COMP90042
Web search and text analysis

Workshop Week 3

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https://github.com/HanXudong/COMP90042_Workshops

Review

- Inverted index
- TF*IDF
- BM25

Inverted index

	two	tea	me	you
doc1	0.707	0.707	0	0
doc2	0	0.707	0.353	0.353
doc3	0	0	0.707	0.707

- Query 1: Tea me
- Query 2: Two

$$S_{TF-IDF}(d, Q) = \sum_{t\in Q} tf_{d,t} \times log\frac{N}{df_t}$$

two	1: 0.707;
tea	1:0.707; 2: 0.707
me	2: 0.353; 3:0.707
you	2: 0.353; 3:0.707

BM25

$$w_t = log\frac{N - df_t + 0.5}{df_t + 0.5} \times \frac{(K_1 + 1)tf_{d,t}}{k_1((1 - b) + b\frac{L_d}{L_{avg}}) + tf_{d,t}} \times \frac{(k_3 + 1)tf_{q,t}}{k_3 + tf_{q,t}}$$

- Default values：
  k_1 = 1.5
  k_2 = 0.5
  b = 0

This workshop

- Postings list
- Variable Byte Compression
- WAND
- Query expansion
- Relevance feedback

Posting List Compression

Motivations:

- Minimise storage costs
- Fast sequential access
- Support GEQ(x) operation: Return the smallest item in the list that is greater or equal to x

Posting List Compression

Inverted index

the	ids:	25	26	29	…	12345	12347
house	ids:	5213	5234	5454	5591	…	
aeronaut	ids:	251235	251239	251240			

8	10	13	15	18
256	1024	8192	32768	262144

Posting List Compression

the	ids:	25	26	29	…	12345	12347
	gaps:	25	1	3	…	1	2
house	ids:	5213	5234	5454	5591	…	
	gaps:	5213	1	220	137	…	
aeronaut	ids:	251235	251239	251240			
	gaps:	251235	4	1			

Gaps between ids or term frequencies?

Variable Byte Compression

Idea of Variable Byte Compression:

Use variable number of bytes to represent integers. Each byte contains 7 bits “payload” and one continuation bit.

Number	Encoding	
824	00000110	10111000
5	10000101	

Bitwise operators

https://wiki.python.org/moin/BitwiseOperators

The Operators:

- x << y
  Returns x with the bits shifted to the left by y places

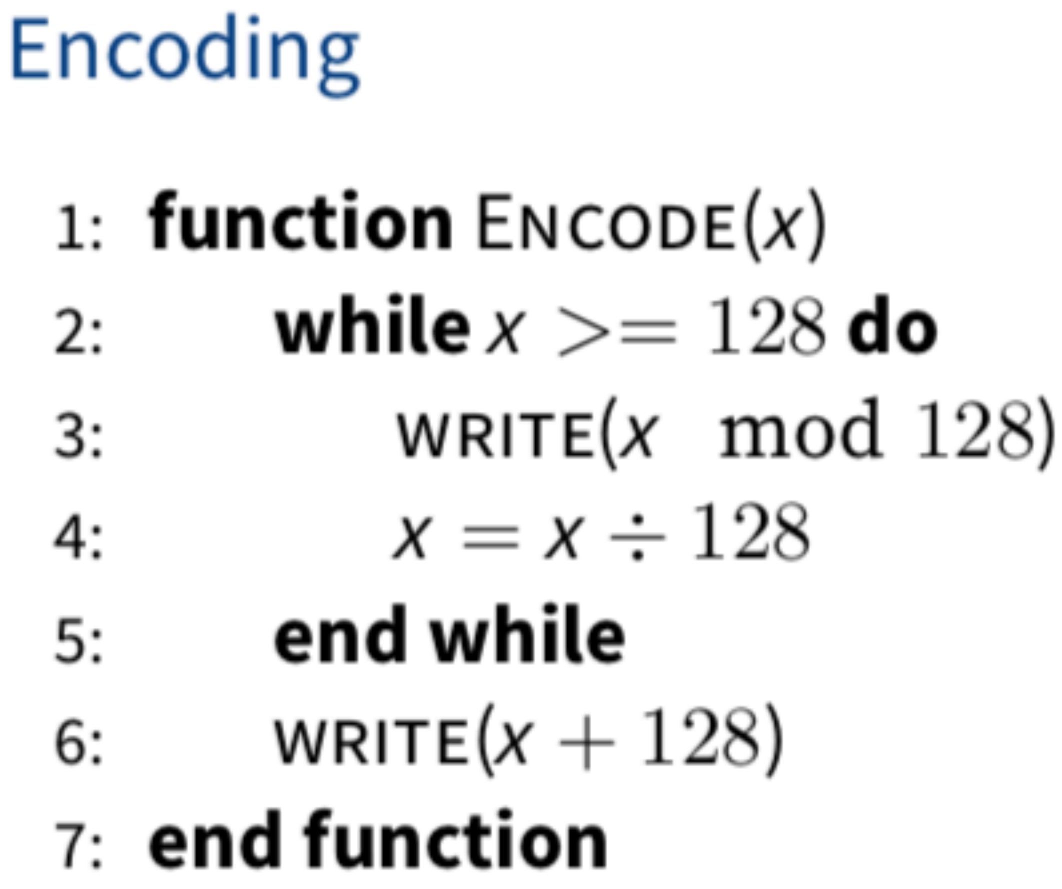
- x >> y
  Returns x with the bits shifted to the right by y places.

