

AN ANALYSIS OF TWITTER MESSAGES IN THE 2011 TOHOKU EARTHQUAKE

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Roles of social media

Social media can be an useful resource for understanding public opinion.

- ❖ Election prediction (O'Connor et al. 2010)
- ❖ Stock market changes (Bollen et al. 2011)
- ❖ Oil price changes (O'Connor et al. 2010)

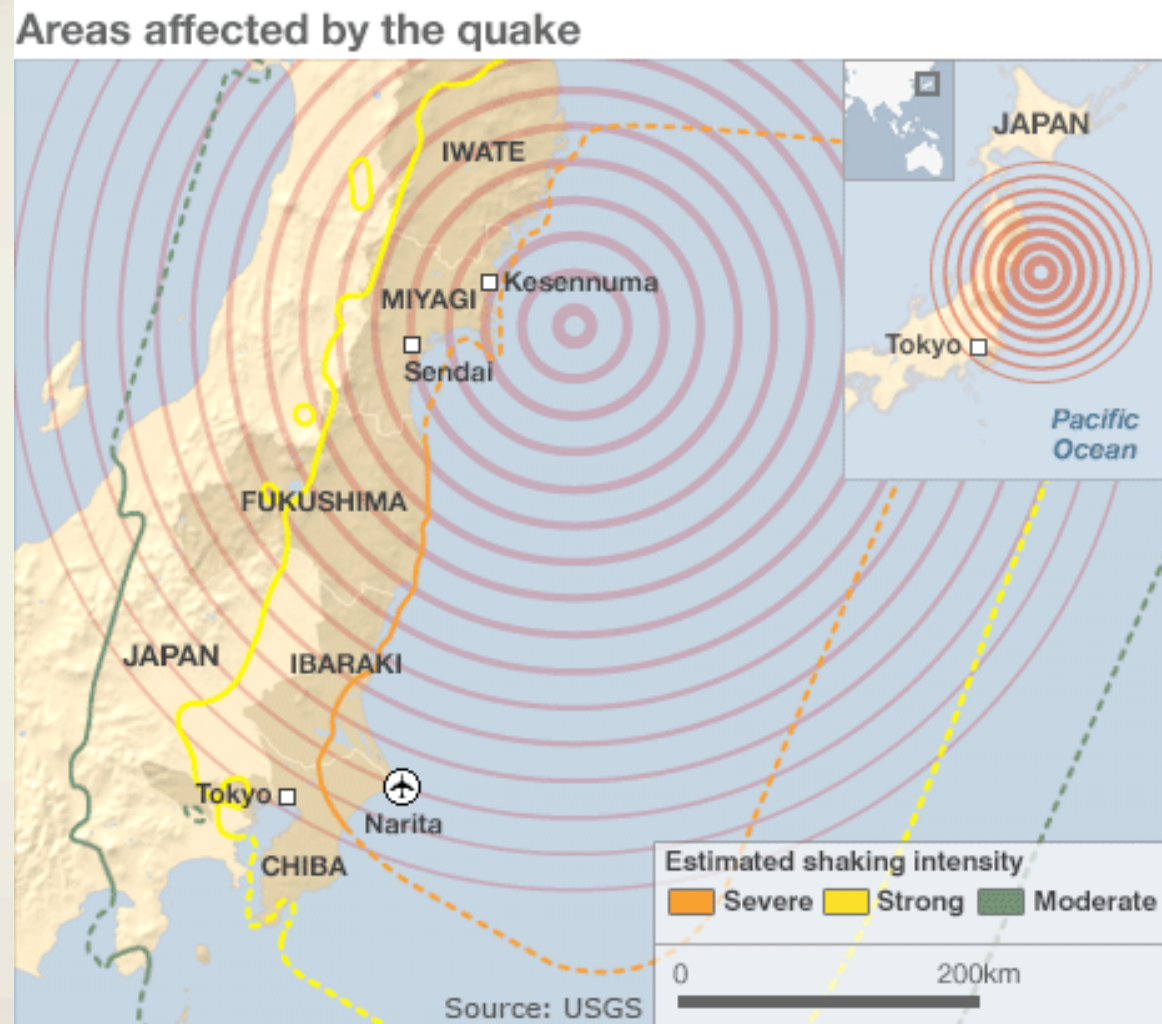
They can be used for early warning natural disaster events.

