



Penn

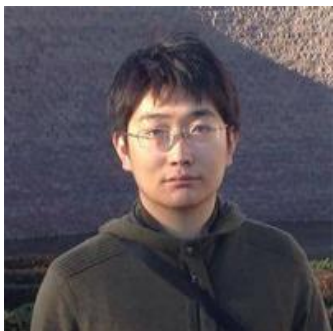
USC Viterbi  
School of Engineering



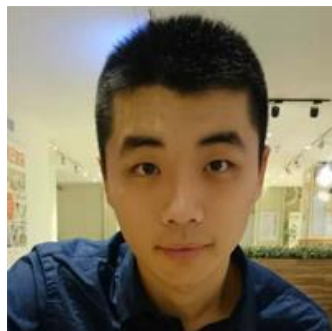
UNIVERSITY OF  
ILLINOIS  
URBANA-CHAMPAIGN



## Event-Centric Natural Language Processing



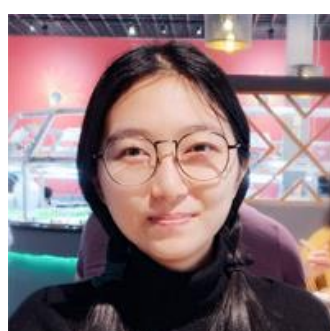
Muhao Chen



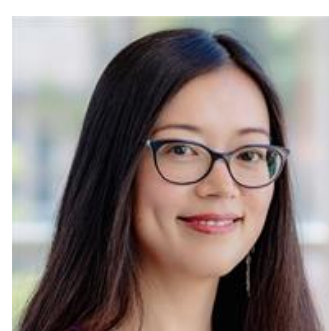
Hongming Zhang



Qiang Ning



Manling Li



Heng Ji



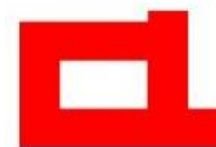
Kathleen McKeown



Dan Roth

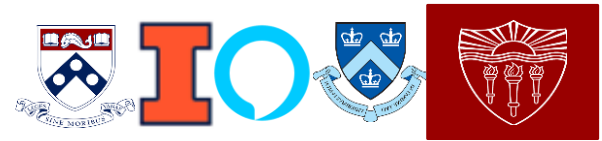
Aug 2021

ACL-IJCNLP Tutorial



Association for  
Computational  
Linguistics

ACL-IJCNLP 2021



- Human Language is used to describe and reason about events.
- We use it to
  - Describe what happened
    - (and would could have happened, or may happen)
  - Reason about Who did what to whom, and why
  - Understand what led to what? What caused what?
  - We describe thoughts, hypotheses feelings, and plans that pertain to events
  - We summarize events and make predictions with respect to future events.

In the months leading up to the riot, Mr. Lee had **helped organize** a series of pro-Trump car caravans around the country, including one that temporarily **blockaded** a Biden campaign bus in Texas and another that briefly shut down a Hudson River bridge in the New York City suburbs. To help pay for dozens of caravans to meet at the Jan. 6 rally, he had **teamed up** with an online fund-raiser in Tampa, Fla., who secured money from small donors and claimed to pass out tens of thousands of dollars.

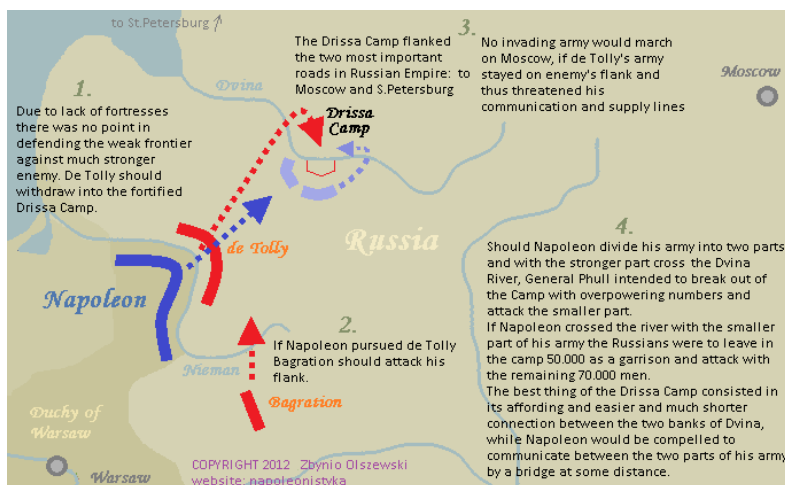
**Rodgers finished 23-of-36 for 296 yards and two touchdowns.** His numbers could've been even better had his receivers not dropped a couple of his passes. One **dropped ball** was a potential score to Allen Lazard. Despite the drop, Lazard made up for it by leading the Packers in receiving. With Davante Adams tied up with Jalen Ramsey, Lazard was able to **snatch** four balls for 96 yards and a touchdown. Adams still had a great game despite Ramsey's coverage, hauling in nine of his 10 targets for 66 yards and a touchdown. The score **frustrated** Ramsey because another defensive back was supposed to pick up Adams, who was in motion.

# Event-Centric Natural Language Understanding



- We describe events at different levels of abstractions

1. Turkey **forces down** Syrian plane.
2. Damascus sends note to Ankara over Syrian plane.
3. Turkey Escalates Confrontation with Syria.
4. Turkish PM says plane was carrying ammunition for Syria government.
5. Last night Turkish F16s **grounded** a Syrian passenger jet.
6. Russia angry at Turkey about Russian passengers.



## Napoleon Invades Russia

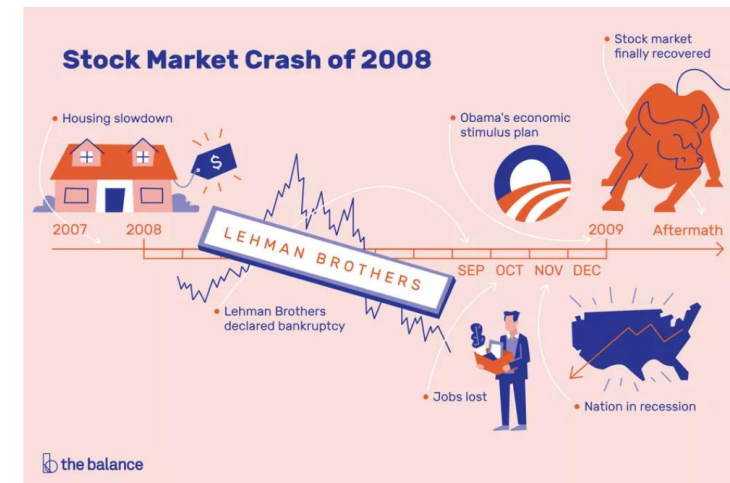
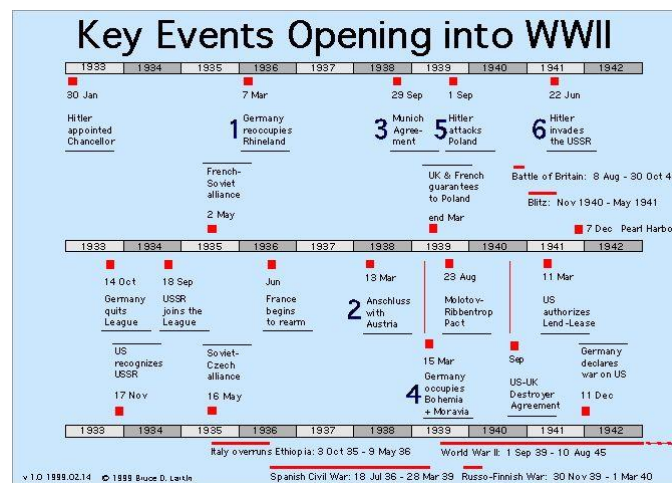
- We reason about events in multiple granularities

- With a range of goals in mind

## What Will Happen In 2021? Here's What People In 1921 Predicted.



- What really happened?
  - What sequence of events led to it?
- What will happen?
- ...



