# Strings for Temporal Annotation and Semantic Representation of Events

by

#### **David Woods**

A dissertation submitted

in fulfillment of the requirements

for the Degree of

**Doctor of Philosophy** 

University of Dublin, Trinity College

November 2020

Declaration

I, the undersigned, declare that this thesis has not been submitted as an exercise for a

degree at this or any other university and it is entirely my own work.

I, the undersigned, agree to deposit this thesis in the University's open access institu-

tional repository or allow the Library to do so on my behalf, subject to Irish Copyright

 $\label{lem:legislation} \mbox{Legislation and Trinity College Library conditions of use and acknowledgement.}$ 

David Woods

November 2020

i

#### Abstract

#### Acknowledgements

This research is supported by Science Foundation Ireland (SFI) through the CNGL Programme (Grant 12/CE/I2267) in the ADAPT Centre (https://www.adaptcentre.ie) at Trinity College Dublin. The ADAPT Centre for Digital Content Technology is funded under the SFI Research Centres Programme (Grant 13/RC/2106) and is co-funded under the European Regional Development Fund.

## Related Publications

## Contents

Declaration							
$\mathbf{A}$	Abstract Acknowledgements						
$\mathbf{A}$							
Related Publications							
1	1 Introduction						
<b>2</b>	Rele	evant l	Literature	2			
	2.1	Times	and Events	2			
		2.1.1	Allen Relations	2			
		2.1.2	Tense and Aspect	2			
	2.2	Annot	ation	2			
		2.2.1	ISO-TimeML	2			
		2.2.2	TimeBank	2			
	2.3	Seman	Semantics				
		2.3.1	Discourse Representation Theory	2			
		2.3.2	Boxer	2			
3	Fini	Finite State Temporality					
	3.1 Strings for Times and Events						
		3.1.1	Creating Strings	3			
		3.1.2	Granularity: Points vs Intervals vs Semi-intervals	3			
		3.1.3	String Operations	3			

	3.2	eations	3					
		3.2.1	Timelines from Texts	3				
		3.2.2	Scheduling (Zebra Puzzle)	3				
4	Methods							
	4.1	1 Extracting Strings from Annotated Text						
		4.1.1	TLINKs	4				
	4.2	Enhancing Strings using DRT						
		4.2.1	Parallel Meaning Bank	4				
		4.2.2	VerbNet and WordNet	4				
	4.3	Inferer	nce via Residuals	4				
5	Implementation							
	5.1	Comp	utational Pipeline	5				
6	Evaluation							
	6.1	Timeli	ine Validity	6				
	6.2	FRAC	CAS Semantic Test Suite	6				
	6.3	Correc	etness of Code	6				
7	Con	Conclusion						
Bi	Bibliography							
$\mathbf{A}_{]}$	Appendices							
	Python Code							

## 1 Introduction

#### 2 Relevant Literature

- 2.1 Times and Events
- 2.1.1 Allen Relations
- 2.1.2 Tense and Aspect
- 2.2 Annotation
- 2.2.1 ISO-TimeML
- 2.2.2 TimeBank
- 2.3 Semantics
- 2.3.1 Discourse Representation Theory
- 2.3.2 Boxer

## 3 Finite State Temporality

- 3.1 Strings for Times and Events
- 3.1.1 Creating Strings
- 3.1.2 Granularity: Points vs Intervals vs Semi-intervals
- 3.1.3 String Operations
- 3.2 Applications
- 3.2.1 Timelines from Texts
- 3.2.2 Scheduling (Zebra Puzzle)

## 4 Methods

- 4.1 Extracting Strings from Annotated Text
- 4.1.1 TLINKs
- 4.2 Enhancing Strings using DRT
- 4.2.1 Parallel Meaning Bank
- 4.2.2 VerbNet and WordNet
- 4.3 Inference via Residuals

- 5 Implementation
- 5.1 Computational Pipeline

- 6 Evaluation
- 6.1 Timeline Validity
- 6.2 FRACAS Semantic Test Suite
- 6.3 Correctness of Code

## 7 Conclusion

# Bibliography

# Appendices

Python Code