



TEXAS TECH UNIVERSITY SYSTEM™

# IoTNegViz: An Interactive Tool for Visualizing Negative Aspects of IoT



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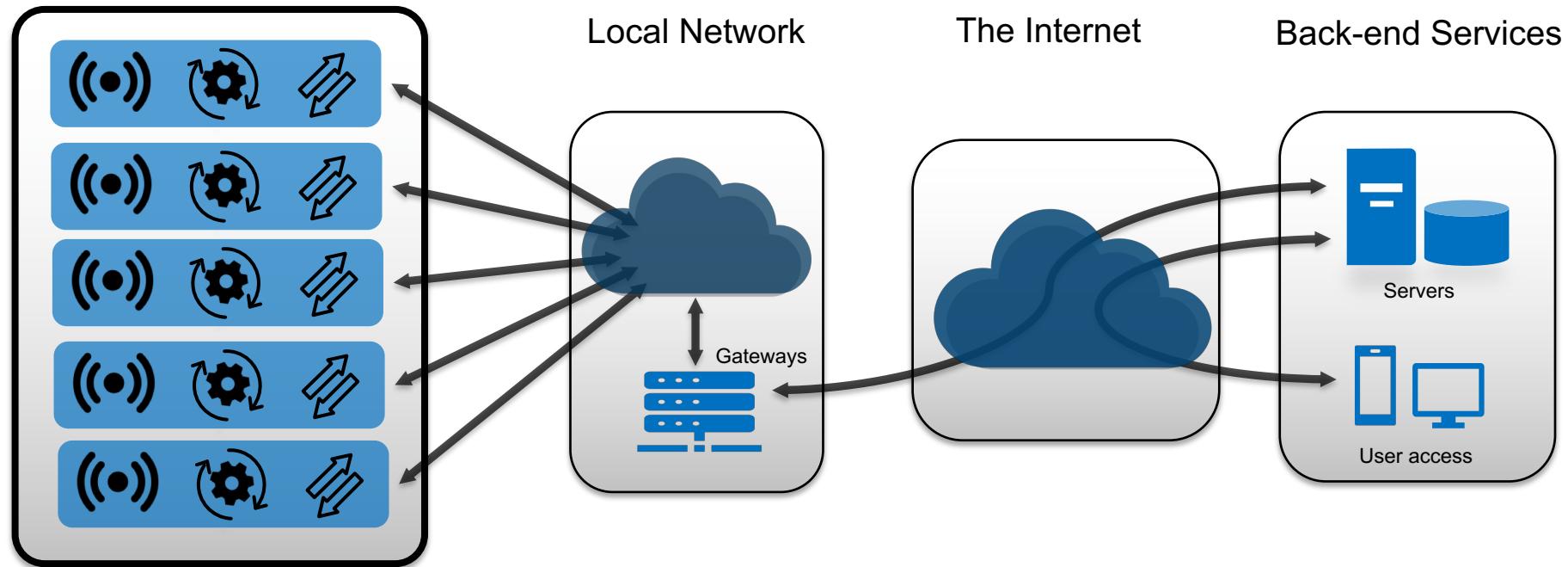


# Outline

1. Introduction
2. Related Work
3. Visualization Architecture
4. Case Study
5. Conclusion

# Introduction

## Things



**Billions data nodes**

➡ Potential subsequent risks can become severe due to the pervasive influence



# Project Overview

Gaining **insights** into **negative aspects** of IoT is crucial for raising awareness of the issues.

This project proposes visual approaches for exploring the downsides of IoT.

The visualization is expanded on the following dimensions:

- The relationship between the aspects
- Temporal domain: The evolution of topics over time



# Project Overview

We therefore focus the following design goals:

- Temporal overview across negative aspects distribution
- Details-On-Demands and Filtering: Provide specific information of the IoT downsides
- Relationship between the negative aspects



