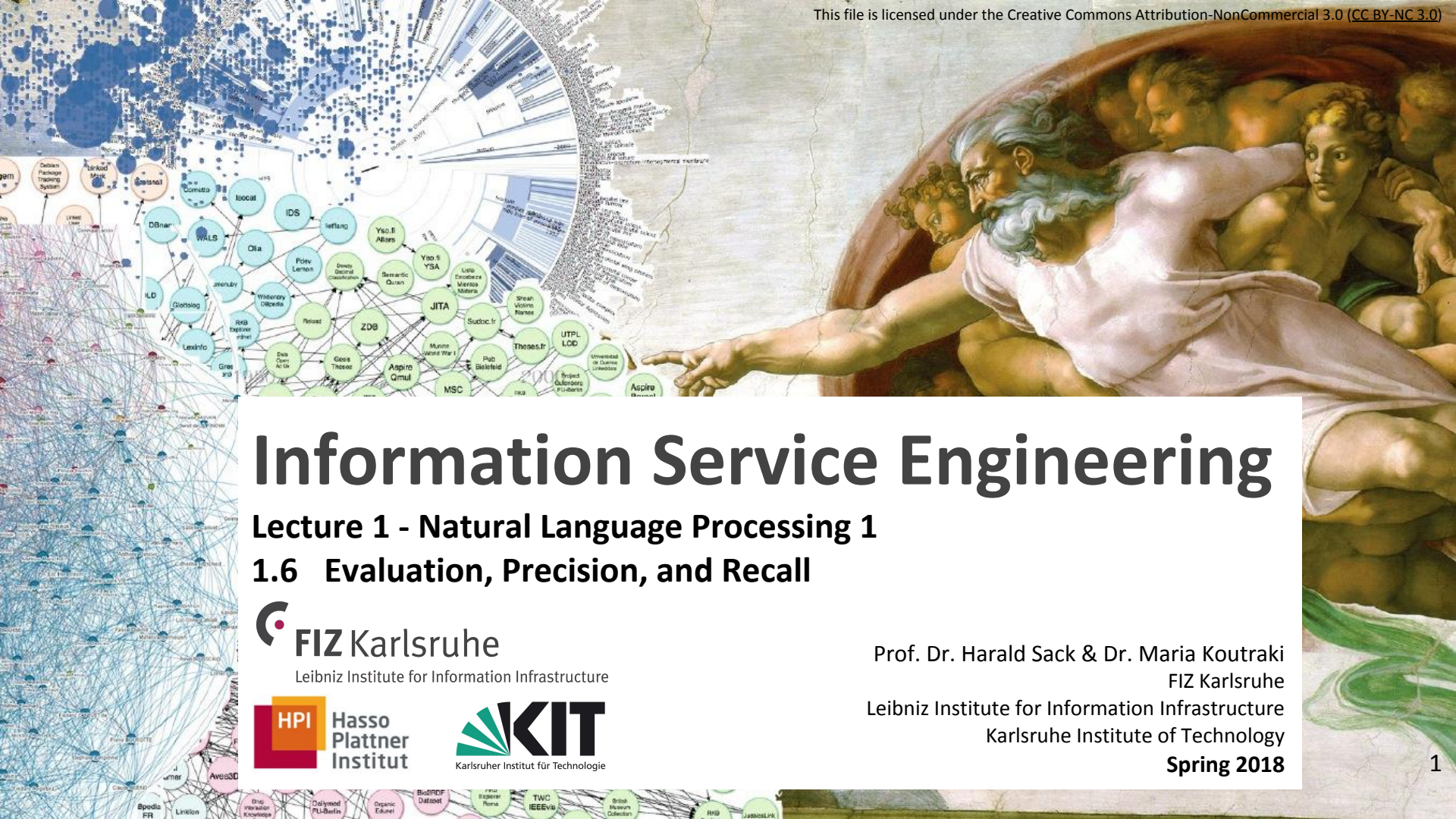




Information Service Engineering

Lecture 1 - Natural Language Processing 1

1.6 Evaluation, Precision, and Recall



Leibniz Institute for Information Infrastructure



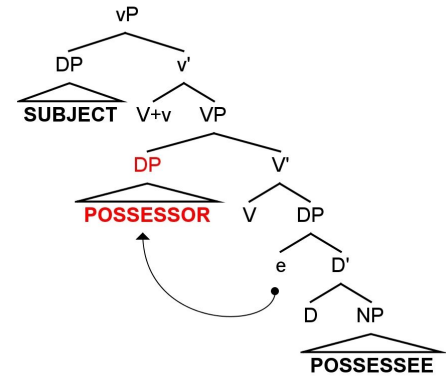
Prof. Dr. Harald Sack & Dr. Maria Koutraki
FIZ Karlsruhe

