NLP - 문서 요약

Index

Document Summarization

문서 요약

문서 요약 (Document Summarization)

- 문서 요약은 문서에서 중요한 문장을 자동으로 추출하는 과정
- 중요한 문장을 추출한다 → 문장의 중요성을 어떻게 판단할 것인가

문서 요약 방법

- 추상적 요약 (Abstractive Summarization)
  - 문서를 의미적으로 이해한 것을 바탕으로 요약
  - 요약 문장에 문서에서 언급되지 않는 단어가 등장하기도 함
  - 추상적 요약은 "문서 > 문맥의 이해 > 의미 추출 > 요약 생성"의 과정으로 진행
  - 사람이 문서를 읽고 해석하여 자신의 단어로 표현하여 요약하는 것과 같은 맥락

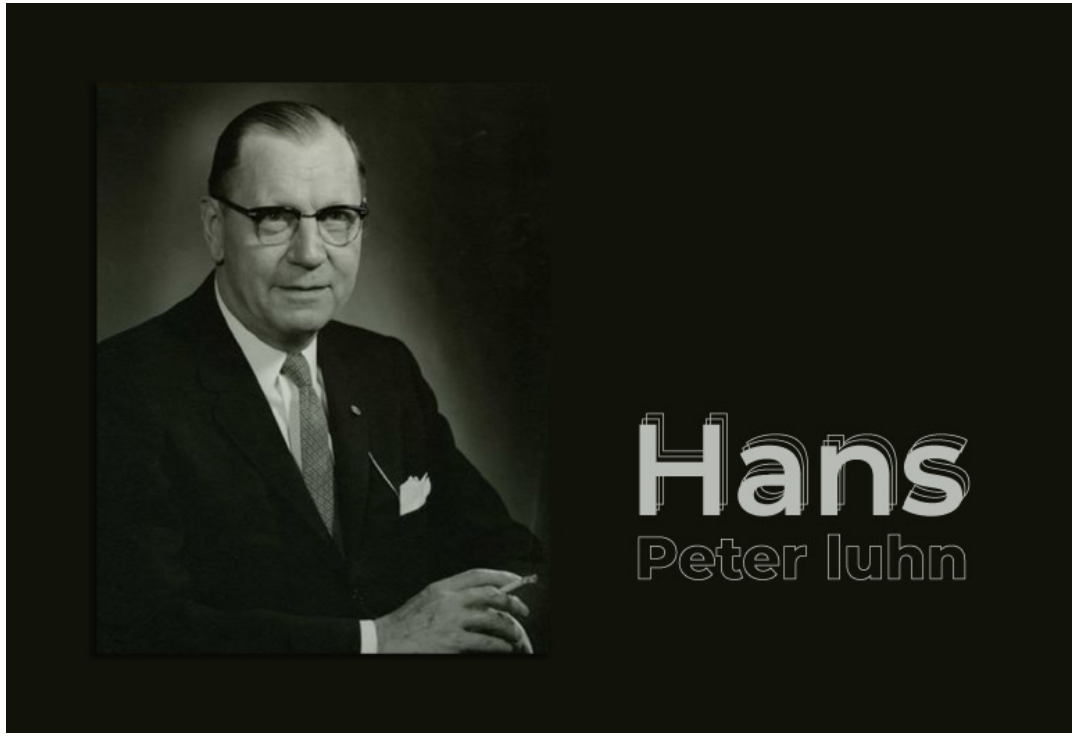
- 추출 요약 (Extractive Summarization)
  - 문장별로 중요도를 계산하여 요약
  - 추출 요약은 "문서 > 문장 중요도 계산 > 순위 높은 문장 선택"의 과정으로 진행
  - 추상적 요약이 더 좋은 결과를 제공해줄 것이라는 예상을 할 수 있지만 추출 요약이 더 나은 결과를 제공하기도 함
  - 추상적 요약은 의미 이해, 추론, 자연어 생성과정의 어려움이 있다.

Luhn Summarize

Luhn Summarize

Hans Peter Luhn

- 정보 검색의 아버지
- 표제어가 문맥에 포함된 채 배열된 색인(KWIC : keyword-in-context) 개발, 정보 선택 제공(SDI), 완전 텍스트 프로세싱, 자동 발췌(요약), 단어 시소러스의 최초 현대식 사용으로 신뢰를 얻었다.



Luhn Summarize 개요

- The justification of **measuring word significance by use frequency** is based on the fact that a **writer normally repeats certain words** as he advances or varies his arguments and as he elaborates on an aspect of a subject. This means of emphasis is taken as an indicator of significance. The more often certain words are found in each other's company within a sentence, the more significance may be attributed to each of these words.

