# Part 2

## Analysis Tasks

# Outline

## Part 2: Analysis Tasks

**2.1 Argument Mining Overview**

**2.2 Segmenting Texts into Argumentative Units**

**2.3 Classifying Types of Units**

**2.4 Identifying Relations between Units**

**2.5 Classifying Stance and Analyzing Polarity**

**2.6 Assessing Argumentation Quality**

# Argument Mining Overview

## *Definition*

- Analyzing **discourse** on the **pragmatic** level and applying a certain **argumentation theory** to **model** and automatically **analyze** the data at hand

- ***Discourse*** = goes beyond sentence
- ***Pragmatics*** = considers the function of the language (which corresponds to the particular role in the argumentation model, for instance)
- ***Argumentation theory*** = provides the theoretical foundation
- ***Model*** = basically our model of the data at hand (be it a flat annotation, a graph, a scheme category, etc.)
- ***Analyze*** = computational approaches to mimic human cognition

# Argument Mining Overview

## *Example*

*"Since researchers at the Roslin Institute in Edinburgh cloned an adult sheep, there is an ongoing debate if cloning technology is morally and ethically right or not. Cloning will be beneficial for many people who are in need of organ transplants. Cloned organs will match perfectly to the blood group and tissue of patients since they can be raised from cloned stem cells of the patient. In addition, it shortens the healing process. Usually, finding an appropriate organ donor takes a long time and by using cloning in order to raise required organs the waiting time can be shortened tremendously."*

# Argument Mining Overview

## *Example: Segmenting Texts into Argumentative Units*

"*Since researchers at the Roslin Institute in Edinburgh cloned an adult sheep, there is an ongoing debate if cloning technology is morally and ethically right or not. Cloning will be beneficial for many people who are in need of organ transplants. Cloned organs will match perfectly to the blood group and tissue of patients since they can be raised from cloned stem cells of the patient. In addition, it shortens the healing process. Usually, finding an appropriate organ donor takes a long time and by using cloning in order to raise required organs the waiting time can be shortened tremendously*."

# Argument Mining Overview

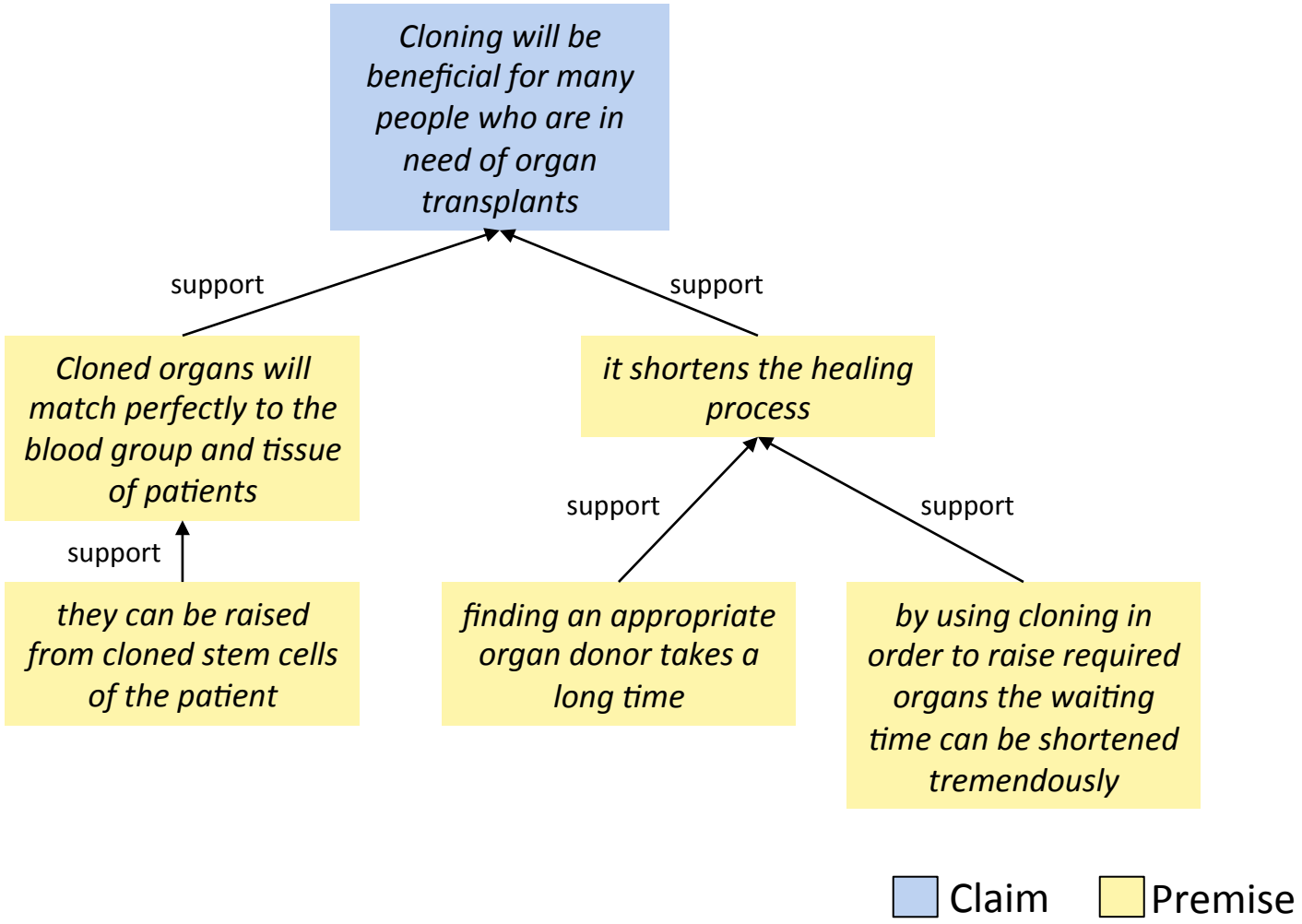
## *Example: Classifying Types of Units*