Leibniz Institute for Information Infrastructure
Karlsruhe Institute of Technology
Spring 2018

Information Service Engineering

Lecture 1: Natural Language Processing

- 1.1 Information and Knowledge
- 1.2 Language and Understanding
- 1.3 NLP Techniques and Challenges
- 1.4 Linguistic Basics
- 1.5 Morphology
- 1.6 Evaluation, Precision and Recall**
- 1.7 Regular Expressions



Evaluation

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- How to **objectively measure the quality** of a (classification) experiment?
 - Compare your achieved results with a **ground truth (gold standard)**
- How to **achieve a ground truth**?
 - Often this means to invest **manual effort**...
- **How to compare** achieved results with a ground truth?
 - Correctness **Precision**
 - Completeness **Recall**
 - Correctness & Completeness **F-Measure**

Confusion Matrix

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- Contains information about **actual and predicted classifications** done by a classification system
- A table with two rows and two columns that reports the number of
 - **false positives**, **false negatives**, **true positives**, and **true negatives**.

experiment

ground truth

		predicted	
		true	false
actual	true	true positive	false negative
	false	false positive	true negative

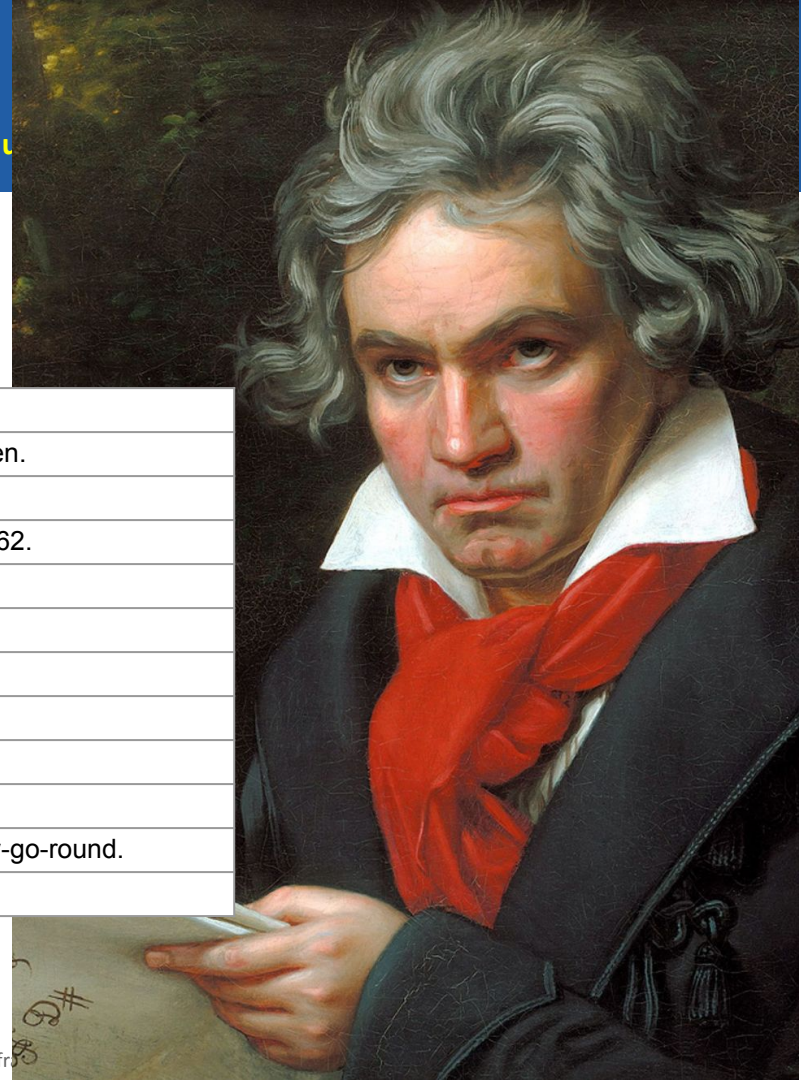
Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation

- Let's consider the following text corpus:
BEETHOVENCORPUS

1	The Andante favori is a work for piano solo by Ludwig van Beethoven.
2	The other great passion of the young Mirabehn was the music of van Beethoven.
3	L.V. Beethoven spent the better part of his life in Vienna.
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.
5	Among the few composers writing for the orphica was Ludvig von Beethoven
6	Betthoven, too, used this key extensively in his second piano concerto.
7	Naue went to Vienna to study briefly with von Beethoven.
8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.
10	Camper van Beethoven were inactive between late 1990 and 1999.
11	Beethoven, meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.
12	Beetehoven hit theaters in april 1992.

C. Barrière, *Natural Language Processing in a Semantic Web Context*, Springer, 2016, p.11
<http://bit.ly/Beethovencorpus>



Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

1	The Andante favori is a work for piano solo by Ludwig van Beethoven.
2	The other great passion of the young Mirabehn was the music of van Beethoven.
3	L.V. Beethoven spent the better part of his life in Vienna.
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.
5	Among the few composers writing for the orchestra was Ludwig von Beethoven
6	Beethoven, too, used this key extensively in his second piano concerto.
7	Napier went to Vienna to study briefly with von Beethoven.
8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.
10	Camper van Beethoven were inactive between late 1990 and 1999.
11	Beethoven, meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.
12	Beethoven hit theaters in April 1992.

- **Task:** Identify sentences that refer to **Ludwig van Beethoven**

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

1	The Andante favori is a work for piano solo by Ludwig van Beethoven.	Actual positive
2	The other great passion of the young Mirabeau was the music of van Beethoven.	
3	L.V. Beethoven spent the better part of his life in Vienna.	
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.	
5	Among the few composers writing for the orchestra was Ludwig von Beethoven	
6	Beethoven, too, used this key extensively in his second piano concerto.	
7	Napoleon went to Vienna to study briefly with von Beethoven.	
8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).	
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.	Actual negative
10	Camper van Beethoven were inactive between late 1990 and 1999.	
11	Beethoven, meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.	
12	Beethoven hit theaters in April 1992.	

- **Task:** Identify sentences that refer to **Ludwig van Beethoven**

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

1	The Andante favori is a work for piano solo by Ludwig van Beethoven.	Actual positive
2	The other great passion of the young Mirabehn was the music of van Beethoven.	
3	L.V. Beethoven spent the better part of his life in Vienna.	
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.	
5	Among the few composers writing for the orphica was Ludvig von Beethoven	
6	Betthoven, too, used this key extensively in his second piano concerto.	
7	Naue went to Vienna to study briefly with von Beethoven.	
8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).	
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.	Actual negative
10	Camper van Beethoven were inactive between late 1990 and 1999.	
11	Beethoven, meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.	
12	Beetehoven hit theaters in april 1992.	

- **Task:** Identify sentences that refer to Ludwig van Beethoven
- **Baseline Algorithm:** *Exact String Match* with full name “**Ludwig van Beethoven**”

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

1	The Andante favori is a work for piano solo by Ludwig van Beethoven.	Actual positive
2	The other great passion of the young Mirabehn was the music of van Beethoven.	
3	L.V. Beethoven spent the better part of his life in Vienna.	
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.	
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8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).	
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.	Actual negative
10	Camper van Beethoven were inactive between late 1990 and 1999.	
11	Beethoven, meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.	
12	Beetehoven hit theaters in april 1992.	

- **Baseline Algorithm:** *Exact String Match* with full name “Ludwig van Beethoven”
 - Identified **3 lines** (1, 4, 8) as **positive**
 - Identified **9 lines** (2, 3, 5, 6, 7, 9, 10, 11, 12) as **negative**