- ❖ Earthquake detector (Sasaki et al. 2010, Guy et al. 2010)
- ❖ ILI rate (Cullota 2010, Lampos and Christinini 2010, Polgreen et al. 2010)
- ❖ Google Flu Trends (Ginsberg et al. 2009, Valdivia et al. 2010)
- ❖ Syndromic surveillance (Collier and Doan 2011)

In this study, we will investigate the role of Twitter data in the 2011 Tohoku earthquake in order to track awareness and anxiety levels of public opinion in Tokyo metropolitan district

2011 Tohoku Earthquake

- ❖ Occurred at 14:46:24 JST (5:46:24 UTC) on Friday, 11 March, 2011 at epicenter
- ❖ Epicenter approximately 129 km E of Sendai, 373 km NE of Tokyo
- ❖ The earthquake triggered tsunami waves, reached heights of up to 40.5 metres and travelled up to 10 km inland.
- ❖ The tsunami caused a number of nuclear accidents at three reactors in the Fukushima I Nuclear Power Plant.
- ❖ 15,839 deaths, 5,950 injured, and 3,642 missing.



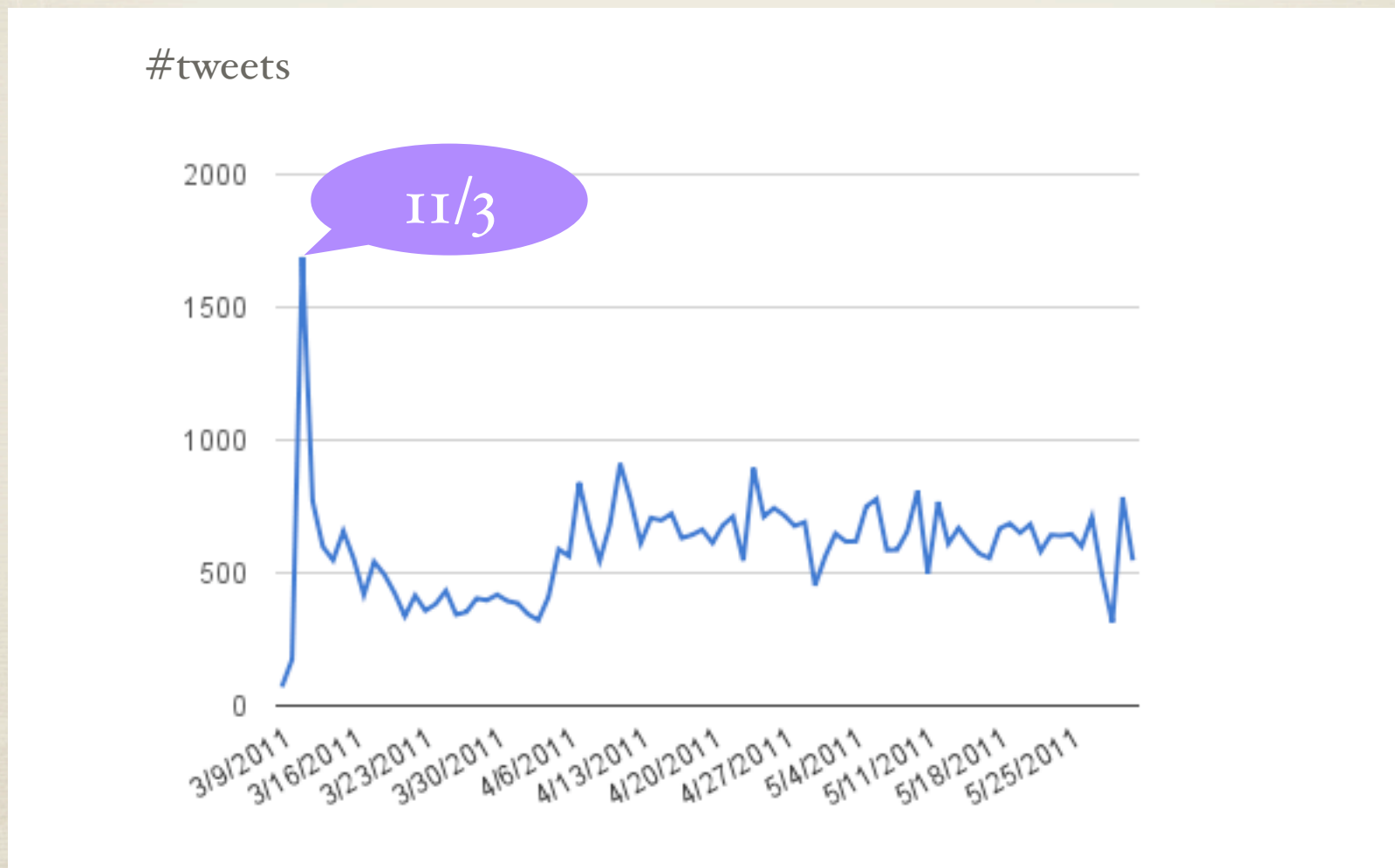


Tweet corpus

- ❖ Timeline: From March 9th 2011 to May 31st 2011
- ❖ Location: Tokyo using Twitter API functions
- ❖ Number:
 - English tweets: 48,870
 - Japanese tweets: 1,611,753