*"Since researchers at the Roslin Institute in Edinburgh cloned an adult sheep, there is an ongoing debate if cloning technology is morally and ethically right or not. Cloning will be beneficial for many people who are in need of organ transplants. Cloned organs will match perfectly to the blood group and tissue of patients since they can be raised from cloned stem cells of the patient. In addition, it shortens the healing process. Usually, finding an appropriate organ donor takes a long time and by using cloning in order to raise required organs the waiting time can be shortened tremendously."*

Claim Premise

# Argument Mining Overview

## *Example: Identifying Relations between Units*



# Argument Mining Overview

## *Tasks in Argument Mining*

### *Raw input text*

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### *Argument components*

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- Separate argumentative from non-argumentative text units
- Identification of argument component boundaries

### *Component types*

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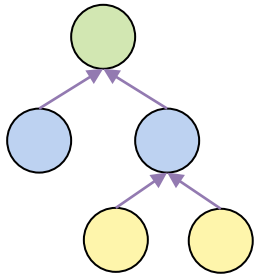
- Argumentative role of argument components
- e.g. conclusions, claims, different types of evidence, etc.

### *Argument structure*



- Identification of relations between argument components
- e.g. support / attack relations

# Argument Mining Overview

## *Challenges and Tasks*

***Non-argumentative information***

➔ Separation of argumentative and non-argumentative text units

***Component boundaries differ from sentence boundaries***

➔ Multi-sentence components

➔ Micro-level components

***Argument boundaries are not equal to paragraph boundaries***

➔ Separation of arguments

***Argumentative relations between non-adjacent units***

➔ Consider each argument component pair; skewed class distribution

# Outline

## Part 2: Analysis Tasks

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**2.2 Segmenting Texts into Argumentative Units**

2.3 Classifying Types of Units

2.4 Identifying Relations between Units

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# Segmenting Texts into Argumentative Units

Separation of argumentative from non-argumentative text units

- Identify argumentatively relevant text units
- Recognize **argument components**

Granularity of argument components differs (depends on corpora)

- Sentence-level
- Clause-level
- Multi-sentence

There is a tendency to use clause-level and multi-sentence components

- A sentence can include several argument components
- An argument component can cover several sentences (Rinott et al. 2015) (Habernal and Gurevych, 2016)

# Segmenting Texts into Argumentative Units

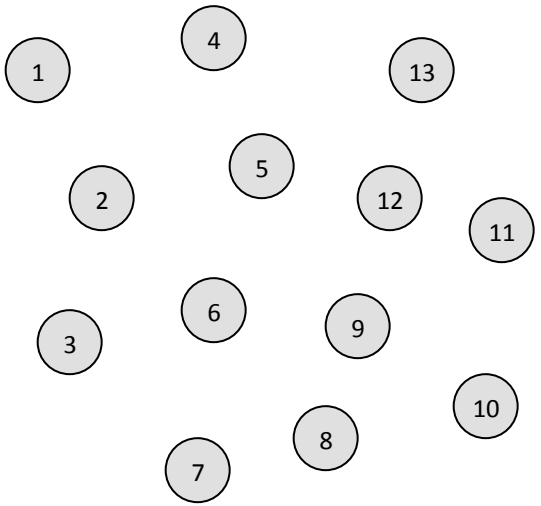
***Example Essay:***

Museums and art galleries will disappear soon?

It is quite common that more and more people can watch exhibitions through television or internet at home due to modern technology; therefore, some people think museums and art galleries will disappear soon. However, I still believe [some museums and art galleries will not disappear]$_1$.
[Technology indeed simplifies people's life all the time]$_2$. Obviously, [people who watch exhibitions on TV or internet at home, save the time and money on the road, which is increasingly significant particularly to people in modern society]$_3$. However, [in accordance with recent research, experts suggest the lifestyle of individuals in modern society is unhealthy]$_4$ because [they lack of physical exercise and face-to-face communication]$_5$.
[The importance of museums and art galleries is plain in terms of education and culture]$_6$. First of all, [authentic exhibits cannot be completely displayed only by images and videos]$_7$. [Travelling to a place is much better than viewing the landscape of that place on TV or photos]$_8$, so [the best method to learn one thing is to experience it]$_9$. Furthermore, [museums and art galleries preserve some culture heritages]$_{10}$; therefore, [these buildings will not disappear unless people abandon their culture]$_{11}$.
In conclusion, I admit that [modern technology has provided a more convenient and comfortable manner for people to watch exhibitions]$_{12}$ but [museums and art galleries are necessary to be preserved for its importance of education and culture]$_{13}$.