- x & y
  Does a "bitwise and".

- x | y
  Does a "bitwise or".

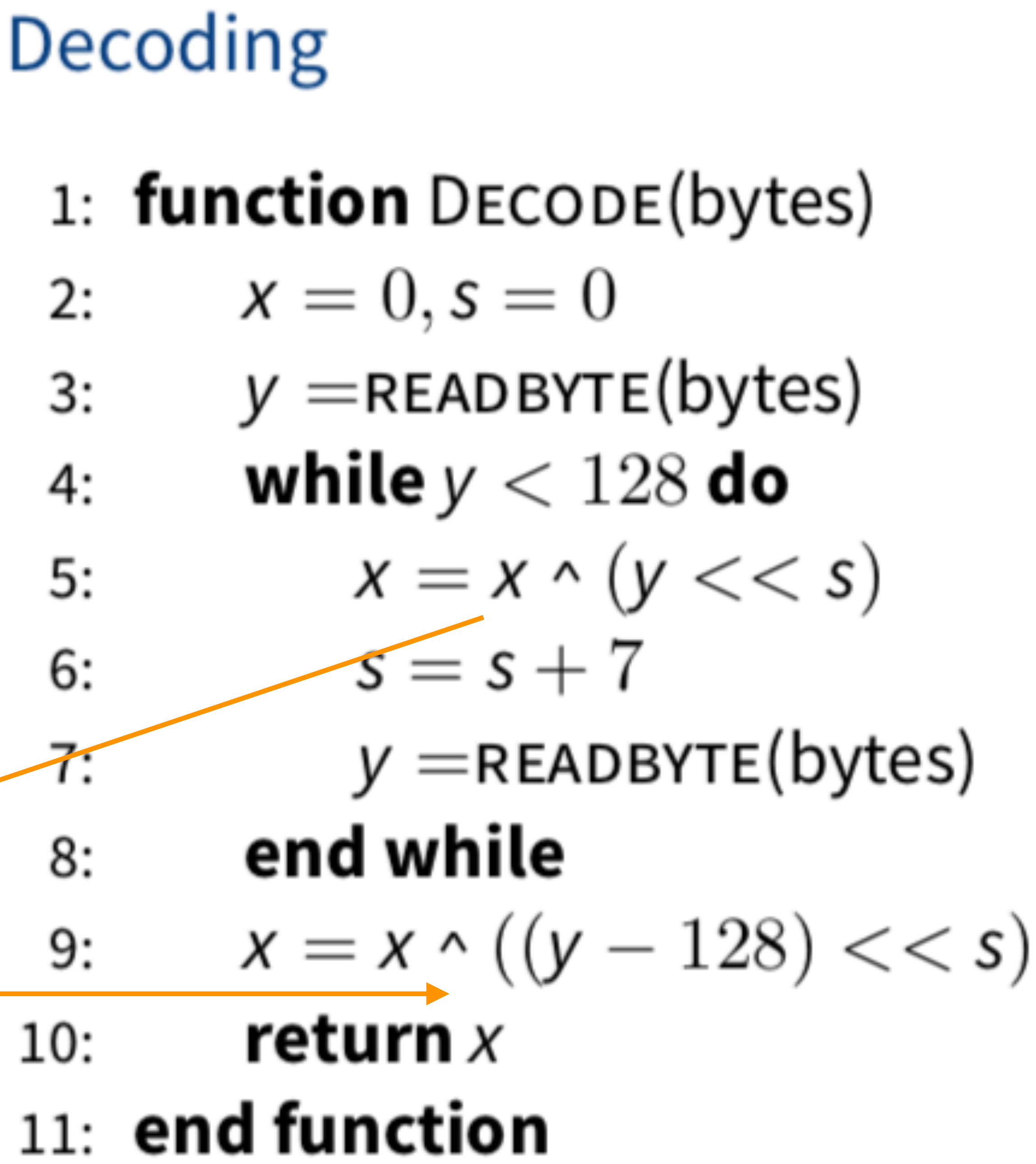
- x ^ y
  Does a "bitwise exclusive or".

