Linear Text Segmentation with Neural OIE on Novels and Subtitles

Olena Mashkina

Do Androids Dream of Text Segmentation?

MAN HAS MADE HIS MATCH . . . NOW IT'S HIS PROBLEM
HARRISON FORD
BLADE RUNNER
DO ANDROIDS DREAM OF ELECTRIC SHEEP?
PHILIP K. DICK

Outline

1. Related work
2. Dataset
3. Research questions
4. Method
5. Results

Related work

Linear text segmentation

algorithm	publication year	supervised	similarity-based	generative	key features
TextTiling	1997	no	✓		lexical co-occurance
C99	2000	no	✓		ranking matrix, divisive hierarchical clustering
U00	2001	no		✓	minimum cost segmentation, dynamic programming
LCSeg	2003	no	✓		TextTiling-based, lexical chains
Sun et al.	2007	no		✓	mutual information, dynamic programming
BayesSeg	2008	no		✓	Bayesian framework, incorporating cue phrases, dynamic programming
TopicTiling	2012	yes		✓	LDA-based
GraphSeg	2016	no	✓		semantic relatedness graph, word embeddings
Sector	2019	no			LSTM neural network, topic labeling

Open Information Extraction

OIE system	publication year	key features
TextRunner	2007	● POS tags, NP chunks ● labeling by handcrafted patterns
ReVerb	2011	● rule-based ● POS tags, NP chunks ● lexical and semantic constraints
ClausIE	2013	● clause-based ● dependency parsing ● no training required
Stanford OIE	2015	● clause-based ● dependency parsing ● minimization of extracted clauses ● extraction based on handcrafted patterns
RnnOIE	2018	● neural-based ● bi-LSTM transducer for supervised model training ● extracts n-ary relational tuples ● OIE as a sequence labeling problem
Cui et al.	2018	● neural-based ● encoder-decoder LSTM RNN for supervised model ● training ● extracts binary relational tuples ● OIE as a sequence-to-sequence generation problem

Dataset

Dataset (novels)

Selection criteria:

- dystopian genre
- structured in chapters
- adapted into film
- in English

	Novel title	Author	Publication year	Length in words
1	1984: A Novel	G. Orwell	1949	101,327
2	Brave New World	A. Huxley	1932	66,511
3	We	Y. Zamyatin	Written in 1920, translated into English in 1924	62,794
4	The Handmaid's Tale	M. Atwood	1985	94,643
5	Do Androids Dream of Electric Sheep?	P. K. Dick	1968	64,106
6	The Hunger Games	S. Collins	2008	103,624
7	Catching Fire	S. Collins	2009	105,631
8	Mockingjay	S. Collins	2010	104,812
9	The Giver	L. Lowry	1993	44,790
10	The Maze Runner	J. Dashner	2009	79,431
11	Ready Player One	E. Cline	2011	140,721

Dataset (subtitles)

Selection criteria:

- film is an adaptation of a dystopian novel
- subtitle-novel pair
- in English

	Film title	Director	Release year	Length in words
1	1984	M. Anderson	1956	6,252
2	1984	M. Radford	1984	7,011
3	Brave New World	L. Libman, L. Williams	1998	7,464
4	We	V. Jasný	1982	6,587
5	The Handmaid's Tale	V. Schlöndorff	1990	6,448
6	Blade Runner	R. Scott	1982	4,303
7	The Hunger Games	G. Ross	2012	6,365
8	The Hunger Games: Catching Fire	F. Lawrence	2013	9,309
9	The Hunger Games: Mockingjay - Part 1	F. Lawrence	2014	8,443
10	The Hunger Games: Mockingjay - Part 2	F. Lawrence	2015	8,517
11	The Giver	P. Noyce	2014	7,172
12	The Maze Runner	W. Ball	2014	6,523
13	Ready Player One	S. Spielberg	2018	10,863

Research questions

Research question

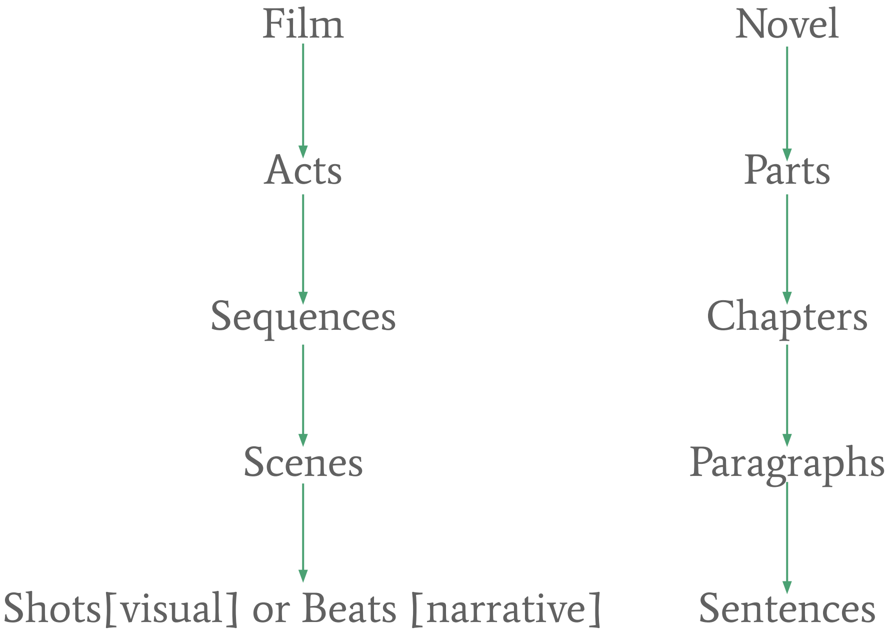
Related to Natural Language Processing (NLP):

How does a modification of a linear text segmentation method by adding word embeddings and knowledge generated by Open Information Extraction (OIE) influence the performance of this method?

Research question

Related to the created dataset:

How does the performance of presented in this work text segmentation pipeline compare for different fictional narrative text corpora (novels and subtitles)?



Film

Acts

Sequences

Scenes

Shots[visual] or Beats [narrative]

Novel

Parts

Chapters

Paragraphs

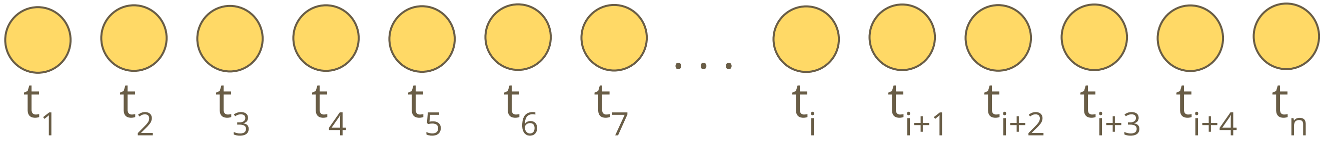
Sentences

Method

TextTiling

TextTiling

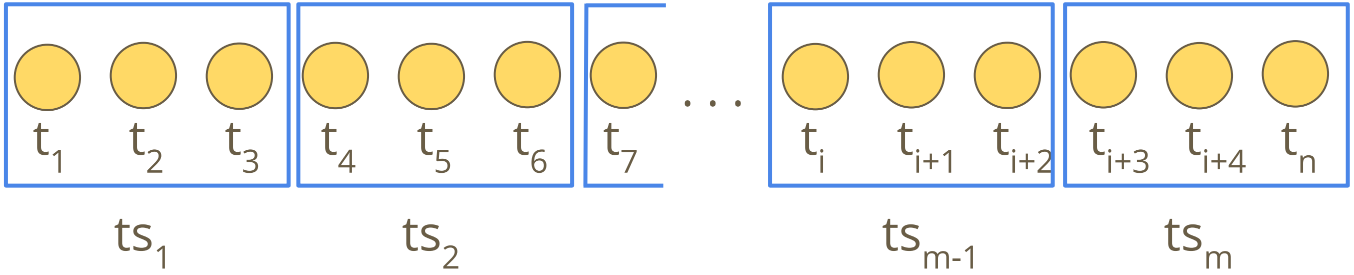
- words of the input text are lemmatized
- a series of word tokens $t_1 \dots t_n$