# Related work

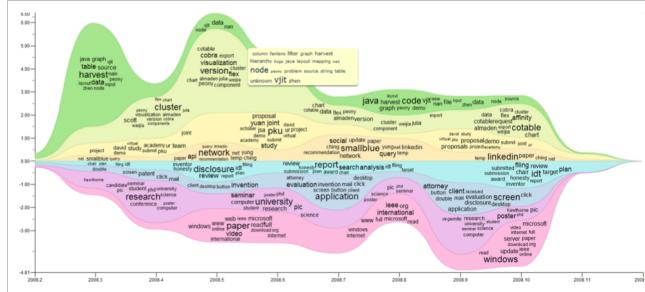
## Text visualization



Wordle

Topic 01 graphics visual simulation **interaction** pie classification surface **visual** human-machine physical media touch image media interactive face tracking  
 Topic 07 recognition session sign musical music signed signing sound speaker computer-based automatic auditory emotions **processing** channel surfaces communication  
 Topic 22 language text tagging linguistic natural categorization machine relation **processing** message meaning nlp corpora extraction sentence translation word training  
 Topic 23 mining discover dataset massive machine network scientific detection statistical pattern novel knowledge complex field developing time source  
 Topic 20 **network** security policy response service communication distributed emergency policy collaborative justice wireless criminal released internet privacy file sharing  
 Topic 01 parallel database query relational management **processing** http performance estimate optimizer spatio-temporal implementation answer operation hardware  
 Topic 04 model reduction **performance** dimensionality existing system statistical measure optimization solution approach based novel popular method machine  
 Topic 13 reasoning planning **complex** decision theory cause intelligence uncertainty computational domain real-world processes knowledge graphical  
 Topic 01 graduate student education program education computing engineering university concern interdisciplinary project school women underrepresented  
 Topic 19 undergraduate graduate course education program education computing engineering university concern interdisciplinary project school women underrepresented  
 Topic 06 creative creative **computational** media search system interactive reading designer content art study technology animation collaboration  
 Topic 05 user create help potential available goal process **people** generate ability current solution set builder example enable cost knowledge difficult complex  
 Topic 11 intelligence cognitive agent **people** human behavior intelligent strategy **interaction** individual learn environment ability understanding machine  
 Topic 12 visual computational neuroscience brain cortex stimuli memory response active **understanding** mechanism neurons natural neural movement  
 Topic 09 biology computational biological network sequencing high-throughput sequence **interaction** protein gene proposed bioinformatics evolutionary

ParallelTopics



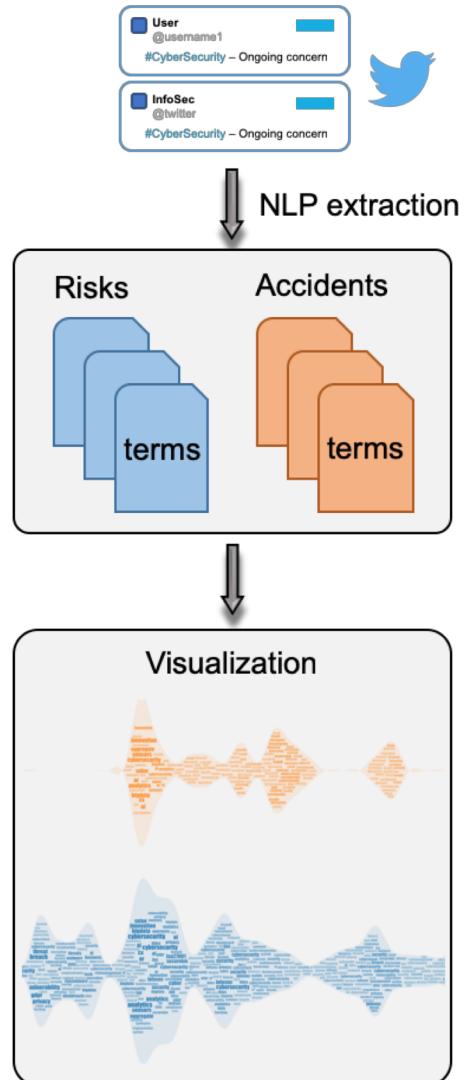
TIARA

## Topic modeling - LDA

“Arts”	“Budgets”	“Children”	“Education”
NEW	MILLION	CHILDREN	SCHOOL
FILM	TAX	WOMEN	STUDENTS
SHOW	PROGRAM	PEOPLE	SCHOOLS
MUSIC	BUDGET	CHILD	EDUCATION
MOVIE	BILLION	YEARS	TEACHERS
PLAY	FEDERAL	FAMILIES	HIGH
MUSICAL	YEAR	WORK	PUBLIC
BEST	SPENDING	PARENTS	TEACHER
ACTOR	NEW	SAYS	BENNETT
FIRST	STATE	FAMILY	MANIGAT
YORK	PLAN	WELFARE	NAMPHY
OPERA	MONEY	MEN	STATE
THEATER	PROGRAMS	PERCENT	PRESIDENT
ACTRESS	GOVERNMENT	CARE	ELEMENTARY
LOVE	CONGRESS	LIFE	HAITI