- 단어의 중요도는 사용 빈도로 측정
- 작가는 중요한 단어를 반복해서 사용한다는 사실에 기반함

중요 단어 (Significant Words)

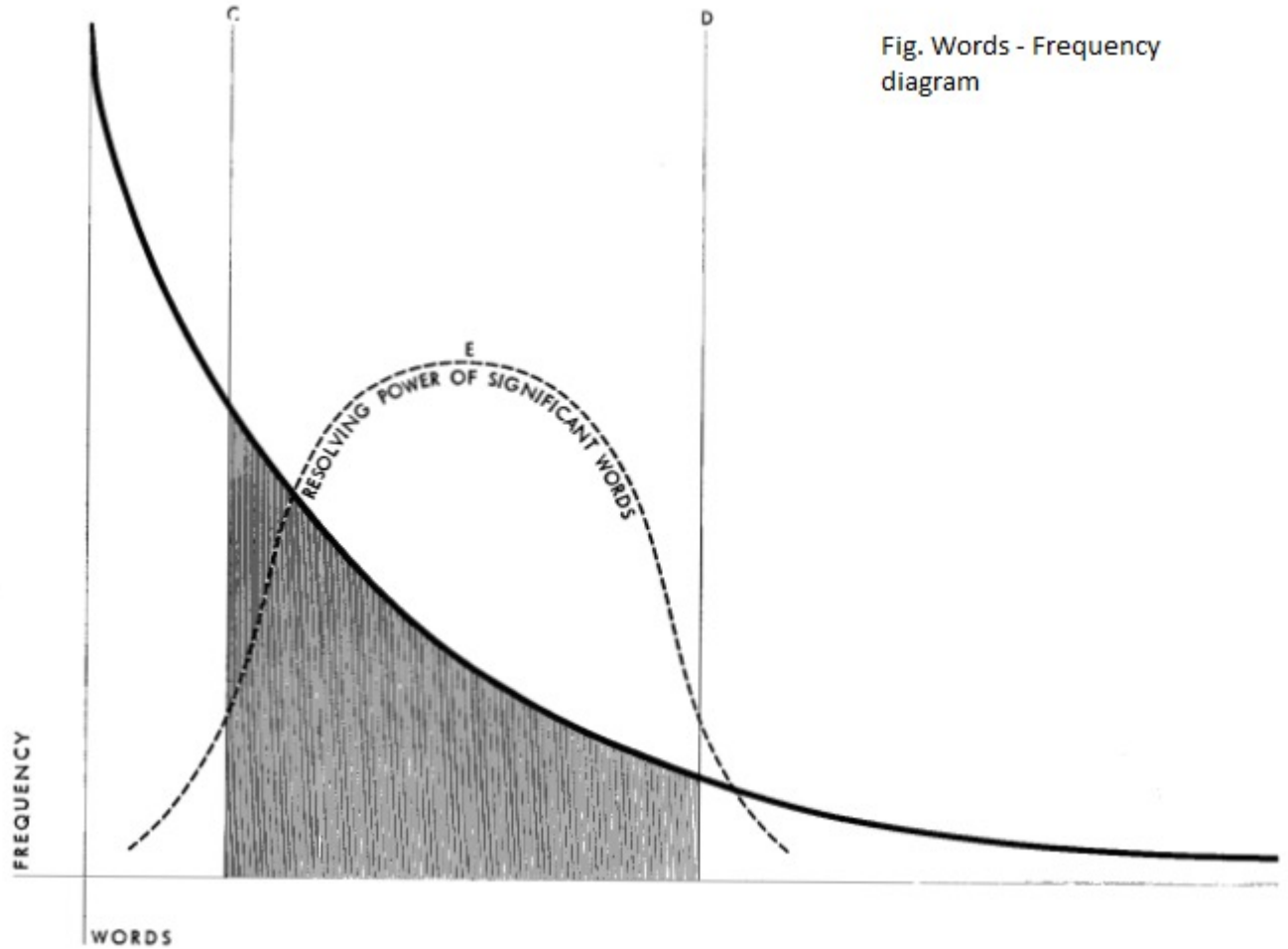
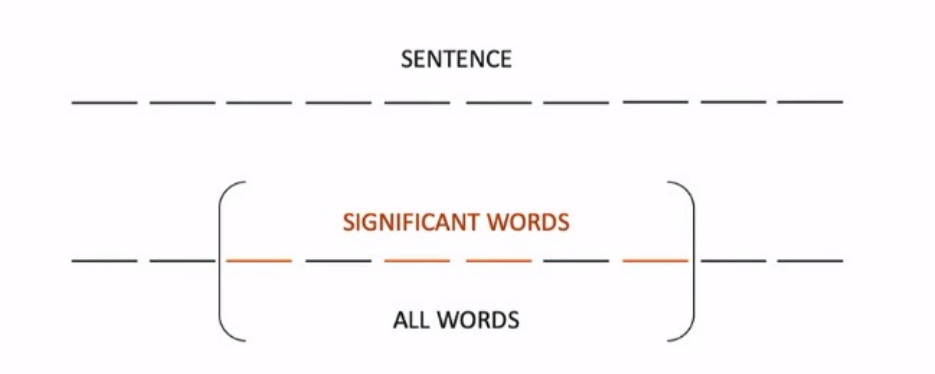


