Lecture reviews — Week 11
with solutions

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Week 11 keypoints

- preprocessing & indexing (tokenization, stemming/lemmatization, PoS-tag filtering, stop words, frequencies)
  (we could also add: sentence spliter, NERs, *n*-grams, parsers)
- weightings (desequentialisation): tf, tf-idf
- cosine similarity
- Information Retrieval (what, how)
- Information Retrieval evaluation metrics: P@n, R-P, MAP, P-R curves
- beyond standard vector space model:
  - topic models
  - word embeddings (and modern NLP)

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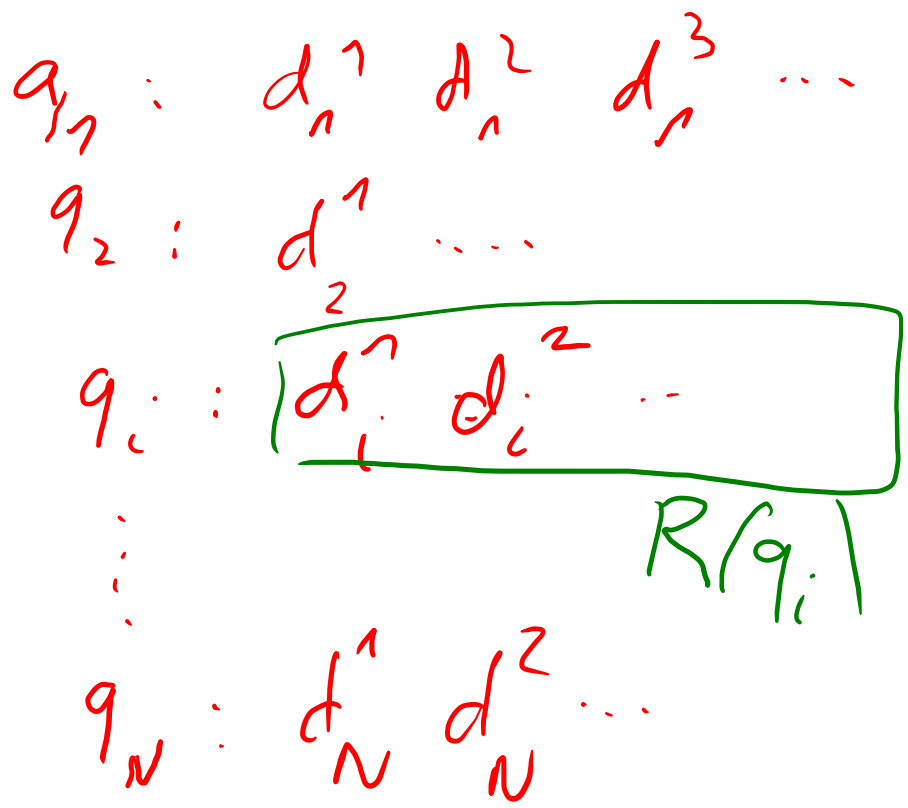


System:

q : 1 d V (Relevant)
2 d'

rank d'' V $\quad P@rank(q) = \frac{nrev}{rank}$

: V

$d^{(n)}$

$$R\text{-}Prec = \frac{1}{N}\sum_{i=1}^{N} P@\underbrace{|R(q_i)|}_{}(q)$$

$$AvgP = \frac{1}{|R(q)|}\underbrace{\sum_{d\in R(q)} P@rank(d)}_{\frac{1}{r_1}+\frac{2}{r_2}+\cdots+\frac{|R(q)|}{r_{\cdots}}}$$