Variable Byte Compression



Encoding

```
function ENCODE($x$)
    while $x >= 128$ do
        WRITE($x \mod 128$)
        $x = x \div 128$
    end while
    WRITE($x + 128$)
end function
```



Decoding

```
function DECODE(bytes)
    $x = 0, s = 0$
    $y =$READBYTE(bytes)
    while $y < 128$ do
        $x = x$ ^ $(y << s)$
        $s = s + 7$
        $y =$READBYTE(bytes)
    end while
    $x = x$ ^ $((y - 128) << s)$
    return $x$
end function
```

Q: why do we use “ ^ ”?

Variable Byte Compression

Decoding(Q1-c):

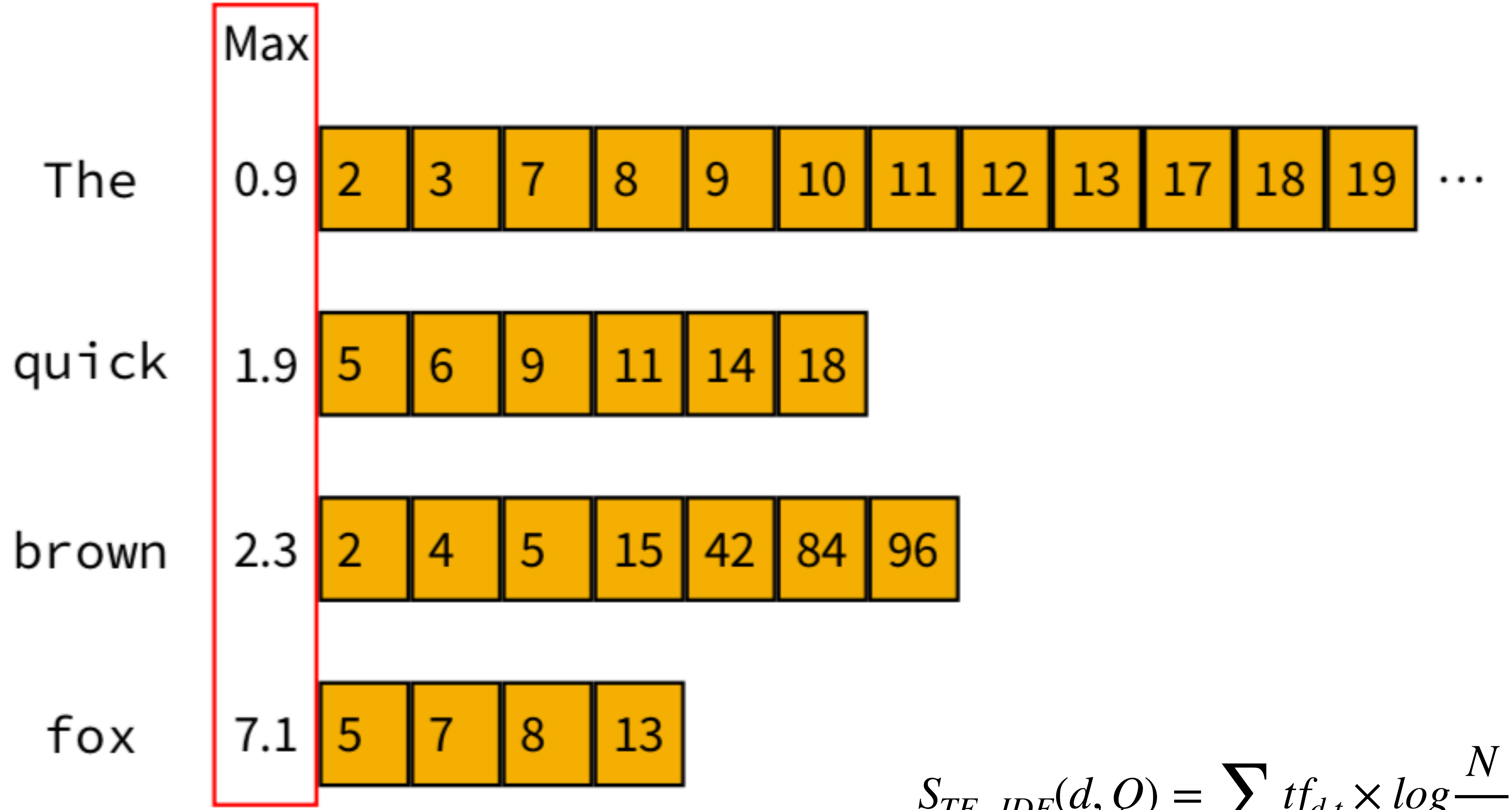
Determine the values of integers X and Y that were encoded as the byte sequence [52,34,147,42,197] using the Variable Byte algorithm described in the lecture slides 9/10.