M. A. Hearst. Texttiling: Segmenting text into multi-paragraph subtopic passages. Journal of Computational linguistics, 23(1):33–64, 1997

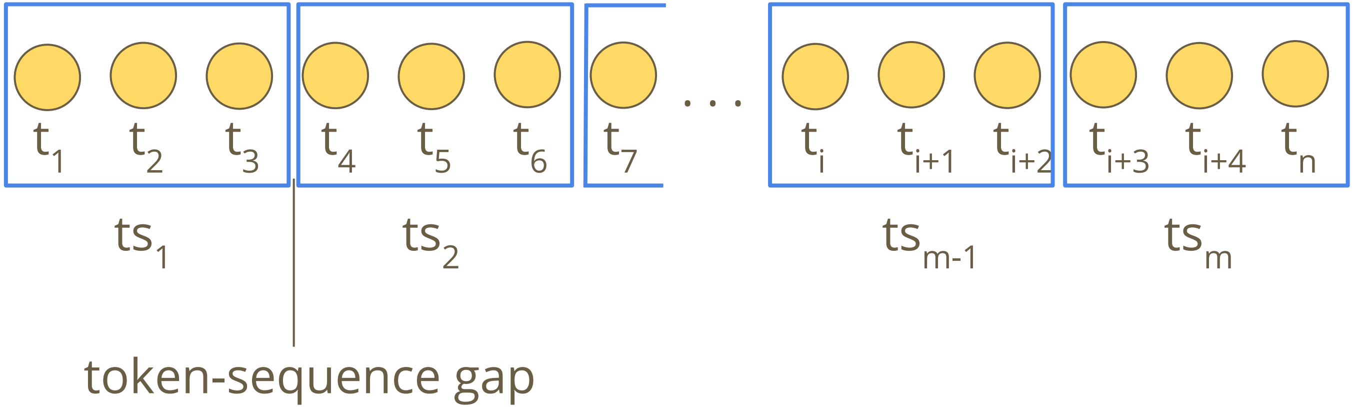
TextTiling

- token-sequence size *w*
- w approximates the length of the sentence
- *w* = 3 in this example



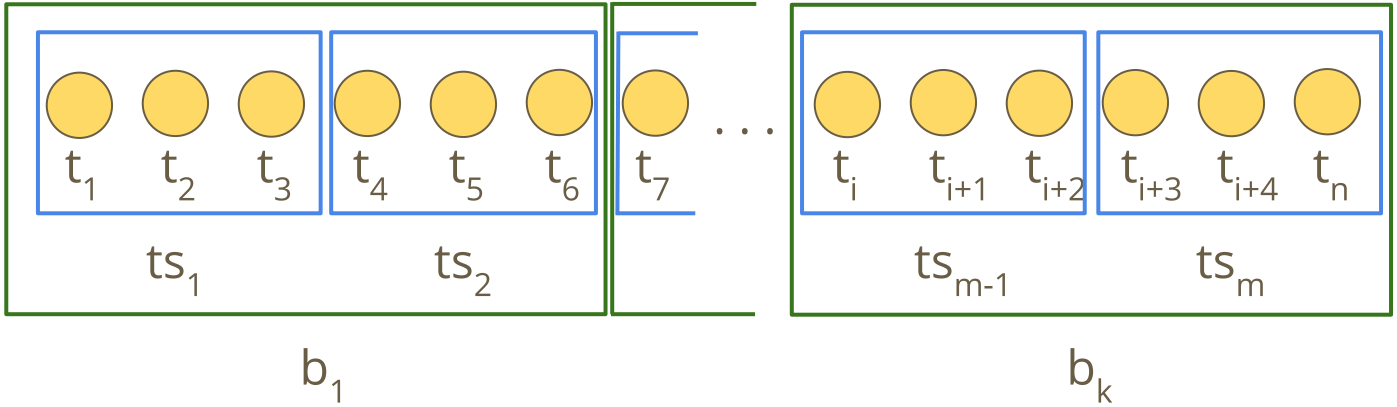
TextTiling

- token-sequence size *w*
- *w* approximates the length of the sentence
- *w* = 3 in this example



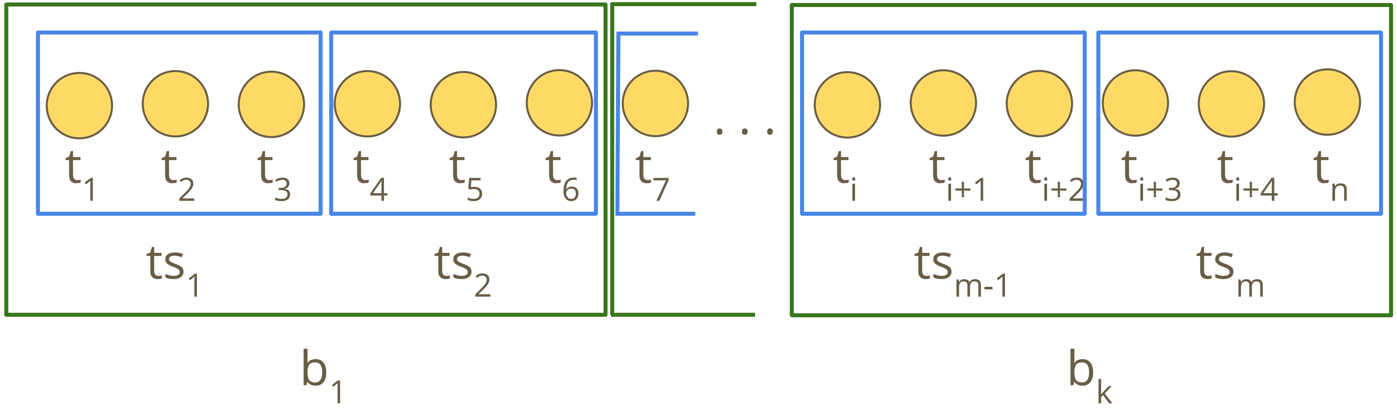
TextTiling

- block size k
- block size approximates the length of the paragraph in sentences
- k = 2 in this example



TextTiling (lexical score)

- vocabulary change signifies a change of subtopic in text
- a lexical score is computed between 2 neighboring blocks at each step
- moving window: shift by one token-sequence, compare 2 blocks
- each token-sequence gap is assigned a lexical score



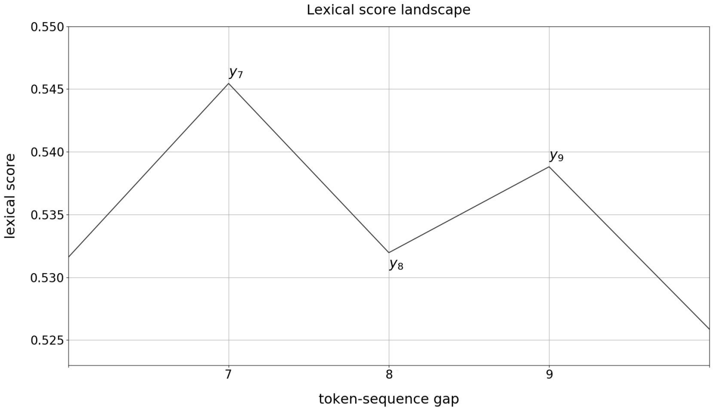
TextTiling (lexical score)