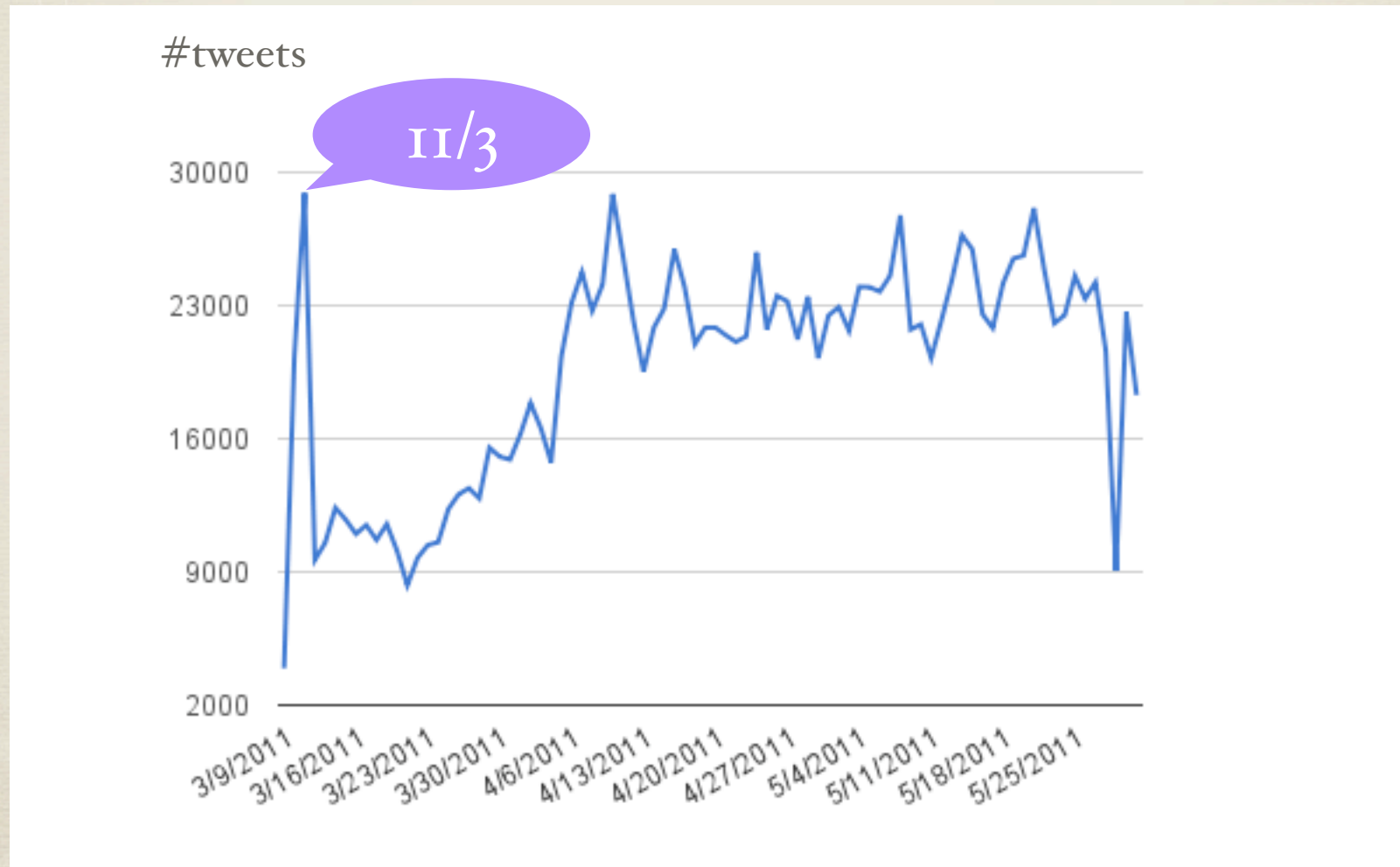
Tweet corpus

English tweets by time



Tweet corpus

Japanese tweets by time



Method

Relevant English terms

Earthquake and Tsunami event

earthquake, quake, quaking, post-quake, shake, shaking, shock, aftershock, temblor, tremor, movement, sway, landslide seismic, seismography, seismometer, seismology, epicenter, tsunami, wave

Radiation event

radiation, radioactivity, radioactive, radiation ray, nuclear, power plant, nuclear power plant, reactor, iodine, TEPCO, Fukushima, meltdown, micro sievert, iodine, isodine, explosion, flame, fire

Anxiety event

die, death, risky, scary, scared, incredible, freaked out, chaos, evacuate, help, unable to contact, bad, worrying, worried, anxious, annoying

Method

Relevant Japanese terms

Earthquake and Tsunami event

大地震 (major earthquake), 大震災 (great earthquake), 震災 (earthquake disaster), 地震 (earthquake), 余震 (aftershock), 揺れ (quake/tremor), 震度 (seismic intensity), 震源 (epicenter), マグニチュード (magnitude) 津波 (tsunami)

Radiation event