52	00110100
34	00100010
147	10010011
42	00101010
167	11000101

WAND

- **Top K retrieval**
- **Overestimate**

Query Q: `The quick brown fox` with $k = 2$

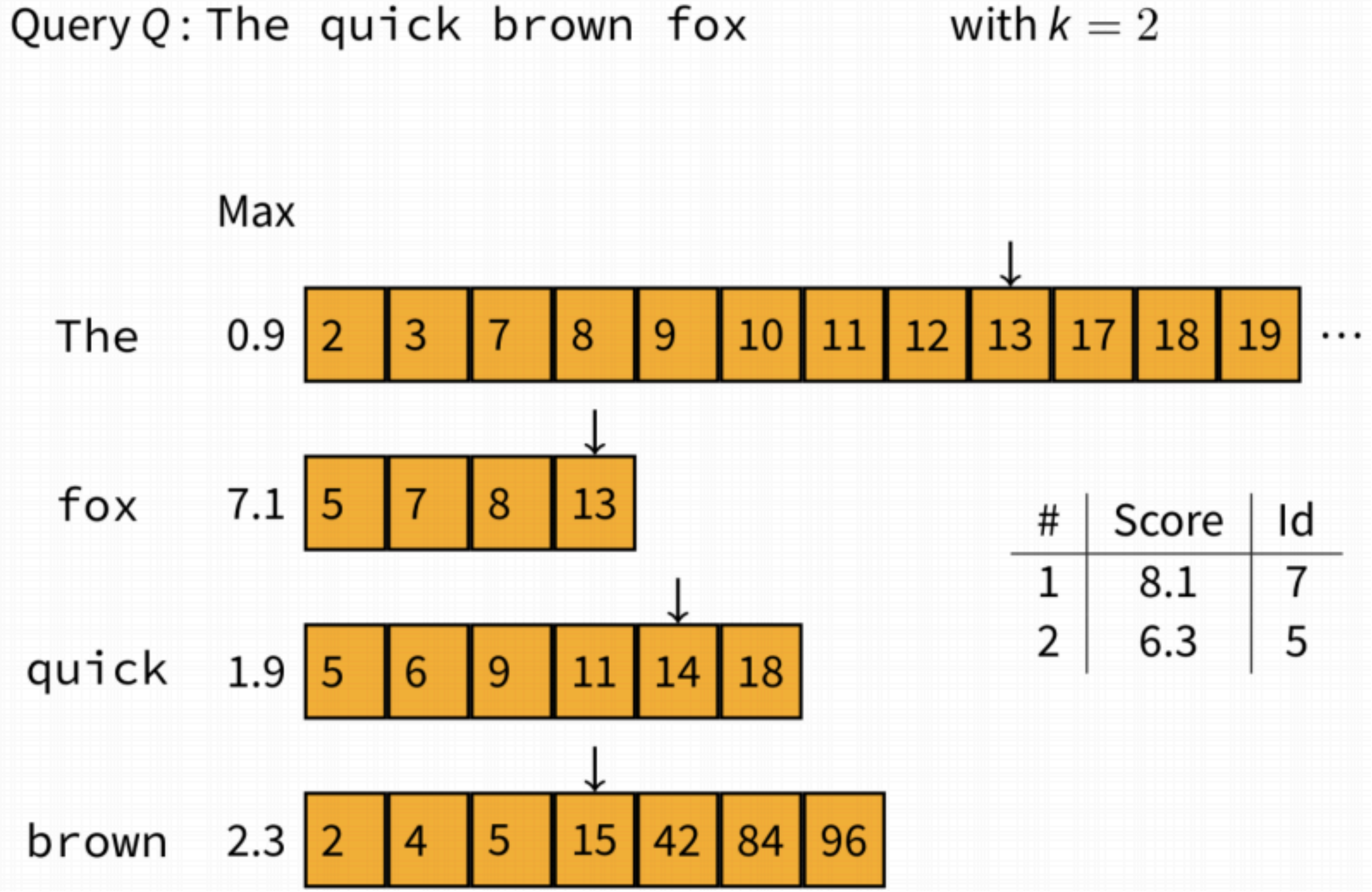


Maximum Contribution for each query term

	Max													
The	0.9	2	3	7	8	9	10	11	12	13	17	18	19	…
quick	1.9	5	6	9	11	14	18							
brown	2.3	2	4	5	15	42	84	96						
fox	7.1	5	7	8	13									

$$S_{TF-IDF}(d, Q) = \sum_{t \in Q} tf_{d,t} \times log \frac{N}{df_t}$$

Assume Document 13 has just been evaluated. In the setting below, what is the next document that will be evaluated?