- lexical score value is cosine similarity between blocks

$$score = \frac{\sum_t w_{t,b1} w_{t,b2}}{\sqrt{\sum_t w_{t,b1}^2 w_{t,b2}^2}}$$

$w_{t,b1}$ … frequency of a vocabulary token *t* within a block b_1

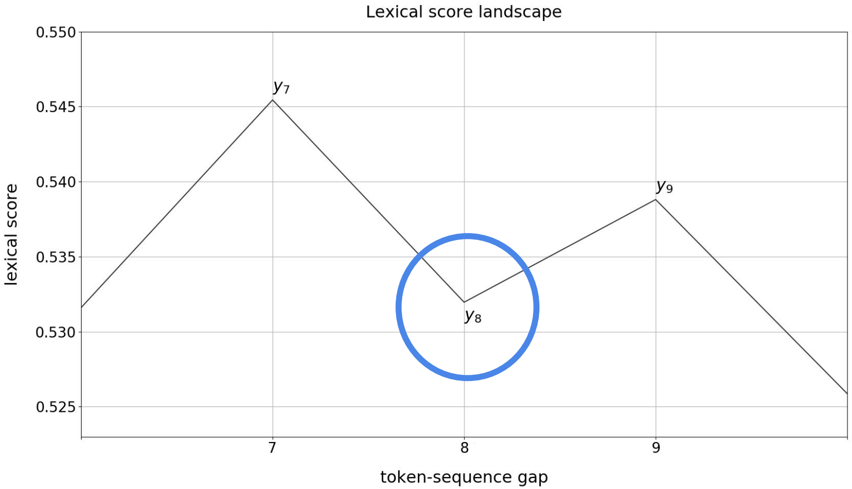
$w_{t,b2}$ … frequency of a vocabulary token *t* within a block b_2



TextTiling (depth score)

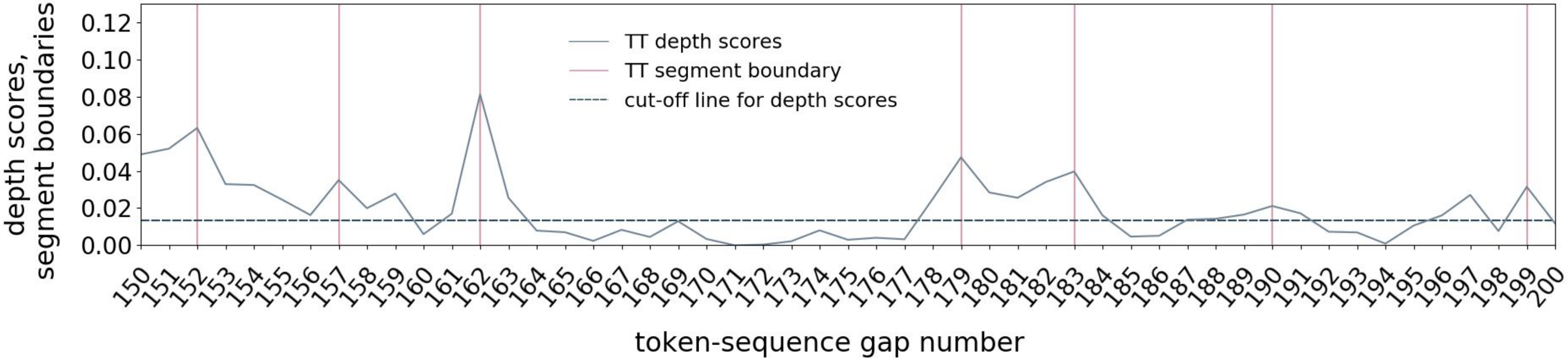
- the depth of the valley
- distance from the top peaks on both sides of the token-sequence gap

$$depth\_score(gap_j) = score(gap_l) - score(gap_j) + score(gap_r) - score(gap_j)$$



TextTiling (depth score)

- the larger the depth score value, the more probable is a topic switch



Word embeddings

Word embeddings (model)

- a novel and its film adaptation share the fictional terms and proper names
- a model was trained on the novel and fine-tuned on subtitle text
- stop words were not included as they do not carry semantic meaning and should have no significant impact on the vector space
- the same model was used at the parameter optimization step

Word embeddings

- at the step of splitting input into token sequences word tokens are replaced by their vector representations
- a block is represented by a vector (unchanged)
- moving window (unchanged): shift by one token-sequence, calculate lexical score of neighboring blocks
- a block is represented by a vector sum of all word embedding vectors in the block

Open Information Extraction

Open Information Extraction weights

- propositions are extracted from the sentence in form of n-ary relational tuples
- a word token may not be a part of any tuple and multiple tuples may share the same word token
- frequency of a word token in tuples corresponds to the strength of syntactic meaning
- an overall number of occurrences of a word token in all extracted propositions of a single sentence is considered token’s weight

Open Information Extraction weights (example)

Sentence: Better her than me, Rita said, and I opened the door.

Proposition 1: "Better her than me , [ARG0: Rita] [V: said] , and I opened the door ."

Proposition 2: "Better her than me , Rita said , and [ARG0: I] [V: opened] [ARG1: the door] ."

	Better	her	than	me	Rita	said	and	I	opened	the	door
Proposition 1	0	0	0	0	1	1	0	0	0	0	0
Proposition 2	0	0	0	0	0	0	0	1	1	1	1
Term weight	0	0	0	0	1	1	0	0	1	0	1

Results

Results (novels)

- replacing word tokens by their embedding vector representations
- decrease in the WindowDiff measure
- 9 out of 11 novels

	Novel title	Parameters	TextTiling	**TextTiling with word embeddings**
1	1984: A Novel	k=24, w=136	WD=0.961 P_k=0.531	**WD=0.917** P_k=0.514
2	Brave New World	k=100, w=258	WD=0.542 P_k=0.424	WD=0.623 P_k=0.503
3	We	k=22, w=88	WD=0.783 P_k=0.521	**WD=0.703** P_k=0.499
4	The Handmaid's Tale	k=14, w=112	WD=0.788 P_k=0.525	**WD=0.721** P_k=0.485
5	Do Androids Dream of Electric Sheep?	k=20, w=70	WD=0.99 P_k=0.523	**WD=0.953** P_k=0.508
6	The Hunger Games	k=39, w=54	WD=0.996 P_k=0.509	**WD=0.981** P_k=0.512
7	Catching Fire	k=11, w=44	WD=1.0 P_k=0.509	WD=1.0 P_k=0.509
8	Mockingjay	k=19, w=46	WD=1.0 P_k=0.524	**WD=0.989** P_k=0.528
9	The Giver	k=12, w=107	WD=0.723 P_k=0.529	**WD=0.69** **P_k=0.468**
10	The Maze Runner	k=13, w=49	WD=0.989 P_k=0.511	**WD=0.947** P_k=0.503
11	Ready Player One	k=8, w=71	WD=0.998 P_k=0.51	**WD=0.992** P_k=0.513

Results (subtitles)

- replacing word tokens by their embedding vector representations
- decrease in the WindowDiff measure
- 6 out of 13 subtitle files

	Film title	Parameters	TextTiling	**TextTiling with word embeddings**
1	1984 (1956)	k=39, w=22	WD=0.412 P_k=0.387	WD=0.423 P_k=0.401
2	1984 (1984)	k=29, w=22	WD=0.41 P_k=0.393	**WD=0.395** P_k=0.376
3	Brave New World	k=32, w=41	WD=0.395 P_k=0.372	**WD=0.393** P_k=0.37
4	We	k=50, w=48	WD=0.393 P_k=0.385	WD=0.413 P_k=0.408
5	The Handmaid's Tale	k=56, w=44	WD=0.349 P_k=0.334	WD=0.367 P_k=0.352
6	Blade Runner	k=18, w=34	WD=0.336 P_k=0.325	WD=0.36 P_k=0.351
7	The Hunger Games	k=46, w=20	WD=0.374 P_k=0.359	WD=0.411 P_k=0.4
8	The Hunger Games: Catching Fire	k=57, w=40	WD=0.32 P_k=0.305	WD=0.334 P_k=0.324
9	The Hunger Games: Mockingjay - Part 1	k=13, w=97	WD=0.354 P_k=0.35	**WD=0.335** P_k=0.331
10	The Hunger Games: Mockingjay - Part 2	k=21, w=97	WD=0.326 P_k=0.322	**WD=0.315** P_k=0.312
11	The Giver	k=,82 w=28	WD=0.427 P_k=0.388	**WD=0.408** P_k=0.372
12	The Maze Runner	k=43, w=27	WD=0.357 P_k=0.338	WD=0.373 P_k=0.36
13	Ready Player One	k=95, w=34	WD=0.365 P_k=0.346	**WD=0.354** P_k=0.339

