

# SUTime: A Library for Recognizing and Normalizing Time Expressions

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## Introduction

SUTIME is a deterministic rule-based **temporal tagger** for recognizing and normalizing temporal expressions in English text.

Given **Text**:  
*George Walker Bush (born July 6, 1946) is an American politician who served as the 43rd President of the United States from 2001 to 2009.*

**Temporal expressions** are extracted and normalized:

	Expression	Type	Normalized
Birth	July 6, 1946	DATE	1946-07-06
Pres.	2001 to 2009	RANGE	2001/2009

## Features

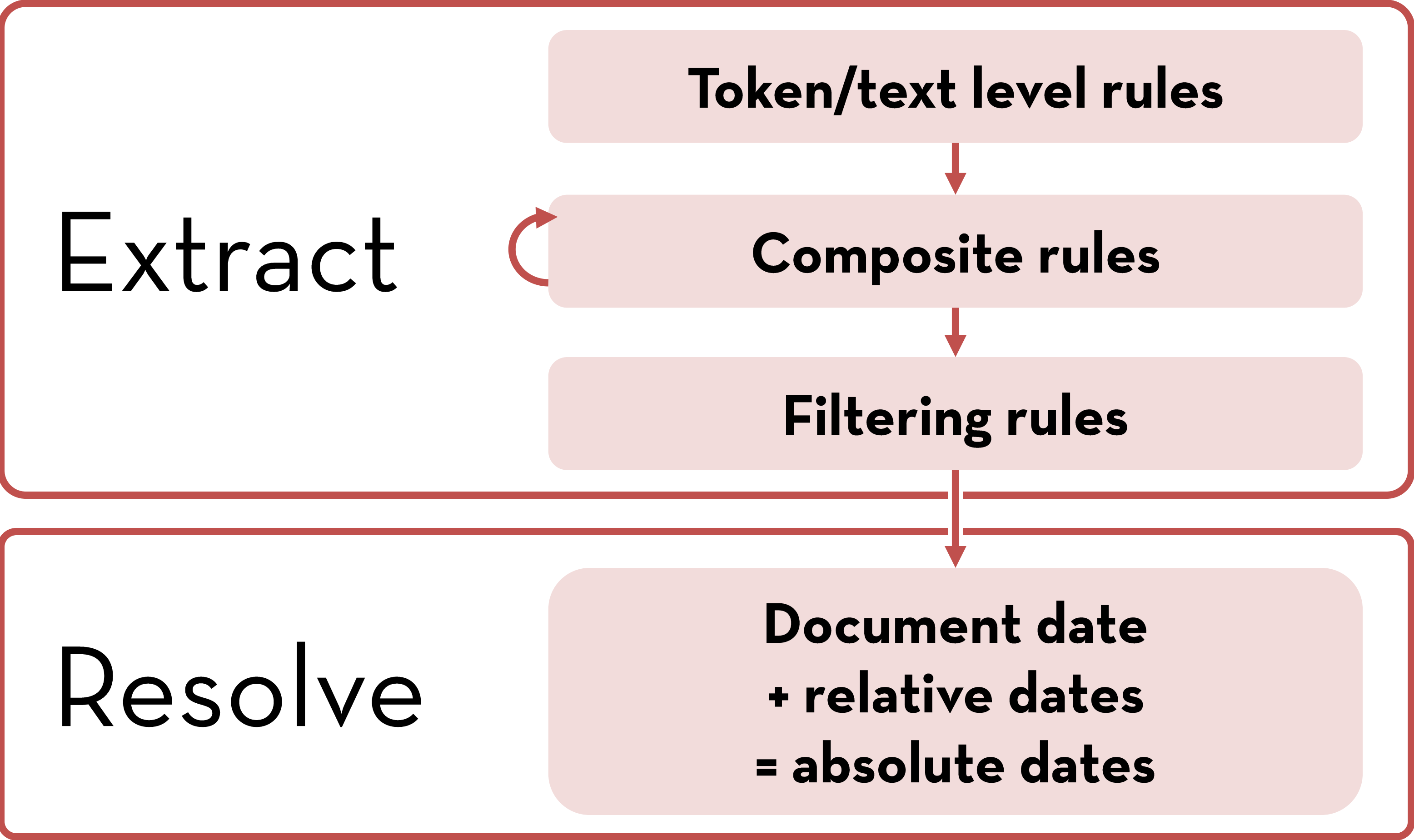
Advantages of SUTime:

- **Easy to Use** - Download and use! All in one system!
  - Platform independent (all Java)
  - Integrated with Stanford CoreNLP pipeline
  - Access to other levels of NLP annotations
    - POS tags, NER tags, parse trees, and more!
- **Best Performance**
  - State of the art results on TempEval-2
- **Extensible**
  - Pattern language for defining new rules
  - Temporal objects represented as Java objects allowing for programmatic manipulation