- Most of the work in NLP focuses on understanding “**what the text says**”
  - We analyze “what’s written here” at the sentence level (mostly)
    - But more and more also at a document level
    - And even, rarely, at a multi-document level
- But with the level of progress in “what the text says”
  - We can now attend to “**what is happening**”
    - And ground it in the world

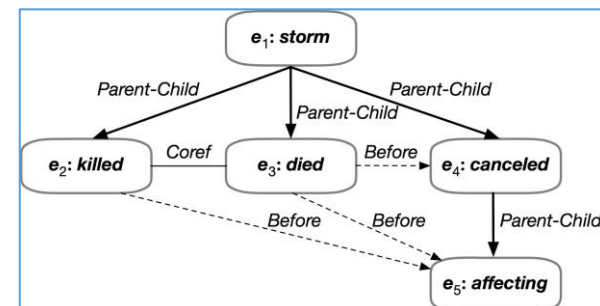


# Understanding “What is Happening”



## ■ Event-Centric Natural Language Understanding and Information Extraction

- Brings some change in foci and priorities
- It requires “local” text understanding
- But necessitates integrating information from multiple documents (and modalities)



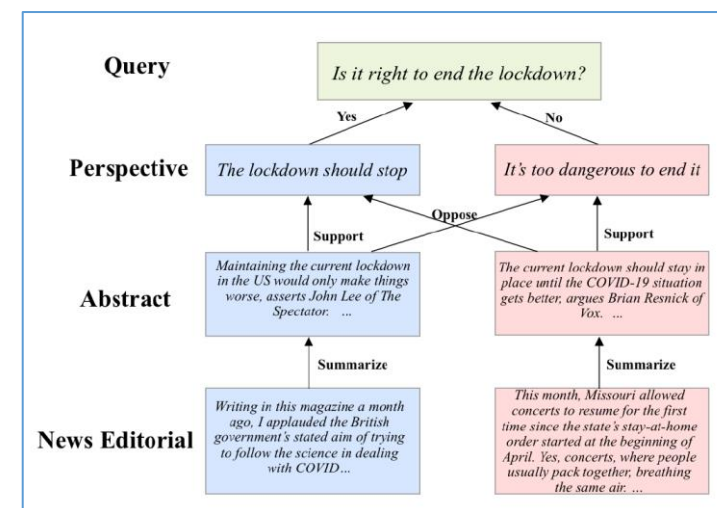
On Tuesday, there was a typhoon-strength ( $e_1$ :*storm*) in Japan. One man got ( $e_2$ :*killed*) and thousands of people were left stranded. Police said an 81-year-old man ( $e_3$ :*died*) in central Toyama when the wind blew over a shed, trapping him underneath. Later this afternoon, with the agency warning of possible tornadoes, Japan Airlines ( $e_4$ :*canceled*) 230 domestic flights, ( $e_5$ :*affecting*) 31,600 passengers.

- Information aggregation and consolidation
- Understanding multiple types of events
- Understanding relations between events
- Understanding time and causality
- Acquiring and using background and commonsense knowledge
- The ability to generalize from specific, observed, processes
- The ability to predict – implicit events and possible future events
- Eventually, it will also require us to identify that there are multiple perspectives
- ...

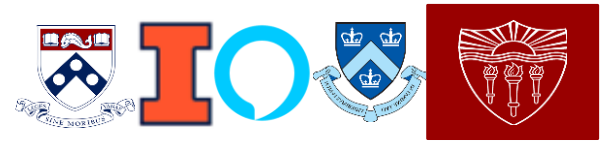
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5. Last night Turkish F16s **grounded** a Syrian passenger jet.
6. Russia angry at Turkey about Russian passengers.