放射 (radiation), 放射線 (radiation ray), 放射能 (radioactivity), 放射性物質 (radioactive material), 原発 (nuclear power plant), TEPCO, 東京電力 (TEPCO), メルトダウン (meltdown), マイクロシーベルト (micro sievert), ヨウ素 (iodine), イソジン (isodine), ヨウ化カリウム (potassium iodide), 炉心溶融 (core meltdown), 爆発 (explosion), 火炎 (flame), 火事 (fire)

Anxiety event

死亡 (death), 死ぬ (die), やばい, やばかった, ヤバい, やばっ, やべ (risky; dangerous), 怖い, 怖かった, 怖っ, 恐れ (scary, scared), すごい, すげえ, すげー, すっげー (incredible), びびる, びびった (freaked out), 混乱 (chaos), 避難 (evacuation), 助けて (help), 連絡とれない (unable to contact), 大変 (bad; oh, my God), 心配 (worrying), 船酔い (seasick)

Method

Calculate frequency for each event

We filtered tweets by relevant keywords and calculate frequency of each event as follows.

$$f(\text{event}) = \# \text{filtered tweets per day} / \# \text{tweets per day}$$

RESULTS

EARTHQUAKE AND TSUNAMI

Results

Earthquake and tsunami event

The earthquake happened at 05:46:23 UTC on Friday, 11th March 2011 with 9.0 magnitude near the east coast of Honshu, Japan which was 373 km NE of Tokyo

First Tweets in English

Two first tweets in English came from iPhones

- ❖ 11-03-2011T05:48:54 Huge earthquake in TK we are affected!
- ❖ 11-03-2011T05:49:01 BIG EARTHQUAKE!!!
- ❖ 11-03-2011T05:50:00 Massive quake in Tokyo