Fig. Words - Frequency diagram

문장 중요도 (Significance factor)

- 문장 중요도
  - 중요 단어를 포함하는 경우
  - 중요 단어가 등장하는 처음과 끝 사이 단어들 중 중요단어의 상대 비율
  - 예시: 중요단어 4개, 윈도내 단어 6개 = $4^2/6 = 2.667$

$$\text{문장 중요도} = \frac{\text{윈도내 포함된 중요단어 개수}^2}{\text{윈도내 포함된 단어갯수}}$$



Luhn Summarize 절차

TextRank

TextRank

4. Sentence Extraction

– The other TextRank application that we investigate consists of sentence extraction for automatic summarization. In a way, the problem of sentence extraction can be regarded as similar to keyword extraction, since both applications aim at identifying sequences that are more "representative" for the given text. In keyword extraction, the candidate text units consist of words or phrases, whereas in sentence extraction, we deal with entire sentences. TextRank turns out to be well suited for this type of applications, since it allows for a ranking over text units that is recursively computed based on information drawn from the entire text.

– 문장을 추출하는 것은 키워드 추출과 유사
– 두 방법(키워드 추출, 문장 추출) 모두 텍스트를 대표하는 (representative) 시퀀스를 식별하는 것을 목표로 함

4.1 TextRank for Sentence Extraction

– The co-occurrence relation used for keyword extraction cannot be applied here, since the text units in consideration are significantly larger than one or few words, and "co-occurrence" is not a meaningful relation for such large contexts. Instead, we are defining a different relation, which determines a connection between two sentences if there is a "similarity" relation between them, where "similarity" is measured as a function of their content overlap. Such a relation between two sentences can be seen as a process of "recommendation"

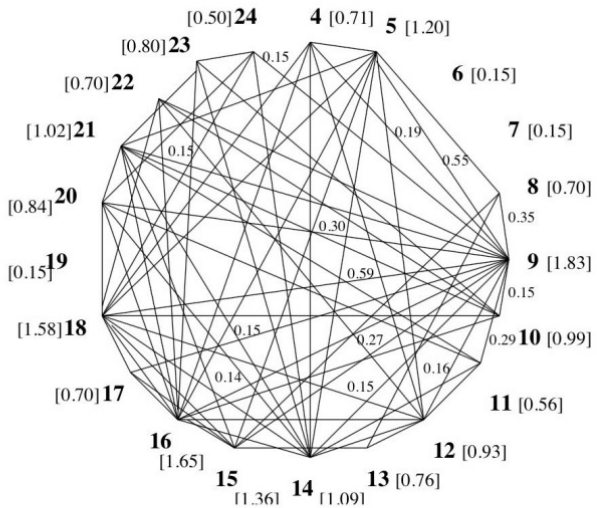
$$Similarity(S_i, S_j) = \frac{|\{w_k | w_k \in S_i \& w_k \in S_j\}|}{log(|S_i|) + log(|S_j|)}$$

– The resulting graph is highly connected, with a weight associated with each edge, indicating the strength of the connections established between various sentence pairs in the text. The text is therefore represented as a weighted graph…After the ranking algorithm is run on the graph, sentences are sorted in reversed order of their score, and the top ranked sentences are selected for inclusion in the summary.