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

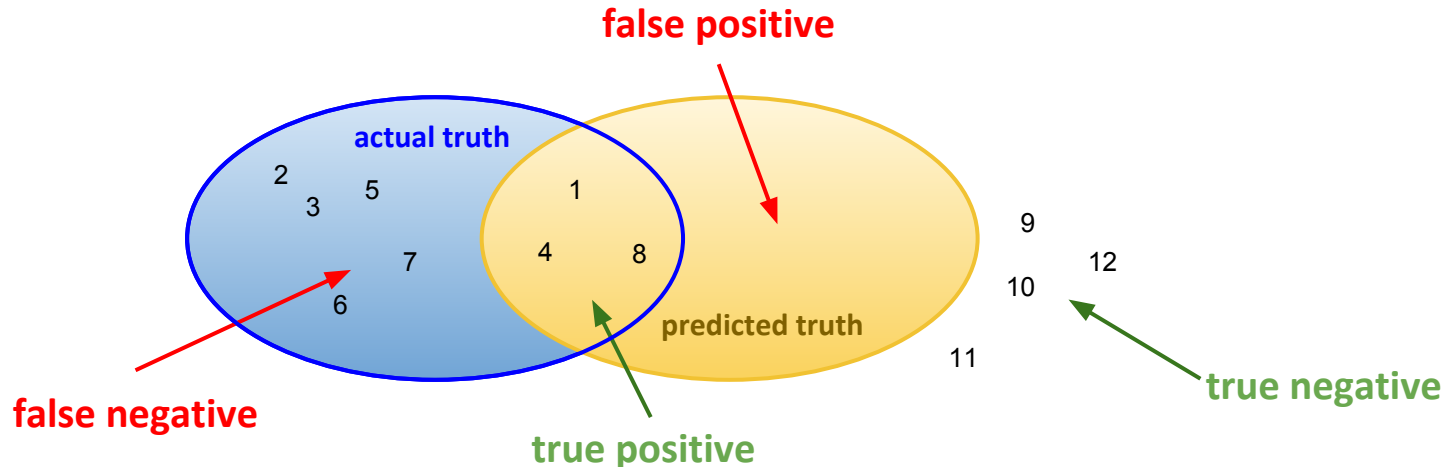
- **Baseline Algorithm:** *Exact String Match* with “*Ludwig van Beethoven*”
 - Identified **3** lines (1, 4, 8) as **positive**, all of it are actual positive (**true positive**)
 - Identified **9** lines (2, 3, 5, 6, 7, 9, 10, 11, 12) as **negative**,
 - **4** lines of it (9, 10, 11, 12) are actual negative (**true negative**)
 - **5** lines of it (2,3,5,6,7) are actual positive (**false negative**)

		predicted	
		true	false
actual	true	3	5
	false	0	4

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **Baseline Algorithm:** *Exact String Match* with “Ludwig van Beethoven”
 - Identified **3 lines** (1, 4, 8) as **positive**, all of it are **actual positive** (**true positive, TP**)
 - Identified **9 lines** (2, 3, 5, 6, 7, 9, 10, 11, 12) as **negative**,
 - **4 lines** of it (9, 10, 11, 12) are **actual negative** (**true negative, TN**)
 - **5 lines** of it (2,3,5,6,7) are **wrongly identified as negative** (**false negative, FN**)