Results (novels)

- replacing word tokens by their embedding vector representations
- OIE weights
- decrease in the WindowDiff measure
- 7 out of 11 novels

	Novel title	Parameters	TextTiling	**TextTiling with word embeddings and OIE weights**
1	1984: A Novel	k=24, w=136	WD=0.961 P_k=0.531	**WD=0.854** P_k=0.515
2	Brave New World	k=100, w=258	WD=0.542 P_k=0.424	WD=0.685 P_k=0.541
3	We	k=22, w=88	WD=0.783 P_k=0.521	**WD=0.739** P_k=0.5
4	The Handmaid's Tale	k=14, w=112	WD=0.788 P_k=0.525	**WD=0.709** P_k=0.518
5	Do Androids Dream of Electric Sheep?	k=20, w=70	WD=0.99 P_k=0.523	**WD=0.983** P_k=0.517
6	The Hunger Games	k=39, w=54	WD=0.996 P_k=0.509	**WD=0.9814** P_k=0.515
7	Catching Fire	k=11, w=44	WD=1.0 P_k=0.509	WD=1.0 P_k=0.509
8	Mockingjay	k=19, w=46	WD=1.0 P_k=0.524	WD=1.0 P_k=0.524
9	The Giver	k=12, w=107	WD=0.723 P_k=0.529	WD=0.739 P_k=0.481
10	The Maze Runner	k=13, w=49	WD=0.989 P_k=0.511	**WD=0.934** **P_k=0.498**
11	Ready Player One	k=8, w=71	WD=0.998 P_k=0.51	**WD=0.981** P_k=0.516

Results (subtitles)

- replacing word tokens by their embedding vector representations
- OIE weights
- decrease in the WindowDiff measure
- 4 out of 13 subtitle files

	Film title	Parameters	TextTiling	**TextTiling with word embeddings and OIE weights**
1	1984 (1956)	k=39, w=22	WD=0.412 P_k=0.387	**WD=0.389** P_k=0.375
2	1984 (1984)	k=29, w=22	WD=0.41 P_k=0.393	**WD=0.405** P_k=0.389
3	Brave New World	k=32, w=41	WD=0.395 P_k=0.372	**WD=0.381** P_k=0.357
4	We	k=50, w=48	WD=0.393 P_k=0.385	WD=0.445 P_k=0.445
5	The Handmaid's Tale	k=56, w=44	WD=0.349 P_k=0.334	WD=0.369 P_k=0.36
6	Blade Runner	k=18, w=34	WD=0.336 P_k=0.325	WD=0.354 P_k=0.343
7	The Hunger Games	k=46, w=20	WD=0.374 P_k=0.359	WD=0.411 P_k=0.394
8	The Hunger Games: Catching Fire	k=57, w=40	WD=0.32 P_k=0.305	WD=0.324 P_k=0.327
9	The Hunger Games: Mockingjay - Part 1	k=13, w=97	WD=0.354 P_k=0.35	**WD=0.349** P_k=0.347
10	The Hunger Games: Mockingjay - Part 2	k=21, w=97	WD=0.326 P_k=0.322	WD=0.329 P_k=0.326
11	The Giver	k=,82 w=28	WD=0.427 P_k=0.388	WD=0.442 P_k=0.414
12	The Maze Runner	k=43, w=27	WD=0.357 P_k=0.338	WD=0.38 P_k=0.367
13	Ready Player One	k=95, w=34	WD=0.365 P_k=0.346	WD=0.378 P_k=0.369

Findings (general)

- generalization of TextTiling parameters which would satisfy all input files equally well is not possible
- automatically generated ground truth may be too coarse for novels
- dialogues present a big challenge for the pipeline

Findings (research questions)

- pipeline is more effective for novels than subtitles (grammatically incomplete informal sentences)
- word embedding have a potential to improve the performance of TextTiling (increase in performance for 6 out of 13 subtitles and 9 out of 11 novels)
- application of word embeddings and OIE weights has a potential to improve the performance of TextTiling (increase in performance for 4 out of 13 subtitles and 7 out of 11 novels)

Thank you for your attention

Additional slides

Basic concepts

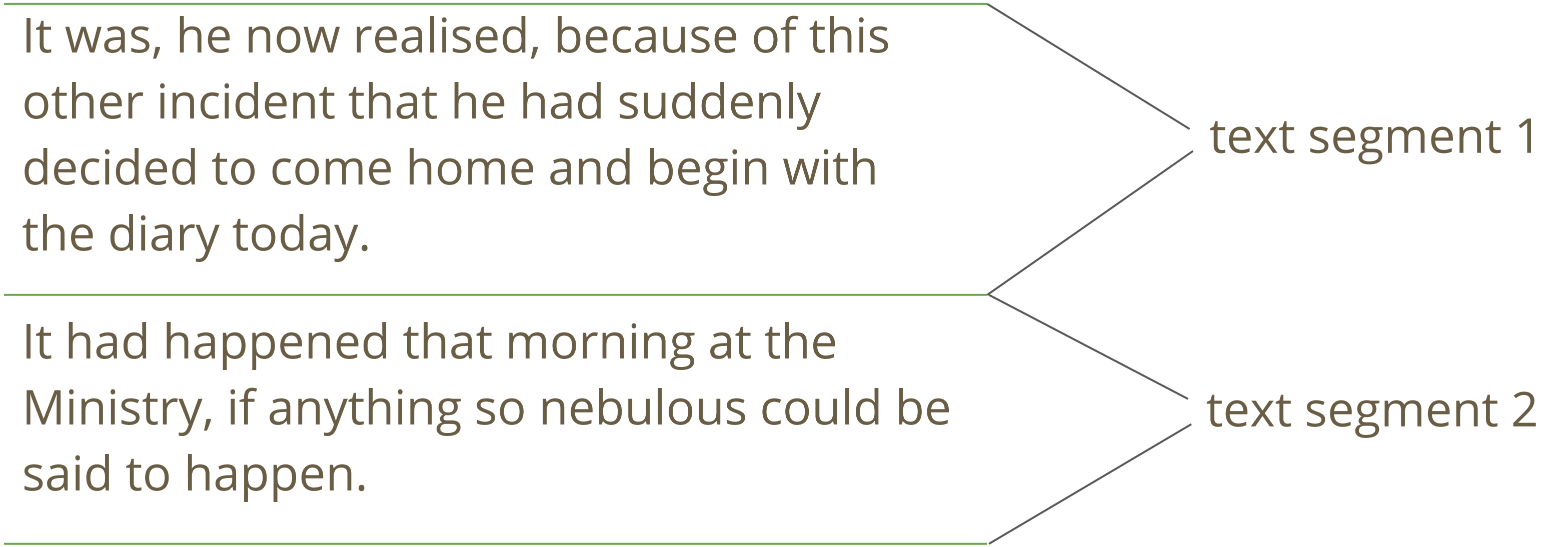
Basic concepts: linear text segmentation

Goal: to automatically locate a transition from one topic to another in a text

Result:

- text is separated into non-overlapping neighboring textual segments
- each segment characterized by a single homogeneous topic
- each segment contains a certain number of passages (e.g. paragraphs or sentences)

Basic concepts: linear text segmentation example



It was, he now realised, because of this other incident that he had suddenly decided to come home and begin with the diary today.

text segment 1

It had happened that morning at the Ministry, if anything so nebulous could be said to happen.

text segment 2

Source: Nineteen Eighty-Four by G. Orwell

Basic concepts: Open Information Extraction

Goal: to create a representation of propositions in a text document in form of n-tuples

Result:

- each sentence in the document is assigned a set of relational n-tuples
- each tuple contains at least two arguments connected by a semantic relation between them (predicate): {argument 1, predicate, argument 2}
- n-tuples should represent propositions clearly expressed in the sentence
- there is no limit to the number of tuples extracted from a single sentence

Basic concepts: Open Information Extraction example

Input sentence:

The sun went down and the dark-gray clouds changed color.

