Where we are

• Done learning about the shell and it’s bizarre “programming language” (but pick up more on hw3)
• Today: Specifying string patterns for many utilities, particularly grep and sed (also needed for hw3)
• Next: sed

• And then: a real programming language – C
Globbing vs Regular Expressions

• “Globbing” refers to shell filename expansion
• “Regular expressions” are a different but overlapping set of rules for specifying patterns to programs like grep. (Sometimes called “pattern matching”)
• More distinctions:
  – Regular expressions as in CS/mathematics
  – “Regular expressions” in grep
  – “Extended regular expressions” in egrep
    • Same as grep –E
  – Other variations in other programs…
Real Regular Expressions

- Some of the crispest, elegant, most useful CS theory out there. What computer scientists know and ill-educated hackers don’t (to their detriment).
- A regular expression $p$ may “match” a string $s$.
- If $p =$
  - $a, b, \ldots$ matches the single character (basic reg. exp.)
  - $p_1 p_2, \ldots$, if we can write $s$ as $s_1 s_2$, where $p_1$ matches $s_1$, $p_2$ matches $s_2$.
  - $p_1 \mid p_2, \ldots$ if $p_1$ matches $s$ or $p_2$ matches $s$
    - (in egrep, for grep use $\mid$)
  - $p_1^*$, if there is an $i \geq 0$ such that $p_1 \ldots p_1$ ($i$ times) matches $s$.
    - (for $i = 0$, matches the zero-character string $\varepsilon$)
Conveniences

• Most regular expressions allow various abbreviations for convenience, but these do not make the language any more powerful
  – $p+$ is $pp^*$
  – $p?$ is $(\varepsilon | p)$
  – $[zd-h]$ is $z | d | e | f | g | h$
  – $[^a-z]$ and . are more complex, but just technical conveniences
  – $p^n$ is $p \ldots p$ ($p$ repeated $n$ times)
  – $p^{n,m}$ is $p \ldots pp^*$ ($p$ repeated $n$ or more times)
  – $p^{n,m}$ is $p$ repeated $n$ through $m$ times
grep – beginning and end of lines

• By default, grep matches each line against .*p.*
• You can anchor the pattern with ^ (beginning) and/or $ (end) or both (match whole line exactly)
• These are still “real” regular expressions
Gotchas

• Modern (i.e., gnu) versions of grep and egrep implement the same regular expression engine, but the syntax is different for historical reasons
  – For instance, \{ for grep vs { for egrep
  – See grep manual sec. 3.6
• Must quote patterns so the shell does not muck with them – and use single quotes if they contain $ (why?)
• Must escape special characters with \ if you need them literally: \. and . are very different
  – But inside [ ] many more characters are treated literally, needing less quoting (\ becomes a literal!)
Previous matches – back references

• Up to 9 times in a pattern, you can group with \((p)\) and refer to the matched text later!
  – (Need backslashes in sed.)
• You can refer to the text (most recently) matched by the \(n^{th}\) group with \(\backslash n\).
• Simple example: double-words  \(^\backslash\([a-zA-Z]*\)\backslash\1\$
• You cannot do this with actual regular expressions; the program must keep the previous strings.
  – Especially useful with sed because of substitutions.
Other utilities

• Some very useful programs you can learn on your own:
  – find (search for files, e.g., find /usr -name words)
  – diff (compare two files’ contents; output is easy for humans and programs to read (see patch))

• Also:
  – For many programs the -r flag makes them recursive (apply to all files, subdirectories, subsubdirectories, …).
  – So “delete everything on the computer” is cd /; rm -rf * (be careful!)