Computing for mathematics handout 4 - Functions, Sorting and Searching algorithms and what to expect on the class test.

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What you have learnt this week:

- How to create an unsorted list;
- Some sorting algorithms;
- Some searching algorithms.

Functions

Some of us are still having problems understanding important concepts of functions:

- Defining functions;
- Using functions.

In *mathematics* we'll often see things like this:

Let us define $f(x) = x^2$, $g(x) = x^3 - 1$ and $h(x) = \sqrt{x}$.
Calculate f(x), g(x) and h(x) for x taking on the following values: $0, .5, 1, 3$.

We would simply calculate this by hand as follows:

- $f(0) = 0, f(.5) = .25, f(1) = 1, f(3) = 9$
- $g(0) = -1, g(.5) = -.875, g(1) = 0, g(3) = 26$
- $h(0) = 0, g(.5) \approx .707, g(1) = 1, g(3) \approx 1.732$

Our question could then go on to ask:

Now define $k(x) = f(g(h(x)))$. Which function (h, f, g or k) has the lowest mean value over the above list of values?

Here we would calculate $k(x)$ for the above function:

- $k(0) = f(g(h(0))) = f(g(0)) = f(-1) = 1, k(.5) \approx .418, k(1) = 0, k(3) = 17.608$

From here we would write: let a, b, c, d be the mean values of h, f, g, k respectively.

$$a \approx 2.563, b \approx 6.03, c \approx .860, d \approx 4.756$$

The way we have *defined* functions and passed values to them is exactly the same as we would do it in Python:

```
def f(x):
    """
    return f(x) from example
    """
    return x ** 2

def g(x):
    """
    return g(x) from example
    """
    return x ** 3 - 1

def h(x):
    """
    return h(x) from example
    """
    return x ** (1/float(2))

values = [0, .5, 1, 3]  # This defines our list of values
for x in values:  # We now loop over our values
    print "When x=%s" %x
    print "f(x)=%s" % f(x)  # Here we calculate f(x) for a given x
    print "g(x)=%s" % g(x)  # Here we calculate g(x) for a given x
    print "h(x)=%s" % h(x)  # Here we calculate h(x) for a given x
```

Now to do the second half of the problem:

```
def k(x):
    """
    Using our previously defined functions to define k(x)
    """
    return f(g(h(x)))

print [k(x) for x in values]  # This just return k(x) for x in values using list comprehensions

def mean(lst):
    """
    A function to return the mean of a list

    Arguments: lst: a list

    Outputs: The mean of all elements in lst
    """
    return sum(lst) / len(lst)

print "f: %s" % mean([f(x) for x in values])
print "g: %s" % mean([g(x) for x in values])
print "h: %s" % mean([h(x) for x in values])
print "k: %s" % mean([k(x) for x in values])
```

Sorting algorithms

- We saw two algorithms for sorting scrambled lists:

- Selection sort
- Bubble sort (this was not a tickable)

Searching algorithms

- We saw binary search this week which relies on constantly 'dividing' a list in to two smaller lists:

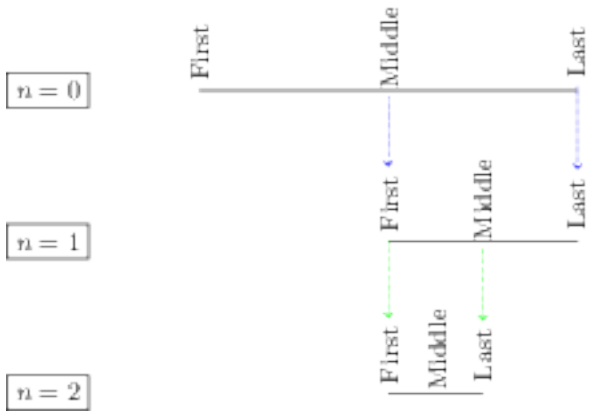

Figure 1:

The class test (8th of November)

- 50 minute class test.
- The class test will have 3 questions:
  - Q1 will be a *non tickable* question from the lab sheets;
  - Q2 will be a question of comparable difficulty to what has been done in the lab sheets;
  - Q3 will be a harder question similar to a question from the lab sheets.
- This will be an open 'book' test. You will have access to the internet. *BUT NOT TO EMAIL* or any other communication with other students: make sure your scripts from the sheets are on your machine: 'I was just logging in to my email to get my sheets' will not be tolerated.
- You will write 3 scripts (1 for each question) and will be uploading and emailing them.

What you should do next:

- Start revising for the class test: work through all your lab sheets. If you can do exercises in the lab sheets (not just 'understand them' but actually 'do them') you will be fine.
- **Start the next sheet**, there is quite a lot to learn and Object Orientated Programming is a very powerful tool so make sure you make progress outside of the labs.
- To make the best use of the lab sessions turn up having finished your sheets;
- If anything is still unclear **please** come and see me during office hours.