The William Randolph Hearst Foundation will give \$1.25 million to Lincoln Center, Metropolitan Opera Co., New York Philharmonic and Juilliard School. “Our board felt that we had a real opportunity to make a mark on the future of the performing arts with these grants an act every bit as important as our traditional areas of support in health, medical research, education and the social services,” Hearst Foundation President Randolph A. Hearst said Monday in announcing the grants. Lincoln Center’s share will be \$200,000 for its new building, which will house young artists and provide new public facilities. The Metropolitan Opera Co. and New York Philharmonic will receive \$400,000 each. The Juilliard School, where music and the performing arts are taught, will get \$250,000. The Hearst Foundation, a leading supporter of the Lincoln Center Consolidated Corporate Fund, will make its usual annual \$100,000 donation, too.

# Visualization Architecture



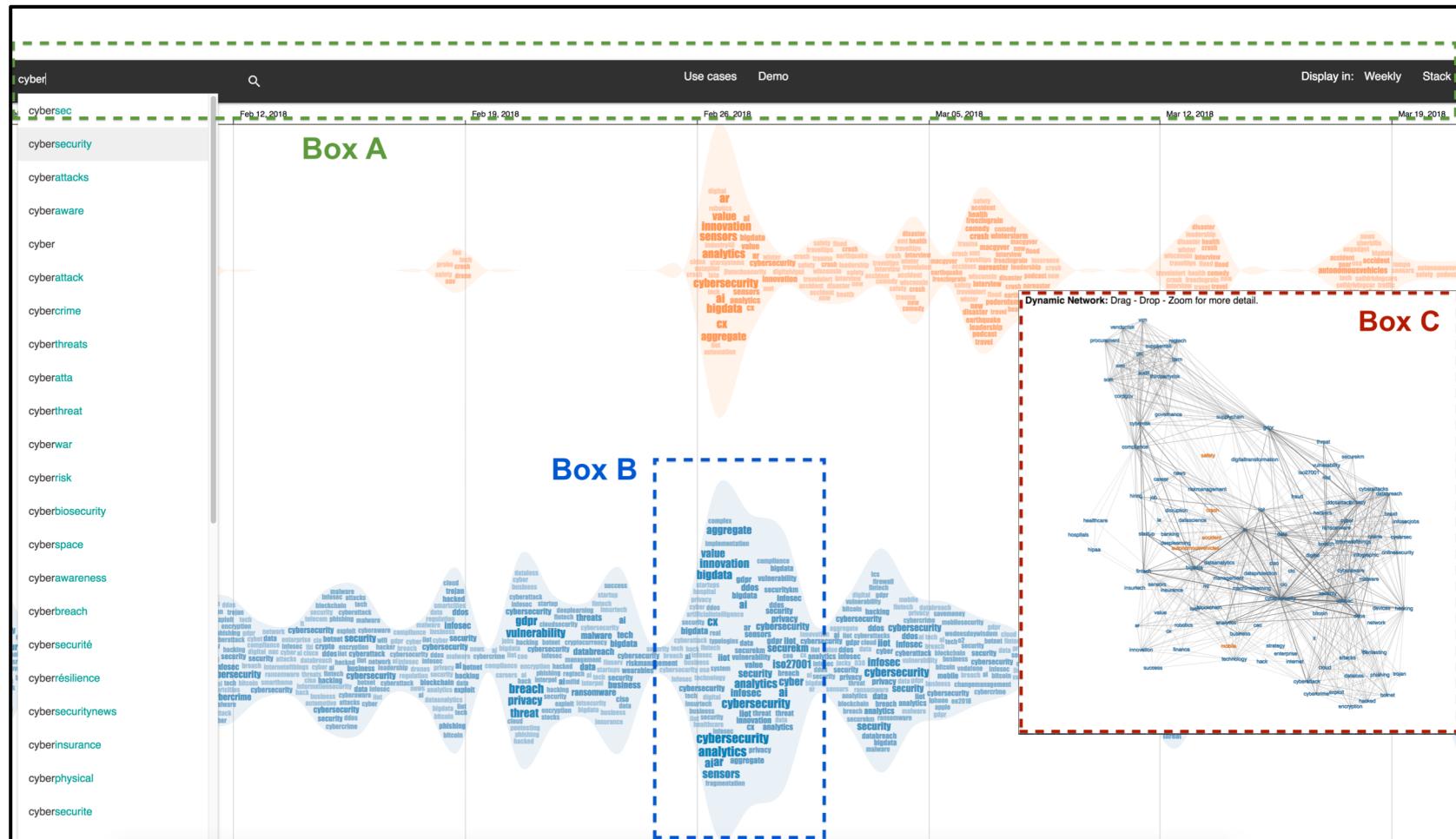
- The dataset is retrieved from Twitter
- Terms and topics are extracted by Natural Language Processing library spaCY
- Two categories: **Security risks** and **Physical accidents**