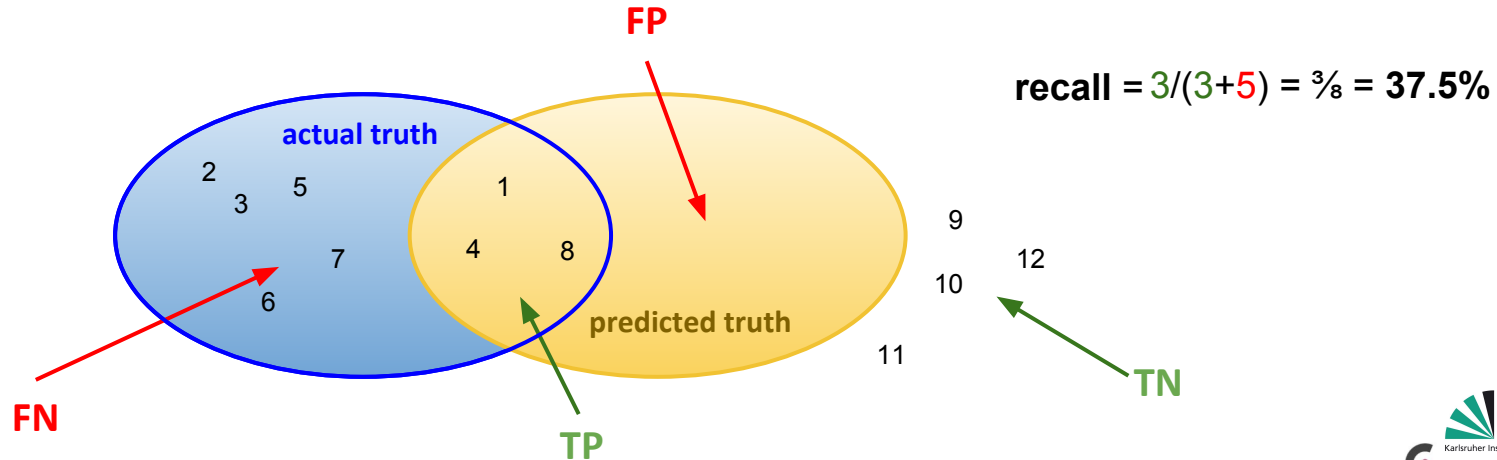


Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **Recall** is the **fraction of relevant instances** that are retrieved/predicted

$$\text{recall} = \frac{\text{true positive}}{\text{true positive} + \text{false negative}}$$

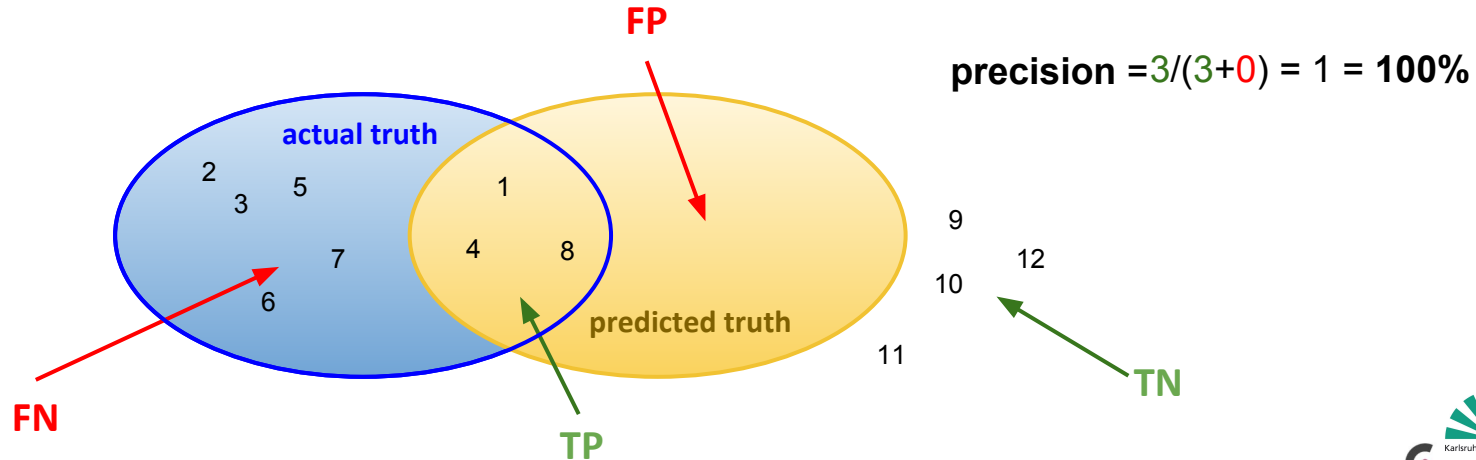


Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **Precision** is the is the **fraction of retrieved instances that are relevant**

$$\text{precision} = \frac{\text{true positive}}{\text{true positive} + \text{false positive}}$$