## ■ And integrating all these into an understanding of “what is happening”



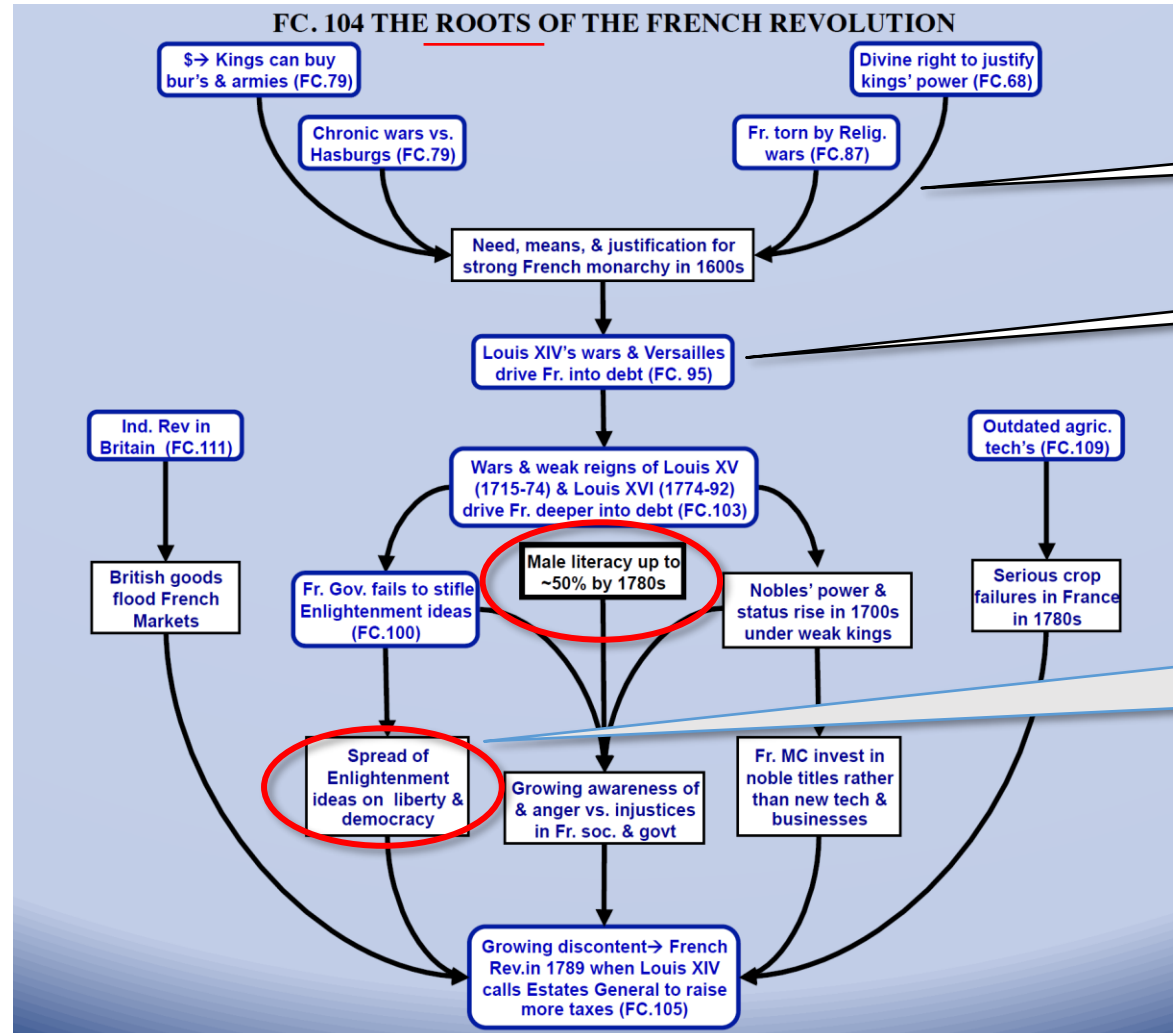
# Compiling a History Book



- Ideally, at multiple levels of granularities
  - And accounting for multiple perspectives and interpretations

## The history of Democracy

- One way to start is with the French revolution



Influence

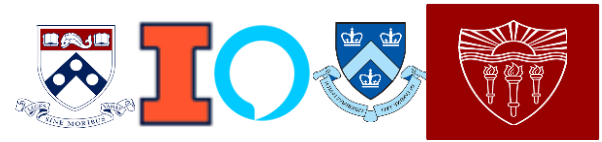
Earlier Flow Charts

What about the role of the rise of democracy in America?

Some say that the Americans' victory over the British has had a significant impact on the French revolution, and that the newly formed government in the United States became a model for the French reformers.

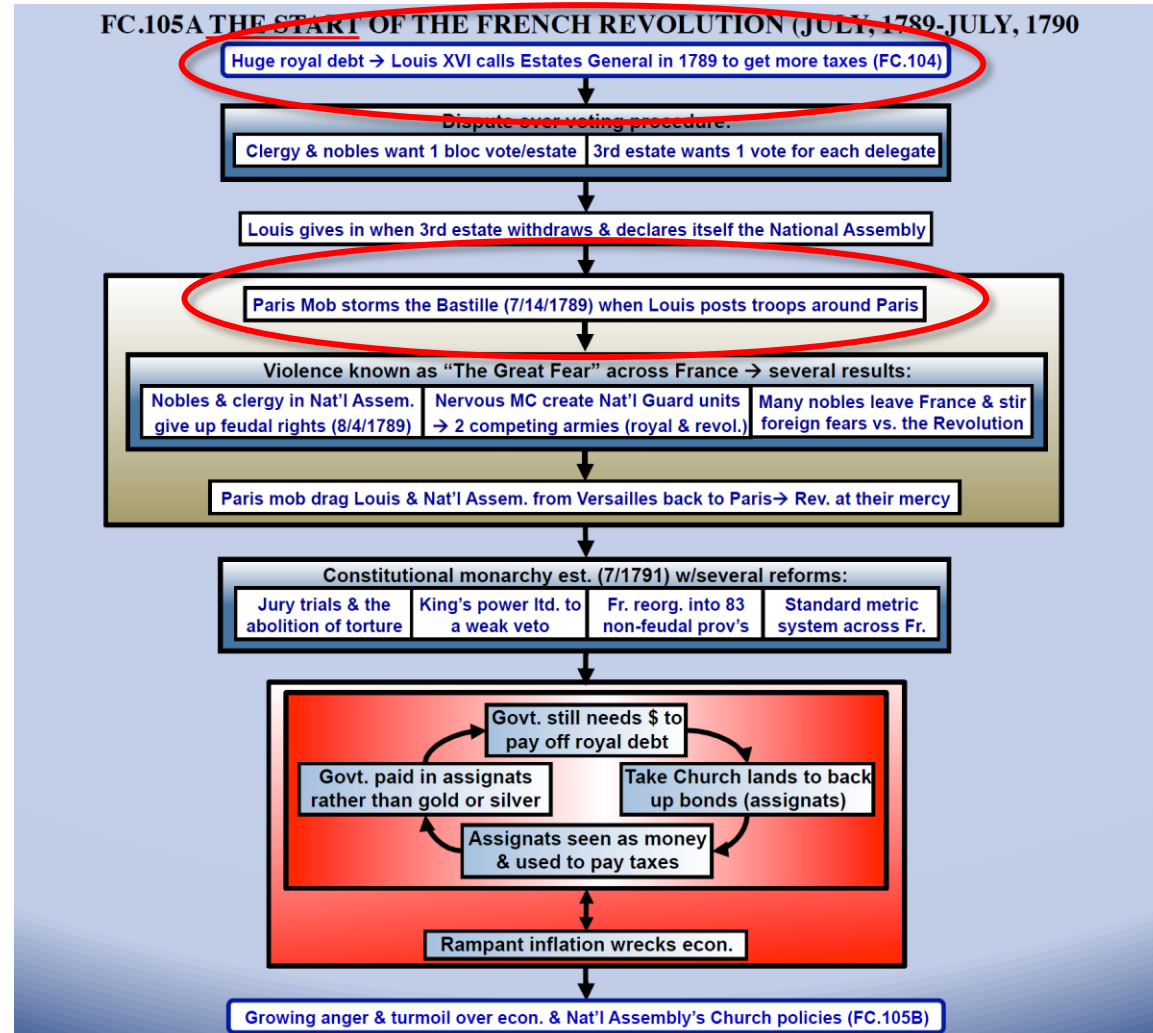
Credit: The Flow of History, by Chris Butler

# Compiling a History Book



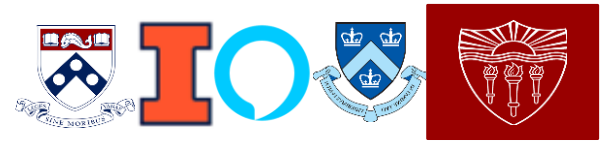
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## The history of Democracy



