Natural Language Generation, Paraphrasing and Summarization of User Reviews with Recurrent Neural Networks

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ReviewDot
www.reviewdot.ru

Meanotek
www.meanotek.com

Kazan, Russian Federation

Introduction

The problem

- Generate summaries for multiple consumer reviews of the same product

Отличный телефон
Excellent phone

Батерия быстро садиться, пользоваться Невозможно.
Short battery life makes this phone unusable

Отличный телефон, но пользоваться невозможно
Excellent, but not usable phone

Introduction

The reason

~~To generate unique content for web site and improve search engine ranking~~

Automatic document summarization helps readers to understand most important points of long documents

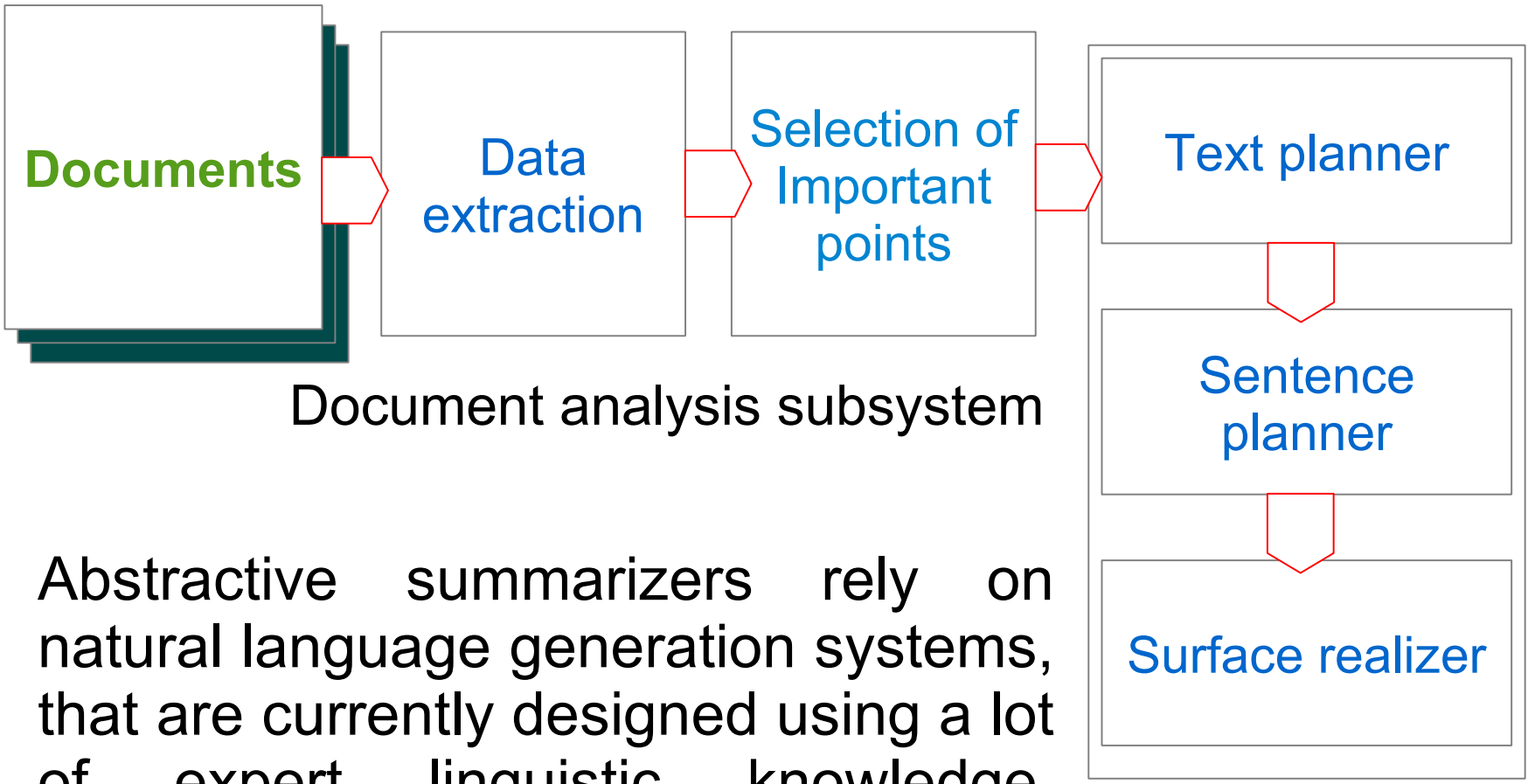
Introduction
How it can be done?

- Summarization can be “extractive” and “abstractive”
  - Extractive summarizers works by selecting sentences from original documents
  - Abstractive summarizers generate new sentences based on their understanding of document content
  - Abstractive summaries can be more concise, coherent and easier to understand

.