<https://twitter.com>

<https://spacy.io>



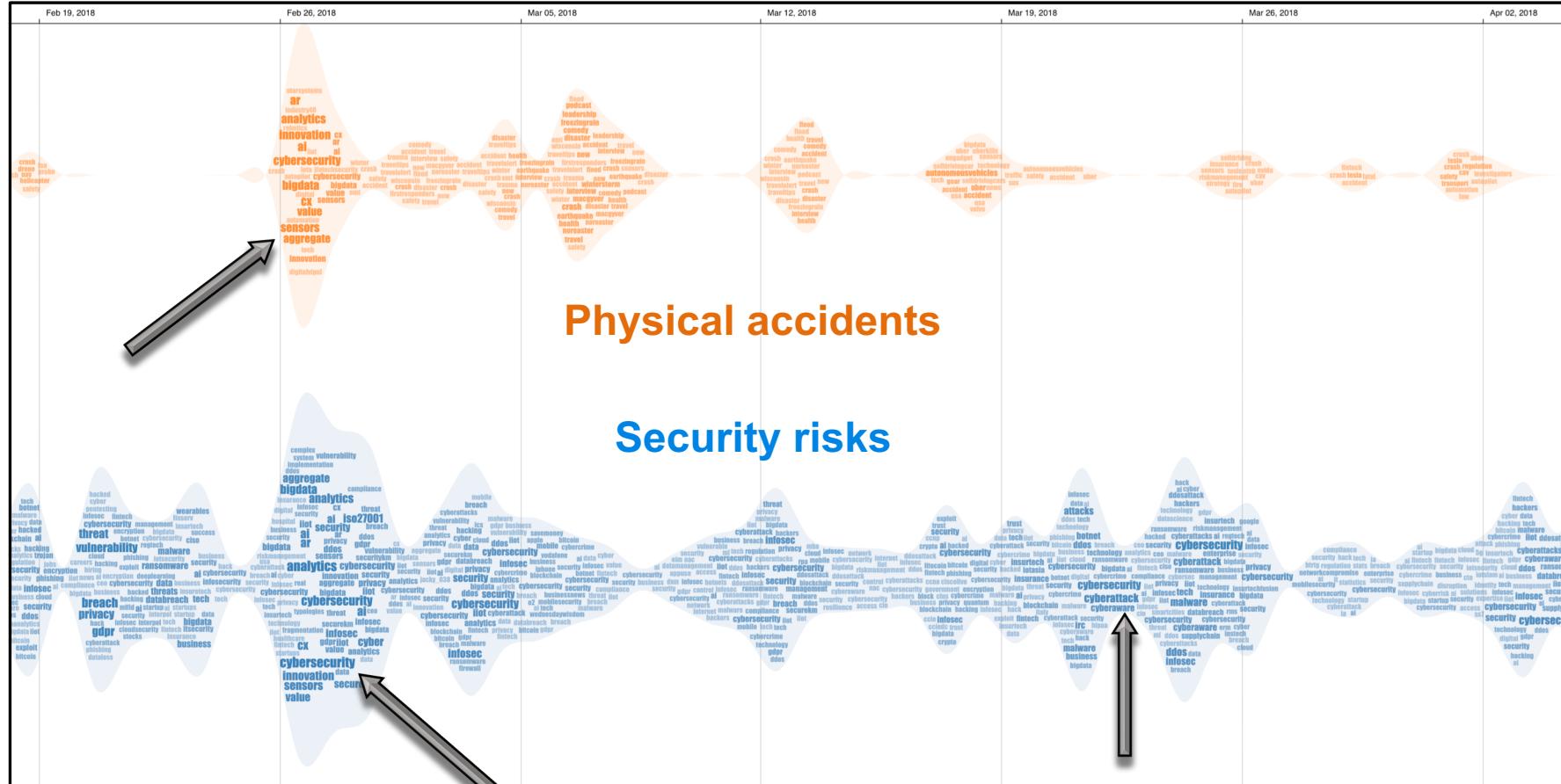
# Visualization Architecture



Three main components of IoTNegViz:  
**A – Utility Component, B – Topic evolution and C – Dynamic network**