Extracted propositions:

1) [ARG0: The sun] [V: went] [ARG1: down]

2) [ARG0: the dark - gray clouds] [V: changed] [ARG1: color]

Basic concepts: word embeddings

Goal:

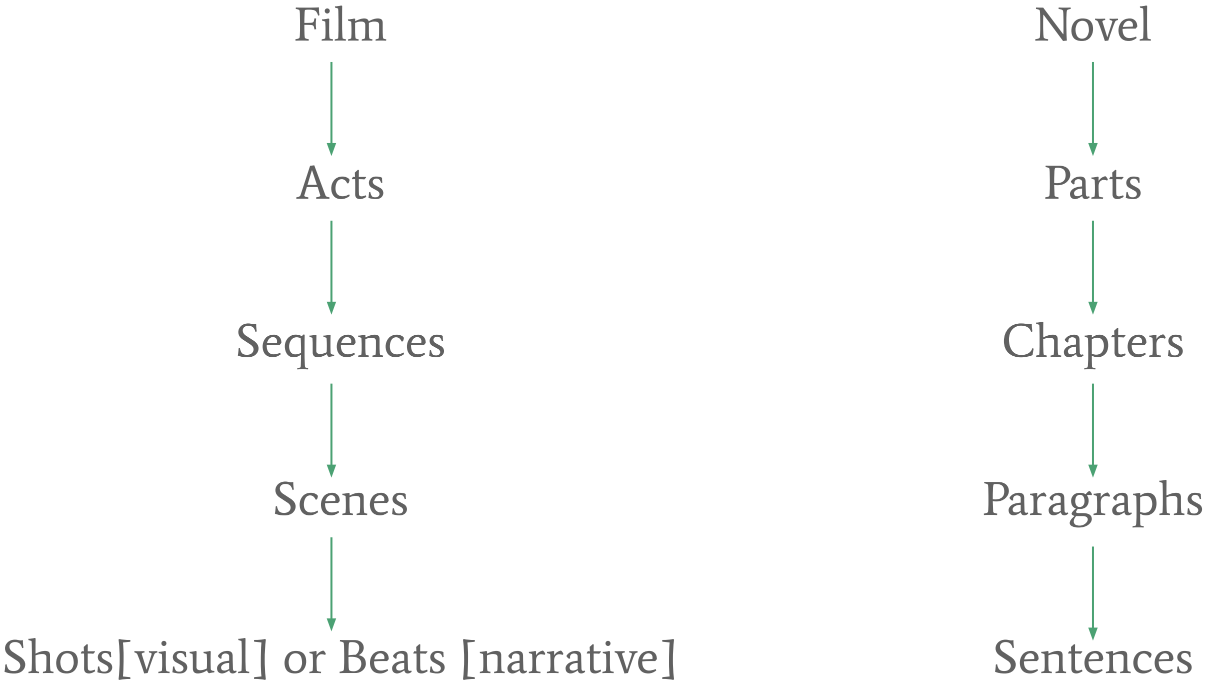
transforming original textual data into a vector space based on prediction from the linguistic context

Result:

- each word in a vocabulary of a corpus is assigned a single real-valued vector
- approximation of word’s meaning. Distributional hypothesis: words occurring in similar context tend to have similar meaning

Narrative structure

Narrative structure



Film

Acts

Sequences

Scenes

Shots[visual] or Beats [narrative]

Novel

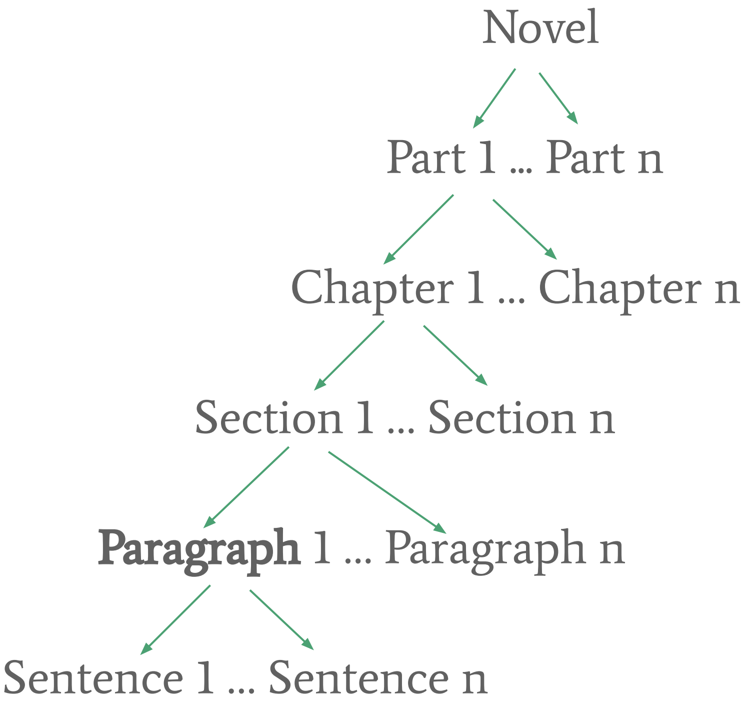
Parts

Chapters

Paragraphs

Sentences

Novel structure



Novel

Part 1 ... Part n

Chapter 1 ... Chapter n

Section 1 ... Section n

Paragraph 1 ... Paragraph n

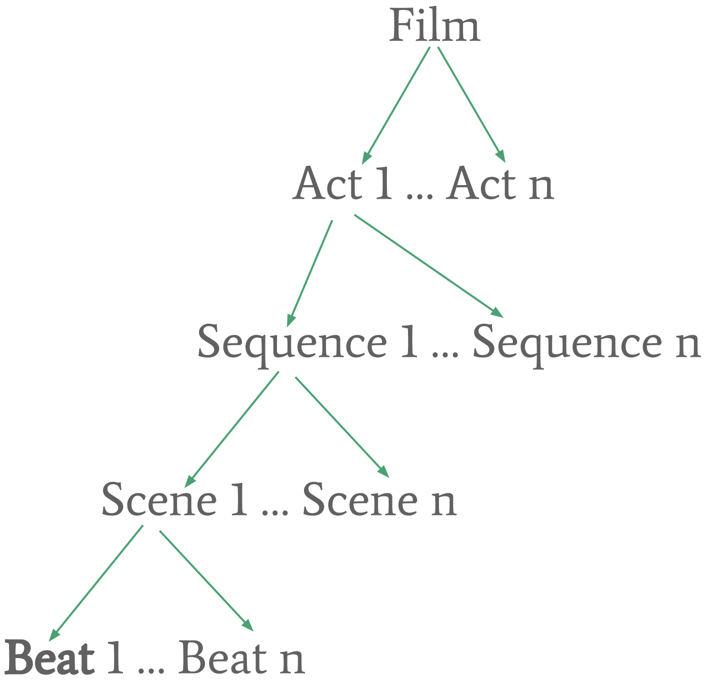
Sentence 1 ... Sentence n

A paragraph is

- a subdivision of a written composition
- begins on a new usually indented line
- consists of one or more sentences
- deals with one point or
- gives the words of one speaker

https://www.merriam-webster.com/dictionary/paragraph

Film screenplay structure



A beat

- is an action/reaction event for moving the plot forward
- should stimulate an emotion from the audience

https://tvtropes.org/pmwiki/pmwiki.php/Main/NarrativeBeats

Dataset

Dataset: ground truth for novels

Chapter 1

A squat grey building of only thirty-four stories.

. . .

. . .

. . .

"Just one glance."

Chapter 2

Mr. Foster was left in the Decanting Room.