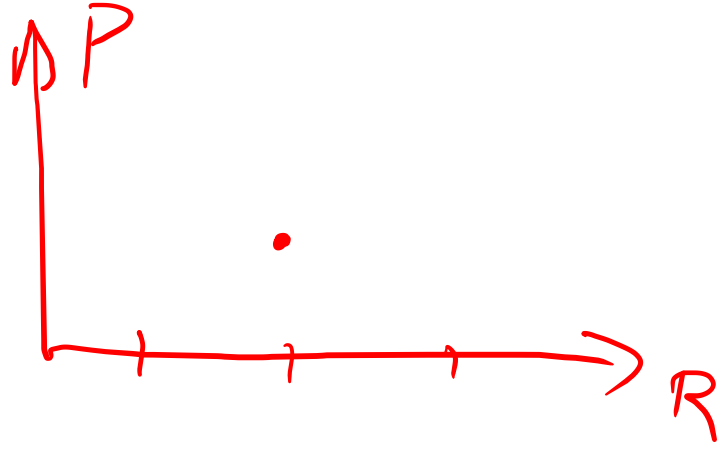
$q: \; a \quad b \quad c$

$R(q) = \{a, b, c\}$

q

S
x
a
z
c

$S(q) = \{x, a, z, c\}$



Week 11 – study case 1

Using tf-idf weightning, what is the cosine similarity between these two "documents":

> *Either the well was very deep, or she fell very slowly, for she had plenty of time as she went down to look about her and to wonder what was going to happen next.*
>
> *Down, down, down. Would the fall* never *come to an end? "I wonder how many miles I've fallen by this time?" she said aloud.*

knowing that, for instance (invent your own if needed), among a corpus of 10'000 documents:

1'000 documents contain "*down*"
1'000 documents contain "*time*"
100 documents contain "*fall*"
100 documents contain "*wonder*"

texts from "Alice's Adventures in Wonderland", Lewis Carroll (1865)

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Week 11 – study case 1

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Week 11 – study case (solution)

After some drastic filtering + normalisation, we could end-up with:

well deep fall slow time go down look wonder happen

down down down fall never come end wonder miles fall time say aloud

Interesting questions:

- *well* (noun): droped by stop-list?
- *fell*, *fallen* $\longrightarrow$ fall?
- *went* $\longrightarrow$ go?
  +keep it or stop list?
  and what about "*going*"? "*was going*"?
- *slowly* $\longrightarrow$ slow?
- *deep* $\longrightarrow$ depth?
- keep *very*? *plenty*? *many*? *next*? *never*?

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Week 11 – study case (solution)

Intersection of the two indexed documents:

down fall time wonder

down (3) fall (2) time wonder

idf: down: 1, fall: 2, time: 1, wonder: 2

d_1: $(1\times 1, \quad 1\times 2, \quad 1\times 1, \quad 1\times 2)$, norm: $\sqrt{10}$
d_2: $(3\times 1, \quad 2\times 2, \quad 1\times 1, \quad 1\times 2)$, norm: $\sqrt{30}$

$$\cos(d_1, d_2) = \frac{16}{\sqrt{10}\sqrt{30}} \simeq 0.9238$$

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Week 11 – study case 2

Compute R, P@5, R-prec, MAP and draw P-R curves for the two systems below

	query q_1		query q_2		query q_3	
	system 1	system 2	system 1	system 2	system 1	system 2
1	✔	✗	✗	✔	✔	✗
2	✗	✔	✔	✔	✔	✗
3	✗	✔	✔	✗	✔	✔
4	✔	✔	✔	✗	✗	✔
5	✔	✗	✔	✔	✔	✔
6	✗	✔	✔	✔	✔	✔
7	✗	✔	✗	✗	✗	✔
8	✔	✔	✔	✔	✔	✔
9	✗	✗	✗	✔	✗	✔
10	✔	✗	✔	✔	✔	✔

knowing that, in the above results, for each query, at least one of the two systems retreived all the relevant documents
(and assume the missing ones are never retreived at a very high rank)

Week 11 – study case 2

$R(q) = \frac{\#\text{correct}}{\text{total correct}}$ $\frac{5}{6}$ $\frac{5}{8}$ $\frac{5}{10}$ $\frac{5}{9}$ $(\frac{3}{5})$