# IoTNegViz – Topic Evolution



Physical accidents

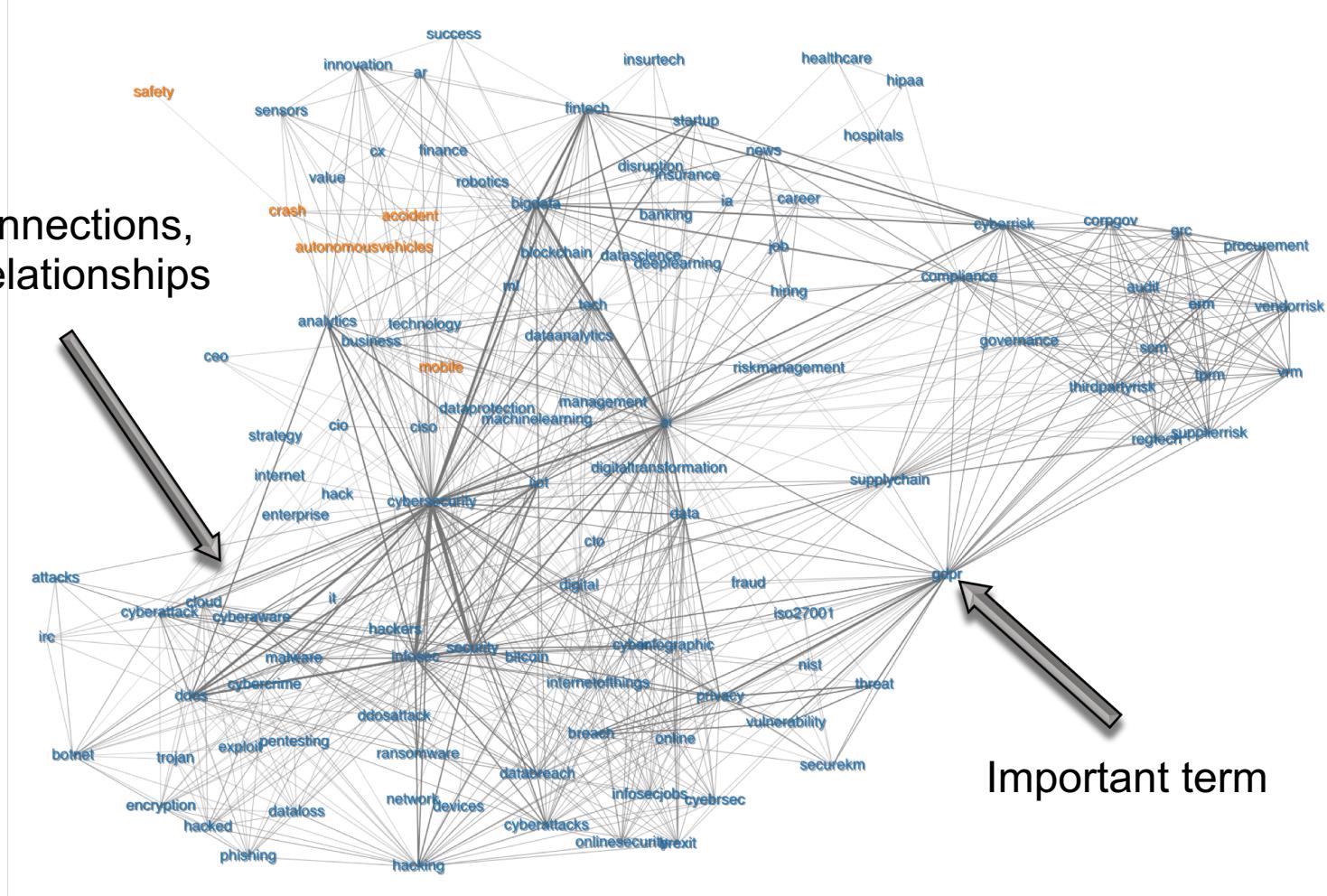
Security risks

High frequency terms



# IoTnegViz – Dynamic Network

The thicker the connections,  
the stronger the relationships



Important term

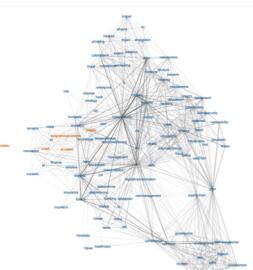
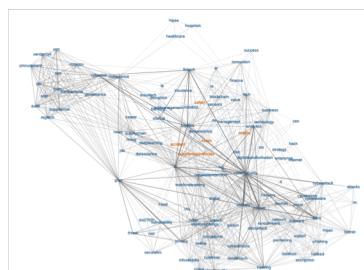
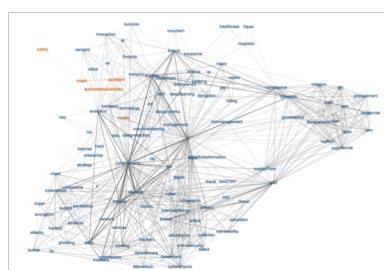
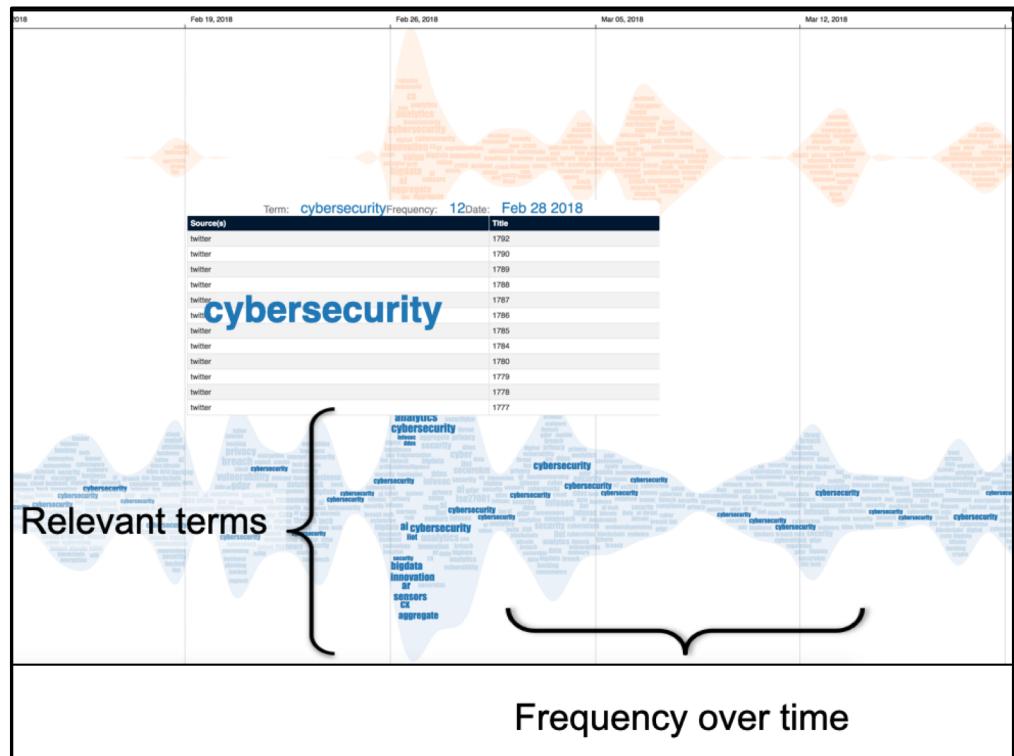
# User Interactions

