ICS Problem Sheet #1 Date: 13/09/2023 Name: Flori Kusari

a) Set of Vaticies V: $V = \{a, b, c, d, e, f, g, h\}$

Set of Edges A: $A = \{(a,b), (a,d), (a,f), (b,c), (b,f), (b,g), (b,h), (c,e), (c,h), (d,f), (e,h), (f,g), (g,h)\}$

b)

Initialization: $E = \{\}$

$C = 0$

$Z = \{a\}, \{b\}, \{c\}, \{d\}, \{e\}, \{f\}, \{g\}, \{h\}$

Step 1: $E = \{(a,d)\}$

$C = 3$

$Z = \{a,d\}, \{b\}, \{c\}, \{e\}, \{f\}, \{g\}, \{h\}$

Step 2: $E = \{(a,d), (d,f)\}$

$C = 11$

$Z = \{a,d,f\}, \{b\}, \{c\}, \{e\}, \{g\}, \{h\}$

Step 3: $E = \{(a,d), (d,f), (f,g)\}$

$C = 12$

$Z = \{a,d,f,g\}, \{b\}, \{c\}, \{e\}, \{h\}$

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Step 4: $E = \{(a,d),(d,f),(f,g),(g,h)\}$

$C = 14$

$Z = \{a,d,f,g,h\},\{b\},\{c\},\{e\}$

Step 5: $E = \{(a,d),(d,f),(f,g),(g,h),(h,b)\}$

$C = 18$

$Z = \{a,b,d,f,g,h\},\{c\},\{e\}$

Step 6: $E = \{(a,d),(d,f),(f,g),(g,h),(h,b),(b,c)\}$

$C = 24$

$Z = \{a,b,c,d,f,g,h\},\{e\}$

Step 7: $E = \{(a,d),(d,f),(f,g),(g,h),(h,b),(b,c),(c,e)\}$

$C = 33$

$Z = \{a,b,c,d,e,f,g,h\}$

The Overall Cost is 33.

# Problem 1.2: Boyer Moore Algorithm

a) Text: FPLFLFRFRFPLFPLFRF
Pattern: FPLFR

```
   0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
   F P L F L F R F R F P  L  F  P  L  F  R  F
1  F P L F r
2    f p l f r
3      f p L F R
4        F p l f r
5          f p l F R
6            F p l f r
7              f p l F r
8                F p l f r
9                  f p l f r
10                   F P L F r
11                     f p l f r
12                       F P L F R
13                         F P L F R
14                           f p l f r
```

Alignments: 14
Comparisons: 70
Match found at index 12

b) Bad Match Table:

| F | P | L | R | * |
|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 5 |

Characters not in the pattern.

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```
   0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17
   F P L F L F R F R F  P  L  F  P  L  F  R  F
1  F P L F (r)
2     f (p) L F R
3       F  p  l  f (r)
4          f  p  l  F  R
5             F  p  l  f (r)
6                f  p  l  F (r)
7                      F  P  L  F (r)
8                            F  P  L  F  R
9                               f  p  l  f (r)
```

Alignments: 9
Comparisons: 18
Match found at index 12

The circled letters are the only real comparisons the other letters are just written for better visualization. We check if the letters match from right to left in the pattern and left to right in the text.

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c)

| F | P | L | R | * |
|---|---|---|---|---|
| 1 | 3 | 2 | 1 | 5 |

→ For "F" we go with the placement of the second "F" not the first.

Alignments Skipped

$V = \max(1, \text{Length of Pattern} - \text{Index of Character} - 1)$

$\max(1, ?)$ because you must skip at least one line.

For F $V = \max(1, 5-3-1) = \max(1, 1) = 1$
For P $V = \max(1, 5-1-1) = \max(1, 3) = 3$
For L $V = \max(1, 5-2-1) = \max(1, 2) = 2$
For R $V = \max(1, 5-3-1) = \max(1, 1) = 1$
For * → it represents any characters not in the text that is not present in the pattern.
After such character is found the nr. of alignments skipped should be equal to the pattern length.

# 1.3 Operator Precedence and associativity (haskell)

a) In Haskell, there are some operators which are classified as non-associative meaning they cannot be used multiple times in one expression without parentheses which define the order. Such operators are common and among the most known ones are "==" (equal), "/=" (not equal), "<" (less than), etc.

An example: `8 == 8 == 8 == 8`

When run in Haskell this will output "Precedence parsing error" which is obviously not correct. However, if we add parentheses:

`(8 == 8) == (8 == 8)`

The result will come back "True" and not "Error....".

b) The "$" operator in Haskell is right associative and has the lowest precedence among operators. It is used in the following expression as a way to avoid parentheses:

`(^) 2 $ (*) 4 $ (+) 1 3`

This can also be written with parentheses to avoid using "$":

`((2 ^ (4 * (1 + 3))))`

Both of those expressions give the output 65536. In the second expression the parentheses ensure the operations are performed in the same order as the original expression.

THE END