. . .

. . .

. . .

Source: Brave New World by A. Huxley

Dataset: ground truth for novels

~~Chapter 1~~

A squat grey building of only thirty-four stories.

. . .

. . .

. . .

"Just one glance."

one text segment

~~Chapter 2~~

Mr. Foster was left in the Decanting Room.

. . .

. . .

. . .

- each chapter is treated as a single text segment
- headers are filtered out

Source: Brave New World by A. Huxley

Dataset: ground truth for subtitles

77
01:28:03,196 --> 01:28:06,108
Ok. Checked and cleared.
Have a better one.

11.35 seconds

778
01:28:17,460 --> 01:28:19,262
Hello.
Hi. Is J.F. there?

779
01:28:19,263 --> 01:28:20,284
Who is it?

780
01:28:20,485 --> 01:28:22,149
This is Eddie, old friend of J.F.'s.

~4.78 seconds

781
01:28:26,928 --> 01:28:28,638
That's no way to treat a friend.

178.595 seconds

782
01:31:27,233 --> 01:31:29,318
Home again, home again, jiggidy-jig.

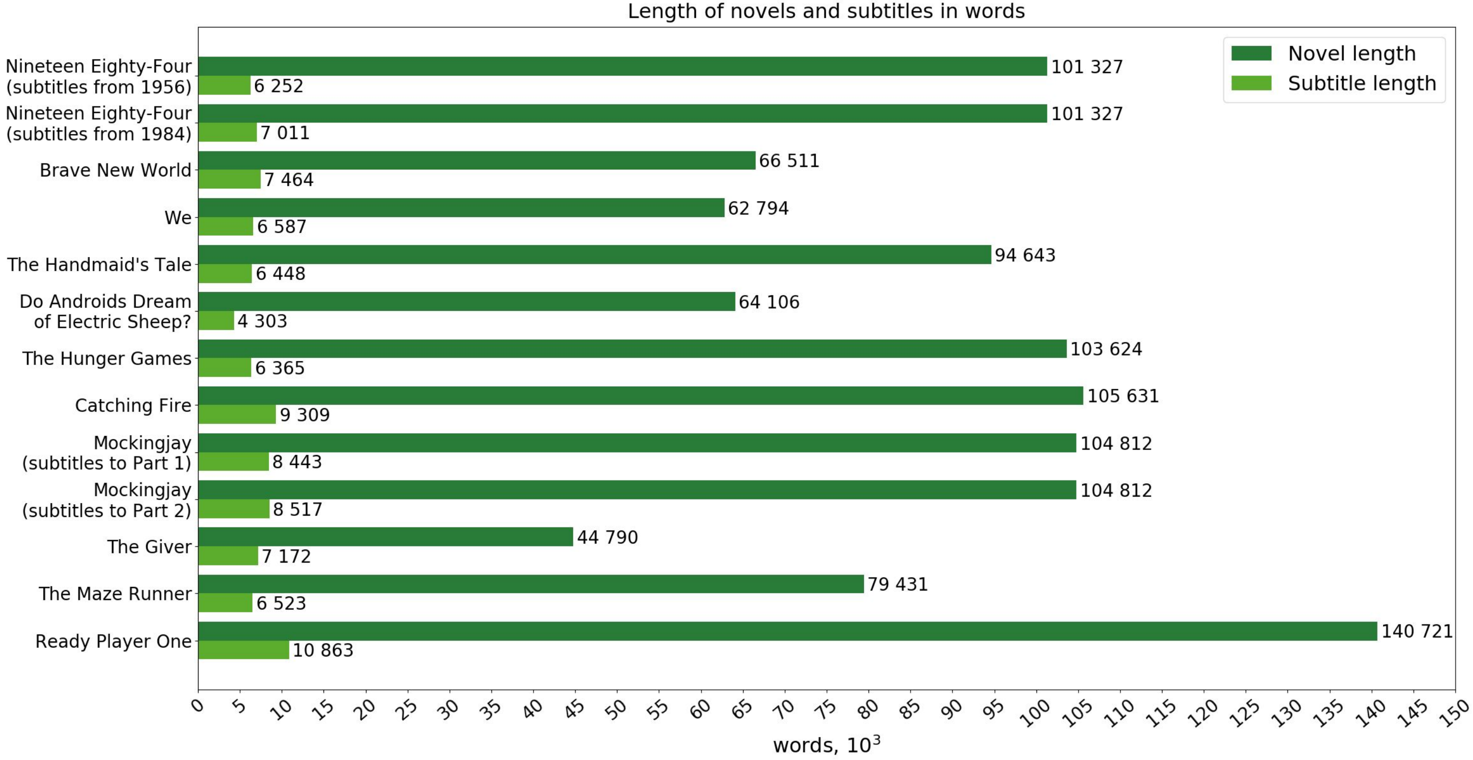
The beginning of a new text segment is identified if there was a pause between subtitle sequences longer than 5 seconds.

one text segment:

"Hello. Hi. Is J.F. there? Who is it? This is Eddie, old friend of J.F.'s. That's no way to treat a friend."

Source: Blade Runner (1982)

Dataset motivation



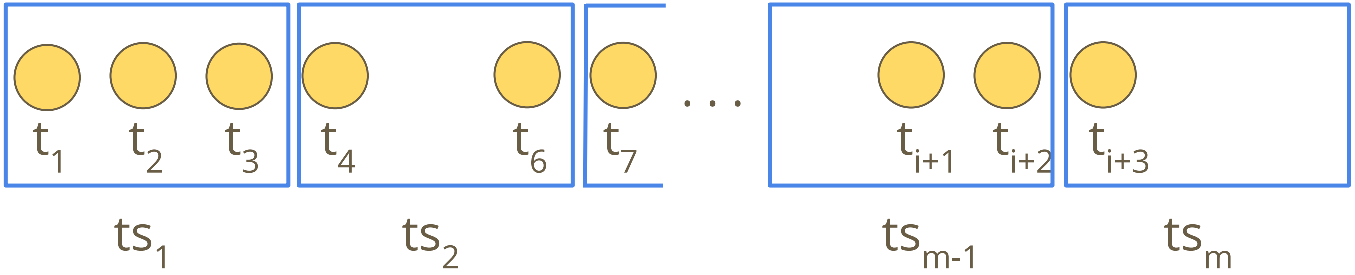
Benefits of the dataset

- synonyms rather than word repetitions
- made up terms
- already existing words may obtain ironic meaning (e.g. “Ministry of Love”)
- irregular length of sentences and paragraphs
- unconfined text structure

Method

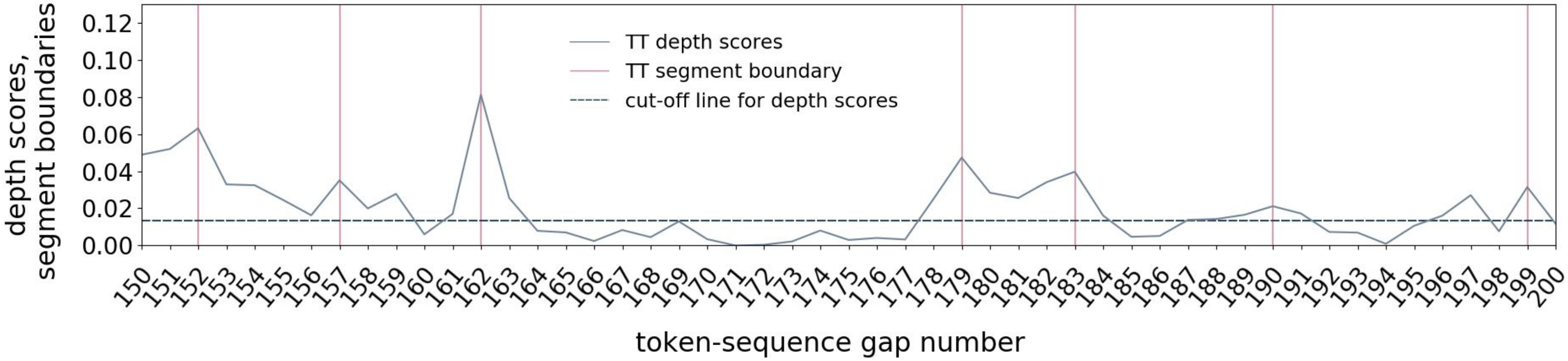
TextTiling

- stop words are removed



TextTiling (depth score)