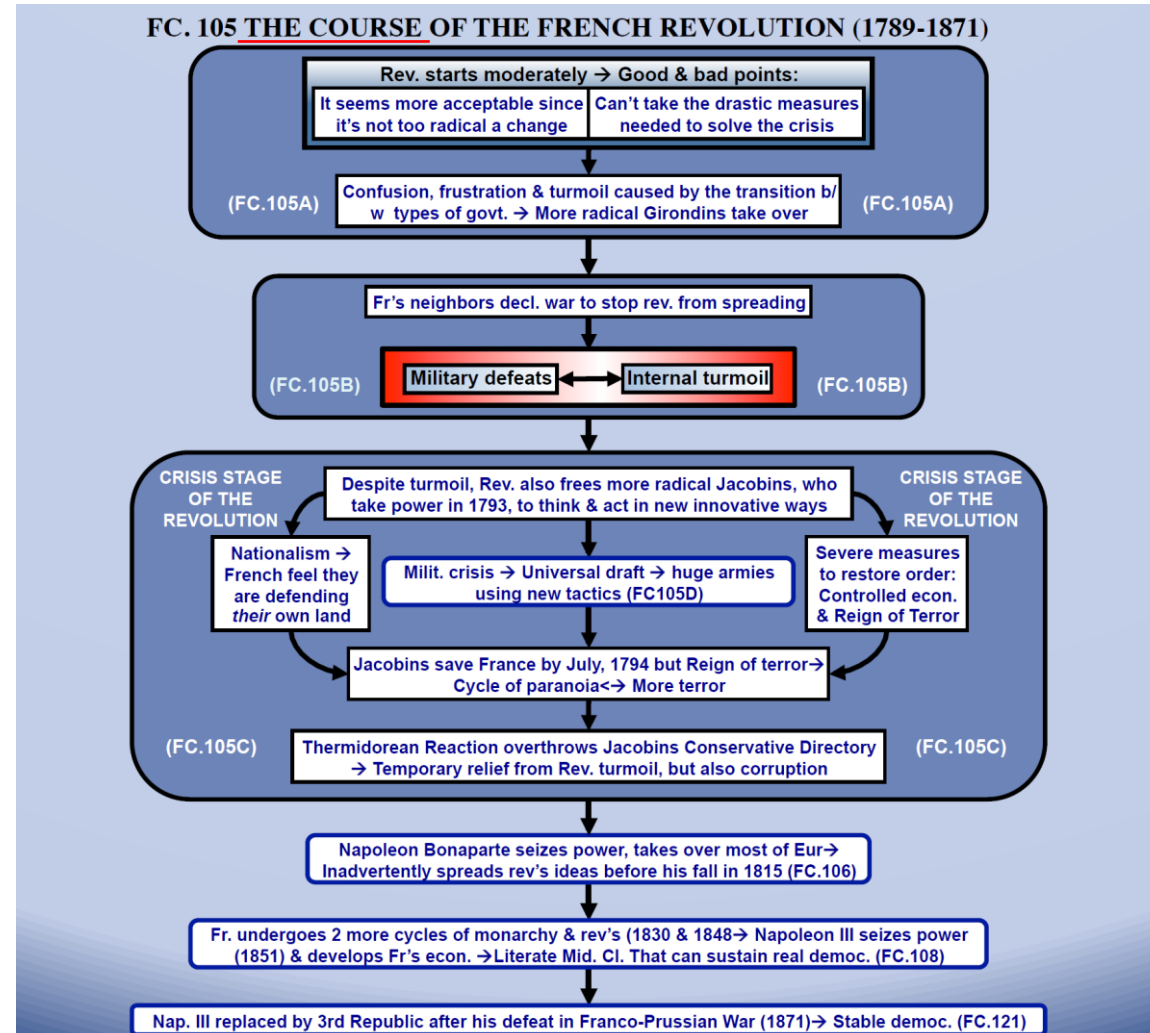
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# Compiling a History Book



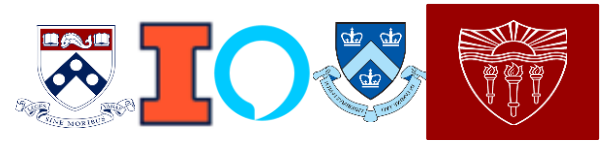
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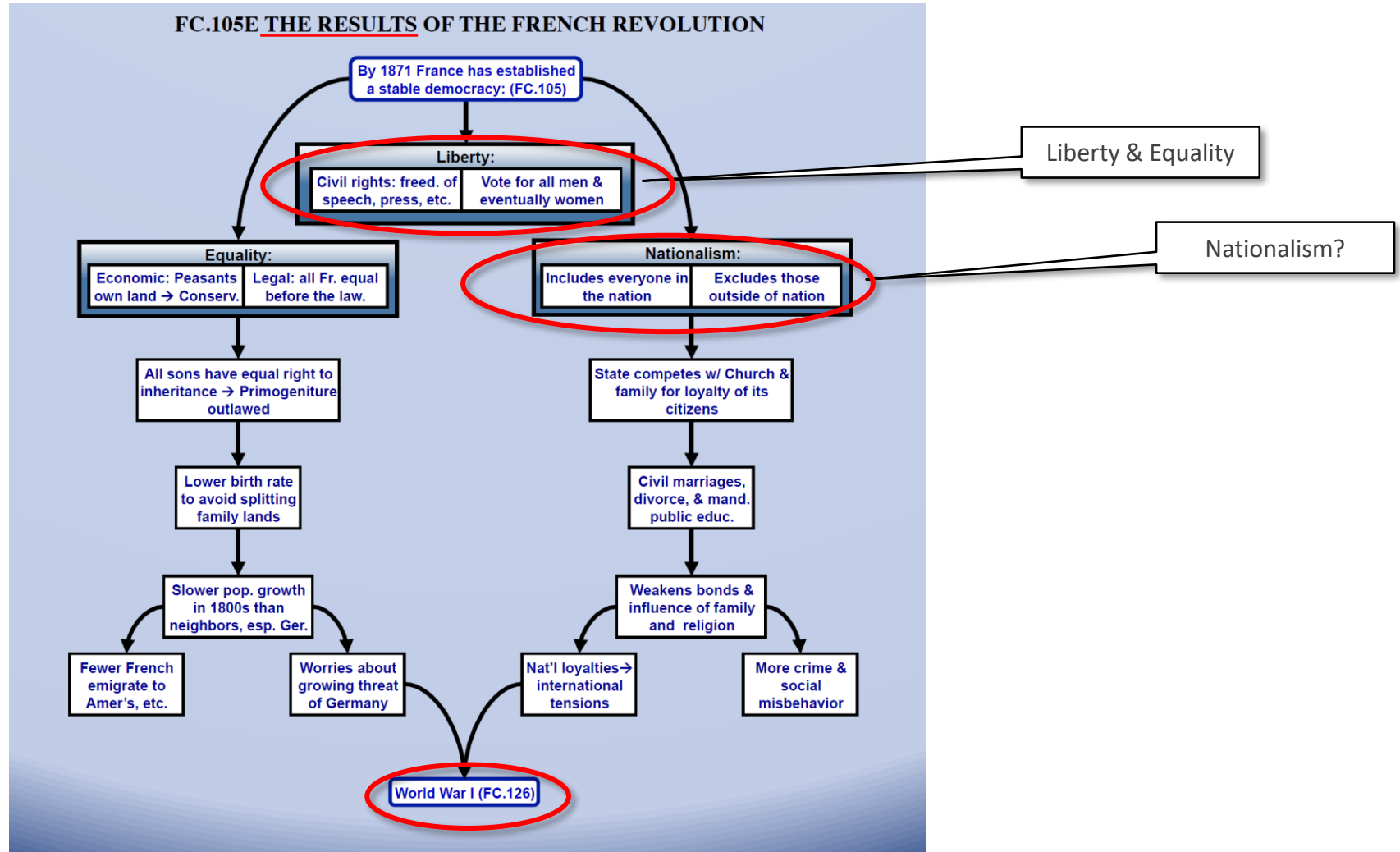
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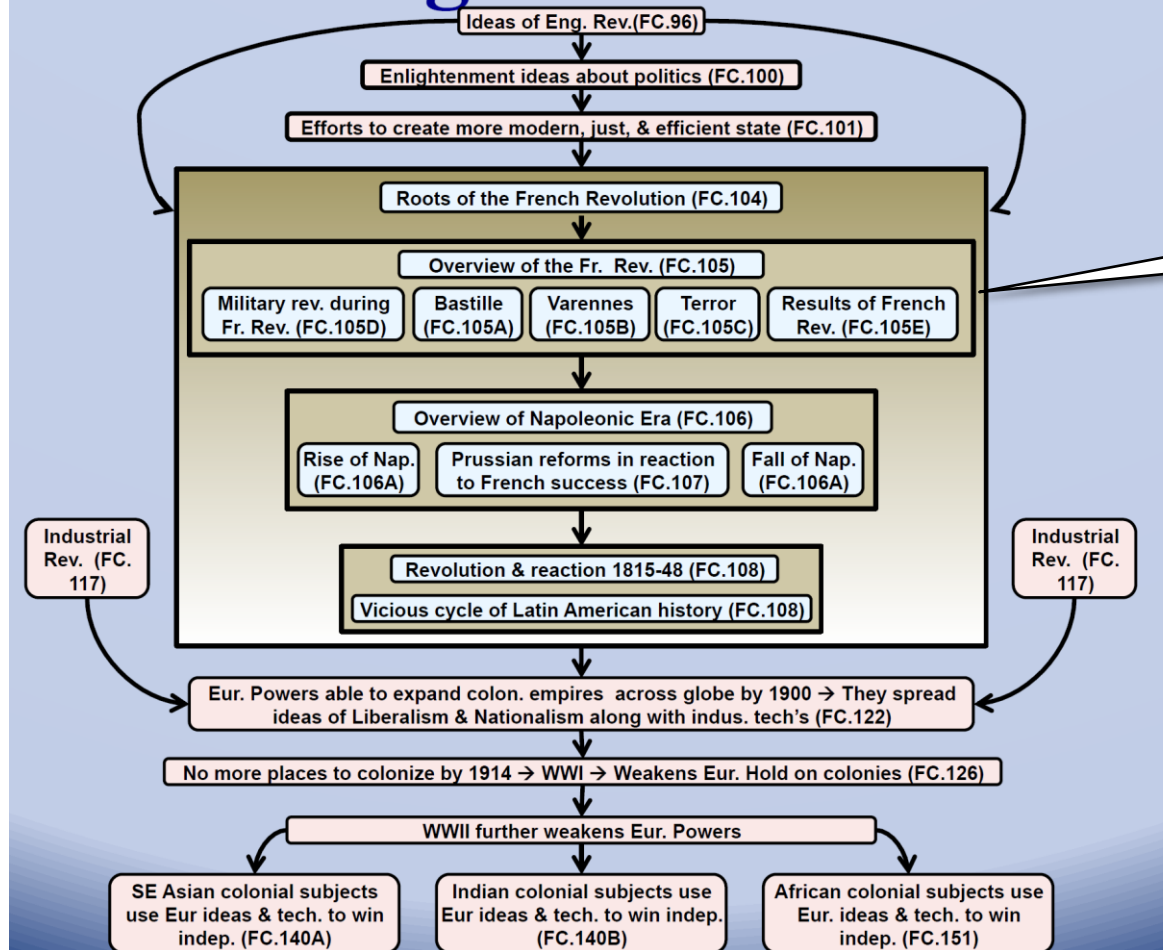