## System Description

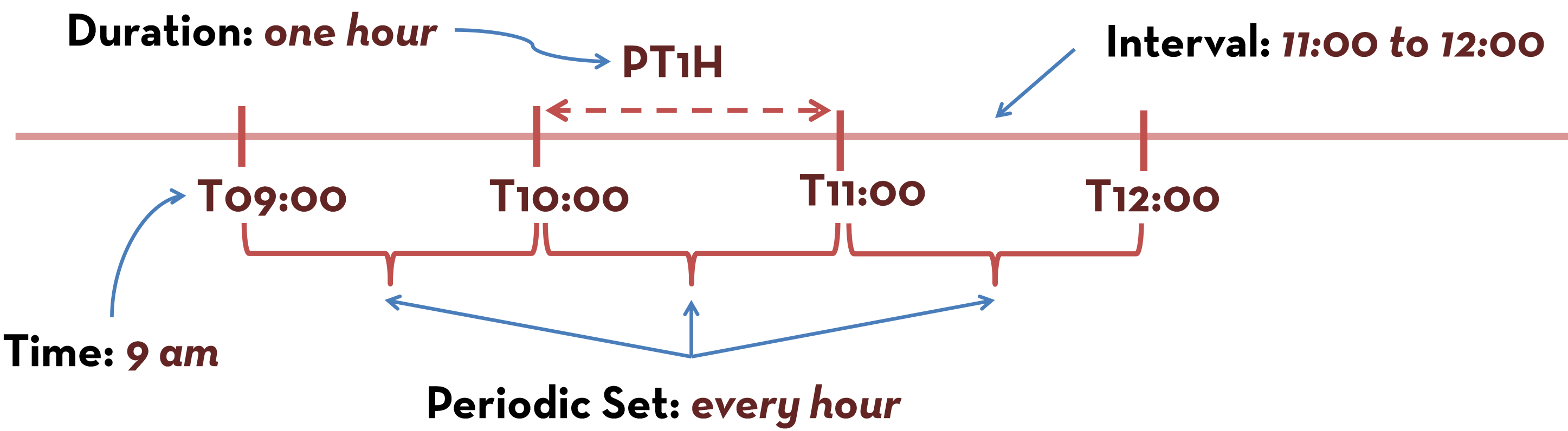
SUTime provides the following:

- **Extraction** of temporal expressions from text.
  - Rules are specified using **TokensRegex**.
- **Representation** of temporal objects as Java classes
  - Convert to Joda-Time classes, or export as TIMEX3 tags.
- **Resolution** of temporal expressions using a reference date.
  - The document date is used as the reference date.