- depth scores are sorted (the highest depth score is a guaranteed boundary)
- we want to avoid many boundaries very close to each other so at least three token sequences are required between boundaries



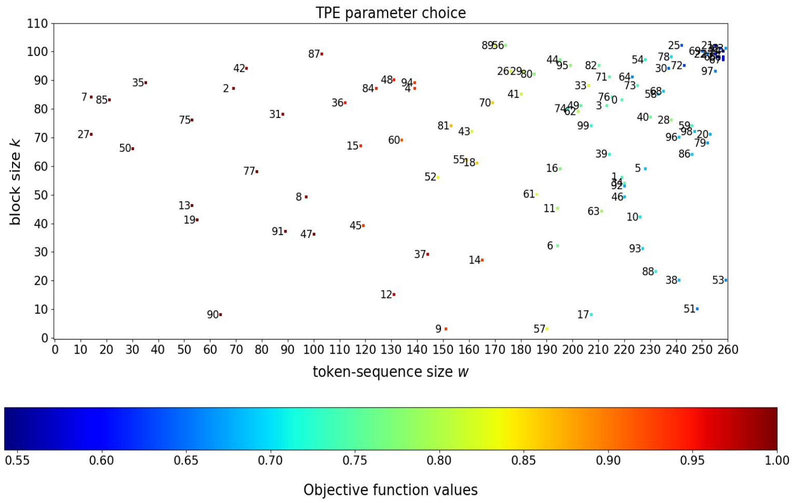
Parameter search

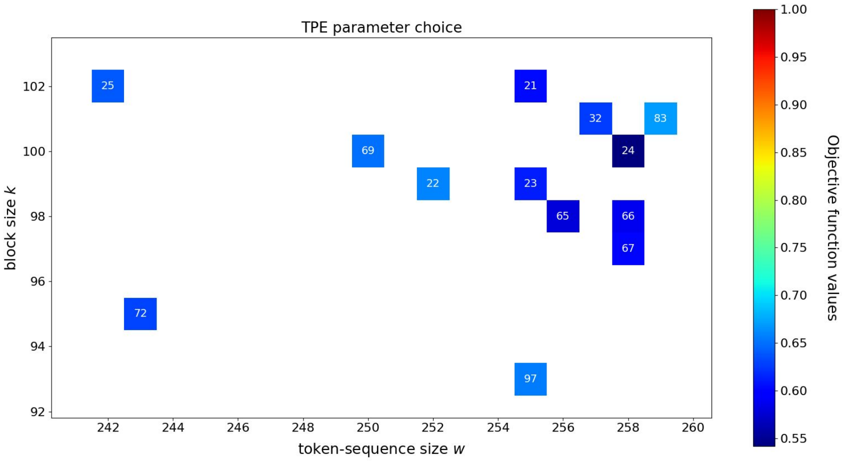
- the minimum of the token-sequence value was set to median sentence length
- the maximum of the token-sequence value was set to maximum sentence length
- the minimum of the block size value was set to median paragraph length in sentences
- the maximum of the block size value was set to maximum paragraph length in sentences
- the output of objective function to minimize is WindowDiff measure value

Parameter search

$$\forall w \in [median\_sl, max\_sl], length\ in\ tokens$$

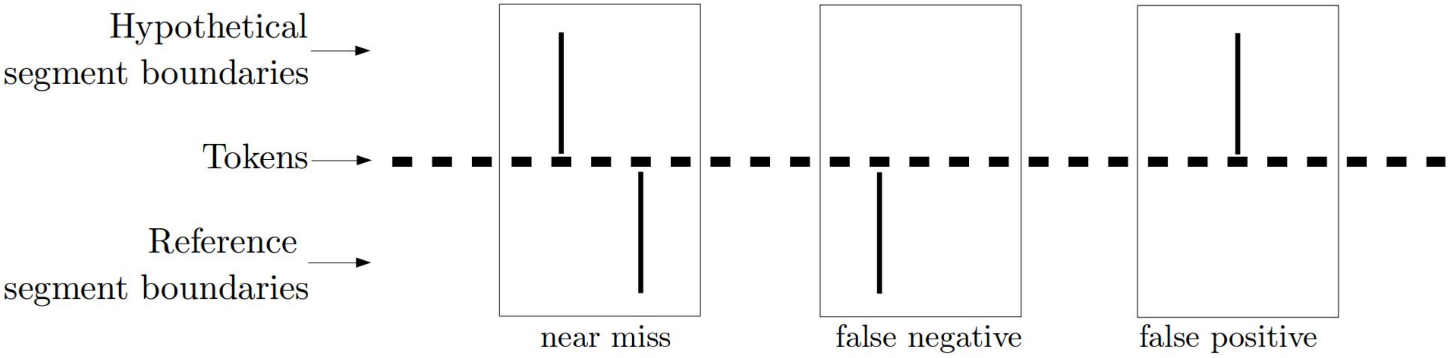
$$\forall k \in [median\_pl, max\_pl], length\ in\ sentences$$





Evaluation metrics

P_k does not penalize if the number of hypothetical boundaries exceeds the number of reference boundaries in the window



Results

Results (novels)

- word embeddings:

  increased performance for 9 out of 11 novels compared to TextTiling

- word embeddings with OIE weights:

  increased performance for 7 out of 11 novels compared to TextTiling

	Novel title	Parameters	TextTiling	TextTiling with word embeddings	TextTiling with OIE weights
1	1984: A Novel	k=24, w=136	WD=0.961 P_k=0.531	WD=0.917 P_k=0.514	**WD=0.854** P_k=0.515
2	Brave New World	k=100, w=258	**WD=0.542** P_k=0.424	WD=0.623 P_k=0.503	WD=0.685 P_k=0.541
3	We	k=22, w=88	WD=0.783 P_k=0.521	**WD=0.703** P_k=0.499	WD=0.739 P_k=0.5
4	The Handmaid's Tale	k=14, w=112	WD=0.788 P_k=0.525	WD=0.721 P_k=0.485	**WD=0.709** P_k=0.518
5	Do Androids Dream of Electric Sheep?	k=20, w=70	WD=0.99 P_k=0.523	**WD=0.953** P_k=0.508	WD=0.983 P_k=0.517
6	The Hunger Games	k=39, w=54	WD=0.996 P_k=0.509	**WD=0.981** P_k=0.512	WD=0.9814 P_k=0.515
7	Catching Fire	k=11, w=44	WD=1.0 P_k=0.509	WD=1.0 P_k=0.509	WD=1.0 P_k=0.509
8	Mockingjay	k=19, w=46	WD=1.0 P_k=0.524	**WD=0.989** P_k=0.528	WD=1.0 P_k=0.524
9	The Giver	k=12, w=107	WD=0.723 P_k=0.529	**WD=0.69** **P_k=0.468**	WD=0.739 P_k=0.481
10	The Maze Runner	k=13, w=49	WD=0.989 P_k=0.511	WD=0.947 P_k=0.503	**WD=0.934** **P_k=0.498**
11	Ready Player One	k=8, w=71	WD=0.998 P_k=0.51	WD=0.992 P_k=0.513	**WD=0.981** P_k=0.516

Results (subtitles)

