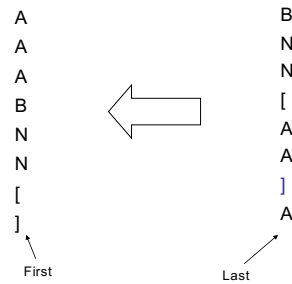


# COMP9319 Web Data Compression and Search

BWT revisit  
Backward Search overview

1

Recall: Last column = BWT

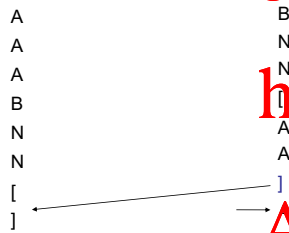


2

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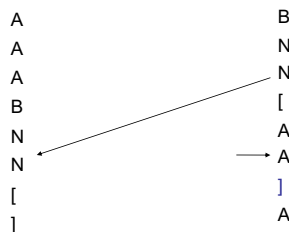


3



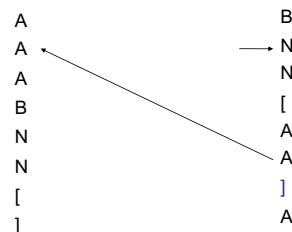
4

ANA]

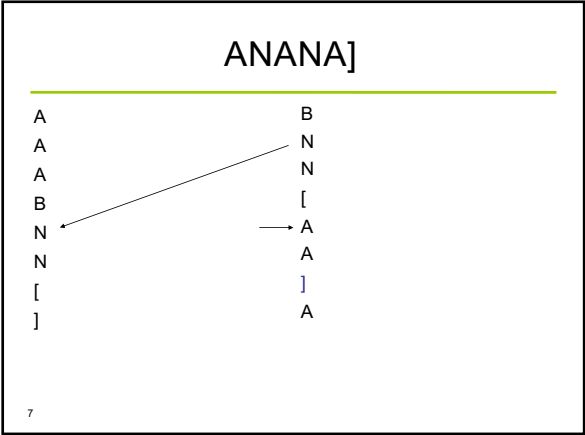


5

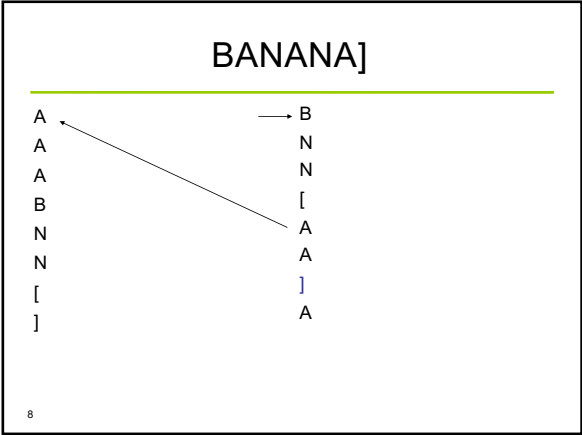
NANA]



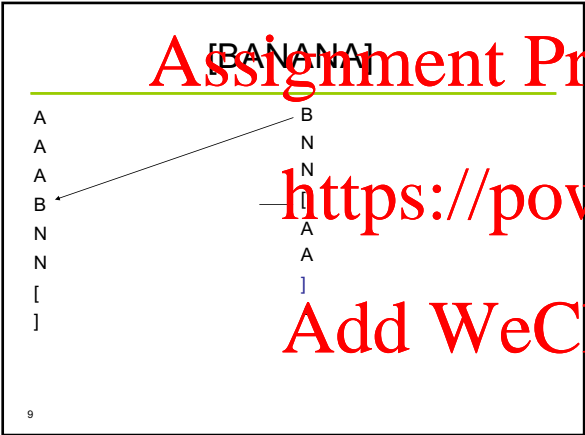
6



7



8



9

Example using C[] & Occ[]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

10

10

???????]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

11

11

???????A]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

12

12

?????NA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

13

13

????ANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

14

14

???NANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	2
N	4
[	6
]	7

15

15

??NANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

16

16

?BANANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

17

17

[BANANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

18

18

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### [BANANA]

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ / Rank

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C [ ]

19

### C[ ] & Occ()

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ(Symbol, Pos)  
=> # Matching

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C[Symbol] =>  
(startPos, endPos)

20

### C[ ] & Occ()

C[Symbol] => (startPos, endPos)  
 Occ(Symbol, Pos) => # Matching

Can these two functions (or tables) be implemented such that they can return the result in constant time ?  
 Yes, have a precomputed table.  
 Can they be precomputed efficiently ?  
 Yes, a single pass.

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### Backward Search for ANA

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ(Symbol, Pos)  
=> # Matching

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C[Symbol] =>  
(startPos, endPos)

22

### Backward Search for NAN

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ(Symbol, Pos)  
=> # Matching

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C[Symbol] =>  
(startPos, endPos)

23

### Backward Search for ANA

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ(Symbol, Pos)  
=> # Matching

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C[Symbol] =>  
(startPos, endPos)

24

### Backward Search for NAN

Position	Symbol	# Matching
0	B	0
1	N	0
2	N	1
3	[	0
4	A	0
5	A	1
6	]	0
7	A	2

Occ(Symbol, Pos) => # Matching

Symbol	# LessThan
A	0
B	3
N	4
[	6
]	7

C[Symbol] => (startPos, endPos)

25

25

### Why not Forward Search: ANA

A	B
A	N
A	N
B	[
N	A
N	A
[	]
]	A

26

26

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