– 문장 내 co-occurrence에 기반한 관계 정의는 적용할 수 없음 (문장이기 때문에)
– 문장 간 "유사성"이 있는 경우 connection 있다고 정의. 유사성은 content overlap 함수로 측정
– 텍스트 내 다양한 문장 사이의 관계 강도가 결정되고, 이를 역순으로 정렬하여 텍스트를 요약

4.1 TextRank for Sentence Extraction

3: BC–HurricaineGilbert, 09–11 339
4: BC–Hurricaine Gilbert, 0348
5: Hurricaine Gilbert heads toward Dominican Coast
6: By Ruddy Gonzalez
7: Associated Press Writer
8: Santo Domingo, Dominican Republic (AP)
9: Hurricaine Gilbert Swept towrd the Dominican Republic Sunday, and the Civil Defense alerted its heavily populated south coast to prepare for high winds, heavy rains, and high seas.
10: The storm was approaching from the southeast with sustained winds of 75 mph gusting to 92 mph.
11: "There is no need for alarm," Civil Defense Director Eugenio Cabral said in a television alert shortly after midnight Saturday.
12: Cabral said residents of the province of Barahona should closely follow Gilbert's movement.
13: An estimated 100,000 people live in the province, including 70,000 in the city of Barahona, about 125 miles west of Santo Domingo.
14. Tropical storm Gilbert formed in the eastern Carribean and strenghtened into a hurricaine Saturday night.
15: The National Hurricaine Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo.
16: The National Weather Service in San Juan, Puerto Rico, said Gilbert was moving westard at 15 mph with a "broad area of cloudiness and heavy weather" rotating around the center of the storm.
17. The weather service issued a flash flood watch for Puerto Rico and the Virgin Islands until at least 6 p.m. Sunday.
18: Strong winds associated with the Gilbert brought coastal flooding, strong southeast winds, and up to 12 feet to Puerto Rico's south coast.
19: There were no reports on casualties.
20: San Juan, on the north coast, had heavy rains and gusts Saturday, but they subsided during the night.
21: On Saturday, Hurricane Florence was downgraded to a tropical storm, and its remnants pushed inland from the U.S. Gulf Coast.
22: Residents returned home, happy to find little damage from 90 mph winds and sheets of rain.
23: Florence, the sixth named storm of the 1988 Atlantic storm season, was the second hurricane.
24: The first, Debby, reached minimal hurricane strength briefly before hitting the Mexican coast last month.



TextRank extractive summary
Hurricane Gilbert swept toward the Dominican Republic Sunday, and the Civil De–fense alerted its heavily populated south coast to prepare for high winds, heavy rains and high seas. The National Hurricane Center in Miami reported its position at 2 a.m. Sunday at latitude 16.1 north, longitude 67.5 west, about 140 miles south of Ponce, Puerto Rico, and 200 miles southeast of Santo Domingo. The National Weather Service in San Juan, Puerto Rico, said Gilbert was moving westward at 15 mph with a "broad area of cloudiness and heavy weather" rotating around the center of the storm. Strong winds associated with Gilbert brought coastal flooding, strong southeast winds and up to 12 feet to Puerto Rico's south coast.

Manual abstract I
Hurricane Gilbert is moving toward the Dominican Republic, where the residents of the south coast, especially the Barahona Province, have been alerted to prepare for heavy rains, and high wind and seas. Tropical storm Gilbert formed in the eastern Carribean and became a hurricane on Saturday night. By 2 a.m. Sunday it was about 200 miles southeast of Santo Domingo and moving westward at 15 mph with winds of 75 mph. Flooding is expected in Puerto Rico and in the Virgin Islands. The second hurricane of the season, Florence, is now over the southern United States and down–graded to a tropical storm.

Manual abstract II
Tropical storm Gilbert in the eastern Carribean strenghtened into a hurricane Saturday night. The National Hurricane Center in Miami reported its position at 2 a.m. Sunday to be about 140 miles south of Puerto Rico and 200 miles southeast of Santo Domingo. It is moving westward at 15 mph with a broad area of cloudiness and heavy weather with sustained winds of 75 mph gusting to 92 mph. The Dominican Republic's Civil Defense alerted that country's heavily populated south coast and the National Weather Service in San Juan, Puerto Rico issued a flood watch for Puerto Rico and the Virgin Islands until at least 6 p.m. Sunday.

5 Why TextRank Works

– Intuitively, TextRank works well because it does not only rely on the local context of a text unit (vertex), but rather it takes into account information recursively drawn from the entire text (graph) ··· The sentences that are highly recommended by other sentences in the text are likely to be more informative for the given text, and will be therefore given a higher score··· Through its iterative mechanism, TextRank goes beyond simple graph connectivity, and it is able to score text units based also on the "importance" of other text units they link to. The text units selected by TextRank for a given application are the ones most recommended by related text units in the text, with preference given to the recommendations made by most influential ones, i.e. the ones that are in turn highly recommended by other related units. The underlying hypothesis is that in a cohesive text fragment, related text units tend to form a "Web" of connections that approximates the model humans build about a given context in the process of discourse understanding.