Compute R, P@5, R-prec, MAP and draw P-R curves for the two systems below

query q_1

	system 1	R	system 2	R
1	✔	1	1/6	✗
2	✗		1/6	✔
3	✗		1/6	✔
4	✔		1/6	✔
5	✔		1/6	✗
6	✗		1/6	✔
	✗		1/6	✔
	✔		1/6	✔
	✗		1/6	✗
10	✔		1/6	✗

$R_1(q_1) = \frac{5}{6}$

query q_2

system 1	system 2
✗	✔
✔	✔
✔	✗
✔	✗
✔	✔
✔	✔
✗	✗
✔	✔
✗	✔
✔	✔

query q_3

system 1	system 2
✔	✗
✔	✗
✔	✔
✗	✔
✔	✔
✔	✔
✗	✔
✔	✔
✗	✔
✔	✔

knowing that, in the above results, all relevant documents are retreived by at least one system

for each query, at least one of the two systems retreived all relevant documents

(and assume the missing ones are never retreived (retrieved a very high rank))

Week 11 – study case 2

avg : $\frac{1}{3}\left(\frac{3}{6}+\frac{5}{7}+\frac{6}{8}\right)$

Compute R, P@5, R-prec, MAP and draw P-R curves for the two systems below

P	query q_1 system 1	R	query q_1 system 2	query q_2 system 1	query q_2 system 2	query q_3 system 1	query q_3 system 2
1/1	✔	1/6	✗	✗	✔	✔	✗
1/2	✗	1/6	✔	✔	✔	✔	✗
1/3	✗	1/6	✔	✔	✗	✔	✔
2/4	✔	2/6	✔	✔	✗	✗	✔
3/5	✔	3/6	✗	✔	✔	✔	✔
3/6	✗	3/6	✔	✔	✔	✔	✔
3/7	✗	3/6	✔	5/7 ✗	✗	✗	✔
4/8	✔	4/6	✔	✔	✔	6/8 ✔	✔
4/9	✗	4/6	✗	✗	✔	✗	✔
5/10	✔	5/6	✗	✔	✔	✔	✔

knowing that, in the above results, all relevant documents are retreived by at least one system
(and assume the missing ones are never retreived (retrieved a very high rank))

Week 11 – study case 2

$Avg P_{s_1}(q_1) = \frac{1}{6}(P_{@1} + P_{@4} + P_{@5} + P_{@8} + P_{@10})$

Compute R, P@5, R-prec, MAP and draw P-R curves for the two systems below

mean: $\frac{1}{3}(Avg P(q_1) + Avg P(q_2) + Avg P(q_3))$

query q_1				query q_2		query q_3	
		system 1	system 2	system 1	system 2	system 1	system 2
$P_{@1}$ ←	1	✔ 1/1	✗	✗	✔	✔	✗
	2	✗	✔	✔	✔	✔	✗
	3	✗	✔	✔	✗	✔	✔
$P_{@4}$ ←	4	✔ 2/4	✔	✔	✗	✗	✔
$P_{@5}$ ←	5	✔ 3/5	✗	✔	✔	✔	✔
	6	✗	✔	✔	✔	✔	✔
	7	✗	✔	✗	✗	✗	✔
$P_{@8}$ ←	8	✔ 4/8	✔	✔	✔	✔	✔
	9	✗	✗	✗	✔	✗	✔
$P_{@10}$ ←	10	✔ 5/10	✗	✔	✔	✔	✔

knowing that, in the above results, all relevant documents are retreived by at least one system

(and assume the missing ones are never retreived (retrieved a very high rank))