## Identification of argument components

- Separate argumentative from non-argumentative text
- Identify boundaries of argument components



# Segmenting Texts into Argumentative Units

## *Overview of existing approaches*

Sentence-level classification

- Feature-driven approaches (Moens et al., 2007)
- Partial Tree Kernels (Lippi and Torroni, 2015)

Several consecutive analysis steps (Goudas et al. 2014)

- ***Step 1***: sentence-level classification
- ***Step 2***: boundary detection with CRF

Ranking-based approaches (Levy et al. 2014)

- ***Step 1***: detect relevant sentences
- ***Step 2***: generate candidate boundaries
- ***Step 3***: rank relevance of claim candidates for a given topic

# Segmenting Texts into Argumentative Units

## *IOB-tagging in student essays*

Combination of (1) separation and (2) boundary detection

Sequence labeling task at token-level

- Encode argument components using an IOB-tagset
  - Labels: Arg-B, Arg-I, O
  - Example:

| Tokens: | 1 | 2 | 3 | 4 | 5 | … |
|---|---|---|---|---|---|---|
| Text: | Obviously | , | people | who | watch | … |
| Labels: | O | O | Arg-B | Arg-I | Arg-I | … |

Features:

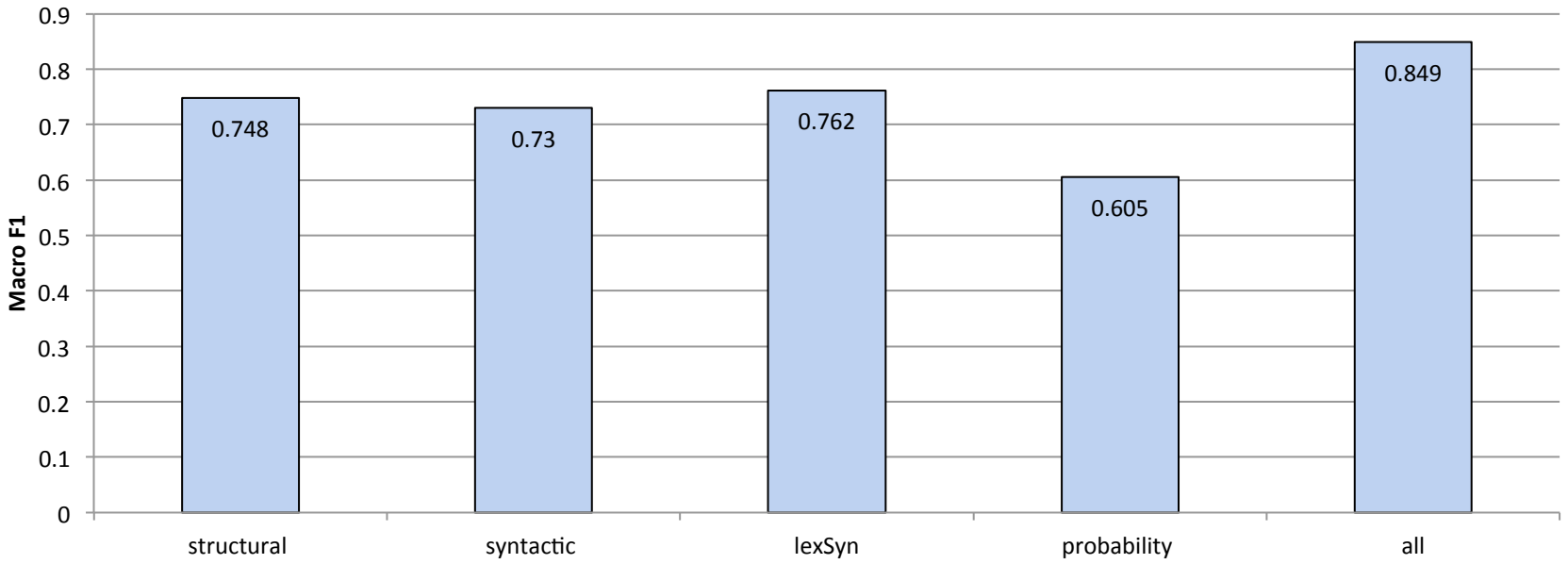
- Structural (e.g. present in introduction or conclusion, relative position in paragraph, etc.)
- Syntactic (part-of-speech, LCA in parse tree)
- Lexico-syntactic (combination of lexical and syntactic features)
- Probability (conditional probability that a token is Arg-B given its three preceding tokens)

Learner: Conditional Random Field (CRF)

