HW 2A in focus

anagram
raga Man

computer science (&) engineering
epic reticence ensuring gnome

notkin beard
drank one bit

HW 2A

- Understanding vs. doing – this is not a straightforward barrier to overcome, and it doesn't happen all at once
- Breaking down solutions into parts is crucial
  - Edsger W. Dijkstra, ACM Turing Lecture 1972, "The Humble Programmer"
- Some amount of "finding things on your own" is essential; perhaps I expected too much of this for this assignment
  - sed and regular expressions
  - loops
  - …
- Performance – not the high priority
  - Linear vs. quadratic (or worse) complexity of the script

Editors

- To write and change your programs you should be using an editor – what's the alternative?
- The most common editors on Unix are pico, emacs and vi – pico is simple, emacs is (arbitrarily) complex, and vi is still loved by many old-time Unix users
- You don't need to become an expert in these, but it's worth an investment to become capable

ed/sed

- But you didn't mention **sed** on the previous slide? Isn't it a "stream editor"? Indeed it is.
- It's closely related to **ed**, a line editor from the first days of Unix
  - **ed** let you interactively edit lines, changing parts of specific lines – referred to by number and/or by content – inserting and deleting lines, etc.

Example **ed** session [Wikipedia]

```
a
ed is the standard Unix text editor.
This is line number two.
.
2i


.
%l
ed is the standard Unix text editor.$
$
This is line number two.$
```

```
3s/two/three/
,l
ed is the standard Unix text editor.$
$
This is line number three.$
w text
65
q
```

The end result is a simple text file containing the following text:

ed is the standard Unix text editor.

This is line number three.

sed: non-interactive **ed**

- But sometimes you wanted to use **ed**-like features – in particular regular expression matching – non-interactively
- That's what **sed** is for – using **ed**-like commands on a string to do transformations that are hard or impossible to do with **tr**, etc.
- A core feature is the use of regular expressions – these are powerful and found in other Unix tools, most noticeably **grep**

What is a regular expression?

- `"[a-zA-Z_\-]+@(([a-zA-Z_\-])+\.)+[a-zA-Z]{2,4}"`
- regular expression: a description of a pattern of text
  - can test whether a string matches the expression's pattern
  - can use a regex to search/replace characters in a string
  - regular expressions are powerful but can be tough to read
    - the above regular expression matches basic email addresses

Regular expressions

- Appear throughout computer science, in tools, in theory, in practice
- Powerful enough to be very useful; other kinds of matching require more powerful languages than regular expressions, but they are more complex
- Lots of variations, but all have the same "power" – that is, they can match the same patterns, although the expressions themselves may be more or less complicated

`egrep` and regexes

command	description
`egrep`	extended `grep`; uses regexes in its search patterns; equivalent to `grep -E`

```
egrep "[0-9]{3}-[0-9]{3}-[0-9]{4}"
```

Basic regexes

- The simplest regexes simply match a particular substring: **`"abc"`**
- Matches any line containing **`"abc"`**
  - YES : **`"abc","abcdef","defabc",".=.abc.=.",`** **`...`**
  - NO : **`"fedcba","ab c","AbC","Bash", ...`**

Wildcards and anchors

- **`.`** (a dot) matches any character except **`\n`**
  - "**`.oo.y`**" matches "**`Doocy`**", "**`goofy`**", "**`LooPy`**", ...
  - use **`\.`** to literally match a dot . character
- **`^`** matches the beginning of a line; **`$`** the end
  - **`"^fi$"`** matches lines that consist entirely of "**`fi`**"
- **`\<`** demands that pattern is the beginning of a word; **`\>`** demands that pattern is the end of a word
  - **`"\<for\>"`** matches lines that contain the word **`"for"`**

Special characters

- **`|`** means *or*
  - **`"abc|def|g"`** matches lines with **`"abc",`** **`"def",`** or **`"g"`**
- precedence of **`^(Subject|Date):`** vs. **`^Subject|Date:`**
- There's no *and* symbol. Why not?
- **`()`** are for grouping
  - **`"(Homer|Marge) Simpson"`** matches lines containing **`"Homer Simpson"`** or **`"Marge Simpson"`**
- **`\`** starts an escape sequence: many characters must be escaped to match them: **`/\$.[]()^*+?`**

Quantifiers: * + ?

