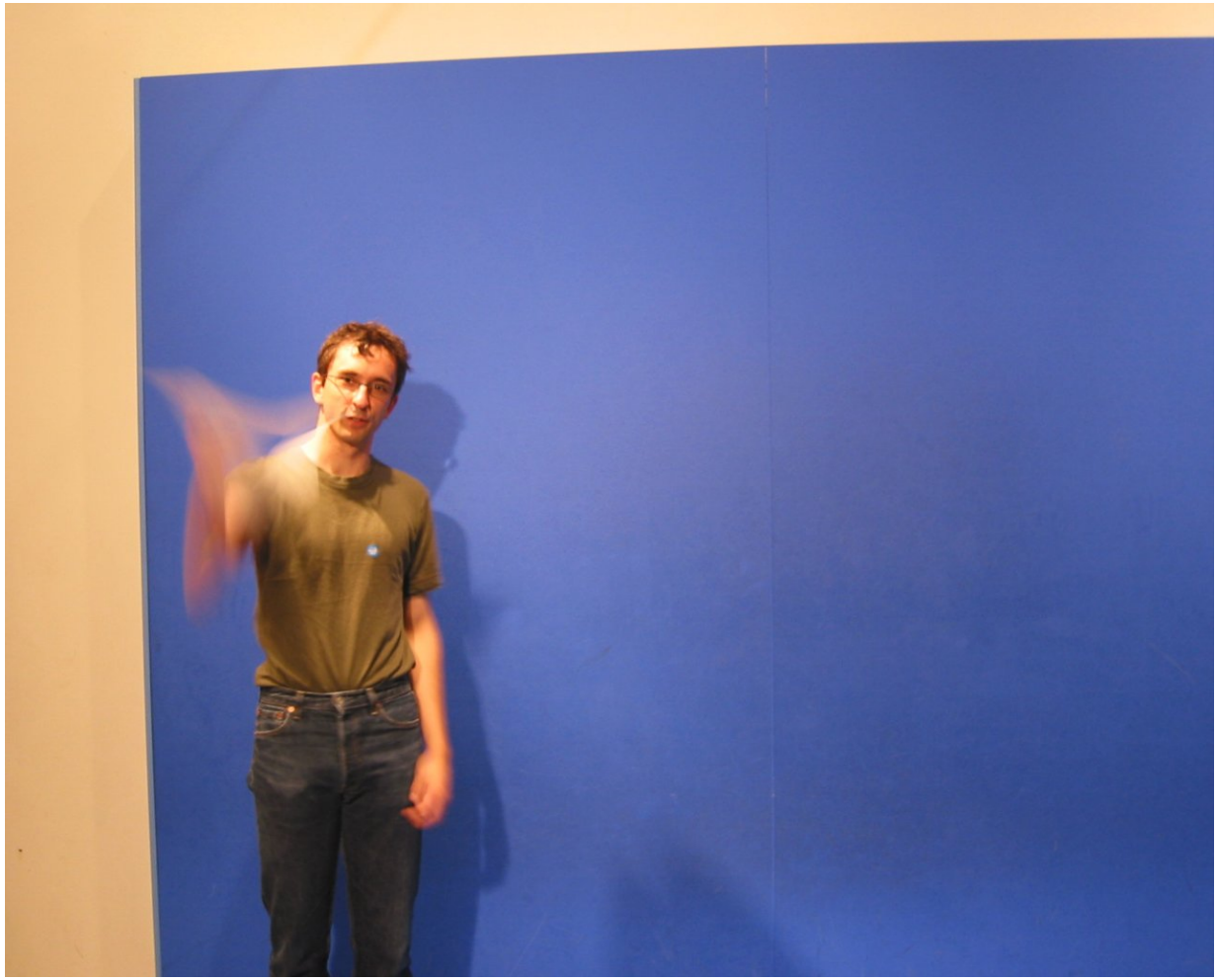
=



```
def paste(canvas, img, x1, y1):
  w, h = img.size()
  for y in range(h):
    for x in range(w):
      canvas.set(x1 + x, y1 + y, img.get(x, y))
```

Chromakey

Chromakey is a technique to overlay one scene on top of another one. It is commonly used for weather maps.