## A. Mouse events

- Mouse over
- Mouse click

## B. Filtering key words with autocomplete

## C. Drag-and-Drop for exploring relations





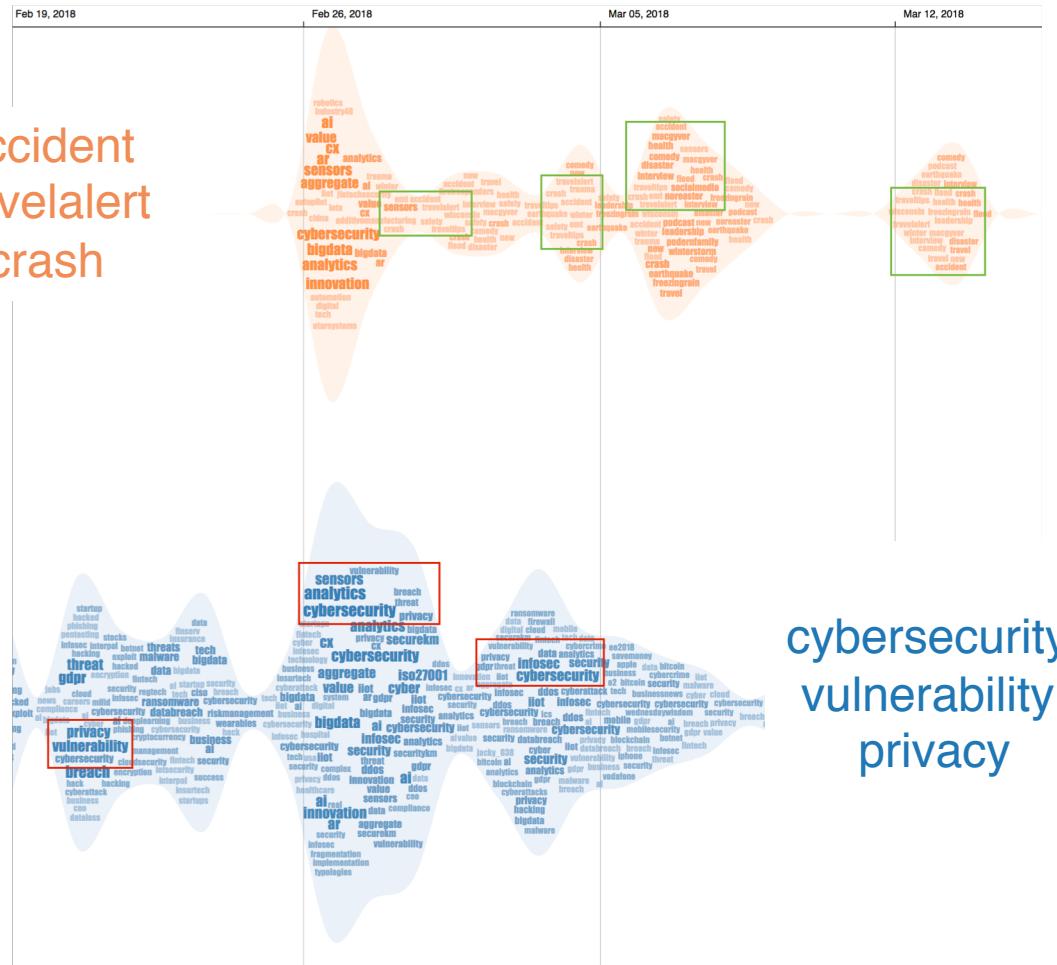
# Case Study

Groups of words that often appear together: Showing relation in context between them