Week 11 – study case 2 (solution)

query q_1

	system 1 P	system 1 R		system 2 P	system 2 R
✔	1/1	1/6	✗	0/1	0/6
✗	1/2	1/6	✔	1/2	1/6
✗	1/3	1/6	✔	2/3	2/6
✔	2/4	2/6	✔	3/4	3/6
✔	3/5	3/6	✗	3/5	3/6
✗	3/6	3/6	✔	4/6	4/6
✗	3/7	3/6	✔	5/7	5/6
✔	4/8	4/6	✔	6/8	6/6
✗	4/9	4/6	✗	6/9	6/6
✔	5/10	5/6	✗	6/10	6/6
R-P	3/6			4/6	
AvgP	0.52			0.67	

query q_2

	system 1 P	system 1 R		system 2 P	system 2 R
✗	0/1	0/7	✔	1/1	1/7
✔	1/2	1/7	✔	2/2	2/7
✔	2/3	2/7	✗	2/3	2/7
✔	3/4	3/7	✗	2/4	2/7
✔	4/5	4/7	✔	3/5	3/7
✔	5/6	5/7	✔	4/6	4/7
✗	5/7	5/7	✗	4/7	4/7
✔	6/8	6/7	✔	5/8	5/7
✗	6/9	6/7	✔	6/9	6/7
✔	7/10	7/7	✔	7/10	7/7
R-P	5/7			4/7	
AvgP	0.71			0.75	

query q_3

	system 1 P	system 1 R		system 2 P	system 2 R
✔	1/1	1/8	✗	0/1	0/8
✔	2/2	2/8	✗	0/2	0/8
✔	3/3	3/8	✔	1/3	1/8
✗	3/4	3/8	✔	2/4	2/8
✔	4/5	4/8	✔	3/5	3/8
✔	5/6	5/8	✔	4/6	4/8
✗	5/7	5/8	✔	5/7	5/8
✔	6/8	6/8	✔	6/8	6/8
✗	6/9	6/8	✔	7/9	7/8
✔	7/10	7/8	✔	8/10	8/8
R-P	6/8			6/8	
AvgP	0.76			0.64	

$$\text{R-Prec}_1 = \frac{1}{3}\left(\frac{3}{6} + \frac{5}{7} + \frac{6}{8}\right) \simeq 0.65$$

$$\text{AvgP}_1(q_1) = \frac{1}{6}\left(1 + \frac{2}{4} + \frac{3}{5} + \frac{4}{8} + \frac{5}{10}\right) \simeq 0.517$$

$$\text{MAP}_1 \simeq 0.66$$

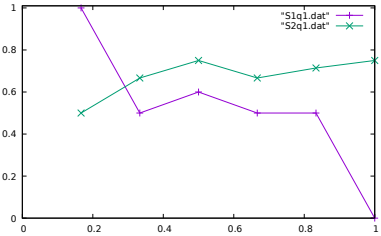
$$\text{R-Prec}_2 = \frac{1}{3}\left(\frac{4}{6} + \frac{4}{7} + \frac{6}{8}\right) \simeq 0.66$$

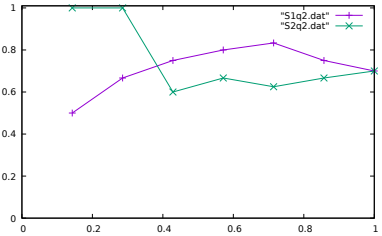
$$\text{AvgP}_2(q_1) = \frac{1}{6}\left(\frac{1}{2} + \frac{2}{3} + \frac{3}{4} + \frac{4}{6} + \frac{5}{7} + \frac{6}{8}\right) \simeq 0.675$$

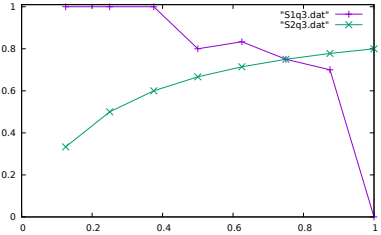
$$\text{MAP}_2 \simeq 0.69$$

Week 11 – study case 2 (solution)

raw plots for each query:







in practice: some averaging and some filtering (keep only max Prec) is done to ensure monotically decreasing (or constant) curves