

# Doubling DOP\*

## A comparison of Double-DOP and DOP\*

Benno Kruit Sara Veldhoen

Supervised by:

Andreas van Cranenburg Khalil Sima'an

University of Amsterdam (UvA)

Project AI, January 2014

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

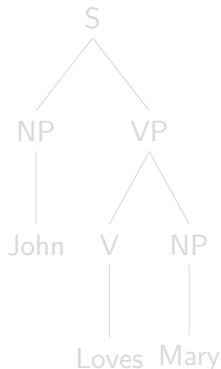
Summary

# Parsing

- ▶ input: sentence

*John Loves Mary*

- ▶ output: constituent tree



Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*  
Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary



A grammar describes:

- ▶ how trees can be built
  - ▶ CFG's - elementary rules
  - ▶ TSG's - larger units: *fragments*
- ▶ how likely constructions are: *probabilistic* grammars
  - ▶ PCFG's - independence
  - ▶ PTSG's - derivations

# Grammar: CFG rules

$S \rightarrow NP VP$

$VP \rightarrow V NP$

$NP \rightarrow John$

$NP \rightarrow Mary$

$V \rightarrow loves$

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

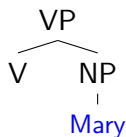
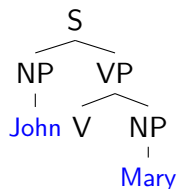
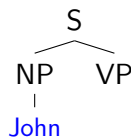
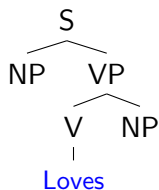
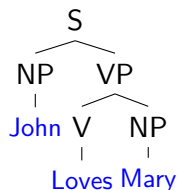
Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Grammar: Tree fragments



Etc...  
Exponentially many

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary



# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Consistency

- ▶ Assumption
  - ▶ Language is an infinite parse tree distribution
  - ▶ Treebank is a finite sample
- ▶ *Estimate* the true distribution
- ▶ Expected estimation should improve when the treebank grows → expected *loss* should decline
- ▶ **Consistency**: Expected loss becomes 0 when the sample size approaches  $\infty$

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

- ▶ Assumption
  - ▶ An estimator should approach *any* distribution
  - ▶ Even finite distributions!
- ▶ If there's a distribution that doesn't match its expected estimate, the estimator is **biased**.
- ▶ What about unseen data?
- ▶ Bias is **good**

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Double-DOP

- ▶ Extraction: Maximal Overlap
- ▶ Estimation: relative frequency
- ▶ Coverage: PCFG rules

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*  
Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

- ▶ Held-out estimation - *HC* and *EC*
- ▶ Extraction: Shortest derivations
- ▶ Estimation: relative frequency *in shortest derivations*
- ▶ Coverage: smoothing PCFG rules with probability  $p_{unkn}$

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Comparison

- ▶ Shortest derivations or Maximal overlap
- ▶ Split or full estimation
- ▶ Consistency

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary



# Example

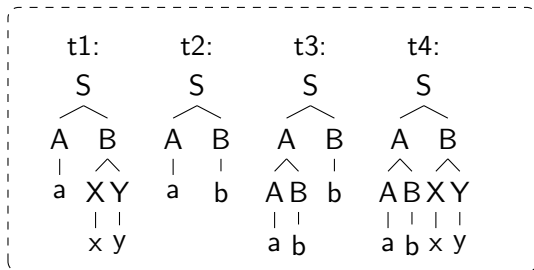


Figure : A toy treebank

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Example

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary



Figure : Some extracted fragments

# Example

Doubling DOP\*

Kruit, Veldhoen

	Maximal overlap	weight	Shortest deriv. <sup>1</sup>	weight
f1	(t1,t3),(t2,t4)	4/12	-	0
f2	(t1,t2)	2/12	1b, 2a	1/4
f3	(t2,t3)	2/12	2b, 3b	1/4
f4	(t3,t4)	2/12	3a, 4b	1/4
f5	(t1,t4)	2/12	1a, 4a	1/4
f6	(t1,t3),(t1,t4), (t2,t3),(t2,t4)	4/6	1a, 2b	1/2
f7	-	0	3b, 4a	1/2
f8	CFG rule	2/6	-	0
f9	(t2,t3),(t2,t4), (t3,t4)	4/6	2a, 3a	1/2
f10	-	0	1b, 4b	1/2
f11	CFG rule	2/6	-	0
f12	CFG rule	2/2	-	0
f13	CFG rule	2/2	-	0

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

Table : Weight assignment of MO and SD, full estimation

<sup>1</sup>  $t_1 = f_5 \circ f_6(a)$  or  $f_2 \circ f_{10}(b)$ ,  $t_2 = f_2 \circ f_8(a)$  or  $f_3 \circ f_6(b)$ ,  
 $t_3 = f_4 \circ f_8(a)$  or  $f_3 \circ f_7(b)$ ,  $t_4 = f_5 \circ f_7(a)$  or  $f_4 \circ f_9(b)$

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Experiments

Estimation and Parsing with the Disco-Dop framework.