# Segmenting Texts into Argumentative Units

*IOB-tagging in student essays*

***Feature Analysis (model selection)***

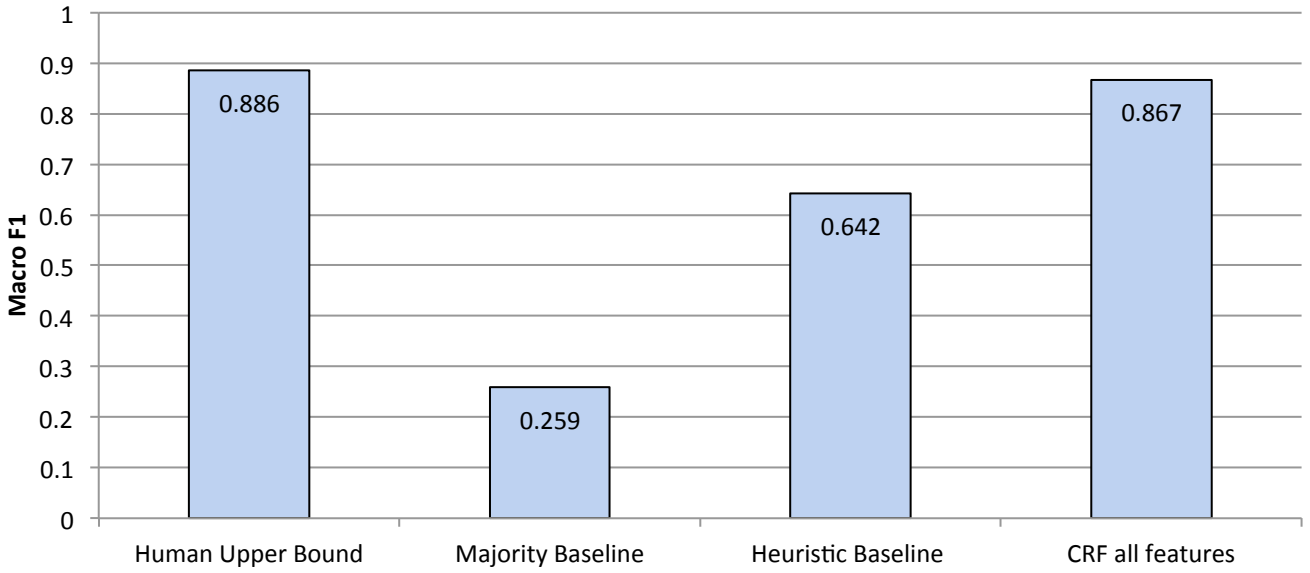



- Lexico-Syntactic features perform best
- Combination of all features outperforms all individual features

# Segmenting Texts into Argumentative Units

*IOB-tagging in student essays*

## *Model Assessment*




- Majority baseline: Classifies each token as Arg-I
- Heuristic baseline: All sentences as argument components except the first two and the last
- The CRF model achieves 98.5% of human performance!

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# Classifying Types of Units

*Overview of existing approaches*

Identification of the **argumentative function** of argument components

Different argument components, e.g.:

- Conclusion and premise (Mochales-Palau et al. 2009)
- Major claim, claim and premise (Stab and Gurevych, 2014b)
- Claim, premise, backing, rebuttal and refutation (Habernal and Gurevych 2016)
- Different types of claims: support, oppose, propose (Kwon et al. 2007)
- Different types of evidence: study, expert and anecdotal (Rinott et al. 2015)

Claim-premise scheme is widely adopted.

# Classifying Types of Units

***Example Essay:***

Museums and art galleries will disappear soon?

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[Technology indeed simplifies people's life all the time]$_2$. Obviously, [people who watch exhibitions on TV or internet at home, save the time and money on the road, which is increasingly significant particularly to people in modern society]$_3$. However, [in accordance with recent research, experts suggest the lifestyle of individuals in modern society is unhealthy]$_4$ because [they lack of physical exercise and face-to-face communication]$_5$.
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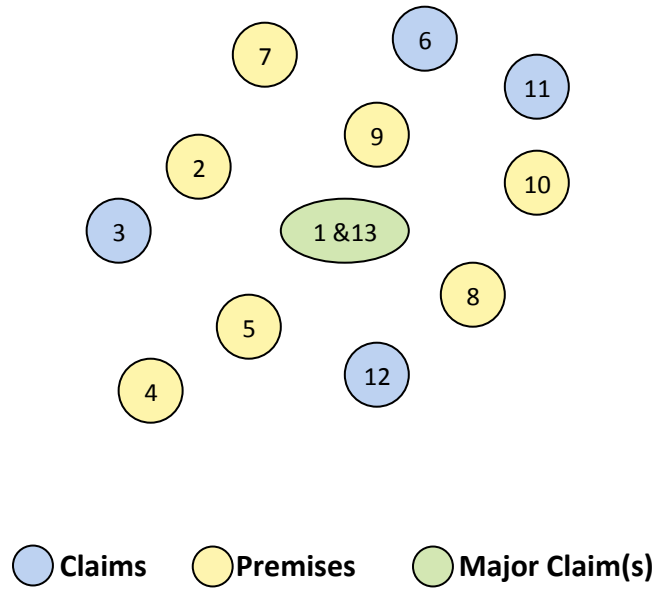
**Classification of component types**



# Classifying Types of Units

***Argumentative types in persuasive essays***

Multi-class classification of arg. components

- Labels: (1) major claim, (2) claim, (3) premise

Features:

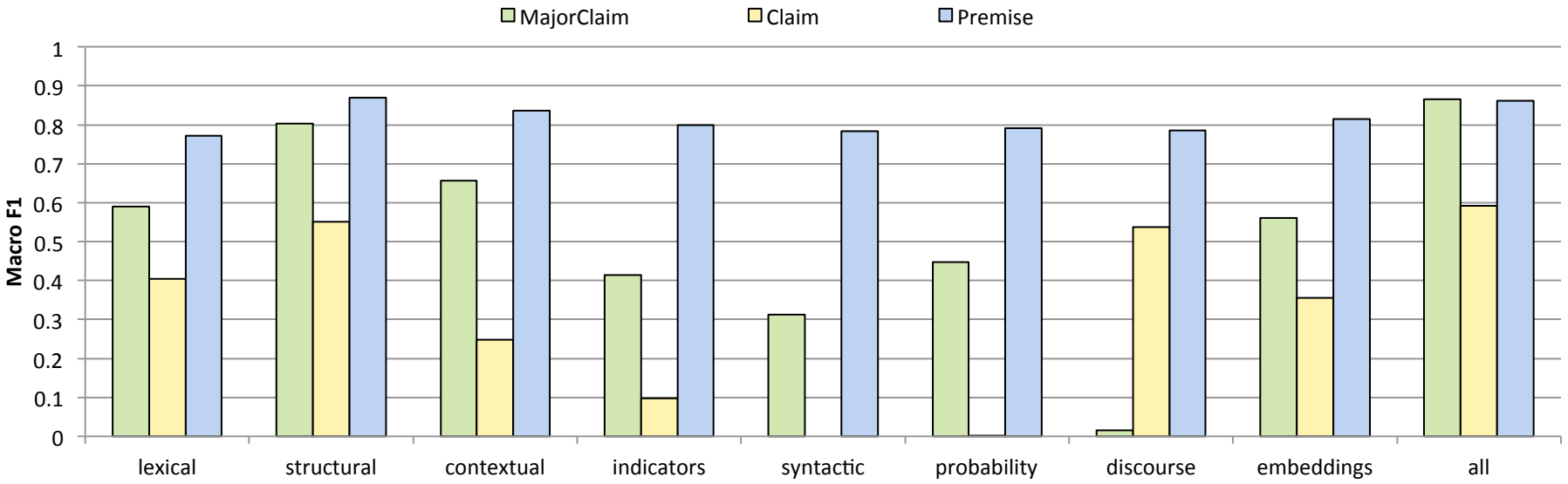
- Lexical (lemmatized unigrams including preceding tokens)
- Syntactic (#subclauses, depth of parse tree, tense of main verb, POS-distribution, modals)
- Structural (first or last in paragraph, present in intro or conclusion, relative position, #tokens, etc.)
- Indicators (discourse indicators: (1) forward or (2) backward reason, (3) thesis or (4) rebuttal)
- Contextual (indicators in context; number of shared words with the introduction or conclusion)
- Probability (conditional probability: P(type | precedingTokens))
- Discourse (discourse relation based on Penn Discourse Treebank; PDTB)
- Embeddings (embeddings with 300 dimensions trained on the google news corpus)

Learner: SVM

# Classifying Types of Units

## *Argumentative types in persuasive essays*

### *Feature Analysis (model selection)*

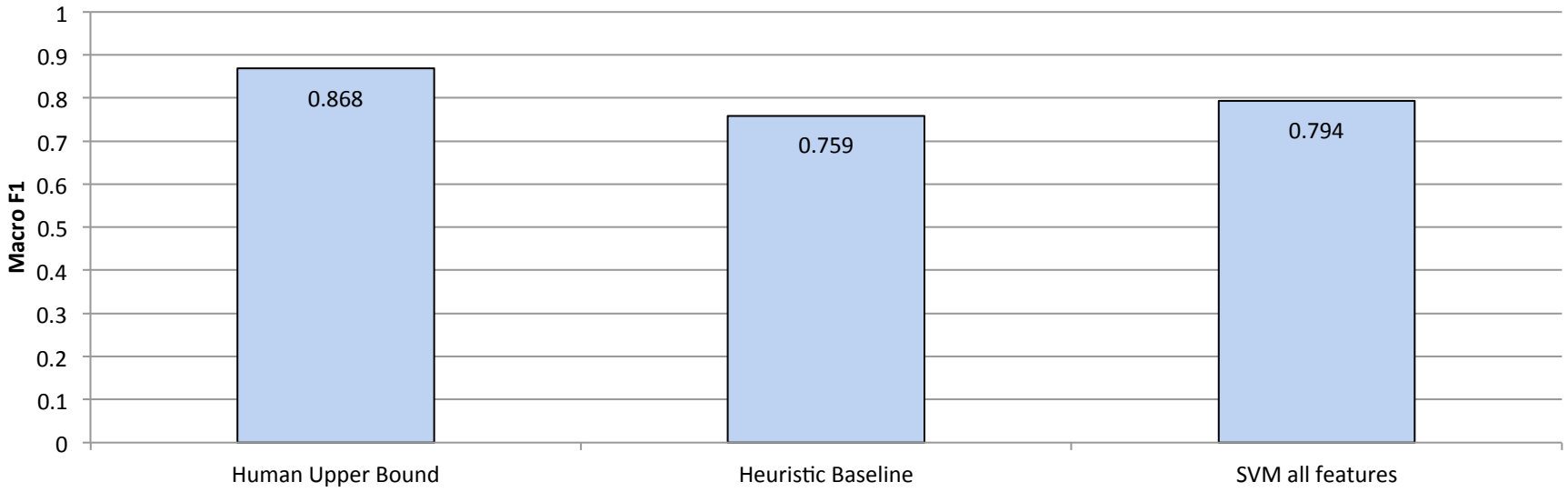



- Structural features perform best
- Word embeddings perform similar to common lexical features
- Discourse features are informative for identifying claims
- Claim classification is the most complicated task
- Using all features results in the best Macro F1 score