Credit: The Flow of History, by Chris Butler

- Ideally, at multiple levels of granularities
  - And accounting for multiple perspectives and interpretations

## The history of Democracy

### 13. The Age of Revolutions

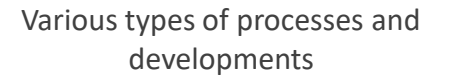


The place of the French revolution in the bigger picture

This is one way to compile and represent a summary of events, done by processing large body of text

Credit: The Flow of History, by Chris Butler

- ## The history of Democracy

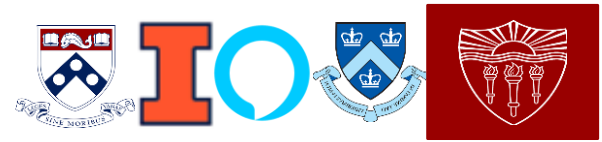


It is challenging to compile such an account given a lot of historical text, and even more so to build it from reported events, as we they occur.

12

# This Tutorial

# Event Extraction



## ■ Event Definition and Representation

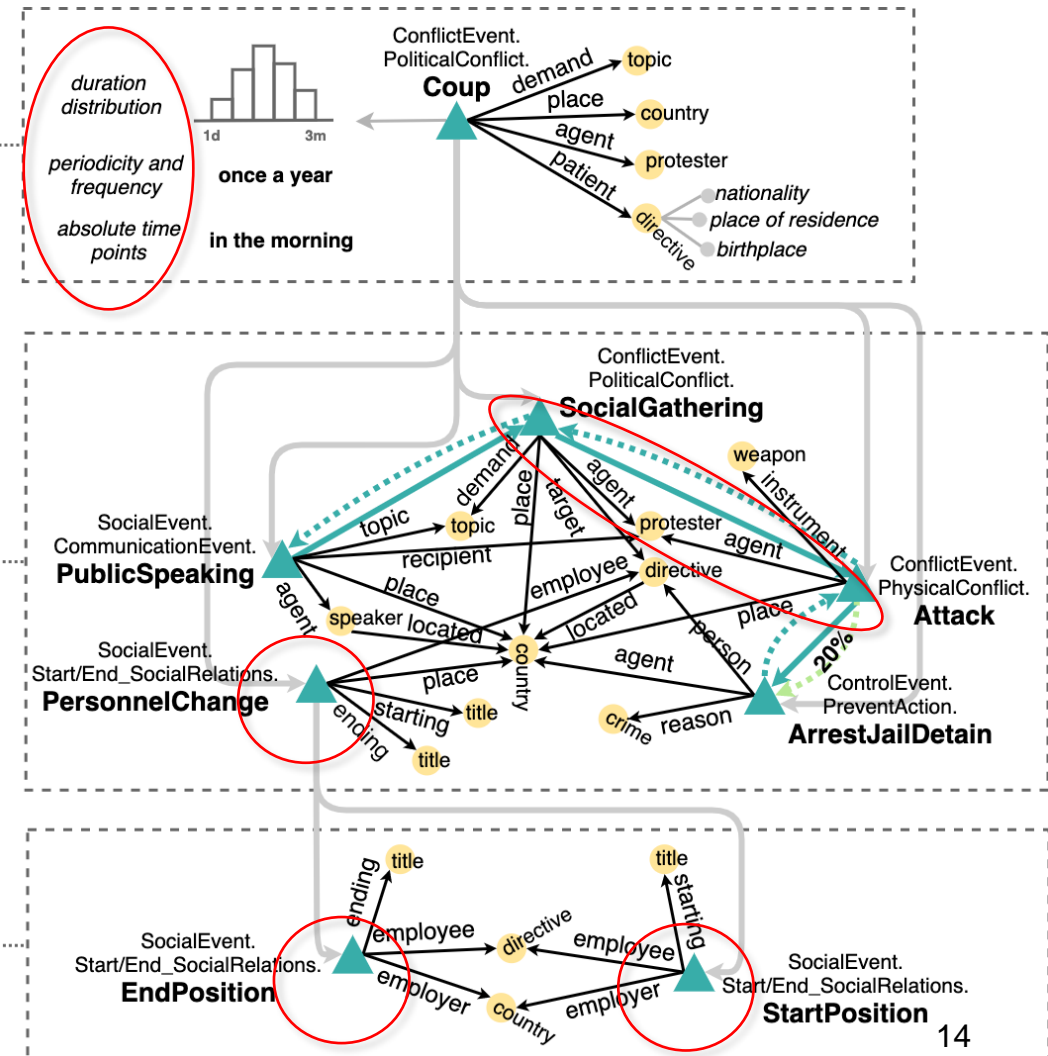
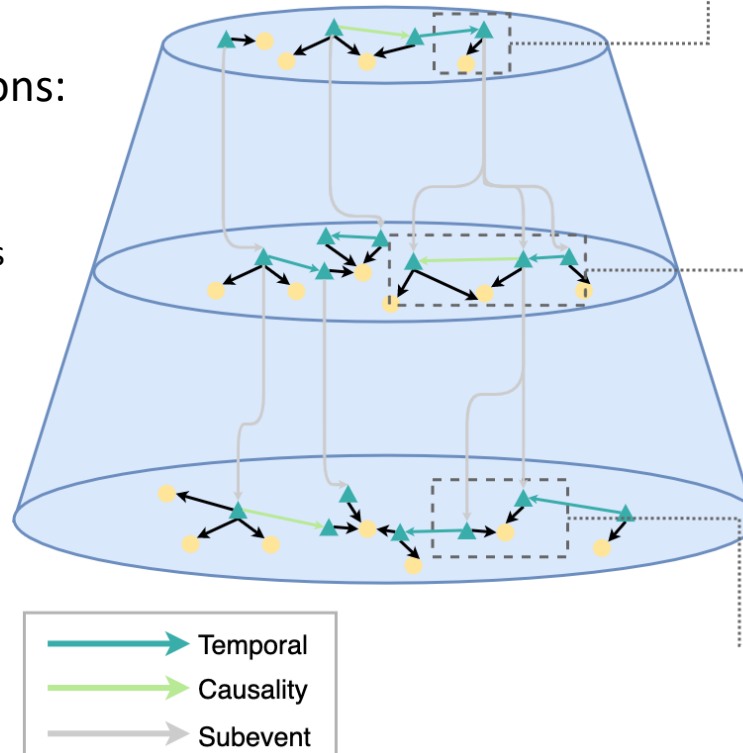
## ■ Event Extraction