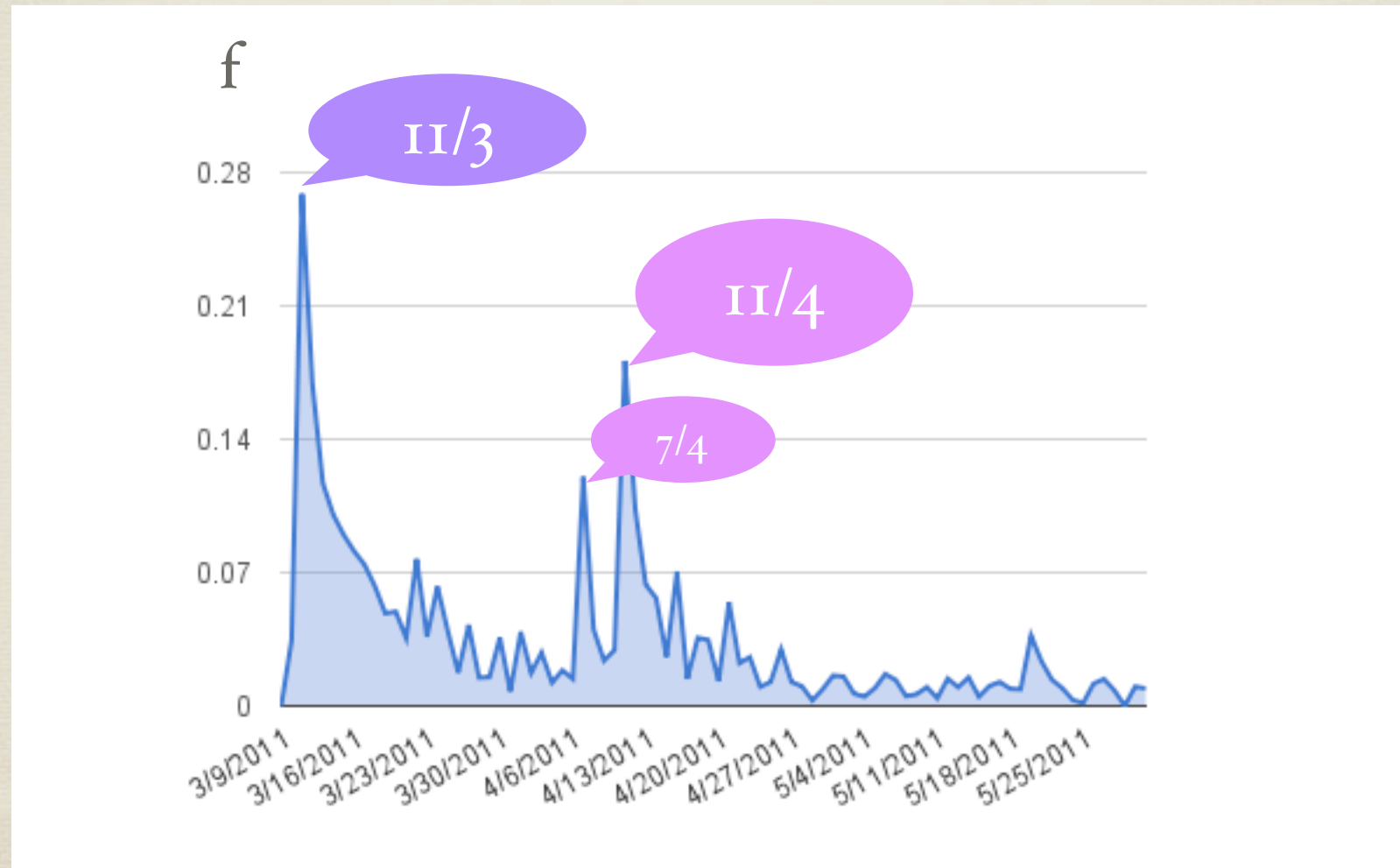
First Tweets in Japanese

- ❖ 11-03-2011T05:48:08 "地震!" [Earthquake!]
- ❖ 11-03-2011T05:48:08 "地震だ～縦揺れ!" [Earthquake ~ vertical shake!]
- ❖ 11-03-2011T05:48:14 "地震!!!!" [Earthquake!!!!]

Japanese tweets were earlier than English tweets, 1 min 25 sec after the earthquake at the epicenter