# Classifying Types of Units

## *Argumentative types in persuasive essays*

### *Model Assessment*




Heuristic baseline: Exploits structure; last component of introduction and first as major claim; first component of body paragraphs as claim; remaining as premise

SVM all features outperforms heuristic baseline and achieves 91.5% of human performance

# References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# Identifying Relations between Units

## *Overview of existing approaches*

Pair classification of argument components

- Argumentative relations are directed
- Each pair of components needs to be considered

Existing approaches

- Encode the target component in the tagset (Peldszus 2014)
- Classify a pair of components as support or not-support (Stab and Gurevych 2014b)
- Joint model based on minimum spanning tree (MST) (Peldszus and Stede 2015)
- Joint model based on integer linear programming (ILP) (Stab and Gurevych 2016)

# Identifying Relations between Units

## *Pair classification in persuasive essays*

***Example Essay:***

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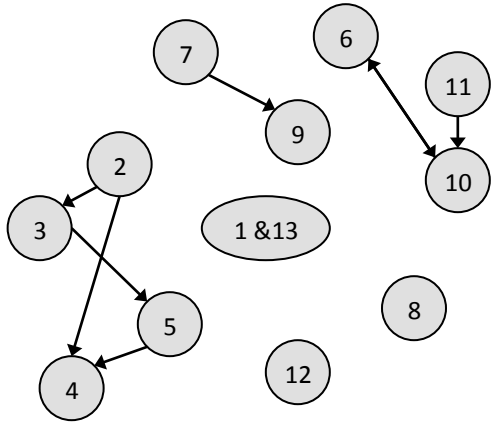
### Identification of argumentative relations

- Classification of ordered argument component pairs



# Identifying Relations between Units

***Pair classification in persuasive essays***

Pair classification task

- Labels: (1) Not-Linked, (2) Linked

Features:

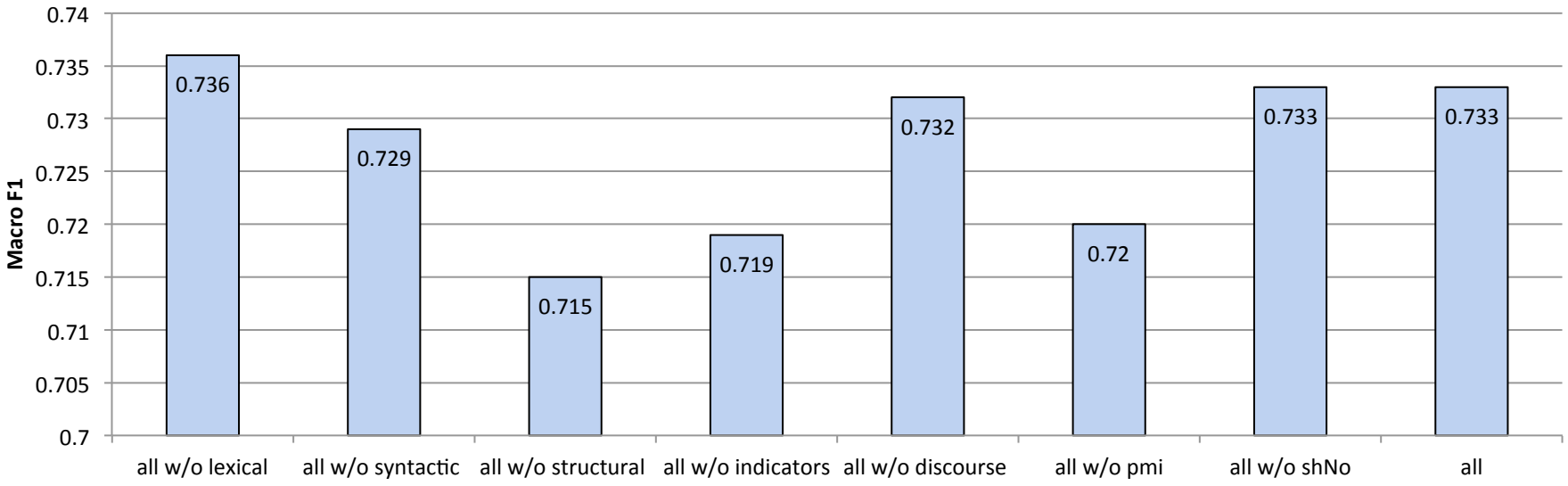
- Lexical (binary lemmatized unigrams of source and target)
- Syntactic (binary POS features, production rules)
- Structural (#tokens, distance, source before target, first or last component of paragraph)
- Indicators (indicators between and of source and target)
- Discourse (for source, target and between both component)
- PMI-feature (PMI information of preceding tokens and incoming or outgoing relations)
- Shared nouns (number of shared nouns between source and target component)

