Regular Expressions
Limits of Computability
Which strings on the right match the regular expressions on the left

- .
- .*  
- \d
- \d*
- \D*
- \w*
- [0-9][0-9](\D)*
- .*(abc).*

- “x”
- “%23a”
- “9”
- “”
- “4192”
- “abc”
- “84#abcdef”
- “46”
- “81xyz”
Which strings on the right match the regular expressions on the left

- `(\D)*\d\d\d`
- `[A-Za-z]*(\s)+[0-9][0-9]`
- `...[0-9]{3}.?`

- “ 32”
- “Abz817”
- “&1A569”
- “a 02”
- “776”
- “1234567”
- “abc1234”
Write Regular Expressions to match the patterns described below

• 1 or more digits
• 1 or more digits followed by a colon followed 0 or more digits
• 1 to 8 upper or lower case letters
• 2 characters followed by 2 digits followed by 0 or more upper case letters
• An optional character followed by 3 upper or lower case letters followed by 1 or more whitespace characters followed by 0 or more digits
Which strings on the right match the regular expressions on the left

- ..[0-9]??..  
- (0|1)+  
- [A-Za-z]([0-9] | [A-Za-z])*
- [0-9]{5}(-[0-9]{4})?
- “ABCD”  
- “001101”  
- ##7$%  
- 54601-1234  
- 54603  
- wa32c1
Write a phrase that describes the regular expressions shown below

• ..[0-9]?..
  – Two characters followed by an optional digit followed by 2 characters

• (0|1)+
  – A string of one or more 0s and 1s

• [A-Za-z]([0-9] | [A-Za-z])*
  – A letter followed by 0 or more letters and digits

• [0-9]{5}(-[0-9]{4})?
  – 5 digits followed by an optional dash and 4 digits
Write a phrase that describes the regular expressions shown below

• (\D)*d\d\d
• [A-Za-z]*\s+[0-9][0-9]
• ...[0-9]{3}.?
Write Regular Expressions to match the patterns described below

• Three digits followed by a comma followed by three digits
• An optional 3 digits and a comma followed by 3 digits followed by a comma followed by 4 digits
• Two upper case letters followed by 3 digits
• An optional exclamation point or dollar sign followed by 1 or more digits followed by an optional exclamation point or dollar sign
Circle the substrings that match the regular expression 
-?\d[A-Z]\D

• ABC -1WX1B# -1Q Z
• -1W2C%-3&-4NN
Limits of Computation

• How long does it take to compute a result?
• Are there problems for which no “efficient” algorithm can be created?
• Are there problems for which no algorithmic solution can exist?
Limits of Computation

• Polynomial time algorithm
  – An algorithm with an execution time that is a polynomial function of the input size

• Exponential time algorithm
  – An algorithm with an execution time that is an exponential function of the input size

• Undecidable (or non-computable) problem
  – A problem for which no algorithm can exist
    – Halting problem
Limits of Computation

• Polynomial time algorithms
  – Linear search
    • $N$
  – Selection sort
    • $N^2$

• Can we sort faster than $N^2$?
  – MergeSort
    • $N\log_2 N$
# Limits of Computation

<table>
<thead>
<tr>
<th>Input Size (N)</th>
<th>Selection Sort</th>
<th>Merge Sort</th>
</tr>
</thead>
<tbody>
<tr>
<td>128</td>
<td>16,386</td>
<td>896</td>
</tr>
<tr>
<td>1024</td>
<td>1,048,576</td>
<td>10,240</td>
</tr>
<tr>
<td>2,097,152</td>
<td>4,398,046,511,104</td>
<td>44,040,192</td>
</tr>
<tr>
<td>N</td>
<td>N^2</td>
<td>Nlog₂N</td>
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</tbody>
</table>