– 텍스트 단위(버텍스)의 로컬 컨텍스트를 고려할 뿐만 아니라, 전체 텍스트(그래프)에서 재귀적으로 정보를 고려하기 때문에 Textrank가 잘 작동
– 링크하는 다른 텍스트 단위의 "중요성"을 바탕으로 텍스트 단위를 평가

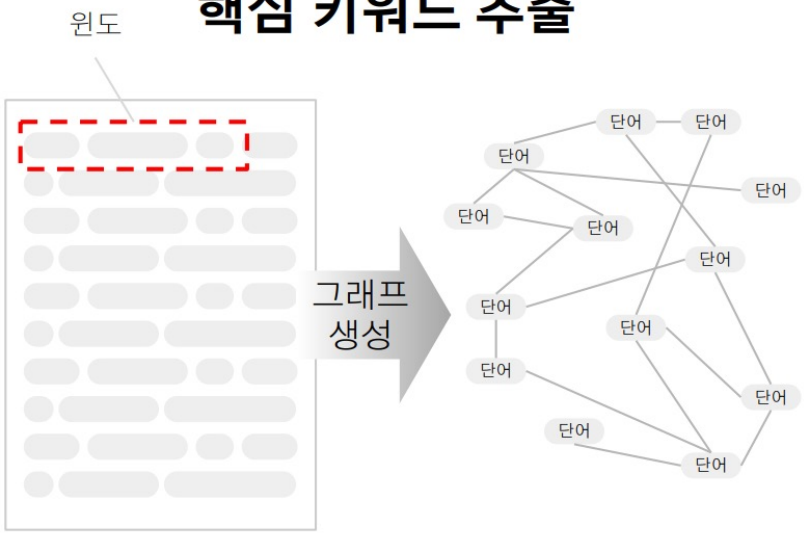
6 Conclusions

– In this paper, we introduced TextRank – a graph- based ranking model for text processing, and show how it can be successfully used for natural language applications. In particular, we proposed and evaluated two innovative unsupervised approaches for keyword and sentence extraction, and showed that the accuracy achieved by TextRank in these applications is competitive with that of previously proposed state-of-the-art algorithms. An important aspect of TextRank is that it does not require deep linguistic knowledge, nor domain or language specific annotated corpora, which makes it highly portable to other domains, genres, or languages.