Learner: SVM

# Identifying Relations between Units

## *Pair classification in persuasive essays*

### *Feature Ablation Test (model selection)*

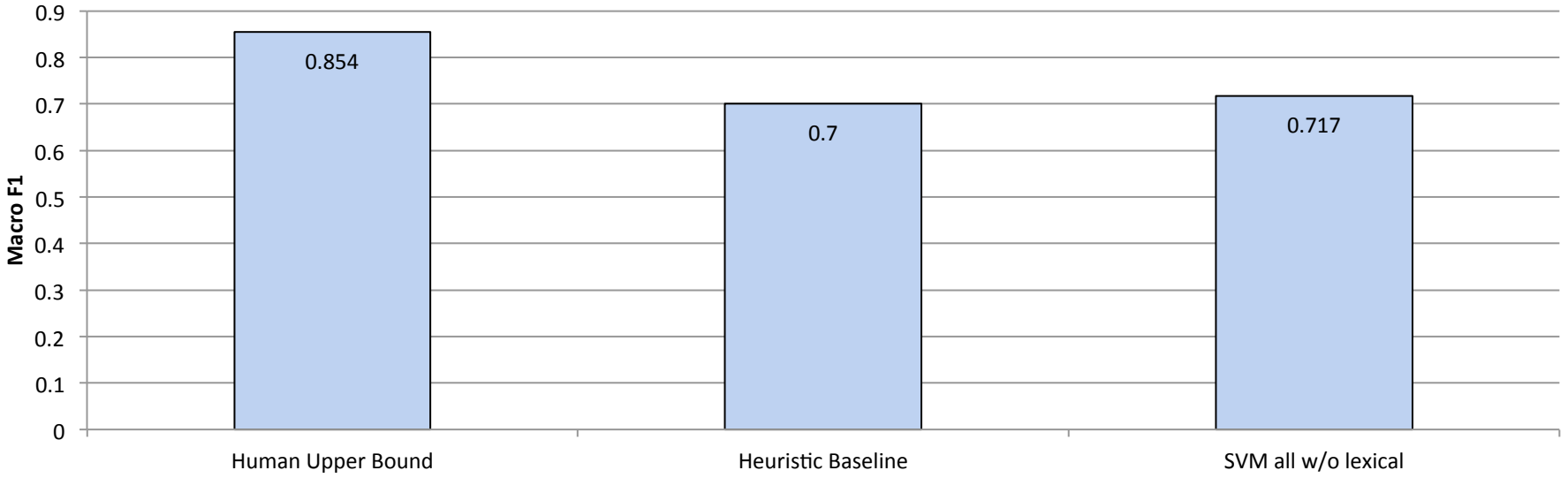



- Structural features are most predictive (largest decrease when removed)
- Indicators are 2nd best features
- Best performance without lexical features

# Identifying Relations between Units

## *Pair classification in persuasive essays*

### *Model Assessment*




Heuristic Baseline: Links each component to the first component of the paragraph

SVM all w/o lexical yields only slight improvement over heuristic baseline

The approach achieves 84.0% of human performance

# Identifying Relations between Units

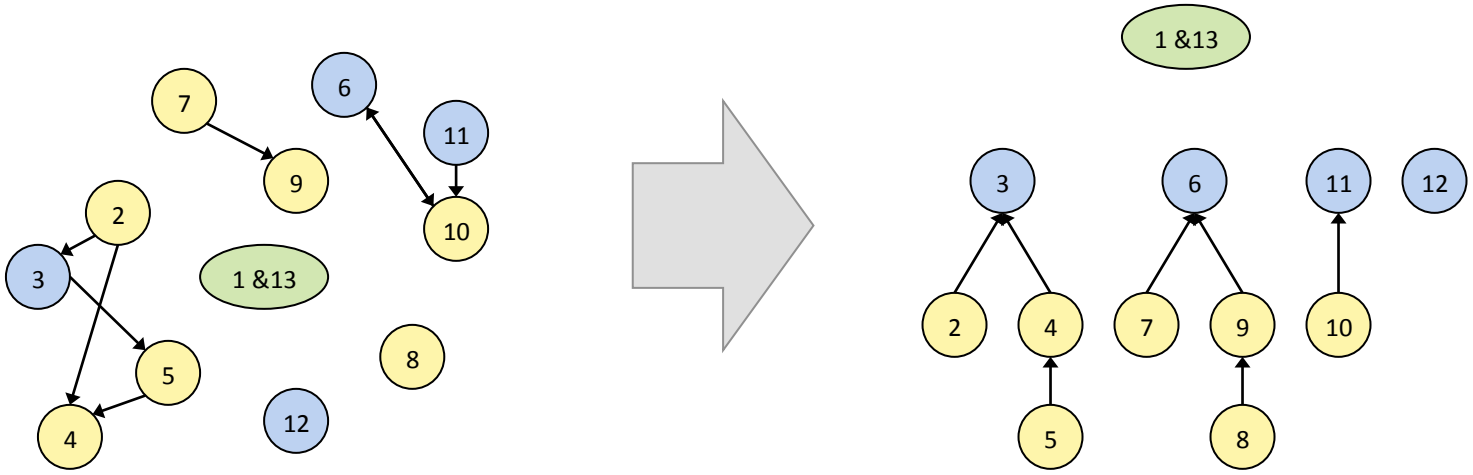
*Jointly modeling argumentation structures*

