Lecture 11b - Regular Expressions

Thanks to Mary Kuhner for many slides

Using objects and classes

- A class is a variable type with associated functions
- An object is an instance of a class
- We have already used the string class
- String offers functions such as upper(), lower(), and find()
- In this lecture we'll use classes; Thursday we'll create some

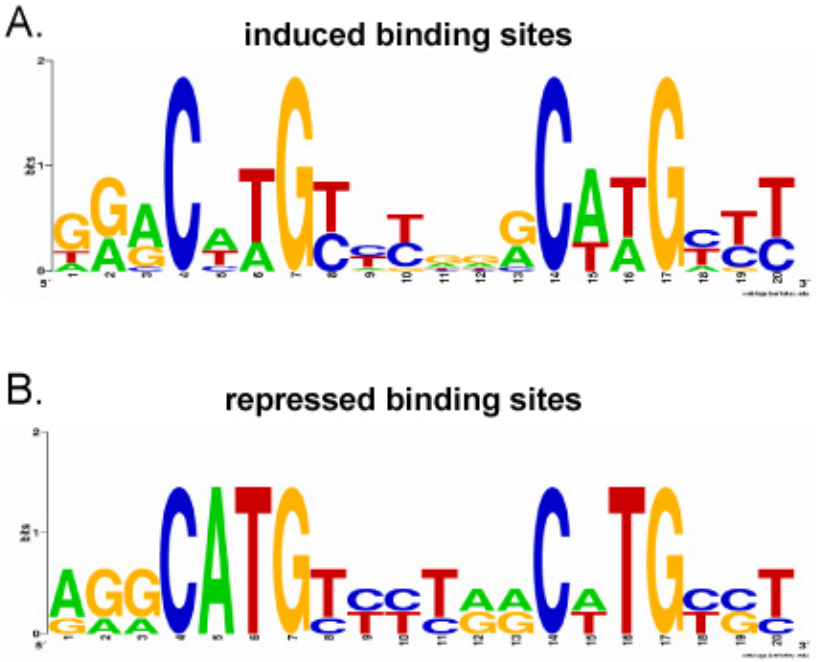
Using an object

```
mystring = "ATCCGCG"
print mystring.find("C")
2   # position of first "C"
print mystring.count("C")
3
```

Regular Expressions

- Regular expressions (regexp) are a text-matching tool embedded in Python
- They are useful in creating string searches and string modifications
- You can always use regular Python instead, but regexps are often much easier
- Documentation: `http://docs.python.org/library/re.html`

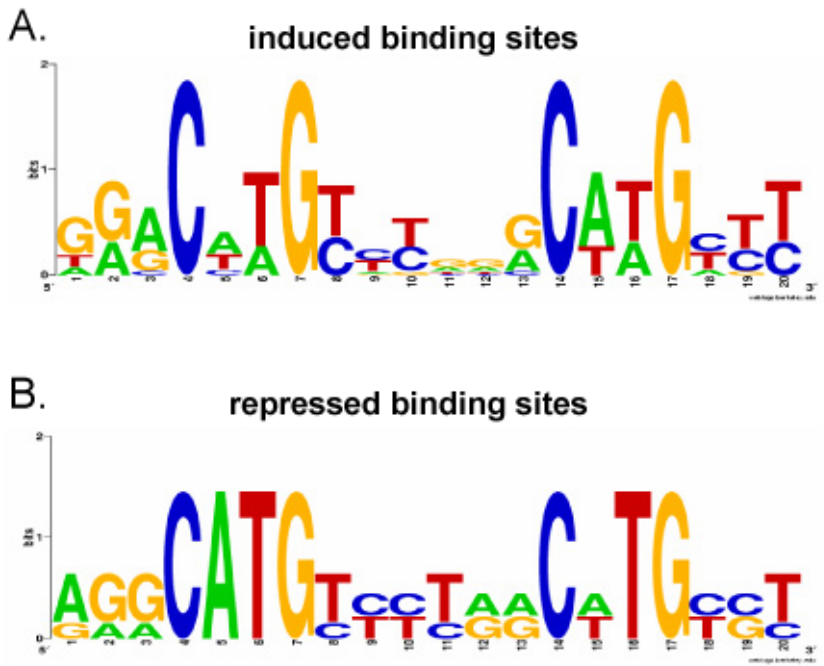
Motivating example



Repressed binding sites in regular Python

```
# assume we have a genome sequence in string variable myDNA
for index in range(0,len(myDNA)-20) :
  if (myDNA[index] == "A" or myDNA[index] == "G") and
     (myDNA[index+1] == "A" or myDNA[index+1] == "G") and
     (myDNA[index+2] == "A" or myDNA[index+2] == "G") and
     (myDNA[index+3] == "C") and
     (myDNA[index+4] == "C") and
# and on and on!
     (myDNA[index+19] == "C" or myDNA[index+19] == "T") :
        print "Match found at ",index
        break
```

Repressed binding sites with regexp




```
import re
p53rule = \
 re.compile(r"[AG]{3,3}CATG[TC]{4,4}[AG]{2,2}C[AT]TG[CT][CG][TC]")
m = p53rule.search(myDNA)
if m != None :
  print "Match found at ",m.start()
```

Basics of regexp construction

- Letters and numbers match themselves
- Normally case sensitive
- Watch out for punctuation–most of it has special meanings!