– Textrank는 깊은 언어 지식이나 도메인 별 corpora를 필요로 하지 않고, 다른 도메인, 장르, 언어에 적용할 수 있음

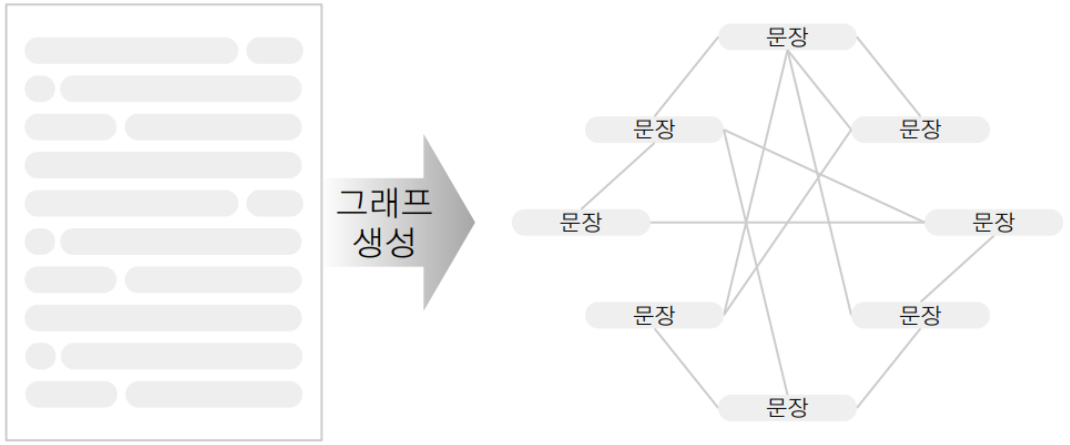
키워드 추출 vs 문서요약

핵심 키워드 추출



윈도가 이동하며
그래프 생성

문서 요약



모든 문장간 유사도를 기준으로
그래프 생성

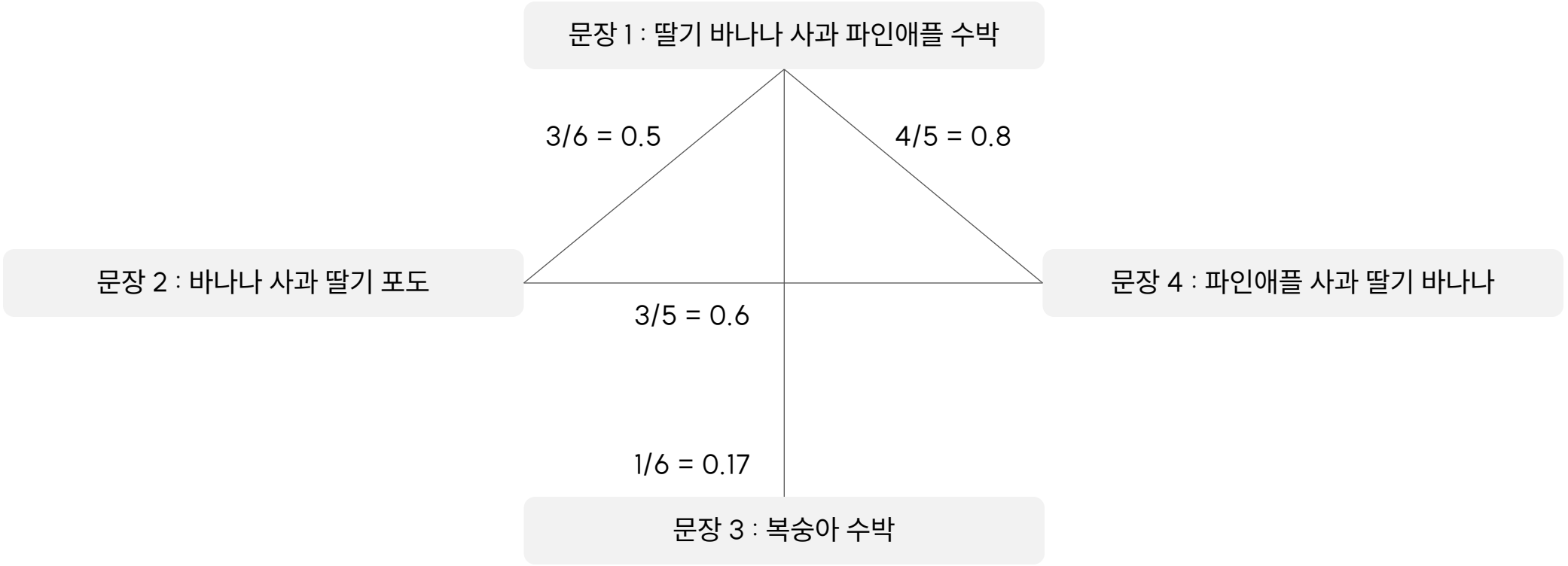
Textrank 과정 : 그래프 생성

딸기 바나나 사과 파인애플 수박. 바나나 사과 딸기 포도. 복숭아 수박. 파인애플 사과 딸기 바나나.