Query Q: The quick brown fox with $k = 2$

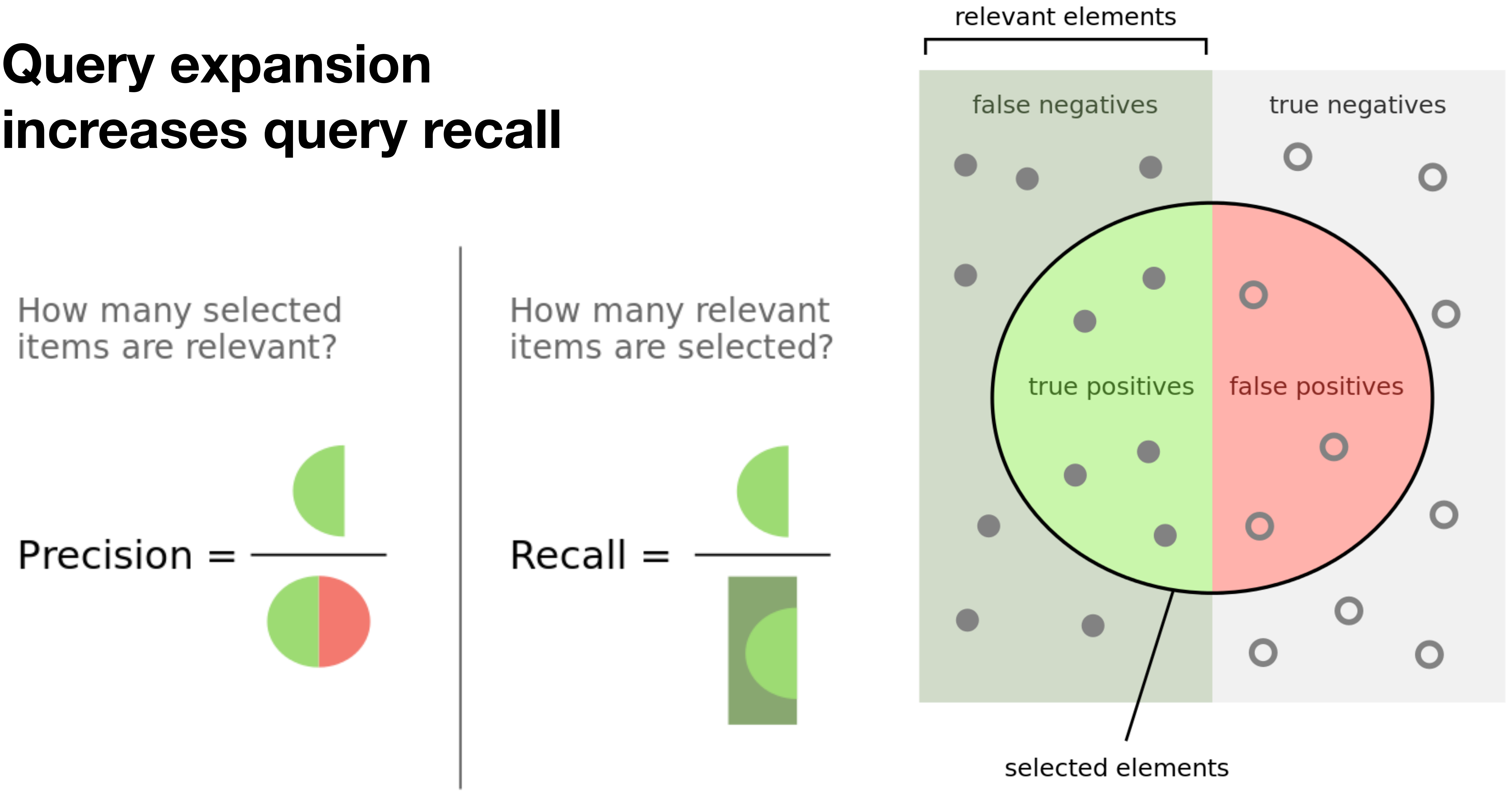
	Max													
The	0.9	2	3	7	8	9	10	11	12	13	17	18	19	⋯
fox	7.1	5	7	8	13									
quick	1.9	5	6	9	11	14	18							
brown	2.3	2	4	5	15	42	84	96						

#	Score	Id
1	8.1	7
2	6.3	5

Query Expansion

Q3

Query expansion increases query recall



relevant elements

false negatives

true negatives

true positives

false positives

selected elements

How many selected items are relevant?

Precision =

How many relevant items are selected?

Recall =

Recall and Precision

- **Documents: [1, 2, 3, 4, 5, … ,99, 100]**
- **Relevance documents: [1, 3, 5, 7, 9]**
- **Prediction 1: [1, 2, 3, 4, 5, 6, 7, 8, 9]**

$$Recall = \frac{5}{5} \quad Precision = \frac{5}{9}$$

- **Prediction 2: [1, 2, 3, 4, 5, … ,99, 100]**

$$Recall = \frac{5}{5} \quad Precision = \frac{5}{100}$$

- **Prediction 3: [1]**

$$Recall = \frac{1}{5} \quad Precision = \frac{1}{1}$$

Relevance Feedback

Q4

A. User relevance feedback
-E.g. ask users to click

B. Pseudo relevance feedback
-E.g. blink feedback

C. Indirect relevance feedback
-E.g. analysis query click logs to re-rank

Relevance Feedback

Q5 query expansion without relevance feedback

WordNet based query expansion

“Improving Query Expansion Using WordNet”

https://arxiv.org/abs/1309.4938