Matching one of several alternatives

- Square brackets mean that any of the listed characters will do
- `[ab]` means either "a" or "b"
- You can also give a range:
- `[a-d]` means "a" "b" "c" or "d"
- Negation: caret means "not"

```
[^a-d]     # anything but a, b, c or d
```

Wild cards

- "." means "any character"
- If you really mean "." you must use a backslash
- WARNING:
  - backslash is special in Python strings
  - It's special again in regexps
  - This means you need too many backslashes
  - We will use "raw strings" instead
  - Raw strings look like `r"ATCGGC"`

Using . and backslash

- To match file names like "hw3.pdf" and "hw5.txt":

```
hw.\....
```

Zero or more copies

- The asterisk repeats the previous character 0 or more times
- "ca*t" matches "ct", "cat", "caat", "caaat" etc.
- The plus sign repeats the previous character 1 or more times
- "ca+t" matches "cat", "caat" etc. but not "ct"

Repeats

- Braces are a more detailed way to indicate repeats
- A{1,3} means at least one and no more than three A's
- A{4,4} means exactly four A's

Practice problem 1

- Write a regexp that will match any string that starts with "hum" and ends with "001" with any number of characters, including none, in between

- (Hint: consider both "." and "*")

Practice problem 2

- Write a regexp that will match any Python (.py) file.
- There must be at least one character before the ".".
- ".py" is not a legal Python file name
- (Imagine the problems if you imported it!)

Using the regexp

First, compile it:

```
import re
myrule = re.compile(r".+\.py")
print myrule
<_sre.SRE_Pattern object at 0xb7e3e5c0>
```

The result of `compile` is a Pattern object which represents your regexp

Using the regexp

Next, use it:

```
mymatch = myrule.search(myDNA)
print mymatch
None
mymatch = myrule.search(someotherDNA)
print mymatch
<_sre.SRE_Match object at 0xb7df9170>
```

The result of `match` is a Match object which represents the result.

All of these objects! What can they do?

Functions offered by a Pattern object:

- `match()`–does it match the beginning of my string? Returns None or a match object
- `search()`–does it match anywhere in my string? Returns None or a match object
- `findall()`–does it match anywhere in my string? Returns a list of strings (or an empty list)
- Note that `findall()` does NOT return a Match object!

All of these objects! What can they do?

Functions offered by a Match object:

- `group()`–return the string that matched
  `group()`–the whole string
  `group(1)`–the substring matching 1st parenthesized sub-pattern
  `group(1,3)`–tuple of substrings matching 1st and 3rd parenthesized sub-patterns

- `start()`–return the starting position of the match

- `end()`–return the ending position of the match

- `span()`–return (start,end) as a tuple

A practical example

Does this string contain a legal Python filename?

```
import re
myrule = re.compile(r".+\.py")
mystring = "This contains two files, hw3.py and uppercase.py."
mymatch = myrule.search(mystring)
print mymatch.group()
This contains two files, hw3.py and uppercase.py
# not what I expected!  Why?
```

Matching is greedy

- My regexp matches "hw3.py"
- Unfortunately it also matches "This contains two files, hw3.py"
- And it even matches "This contains two files, hw3.py and uppercase.py"
- Python will choose the longest match
- I could break my file into words first
- Or I could specify that no spaces are allowed in my match

A practical example

Does this string contain a legal Python filename?

```
import re
myrule = re.compile(r"[^ ]+\.py")
mystring = "This contains two files, hw3.py and uppercase.py."
mymatch = myrule.search(mystring)
print mymatch.group()
hw3.py
allmymatches = myrule.findall(mystring)
print allmymatches
['hw3.py','uppercase.py']
```

Practice problem 3

- Create a regexp which detects legal Microsoft Word file names
- The file name must end with ".doc" or ".DOC"
- There must be at least one character before the dot.
- We will assume there are no spaces in the names
- Print out a list of all the legal file names you find
- Test it on testre.txt (on the web site)

Practice problem 4

- Create a regexp which detects legal Microsoft Word file names that do not contain any numerals (0 through 9)
- Print out the start location of the first such filename you encounter
- Test it on testre.txt

Practice problem

- Create a regexp which detects legal Microsoft Word file names that do not contain any numerals (0 through 9)
- Print out the "base name", i.e., the file name after stripping of the .doc extension, of each such filename you encounter. Hint: use parenthesized sub patterns.
- Test it on testre.txt

Practice problem 1 solution

Write a regexp that will match any string that starts with "hum" and ends with "001" with any number of characters, including none, in between

```
myrule = re.compile(r"hum.*001")
```

Practice problem 2 solution

Write a regexp that will match any Python (.py) file.

```
myrule = re.compile(r".+\.py")

# if you want to find filenames embedded in a bigger
# string, better is:
myrule = re.compile(r"[^ ]+\.py")
# this version does not allow whitespace in file names
```

Practice problem 3 solution

Create a regexp which detects legal Microsoft Word file names, and use it to make a list of them

```
import sys
import re
filename = sys.argv[1]
filehandle = open(filename,"r")
filecontents = filehandle.read()
myrule = re.compile(r"[^ ]+\.[dD][oO][cC]")
matchlist = myrule.findall(filecontents)
print matchlist
```

Practice problem 4 solution

Create a regexp which detects legal Microsoft Word file names which do not contain any numerals, and print the location of the first such filename you encounter

```
import sys
import re
filename = sys.argv[1]
filehandle = open(filename,"r")
filecontents = filehandle.read()
myrule = re.compile(r"[^ 0-9]+\.[dD][oO][cC]")
match = myrule.search(filecontents)
print match.start()
```

Regular expressions summary

- The `re` module lets us use regular expressions
- These are fast ways to search for complicated strings
- They are not essential to using Python, but are very useful
- File format conversion uses them a lot
- Compiling a regexp produces a Pattern object which can then be used to search
- Searching produces a Match object which can then be asked for information about the match