Introduction

Commonly used abstractive summarization pipeline:



Document analysis subsystem

Language generation subsystem

- Abstractive summarizers rely on natural language generation systems, that are currently designed using a lot of expert linguistic knowledge, heuristics and complex pipelines

Introduction

Trainable methods for language generation

Examples of early work:

- Ratnaparkhi A. (2000). Trainable methods for surface natural language generation

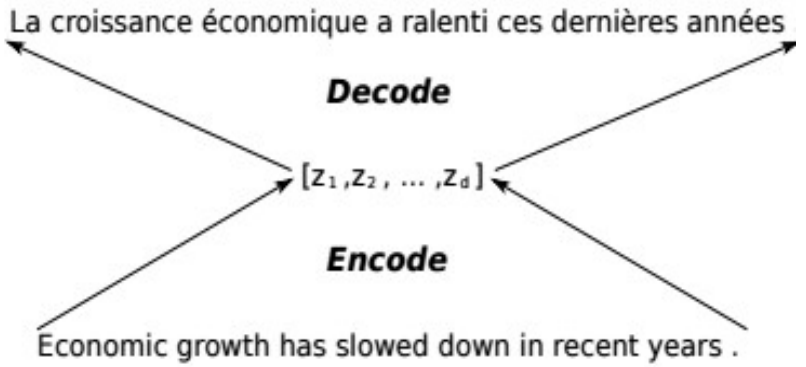
{$city-fr,$city-to,$time-dep,$date-dep} =>

A flight to $city-to that departs from $city-fr at $time-dep on $date-dep

Introduction

Deep learning for language generation

- Neural translation models (Encoder/Decoder)
  - Cho et al, 2014; Sutskever et al, 2014 …



- Generation of image descriptions
  - Mao et al, 2014

Introduction

Our model

- Recurrent neural network (RNN) model capable of generating novel sentences and document summaries
  - Train recurrent neural network language model on a large number of sentences describing positive and negative aspects of various consumer products
  - predict next word given current word and additional sentence-level semantic information (sentence polarity, length, product category,bag of aspects vector).
- Model can generate novel paraphrases and “compress” multiple important points about the product in one statement