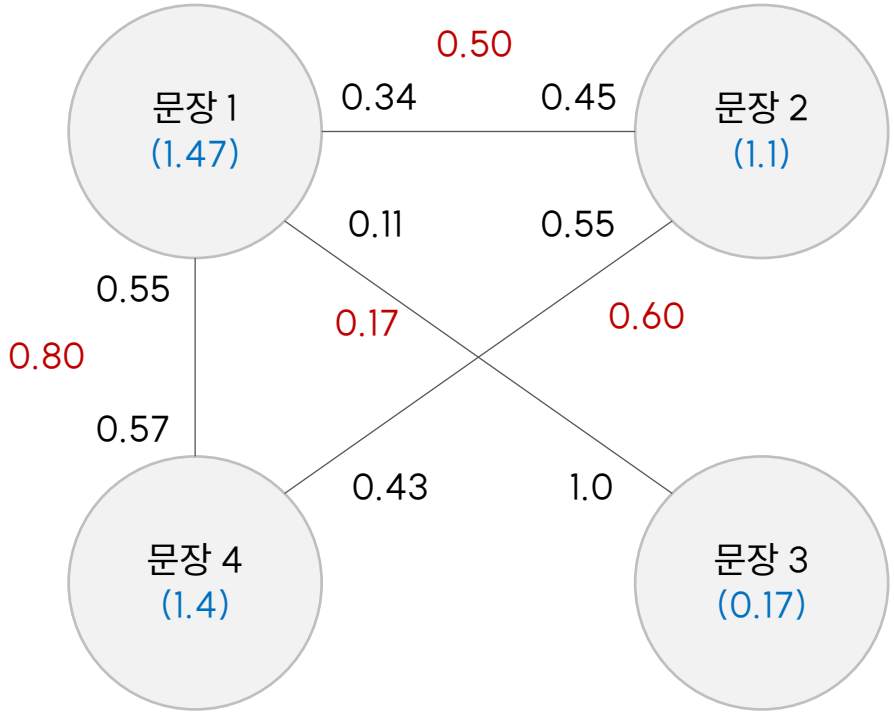
문장 토큰화

문장 1 : 딸기 바나나 사과 파인애플 수박
문장 2 : 바나나 사과 딸기 포도
문장 3 : 복숭아 수박
문장 4 : 파인애플 사과 딸기 바나나

Textrank 과정 : 그래프 생성



Textrank 과정 : 그래프 생성



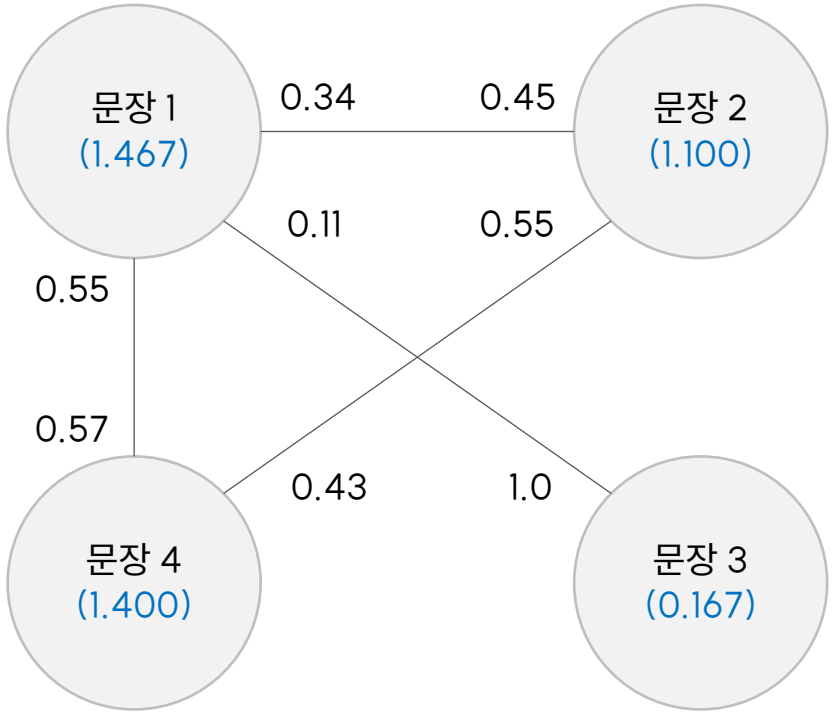
문장간 유사도

문장 1 – 문장 2	0.50
문장 1 – 문장 3	0.17
문장 1 – 문장 4	0.80
문장 2 – 문장 4	0.60

엣지 가중치

	문장1	문장2	문장3	문장4
문장1	0.00	0.34	0.11	0.55
문장2	0.45	0.00	0.00	0.55
문장3	1.00	0.00	0.00	0.00
문장4	0.57	0.43	0.00	0.00

Textrank 과정 : 행렬로 계산하기



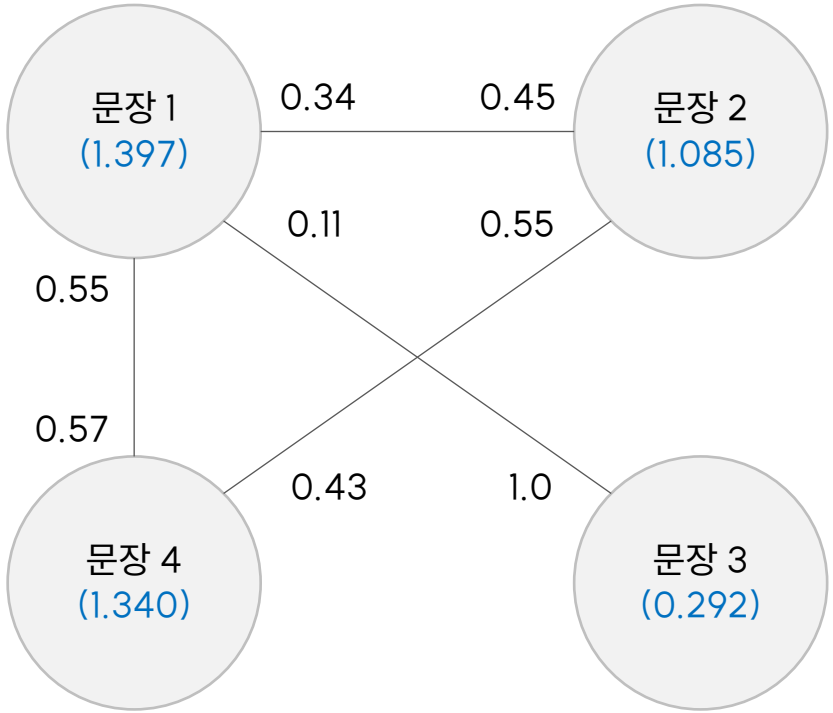
노드	최초 스코어
문장1	1.467
문장2	1.100
문장3	0.167
문장4	1.400