Accuracy of travel alert:  
whether or not an accident  
or crash happens

accident  
travelalert  
crash

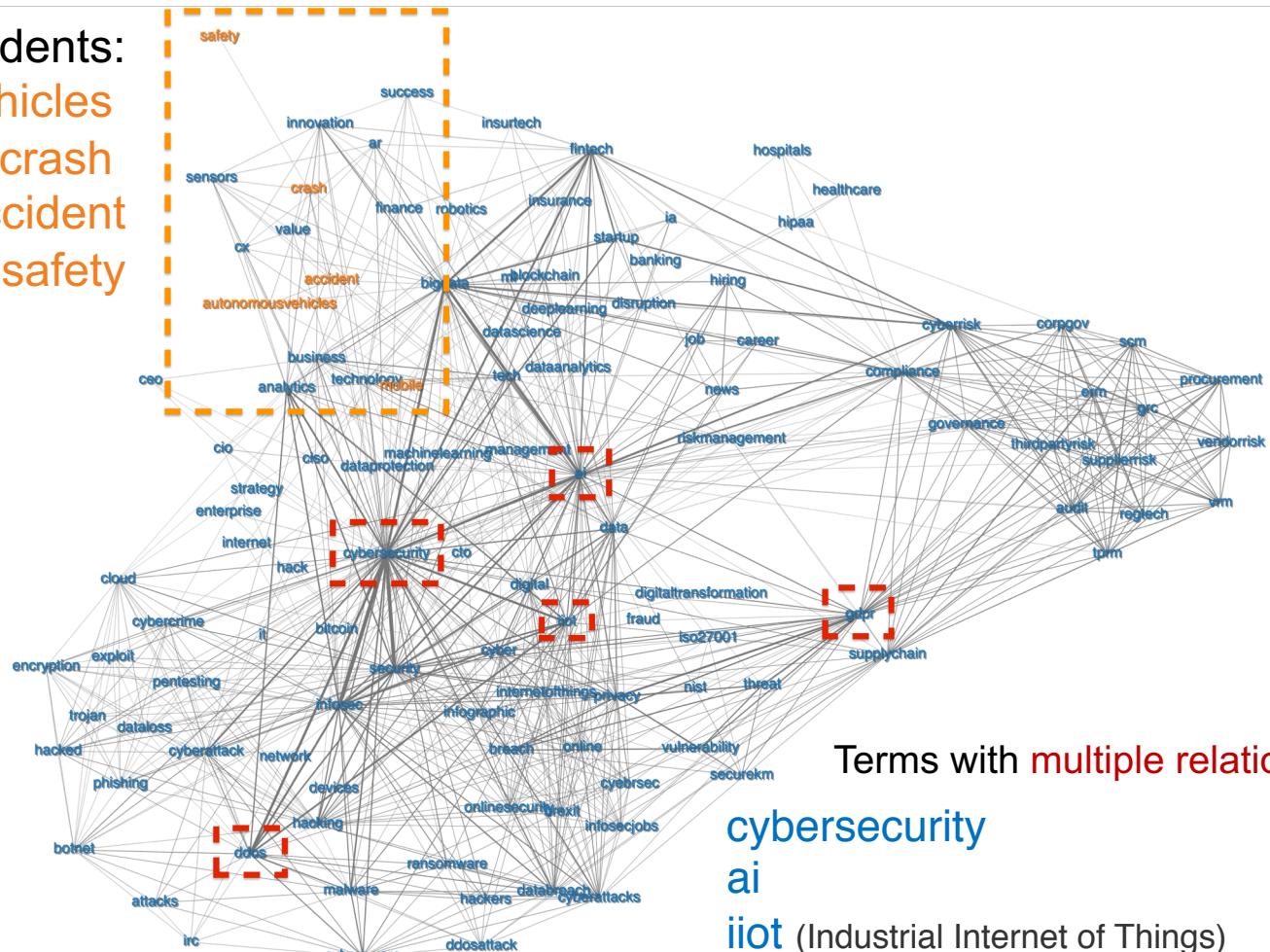
The vulnerability from  
cybersecurity may lead to  
privacy issues