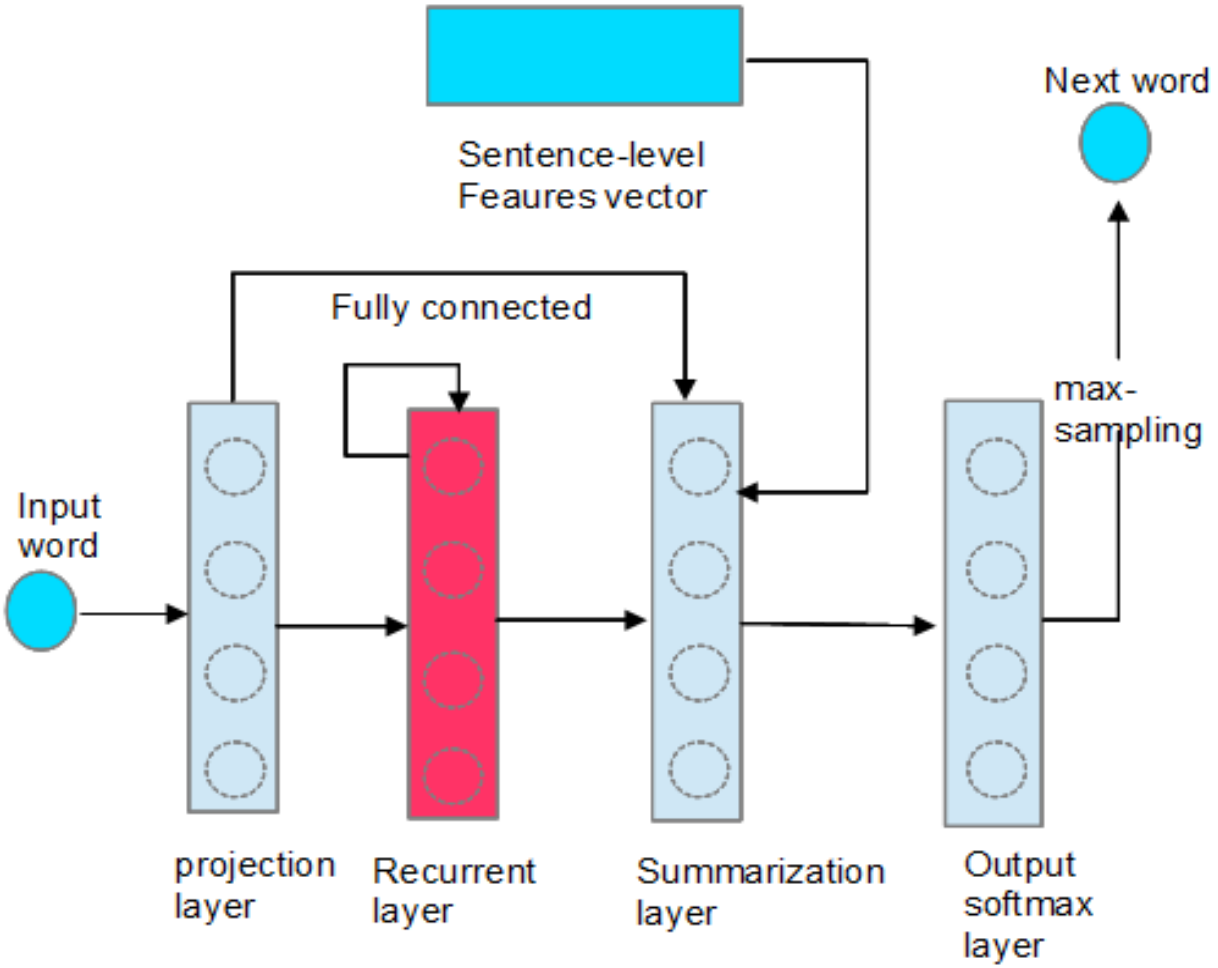
Methodologies

Dataset

- 56 000 sentences
  - Collected with reviewdot.ru web-crawler from various consumer reviews web-sites and online shops
  - Three classes – positive, negative and comment, induced from web page markup using heuristics
  - 25 product cathegories: Mobile phones, Tablets, Printers...

Methodologies

Summarization neural network



Simple Elman-type recurrent layer: $h(t) = f(Wx(t) + Vh(t-1) + b)$ (1)

Methodologies

Sentence-level features

- Sentence polarity
- Product category
- Bag of aspects extracted with supervised learning method
  - screen, reliability, sound volume and other

Results

Paraphrases: overall statistics

Human judgment of generated paraphrases (total of 75 sentences)

Human judgment	Percentage of sentences (average value from results of two human judges).
Grammatically correct and conveying original meaning	65%
Conveying original meaning but not necessary correct	78%
Correct, but not conveying original meaning	18%

Results Examples of generated paraphrases

Original	Neural network parapharse
Качественный и красивый корпус (good and nice looking case)	Красивый, качественный корпус, живучий (Nice looking, good case, reliable) Металлический корпус довольно красиво выглядит (Metallic case looks reasonable good)
Большие кнопки с цифрами,хорошее качество изготовления,приятный корпус, лёгкий, громкий сигнал вызова (Big buttons with numbers, good production quality, nice case, lightweight, loud signal)	Вполне нравится пластик, цифры кнопок / качество изготовления металлический корпус. (Good quality of plastics, number of buttons / quality of production, metallic case) но кнопки , корпус , хорошее качество фотографий (But buttons, case, good quality of photo)
Довольно сносное качество исполнения, легкий и вполне удобный Quality is reasonable good, lightweight and convenient enough.	Маленький, легкий, удобный, хорошее качество звучания (Small, lightweight, convenient, good quality of sound)

Results

Language generation

- Choosing sentence-level features vector provides coarse control over the meaning of generated sentences
  - We can instruct the network, for example, to “say something good about screen and sound quality in about ten words”

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Results Language generation

Examples of sentences produced by s-RNN (polarity set to “positive” and aspects set to “battery, screen, convenience

Desired sentence length	output
3	батарея, экран, удобный (battery, screen, convenient)
5	аккумулятор , размер дисплея солидный , эргономика (accumulator, impressive display size, ergonomics)
10	быстрый аккумулятор, яркий внешне дисплей, удобный функционал, умный помогает. (fast accumulator, bright display from outside, convenient functions, smart helps)

Results

Summarization

- Generate synthetic sentence-level feature vectors by running aspect-based sentiment analysis over all sentences of reviews subjected to summarization, using extracted aspect terms and polarities to generate feature vectors

- Use additional dynamic training step that consists of running one iteration of gradient descent over all sentences with aspect terms

Quality rating	Percentage of review summaries
Good	35%
Acceptable	44%
Unacceptable	21%

Results

Example summary

Качество звука, удобный интерфейс, очень долго держит заряд. Отзывчивый экран, громкий звонок, крупный шрифт, рабочий день. Приятно лежит в руках, 2 сим - карты выручают. Качество сборки, батарея, удобное меню, устойчив к воздействию воды. Явно лидируют, сочный дисплей, качество связи, плеер, фонарь. Хорошая фотокамера, динамик

(Quality of sound, convenient user interface, very long battery life. Responsive screen, loud calling signal, large font, working day. Lies in hands nicely, 2 sim cards help. Quality of production, convenient menu, waterproof. Obviously leading, nice display, player, bright light. Good photo-camera, speaker).

Conclusions

Single neural network architecture can be used for controlled natural language generation, paraphrasing and summarization

We found, that our method usually produces summaries of reasonable quality, while still making a number of mistakes

Future work will consider use of trainable sentence feature vector, perhaps leading to end-to-end unsupervised automatic text understanding

Paper/slides avaliable at www.meanotek.com

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