- From Supervised to zero-shot
- Cross-media event extraction

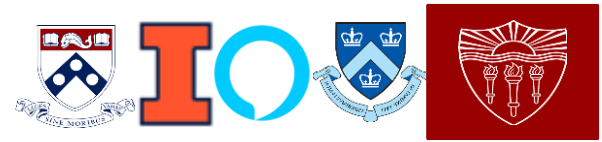
- Hierarchies, event schemas

- Event-event Relations:

- ☐ Coreference
- ☐ Sub-events
- ☐ Temporal Relations



# Multisource, Multimedia, Multilingual Data



## STORY HIGHLIGHTS

Congress and Ukraine long sought anti-tank weapons in battle against separatists.

(CNN) — The US is going to provide lethal anti-tank weapons to Ukraine to help it fight off separatists which have the backing of Russia, a senior State Department official said.



## Ukraine: How we got here

The Ukraine crisis has become the bloodiest European conflict since the wars over the former Yugoslavia in the early 1990s -- but what triggered the violence and what is happening on the ground?



Битва за Донецький аеропорт

Національний президент Володимир Зеленський закликає до необхідності зберегти контроль над кожним міліметром української території.

**КОМЕНТАРІ** На території Мінська договорилися, як і в інших містах України. Обидві сторони з України вернули під свій контроль 24 квадратних кілометра території на Донбасі. Об'їзди говоряться в офіційних повідомленнях. Об'єднані сили з України знову з'явилися в Луганську після першого за останні роки проведення операції на Донбасі.

## ЧИТАЙТЕ ТАКОЖЕ

На Донбасі загорілися АЗС і почалася пожежа



Президент России Владимир Путин (архивное фото)

В предыдущем указе Владимира Путина был упрощен порядок предоставления гражданства жителям Донбасса.

КИЕВ — Россия упрощает порядок получения гражданства для украинцев, временно проживающих на ее территории, украинским беженцам, жителям отдельных районов Донецкой и Луганской областей, а также другим категориям граждан из Украины и ряда стран.

## ЧИТАЙТЕ ТАКОЖЕ

Украина протестует против выдачи паспортов России жителям Донбасса

Нуждается ли жители Донбасса в российском

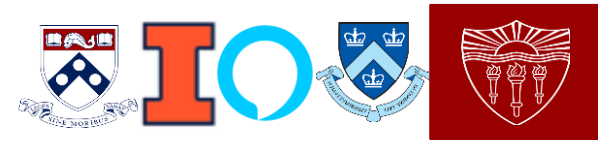


Американский ракетный эсминец Preble

Американські військові повідомили, що два військові кораблі США пройшли поблизу островів, на які претендує Китай, у Південно-Китайському морі в понеділок. Ці дії розгнівали Пекін у час напружених зв'язків між двома найбільшими економіками світу.

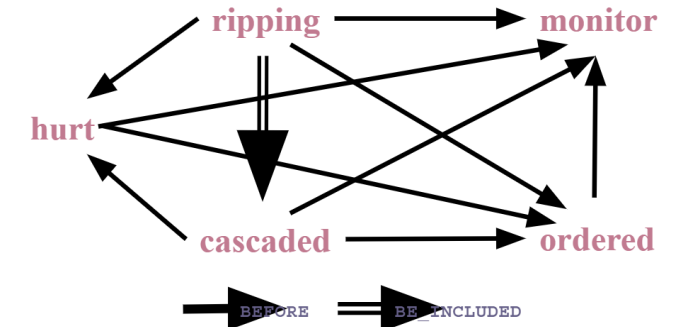
□ Event extraction needs to be done across multiple sources and multiple modalities

# Relations between Events

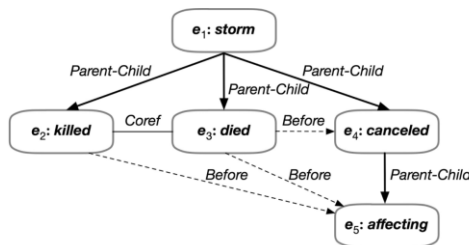


- Types of events
- Relations:
  - Coreference, Temporal, parent-child
- Incorporating knowledge constraints
  - Declarative, Statistical

In Los Angeles that lesson was brought home Friday when tons of earth **cascaded** down a hillside, **ripping** two houses from their foundations. No one was **hurt**, but firefighters **ordered** the evacuation of nearby homes and said they'll **monitor** the shifting ground until March 23<sup>rd</sup>.