Color distance

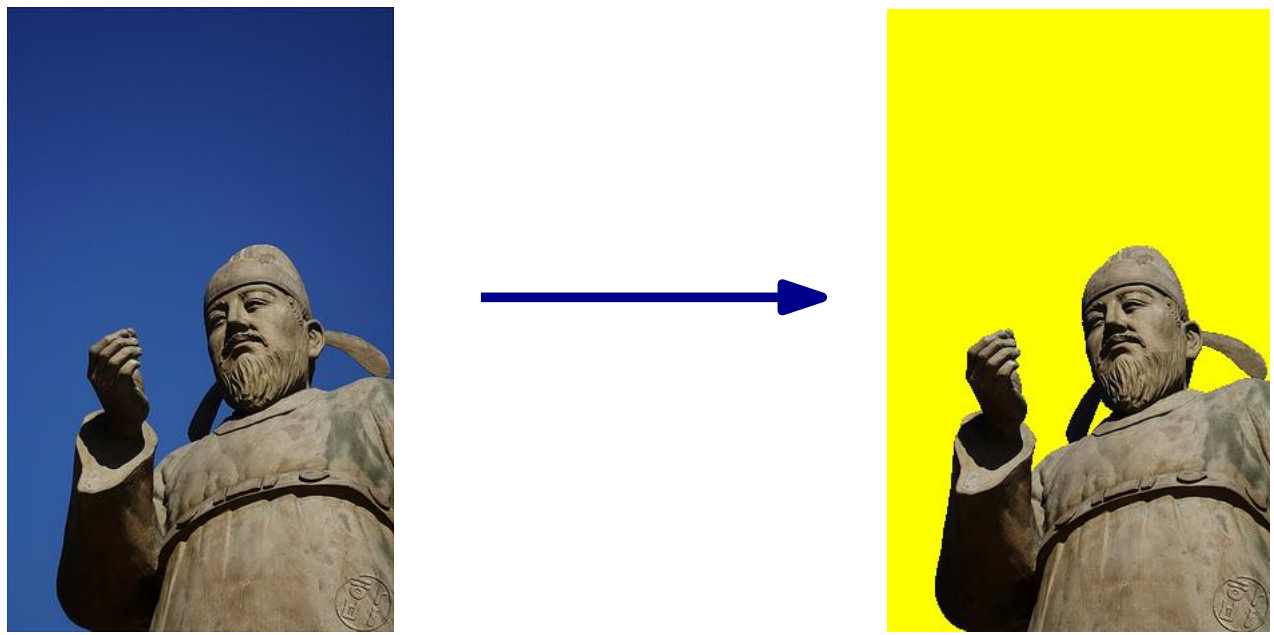
Actually, the background is not exactly blue - just blueish.
We need a function to decide how similar two colors are:

```
def dist(c1, c2):
  r1, g1, b1 = c1
  r2, g2, b2 = c2
  return math.sqrt((r1-r2)**2 + (g1-g2)**2 +
                   (b1-b2)**2)
```

This is just the Euclidean distance in $\mathbb{R}^3$.

Chromakey

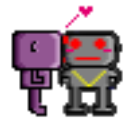
```
def chroma(img, key, threshold):
  w, h = img.size()
  for y in range(h):
    for x in range(w):
      p = img.get(x, y)
      if dist(p, key) < threshold:
        img.set(x, y, Color.yellow)
```



Chromakey

Now all we need is a paste function that skips the color-coded background:

```
def chroma_paste(canvas, img, x1, y1, key):
  w, h = img.size()
  for y in range(h):
    for x in range(w):
      p = img.get(x, y)
      if p != key:
        canvas.set(x1 + x, y1 + y, p)
```



Information hiding

Humans cannot perceive a small change in light intensity or color value. We can use this to hide information inside images.

Here is an algorithm to hide a black/white image `secret` in an image `img`:

- For all pixels `(r, g, b)` of `img`, if `r` is odd then subtract one from `r`;
- For each black pixel of `secret`, add one to the red value of the same pixel in `img`.

To decode the secret, we look at all pixels `(r,g,b)` of the image, and turn it black if `r` is odd, and white otherwise.