Three grammars:

- ▶ Maximal Overlap Full (Double-DOP)
- ▶ Maximal Overlap Split
- ▶ Shortest Derivation Split (DOP\*)

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

Wall Street Journal (WSJ) section of the Penn Treebank  
Preprocessing:

- ▶ Removing functions
- ▶ Binarizing by Markovization ( $h=1$   $v=1$ )

- ▶ Estimation
  - ▶ Full: Maximal Overlap
  - ▶ Split: 10 random folds, interpolating results
    - ▶ Maximal Overlap
    - ▶ Shortest Derivation
  - ▶ Smoothing
- ▶ Parsing
  - ▶ Input: sentences with sentences with a POS-tag attached to each word
  - ▶ Output: Parsing accuracy scores

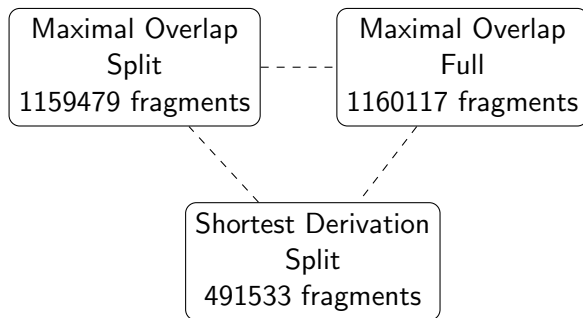


Figure : The grammars and their size

$$p_{unkn} = 1.41 \times 10^{-3}$$



# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Scores

	Maximal Overlap Full	Maximal Overlap Split	Shortest Derivation Split
labeled recall	86.17	85.11	79.20
labeled precision	86.05	85.50	79.32
labeled f-measure	86.11	85.31	79.26
exact match	28.32	25.87	16.52

Table : Results for 1229 sentences of length  $\leq 40$

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Outline

## Data Oriented Parsing

Introduction to DOP

Bias and Consistency

## Double-DOP and DOP\*: a comparison

Introduction to Double-DOP and DOP\*

Comparison

Experiments

## Results

Parsing Performance

Analyzing grammars

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

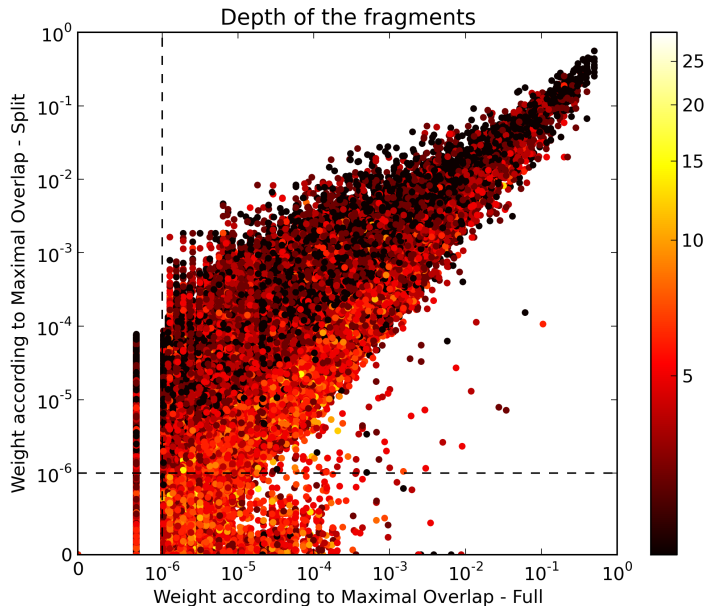
Parsing Performance  
**Analyzing grammars**

Summary

# Split $\leftrightarrow$ Full

Doubling DOP\*

Kruit, Veldhoen



Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*  
Comparison  
Experiments

Results

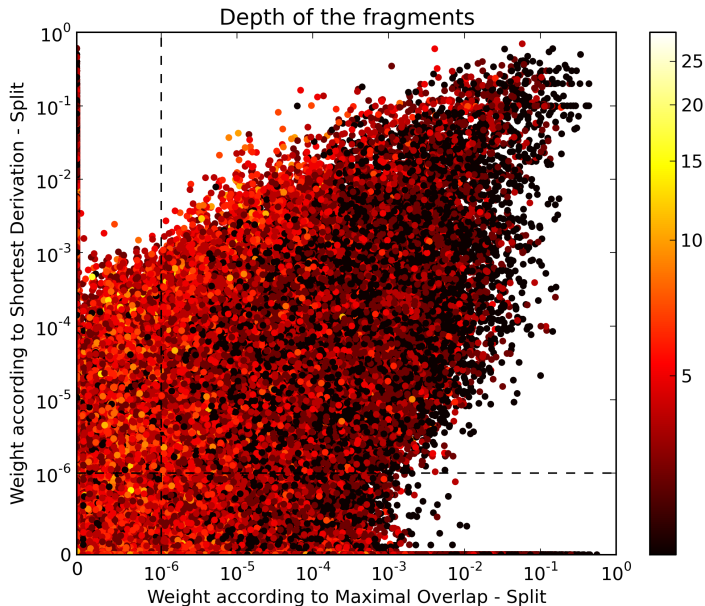
Parsing Performance  
Analyzing grammars

Summary

# Maximal overlap $\leftrightarrow$ shortest derivation

Doubling DOP\*

Kruit, Veldhoen



Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*  
Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Summary

- ▶ **Shortest Derivation** moves weight to larger fragments
- ▶ **Split** moves weight to smaller fragments
- ▶ **Performance** is not necessarily related to **consistency**:  
**DOP\*** has bad parsing performance
- ▶ Outlook
  - ▶ Further analysis
  - ▶ Other estimators

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*

Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary

# Acknowledgments

- ▶ Andreas van Cranenburgh
- ▶ Khalil Sima'an

Doubling DOP\*

Kruit, Veldhoen

Data Oriented  
Parsing

Introduction to DOP  
Bias and Consistency

Double-DOP and  
DOP\*: a  
comparison

Introduction to  
Double-DOP and  
DOP\*  
Comparison  
Experiments

Results

Parsing Performance  
Analyzing grammars

Summary