On Tuesday, there was a typhoon-strength ( $e_1$ :**storm**) in Japan. One man got ( $e_2$ :**killed**) and thousands of people were left stranded. Police said an 81-year-old man ( $e_3$ :**died**) in central Toyama when the wind blew over a shed, trapping him underneath. Later this afternoon, with the agency warning of possible tornadoes, Japan Airlines ( $e_4$ :**canceled**) 230 domestic flights, ( $e_5$ :**affecting**) 31,600 passengers.



$$\hat{I} = \arg \max_I \sum_{i < j} \sum_r f_r(ij) I_r(ij)$$

real variable boolean variable

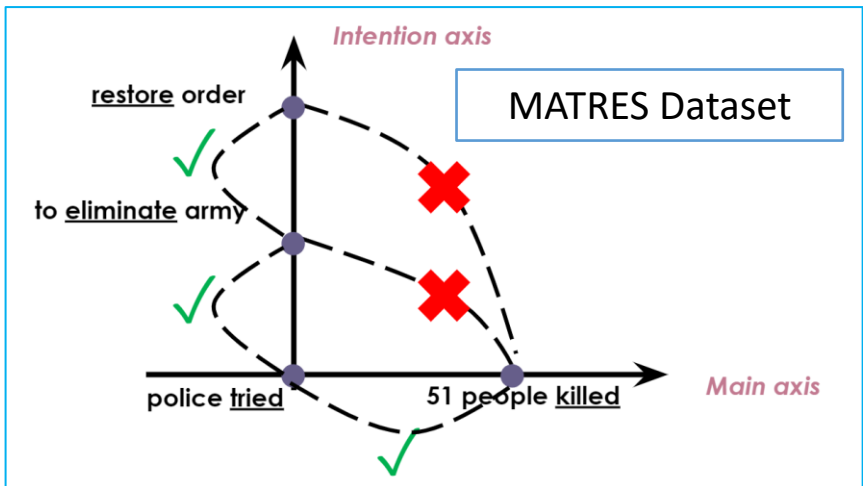
s.t.  $\forall i, j, k$

$$\sum_r I_r(ij) = 1, \quad I_{r1}(ij) + I_{r2}(jk) - I_{r3}(ik) \leq 1$$

Uniqueness

Transitivity (no loops)

Police **tried to eliminate** the pro-independence army and **restore** order. At least 51 people were **killed** in clashes between police and citizens in the troubled region.



I got a free plane ticket to Chicago last week and had some local deep-dish pizza.

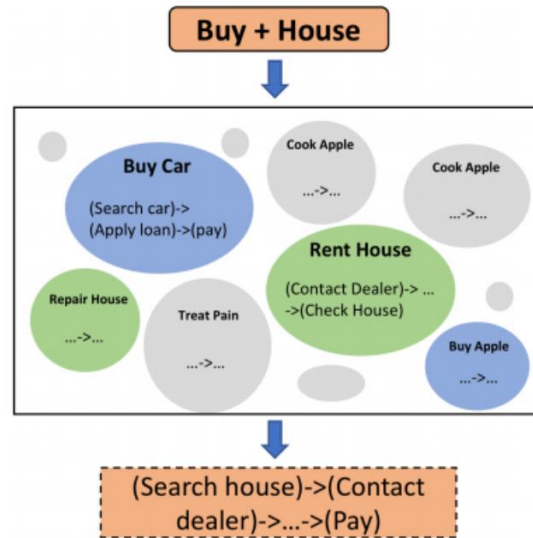
get tickets → fly to Chicago → deep dish pizza

End time is important

Implicit Events

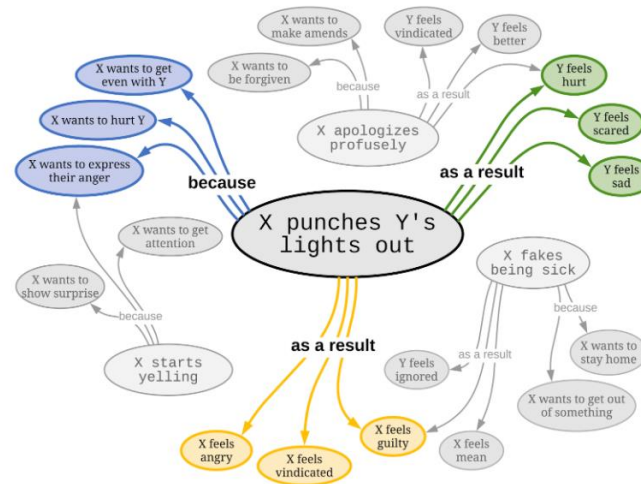
TRACIE Dataset

## 1. Event process completion



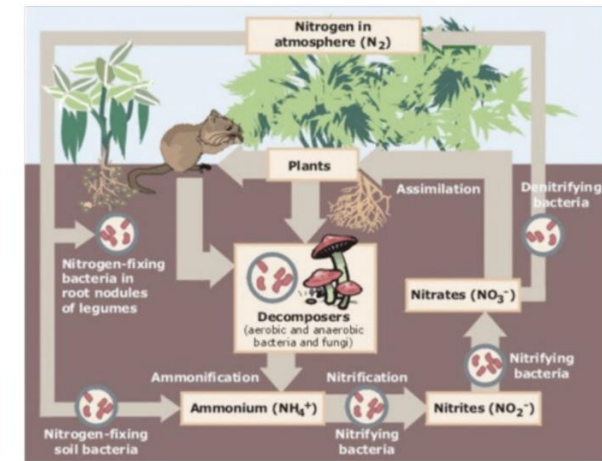
## How to do this task?

## 2. Event intention prediction



# What are they doing?

### 3. Event processes in downstream NLU tasks



## Narrative development

# Large-scale Events



## ■ Complex Events that are composed of many fine-grained events

- Elections, disasters, wars, disease outbreaks, economic impacts

## ■ What might be useful?

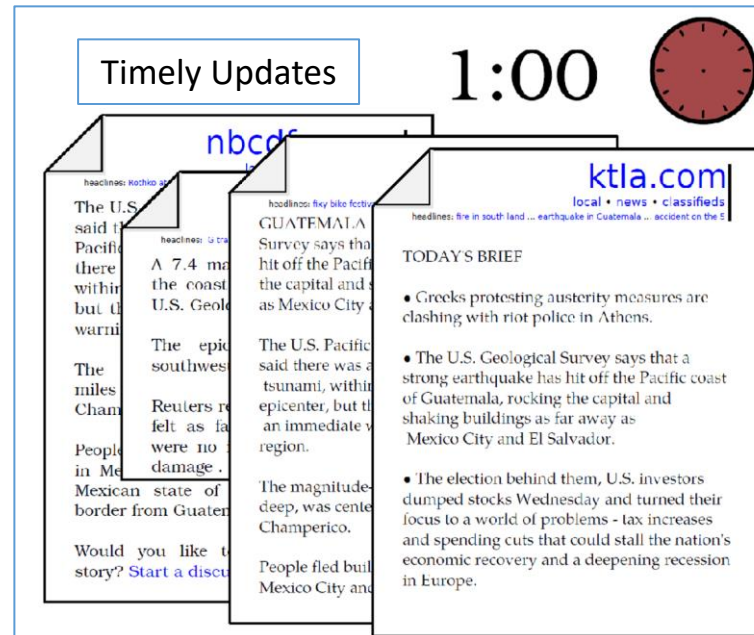
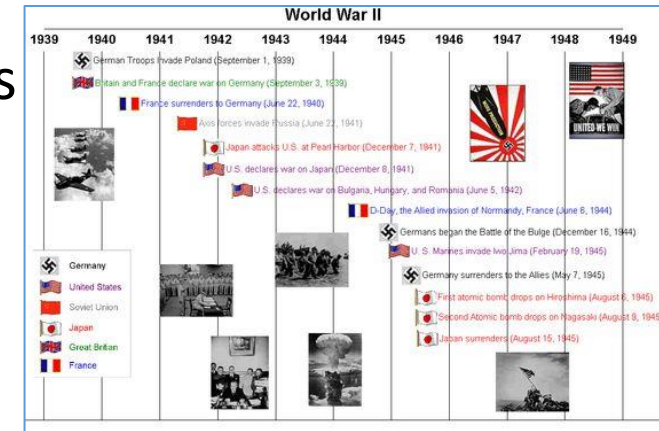
- Understanding the structure of a complex event