- word embeddings:

  increased performance for 6 out of 13 subtitle files compared to TextTiling

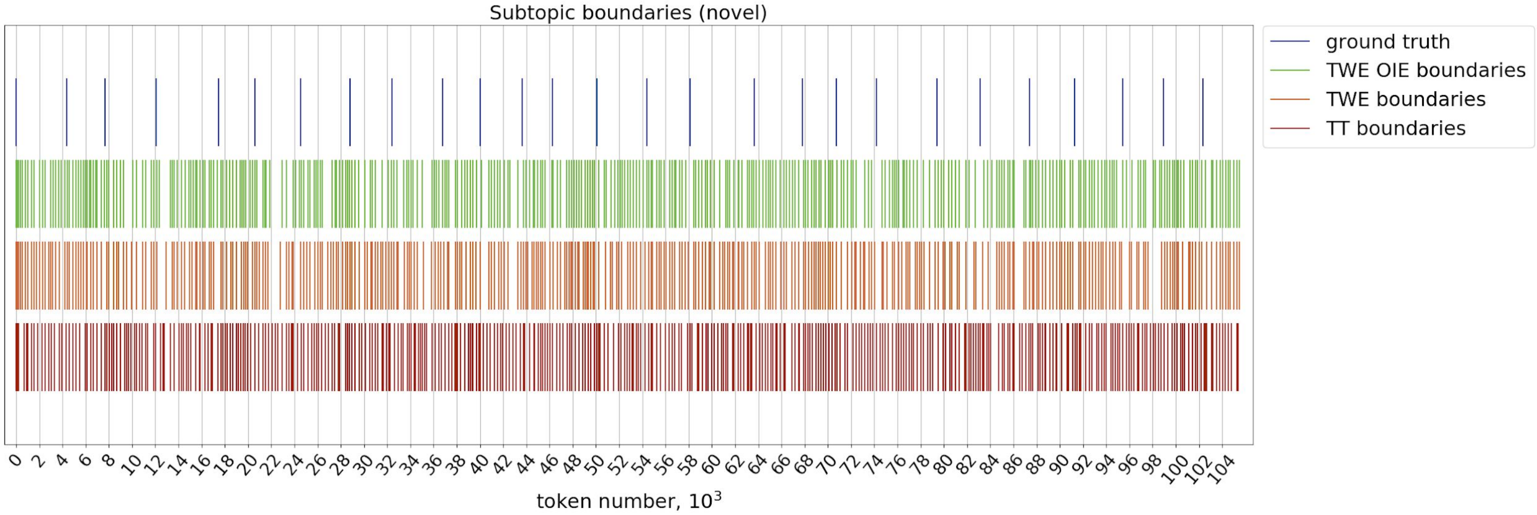
- word embeddings with OIE weights:

  increased performance for 4 out of 13 subtitle files compared to TextTiling

	Film title	Parameters	TextTiling	TextTiling with word embeddings	TextTiling with OIE weights
1	1984 (1956)	k=39, w=22	WD=0.412 P_k=0.387	WD=0.423 P_k=0.401	**WD=0.389** P_k=0.375
2	1984 (1984)	k=29, w=22	WD=0.41 P_k=0.393	**WD=0.395** P_k=0.376	WD=0.405 P_k=0.389
3	Brave New World	k=32, w=41	WD=0.395 P_k=0.372	WD=0.393 P_k=0.37	**WD=0.381** P_k=0.357
4	We	k=50, w=48	**WD=0.393** P_k=0.385	WD=0.413 P_k=0.408	WD=0.445 P_k=0.445
5	The Handmaid's Tale	k=56, w=44	**WD=0.349** P_k=0.334	WD=0.367 P_k=0.352	WD=0.369 P_k=0.36
6	Blade Runner	k=18, w=34	**WD=0.336** P_k=0.325	WD=0.36 P_k=0.351	WD=0.354 P_k=0.343
7	The Hunger Games	k=46, w=20	**WD=0.374** P_k=0.359	WD=0.411 P_k=0.4	WD=0.411 P_k=0.394
8	The Hunger Games: Catching Fire	k=57, w=40	**WD=0.32** P_k=0.305	WD=0.334 P_k=0.324	WD=0.324 P_k=0.327
9	The Hunger Games: Mockingjay - Part 1	k=13, w=97	WD=0.354 P_k=0.35	**WD=0.335** P_k=0.331	WD=0.349 P_k=0.347
10	The Hunger Games: Mockingjay - Part 2	k=21, w=97	WD=0.326 P_k=0.322	**WD=0.315** P_k=0.312	WD=0.329 P_k=0.326
11	The Giver	k=,82 w=28	WD=0.427 P_k=0.388	**WD=0.408** P_k=0.372	WD=0.442 P_k=0.414
12	The Maze Runner	k=43, w=27	**WD=0.357** **P_k=0.338**	WD=0.373 P_k=0.36	WD=0.38 P_k=0.367
13	Ready Player One	k=95, w=34	WD=0.365 P_k=0.346	**WD=0.354** P_k=0.339	WD=0.378 P_k=0.369

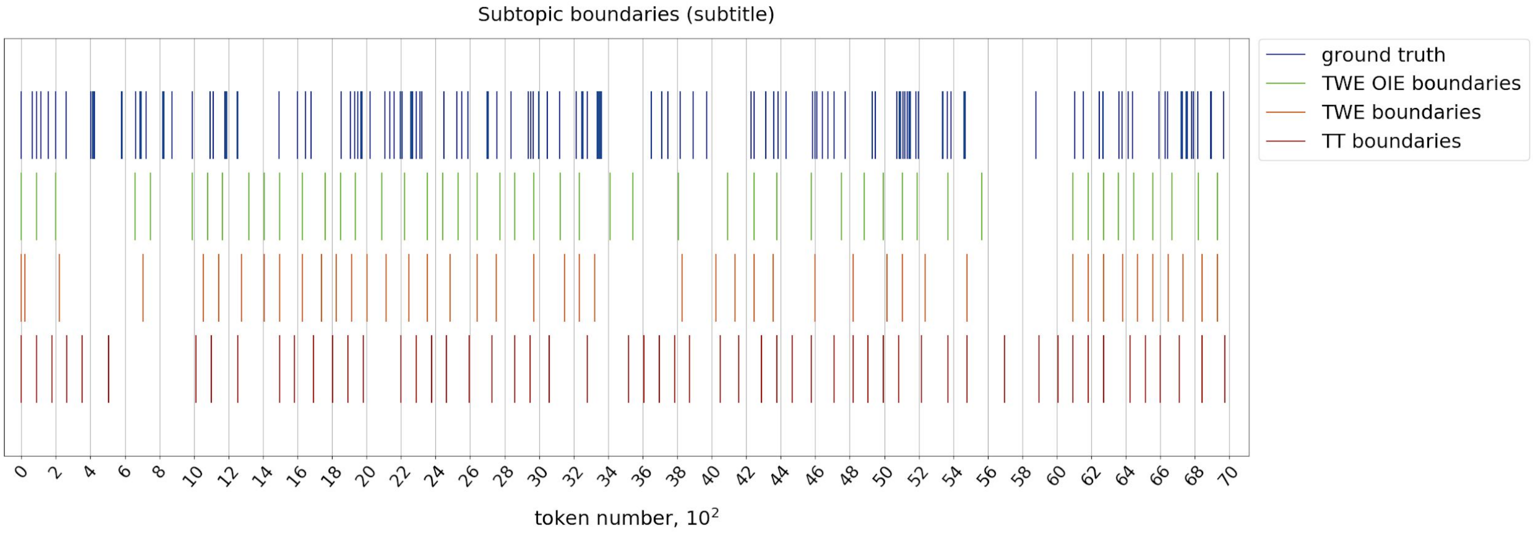
Subtopic boundaries example

- novel ”Catching Fire” by S. Collins
- k=11, w=44, $\mathrm{WD}_{\mathrm{we}}$=1.0, $\mathrm{WD}_{\mathrm{we\_oie}}$=1.0



Subtopic boundaries example

- subtitles to the film ”Ninety Eighty-Four” (1956)
- k=39, w=22, WD_{we}=0.423, WD_{we_oie}=0.389


Subtopic boundaries (subtitle)
ground truth
TWE OIE boundaries
TWE boundaries
TT boundaries
token number, 10^2