	문장1	문장2	문장3	문장4
문장1	0.000	0.500	0.167	0.800
문장2	0.500	0.000	0.000	0.600
문장3	0.167	0.000	0.000	0.000
문장4	0.800	0.600	0.000	0.000

- 스코어 계산

S(문장1) = (1-0.85) + 0.85 x (0.5 + 0.167+0.8) = 1.397
S(문장2) = (1-0.85) + 0.85 x (0.5 + 0.6) = 1.085
S(문장3) = (1-0.85) + 0.85 x (0.167) = 0.292
S(문장4) = (1-0.85) + 0.85 x (0.8+0.6) = 1.340

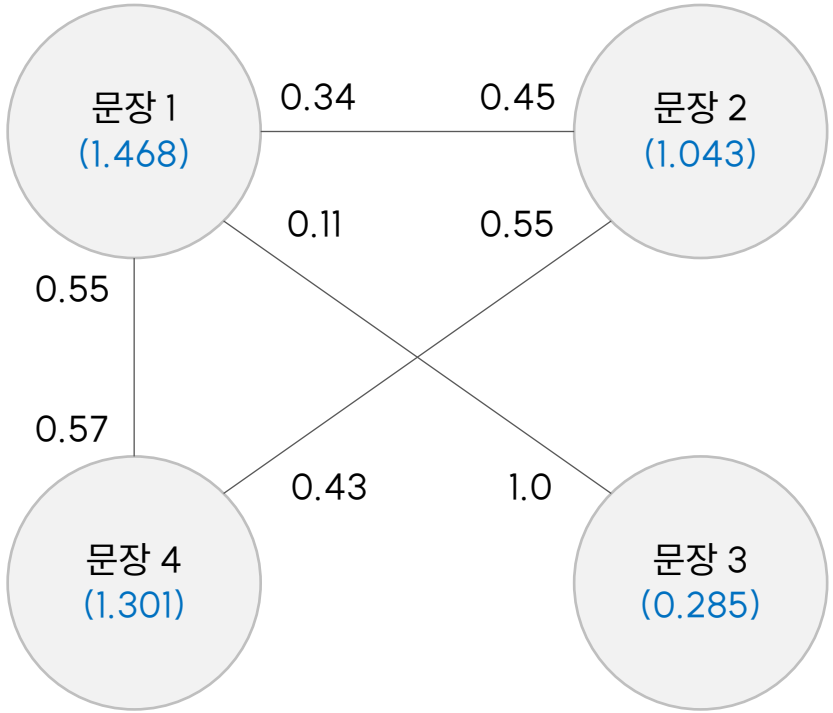
Textrank 과정 : 행렬로 계산하기



노드	이전 스코어	현 스코어
문장1	1.397	1.468
문장2	1.085	1.043
문장3	0.292	0.285
문장4	1.340	1.301

	문장1	문장2	문장3	문장4
문장1	0.000	0.476	0.159	0.762
문장2	0.493	0.000	0.000	0.592
문장3	0.292	0.000	0.000	0.000
문장4	0.766	0.574	0.000	0.000

Textrank 과정 : 행렬로 계산하기



노드	이전 스코어	현 스코어
문장1	1.468	1.427
문장2	1.043	1.049
문장3	0.285	0.292
문장4	1.301	1.314

	문장1	문장2	문장3	문장4
문장1	0.000	0.500	0.167	0.801
문장2	0.474	0.000	0.000	0.569
문장3	0.285	0.000	0.000	0.000
문장4	0.743	0.557	0.000	0.000

Textrank 과정 : 계산 완료