- Track an event

- Provide updates

- Timeline summarization

- Event summarization



## Event Timeline summarization: Ukraine Crisis

### March 16<sup>th</sup>, 2014

- **Crimeans** vote in a referendum to rejoin Russia or return to its status under the 1992 constitution.

### March 17<sup>th</sup>, 2014

- **The Crimean parliament** officially declared independence and requested full accession to the Russian Federation.
- **Obama** declared sanctions on Russian officials considered responsible for the crisis.
- **The leader of the pro-Russian organization** "Youth Unity" was arrested.

### March 18<sup>th</sup>, 2014

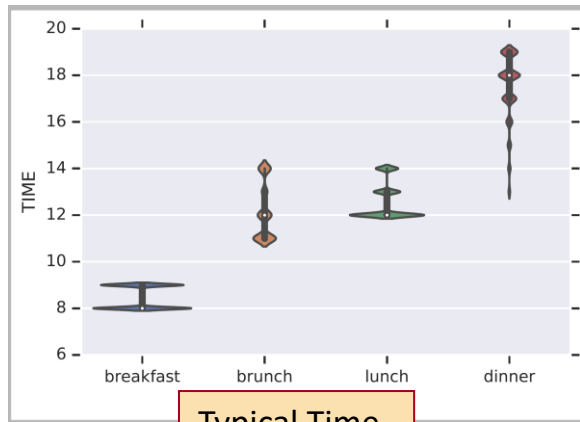
- **President Obama** warned Vladimir Putin that further provocations by Russia could isolate and diminish its influence.
- **One pro-Russian soldier** was killed in the Simferopol incident.

... summaries for other dates ...

# Background and Commonsense Knowledge



- Knowledge Resources that are important to facilitate reasoning about events.
- Commonsense: Event Relations
- Temporal Commonsense



[Elazar et al. ACL'19]

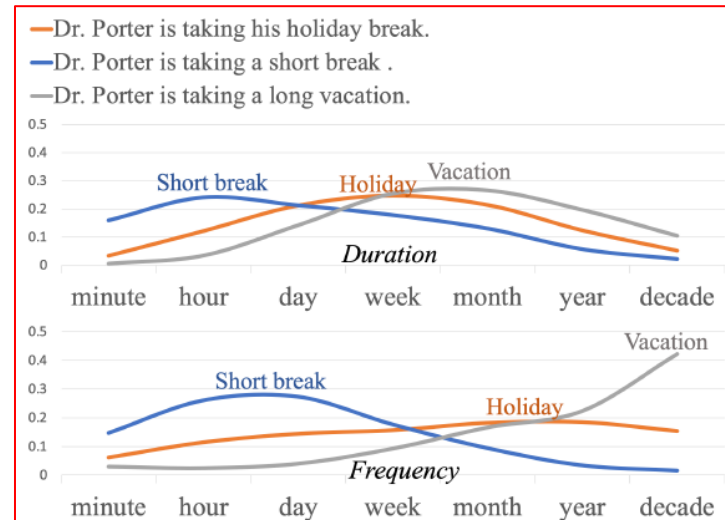
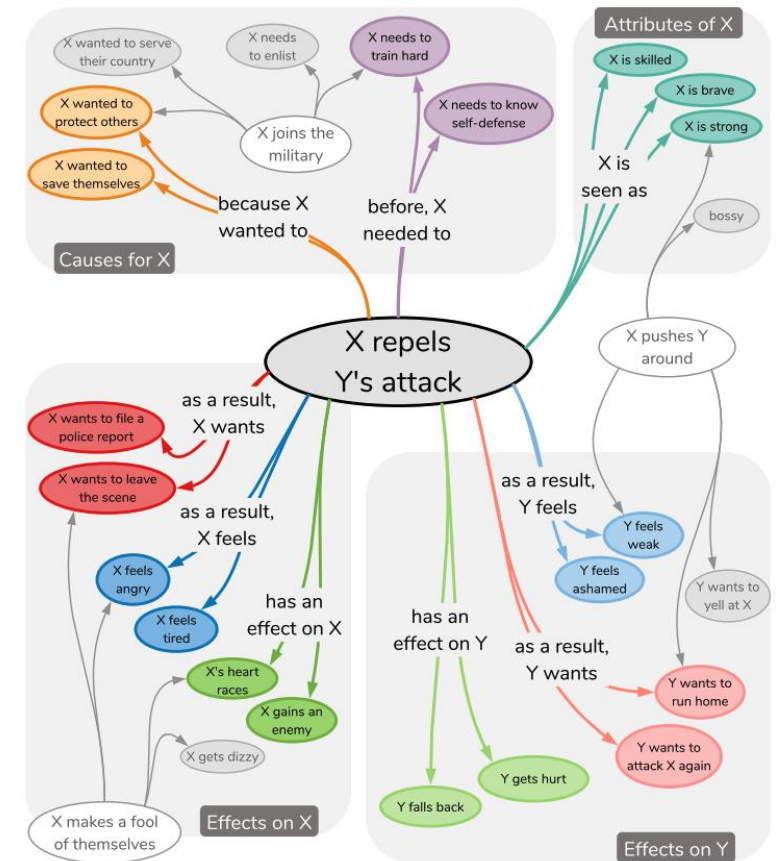


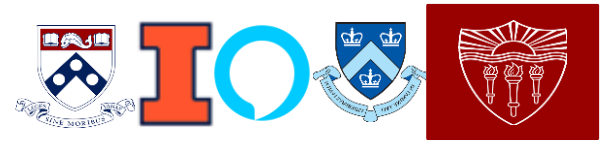
Figure 1: Our model's predicted distributions about event **duration** and **frequency**. The model is able to distinguish fine-grained contexts and produce quality estimations.

[Zhou et al. ACL'20]



Bosselut et al. ACL'19

# Tutorial Outline



- Introduction 20 min.
  - Dan Roth
- Event-Centric Information Extraction 40 min.
  - Heng Ji, Mingling Li
- Event-Centric Information Extraction: Relations 30 min.
  - Qiang Ning
- Break 30 min.
- Event-Centric Prediction: Processes 35 min.
  - Muhao Chen
- Event-Centric Knowledge Acquisition: Commonsense 35 min.
  - Hongming Zhang
- Event Summarization 30 min.
  - Kathleen McKeown
- Conclusion and Future Work 20 min.
  - Heng Ji, Dan Roth

# The End

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