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: FPLFLFRFRLFPFRF
Pattern: FPLFR

```
        F P L F L F R F R L F P 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
```

Alignments: 11
Comparisons: 55

b) Bad Match Table:

F	P	L	R
1	3	2	1

Value = max(1, Length of Pattern − Index of Character − 1)

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```
        F P L F L F R F R L F P F R F
1       F P L F (r)
2           f (p) L F R
3             F p | f (r)
4               f p (|) F R
5                 F p | f (r)
6                     F p L F (r)
7                         F P | f (r)
```

Alignments: 7
Comparisons: 12

The circled (r) comparisons are the only true comparisons that are done and are needed, the other letters and comparisons are just for a better visualization of the alignment.

c)

F	P	L	R	*
1	3	2	1	5

Alignments skipped

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

max(1, ?) because you have to skip atleast 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 character 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 length of the pattern.

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