**Given**

- Argument component types
- Arbitrary relations

**Goal**

- Find tree(s) that optimizes previous analysis steps
- Adapt argument component types accordingly



# Identifying Relations between Units

## *Jointly modeling argumentation structures*

Argument component types and argumentative relations share mutual information

| ***Component Type*** | ***Argumentative Relation*** |
|---|---|
| Claim | No outgoing relations (root node) |
| Premise | Exhibits outgoing relations |
| Claim | More incoming relations |
| Premise | Less incoming relations |

Idea:

Jointly model **argument component types** and **argumentative relations** to find an optimal tree

# Identifying Relations between Units

## *Jointly modeling argumentation structures*

MST-based joint modeling for argumentation mining (Peldszus and Stede 2015)

Four local base classifiers

- Relation identification (pair classification)
- Central claim classification
- Role of argument components (“proponent” or “opponent”)
- Function of argument components (“support” or “attack”)

Combines predictions of base classifiers in edge weights of a fully-connected graph

Minimum Spanning Tree (MST) finds a single tree

# Identifying Relations between Units

## *Jointly modeling argumentation structures*

ILP-based argumentation structure parser (Stab and Gurevych 2016)

Two local base classifiers

- Component classification of argument components
- Relation identification by classifying argument component pairs

Results of base classifier are combined in relation weights

Integer Linear Programming (ILP) globally optimizes the results

Constraints ensure that

- There is at least one component without outgoing edge (claim)
- No component has more that one outgoing relation
- Source and target of a relation are not the same
- Structure is non-cyclic

# Identifying Relations between Units

*Jointly modeling argumentation structures*

Comparison of ILP and MST approaches

**ILP-approach**

- Two base classifiers
- Capable of separating several arguments, i.e. trees
- Does not recognize role and function of components
- Able to detect unlinked components, e.g. unsupported claims

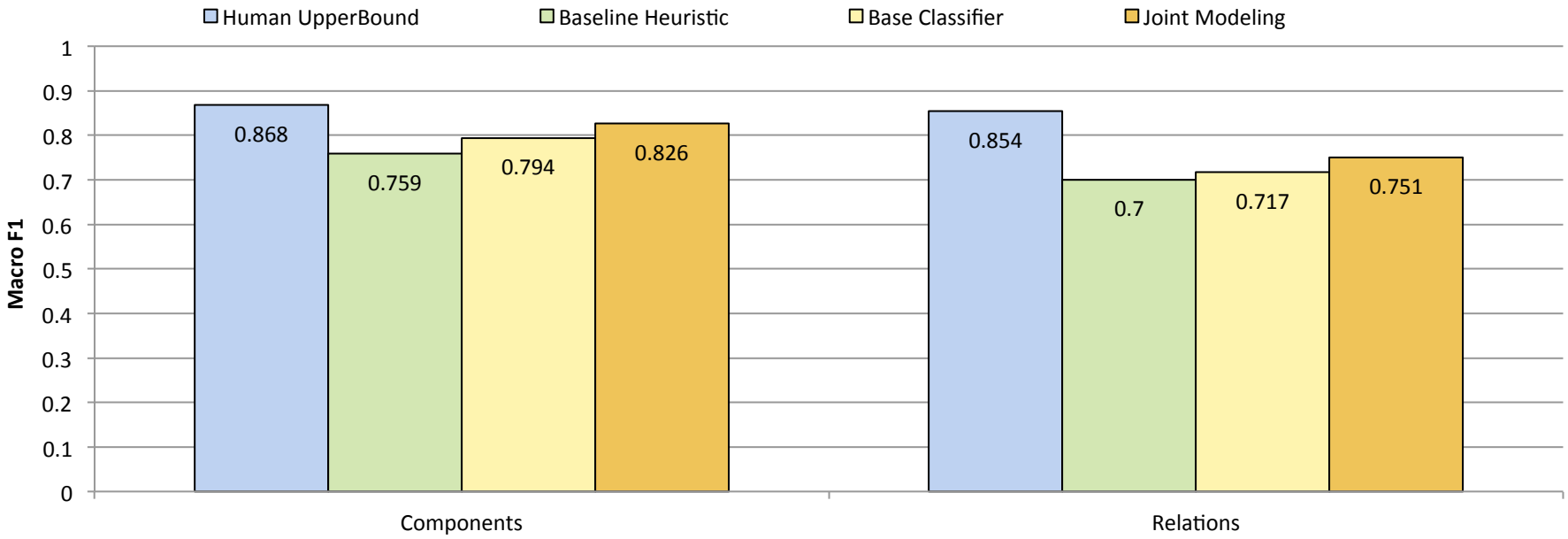
**MST-approach**

- Four base classifiers
- Recognizes one tree
- Models role and function of argument components
- Links all given components in a single tree structure

# Identifying Relations between Units

*Jointly modeling argumentation structures*

***Evaluation of ILP Joint Model on persuasive essays***




Joint model simultaneously improves component and relation classification

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