Experiment

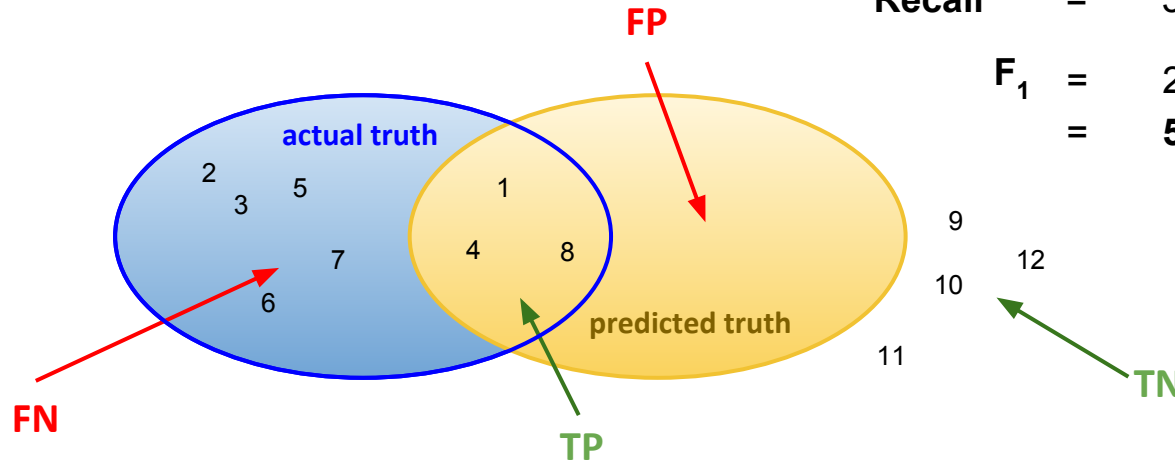
Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **F-Measure** is a measure that combines precision and recall.
- **F₁-Measure** is the harmonic mean of precision and recall.

$$F_1 = 2 \cdot \frac{\text{precision} \cdot \text{recall}}{\text{precision} + \text{recall}}$$

Precision = 100%
Recall = 37.5%

F₁ = 2 * [100 * 37.5 / (100 + 37.5)]
= **54.5 %**



Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

1	The Andante favori is a work for piano solo by Ludwig van Beethoven .	Actual positive
2	The other great passion of the young Mirabehn was the music of van Beethoven .	
3	L.V. Beethoven spent the better part of his life in Vienna.	
4	Charles Munch conducted the symphony no. 9 of Ludwig van Beethoven in 1962.	
5	Among the few composers writing for the orphica was Ludvig von Beethoven	
6	Betthoven, too, used this key extensively in his second piano concerto.	
7	Naue went to Vienna to study briefly with von Beethoven .	
8	Bonn is the birthplace of Ludwig van Beethoven (born 1770).	
9	Johann van Beethoven joined the court, primarily as a singer, in 1764.	Actual negative
10	Camper van Beethoven were inactive between late 1990 and 1999.	
11	Beethoven , meanwhile, runs after a loose hot dog cart and ends up on a merry-go-round.	
12	Beetehoven hit theaters in april 1992.	

- **Task:** Identify sentences that refer to Ludwig van Beethoven
- **Another Algorithm:** *Exact String Match* with surname "**Beethoven**"
 - Identified **10 lines** (1,2,3,4,5,7,8,9,10,11) as **positive**
 - Identified **2 lines** (6,12) as **negative**

Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **Another Algorithm: *Exact String Match* with “Beethoven”**

- Identified **10 lines** (1,2,3,4,5,7,8,9,10,11) as **positive**,
 - **7 lines** of it (1,2,3,4,5,7,8) are **actual positive** (**true positive**),
 - **3 lines** of it (9,10,11) are **actual negative** (**false positive**)
- Identified **2 lines** (6, 12) as **negative**,
 - **1 line** of it (12) is **actual negative** (**true negative**)
 - **1 line** of it (6) is **actual positive** (**false negative**)