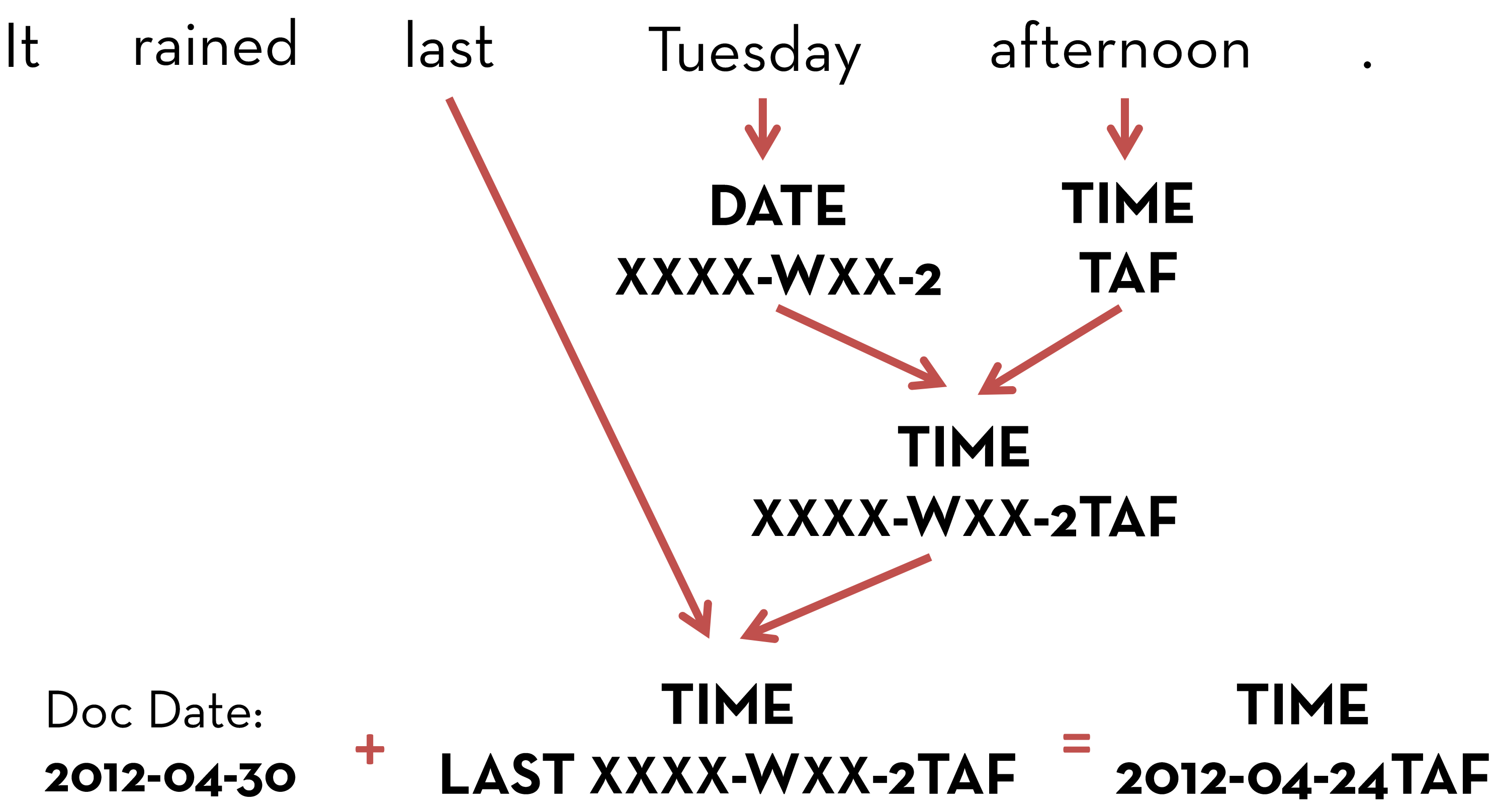
## Temporal Types

SUTime supports different temporal expression types.



	Expression	Timex3 Type	Timex3 Value
Time	October of 1963	DATE	1963-10
Time	Next weekend	DATE	2011-W39-WE
Time	Saturday morning	TIME	2011-09-24TMO
Exact Duration	3 days	DURATION	P3D
Inexact Duration	A few years	DURATION	PXY
Range Duration	2 to 3 months	DURATION	P2M/P3M
Interval	1:00pm to 3:00pm	DURATION	PT2H
Periodic Set	Every third Sunday	SET	XXXX-WXX-7

## Example



## TokensRegex

A generic framework (also part of Stanford CoreNLP) for mapping regular expressions over token sequences to semantic objects

**Sample TokensRegex rules**

Token level rules: /tuesday/ => DayOfWeek(2)

Composite rules:

```
{ ruleType: "composite",
  pattern: ( ( [ { temporal::IS_TIMEX_DATE } ] )
             /at/ ( [ { temporal::IS_TIMEX_TIME } ] ) ),
  result: TemporalCompose(INTERSECT,
    $0[0].temporal, $0[-1].temporal) }
```

## Evaluation

Evaluation is done on the TempEval-2 English evaluation set.

**Evaluation metrics**

- Official TempEval-2 scorer
  - Extents scores are token-based precision, recall, and F1.
  - Attribute scores is accuracy over correctly identified extents.
  - Difficult to compare this metric across systems.
- Revised scoring of attributes
  - Compute the precision, recall, and F1 for each attribute based on the number of temporal expressions with the correct attribute, the total in gold, and the total in the system response.

**Other systems**

- **GUTime**: Perl temporal tagger (rule-based)
- **HeidelTime**: Best performing system from SemEval-2 (rule-based)  
Three variants are considered: HeidelTime1 (precision tuned), HeidelTime2 (recall tuned), HeidelTime\* (downloaded)
- **TRIPS/TRIOS**: Second best system from SemEval-2 (CRF for recognition, rule-based for normalization)

## Results

Table 1: TempEval-2; English evaluation set

System	Extents			Attribute	
	P	R	F <sub>1</sub>	type	value
GUTime	0.89	0.79	0.84	0.95	0.68
SUTime	0.88	<b>0.96</b>	<b>0.92</b>	<b>0.96</b>	0.82
TRIPS/TRIOS	0.85	0.85	0.85	0.94	0.76
HeidelTime1	0.90	0.82	0.86	<b>0.96</b>	<b>0.85</b>
HeidelTime2	0.82	0.91	0.86	0.92	0.77
HeidelTime*	<b>0.91</b>	0.90	0.91	<b>0.96</b>	0.84

Table 2: Revised scoring of attributes

System	Mention Type			Mention Value		
	P	R	F <sub>1</sub>	P	R	F <sub>1</sub>
GUTime	0.85	0.79	0.82	0.59	0.55	0.57
SUTime	0.84	<b>0.94</b>	<b>0.89</b>	0.71	<b>0.78</b>	0.74
HeidelTime*	<b>0.87</b>	0.89	0.88	<b>0.76</b>	0.77	<b>0.76</b>

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