*risk* and *crash* are the most popular words that span over a long period of time

# Case Study

The concern of accidents:  
**autonomousvehicles**  
**crash**  
**accident**  
**safety**



Terms with multiple relations

**cybersecurity**  
**ai**

**iiot** (Industrial Internet of Things)  
**gdpr** (General Data Protection Regulation)  
**ddos** (Distributed Denial of Service).



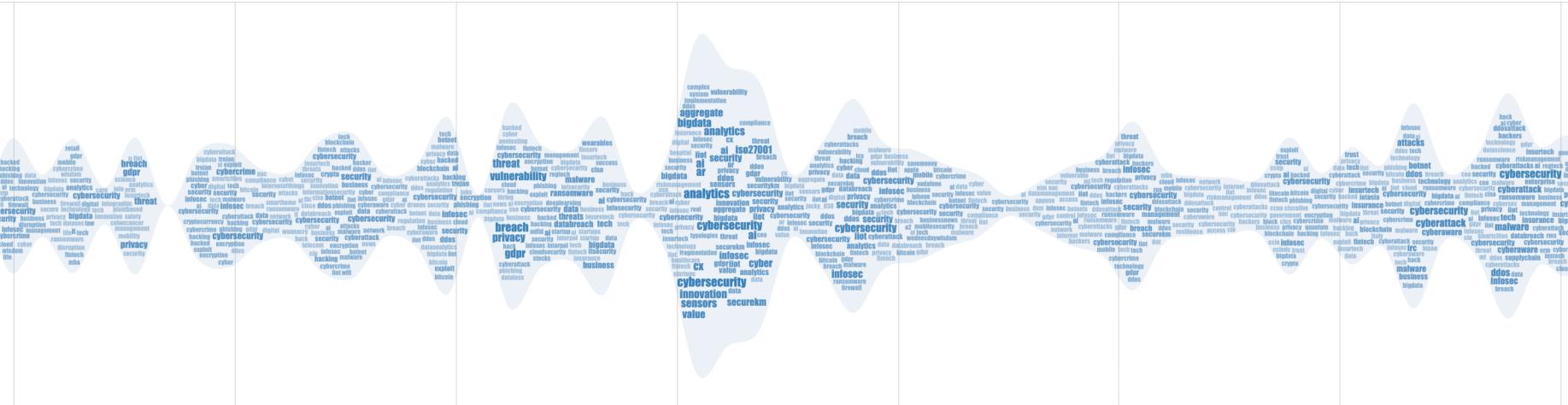
# Conclusion

1. We introduced IoTNegViz, interactive visual tool to help users summarize the IoT-related concerning issues over time.
2. IoTNegViz supports of a range of interactive features, such as highlighting and filtering, allowing users to quickly narrow down events of interest.
3. We demonstrate the usefulness of our tool through different use cases. The purpose is to get users to **raise awareness**, be **prepared**, and therefore **alleviate** the existing problems.



# Questions?

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Demo: <https://idatavisualizationlab.github.io/IoTNegViz/>