		predicted	
		true	false
actual	true	7	1
	false	3	1

● **Precision** = $7/10$ = **70%**

● **Recall** = $7/8$ = **87.5%**

● **F₁** = $2 (0.7 \cdot 0.875) / (0.7 + 0.875)$
= 0.7777 = **77.7%**

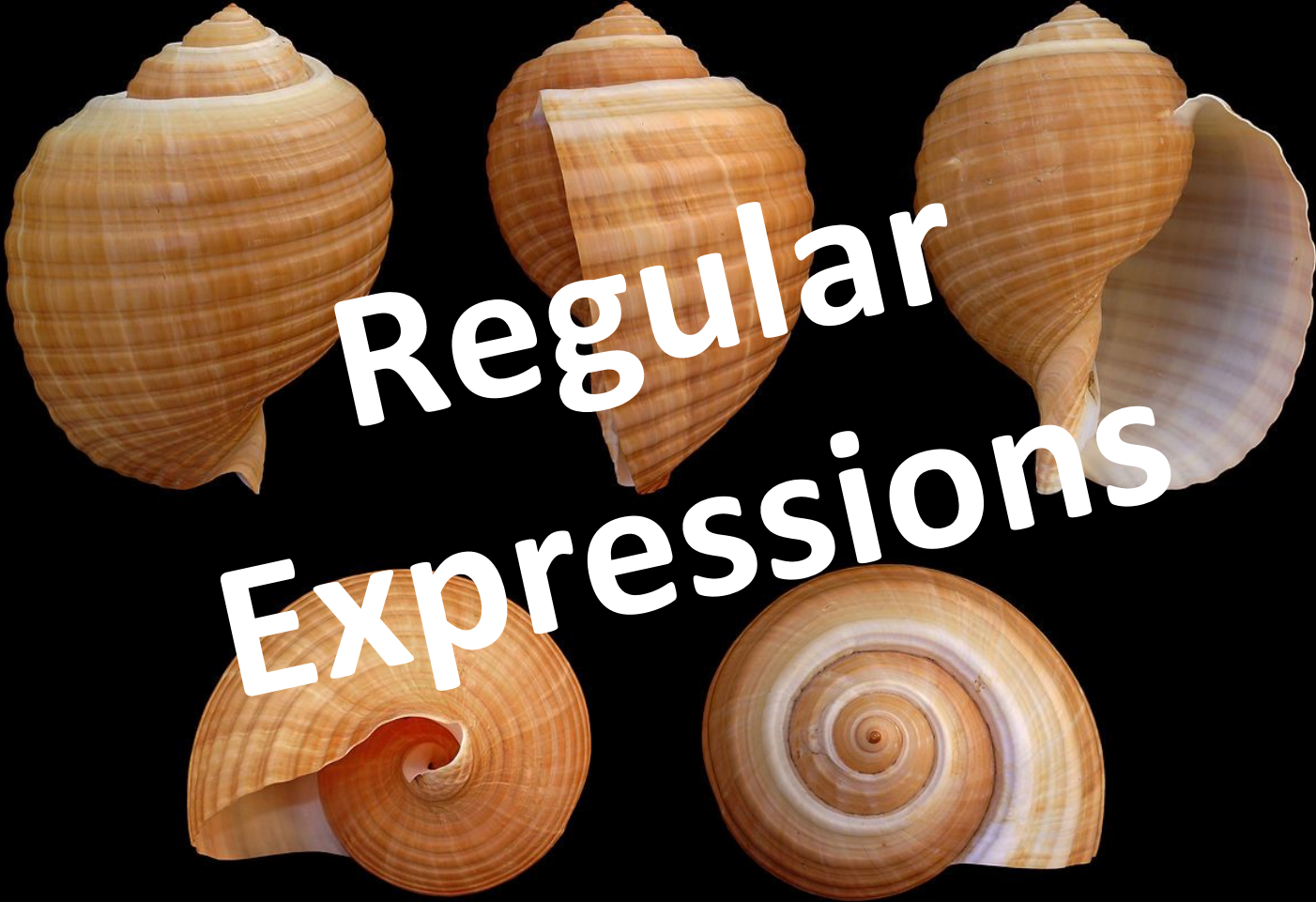
Experiment

Information Service Engineering - Lecture 1 Natural Language Processing - 1.6 Evaluation, Precision, and Recall

- **Another Algorithm: *Exact String Match* with “Beethoven”**
 - Identified **10 lines** (1,2,3,4,5,7,8,9,10,11) as **positive**,
 - **7 lines** of it (1,2,3,4,5,7,8) are **actual positive** (**true positive**),
 - **3 lines** of it (9,10,11) are **actual negative** (**false positive**)
 - Identified **2 lines** (6, 12) as **negative**,
 - **1 line** of it (12) is **actual negative** (**true negative**)
 - **1 line** of it (6) is **actual positive** (**false negative**)

		predicted	
		true	false
actual	true	7	1
	false	3	1

- Precision = $7/10$ = 70%
- Recall = $7/8$ = 87.5%
- F_1 = $2 (0.7 * 0.875) / (0.7 + 0.875)$
= 0.7777 = 77.7%



Regular Expressions

Next Lecture...

Picture References:

- P.5/15: Ludwig van Beethoven, Portrait by Joseph Karl Stieler (1820), <https://commons.wikimedia.org/wiki/File:Beethoven.jpg>
- P.19: Tonna galea, Tonnidae, Giant Tun, length 14 cm, https://commons.wikimedia.org/wiki/File:Tonna_galea_02.jpg