- `*` means 0 or more occurrences
  - `"abc*"` matches `"ab","abc","abcc", "abccc", ...`
  - `"a(bc)*"` matches `"a", "abc", "abcbc", "abcbcbc", ...`
  - `"a.*a"` matches `"aa", "aba", "a8qa", "a!?_a", ...`
- `+` means 1 or more occurrences
  - `"a(bc)+"` matches `"abc", "abcbc", "abcbcbc", ...`
  - `"Goo+gle"` matches `"Google", "Gooogle", "Goooogle", ...`
- `?` means 0 or 1 occurrences
  - `"Martina?"` matches lines with `"Martin", "Martina"`
  - `"Dan(iel)?"` matches lines with `"Dan"` or `"Daniel"`

More quantifiers

- `{min,max}` means between min and max occurrences
  - `"a(bc){2,4}"` matches `"abcbc", "abcbcbc"`, or `"abcbcbcbc"`
- min or max may be omitted to specify any number
  - `"{2,}"` means 2 or more
  - `"{,6}"` means up to 6
  - `"{3}"` means exactly 3

Character sets

- `[ ]` group characters into a character set; will match any single character from the set
  - `"[bcd]art"` matches strings containing `"bart", "cart"`, and `"dart"`
  - equivalent to `"(b|c|d)art"`

Character ranges

- Specify a range of characters with `-`
  - `"[a-z]"` matches any lowercase letter
  - `"[a-zA-Z0-9]"` matches any lower- or uppercase letter or digit
- an initial `^` inside a character set negates it
  - `"[^abcd]"` matches any character other than `a, b, c, d`
- inside a character set, `-` must be escaped to be matched
  - `"[+\-]?[0-9]+"` matches optional `+` or `-`, followed by at least one digit

sed

command	description
`sed`	stream editor; performs regex-based replacements and alterations on input

- Usage:
  - `sed -r "s/REGEX/TEXT/g" filename`
    - substitutes (replaces) occurrence(s) of regex with the given text
    - if filename is omitted, reads from standard input
    - sed has other uses, but most can be emulated with substitutions
- Example (replaces all occurrences of 143 with 303):
  - `sed -r "s/143/303/g" lecturenotes.txt`

more about `sed`

- `sed` is line-oriented; processes input a line at a time
- `-r` option makes regexes work better
  - recognizes `( ) , [ ] , * , +` the "right" way, etc.
- `g` flag after last `/` matches all occurrences
- special characters must be escaped to match them literally
  - `sed -r "s/http:\/\//https:\/\//g" urls.txt`
- `sed` can use other delimiters besides `/` ... whatever follows `s`
  - `find /usr |`
    `sed -r "s#/usr/bin#/home/billy#g"`

Back-references

- every span of text captured by `()` is given an internal number
  - you can use `\number` to use the captured text in the replacement
  - `\0` is the overall pattern
  - `\1` is the first parenthetical capture
  - ...
- Example: swap last names with first names
  - `sed -r "s/([^ ]*), ([^ ]*)/\2 \1/g"`

loops

```
while read line; do
  echo $line
done
```


Debugging

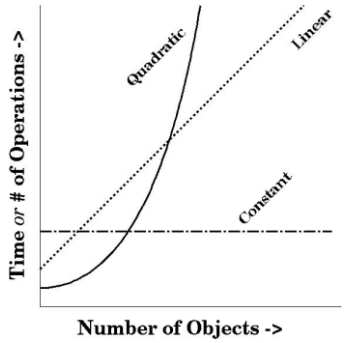
- "Debugging is important, especially since the shell is so sensitive to details. I recommend two things: (a) trying your commands individually in the command-line as you're trying to build your shell scripts; and (b) assigning and echoing 'unnecessary' variables in your scripts that can be used to help see what's happening step-by-step."
- When things don't work, what do you do?

Performance

- I'm not worried about performance (within a little bit of reason) on 2A. Bill Wulf, who served as president of the National Academy of Engineering for over a decade, once said something like: "More mistakes are made by premature optimization than for any other reason including sheer ignorance."
  - OK, maybe it doesn't work right, but at least it's really fast.
  - Well, if it doesn't have to work right, I can make it even faster!

Algorithmic complexity

- When dealing with a lot of data, what is usually most important about performance is the underlying algorithmic complexity
  - *Very roughly*, how many times do you need to touch each data item
- Examples
  - Finding a number in an unsorted list: linear search
  - Finding a number in a sorted list: linear or binary search
  - Sorting a list: $O(N^2)$ vs. $O(N \log N)$
- HW2: if you touch every entry in the dictionary many times for each input string, that might be a problem – there are 479,829 entries



Wednesday

- I'd like to spend about 15 minutes having about three students present their solution to 2A to the class
- I'll pick some varying approaches
- Please send me email if you are willing to present your solution

Questions?