Results

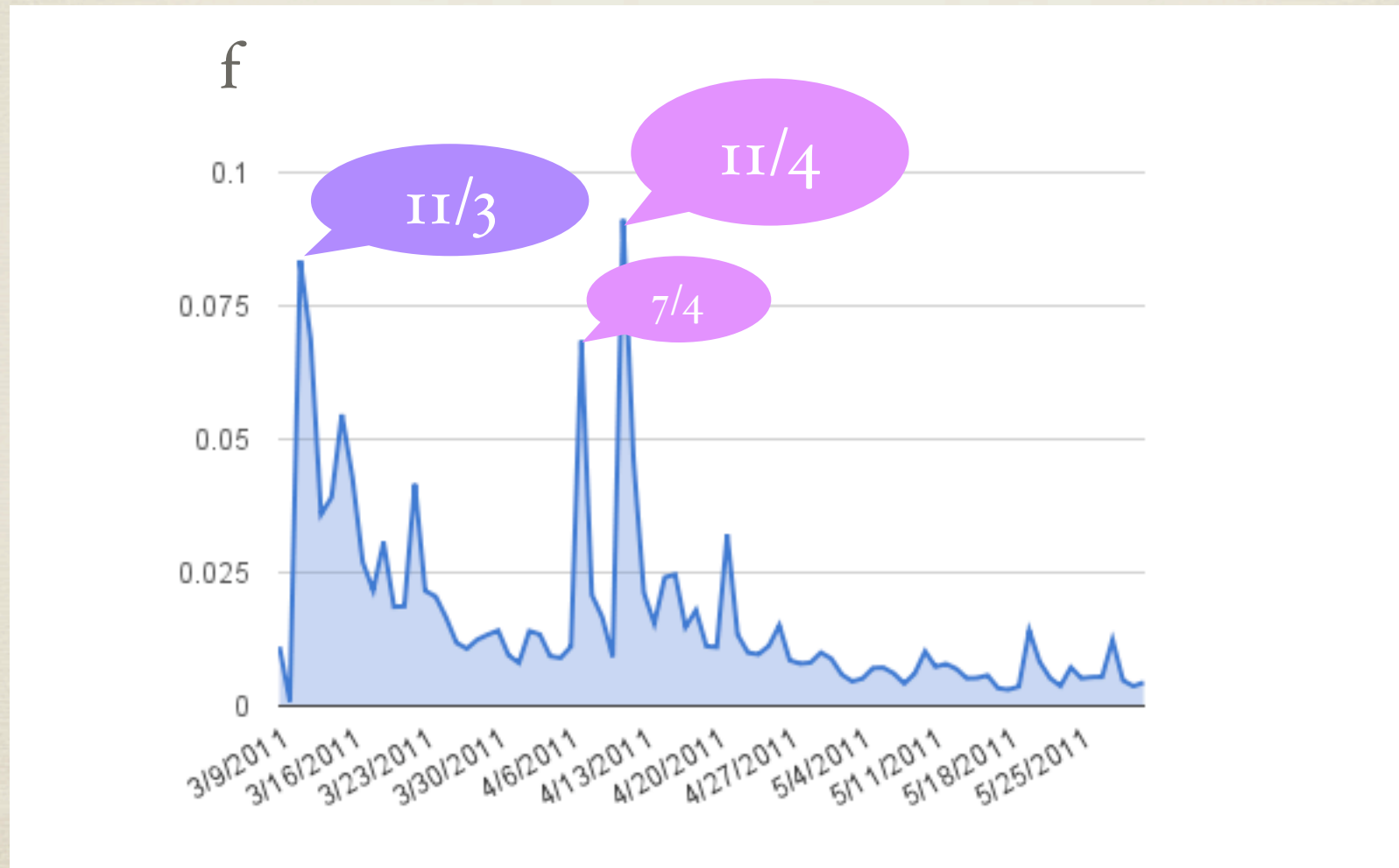
Earthquake and tsunami event - English tweets



A magnitude 7.7 Mw and a 7.9 Mw quake occurred on **March 11** and *the third one struck offshore on **7 April** with a disputed magnitude. On **April 11**, another strong magnitude 6.6 Mw aftershock struck Fukushima*

Results

Earthquake and tsunami event - Japanese tweets



A magnitude 7.7 Mw and a 7.9 Mw quake occurred on **March 11** and *the third one struck offshore on 7 April with a disputed magnitude*. On **April 11**, another strong magnitude 6.6 Mw aftershock struck Fukushima

Tweets concerned after the earthquake

Concerned about the nuclear problem

11-03-2011T05:57:53 "原発大丈夫かな?" [Is the nuclear power plant okay?]

11-03-2011T09:50:49 "福島原発ヤバい状況らしい。。。政府が国民を欺かないことを願います" [The Fukushima plant is in a really bad situation... I hope that the government won't deceive the public.]

Concerned about personal experiences such as a lack of food in convenience store

11-03-2011T11:27:03 People r suggested to prepare an "emergency kit" consist of blanket, water, canned food, flashlight, aid kit, clothes #bigearthquakeinjapan

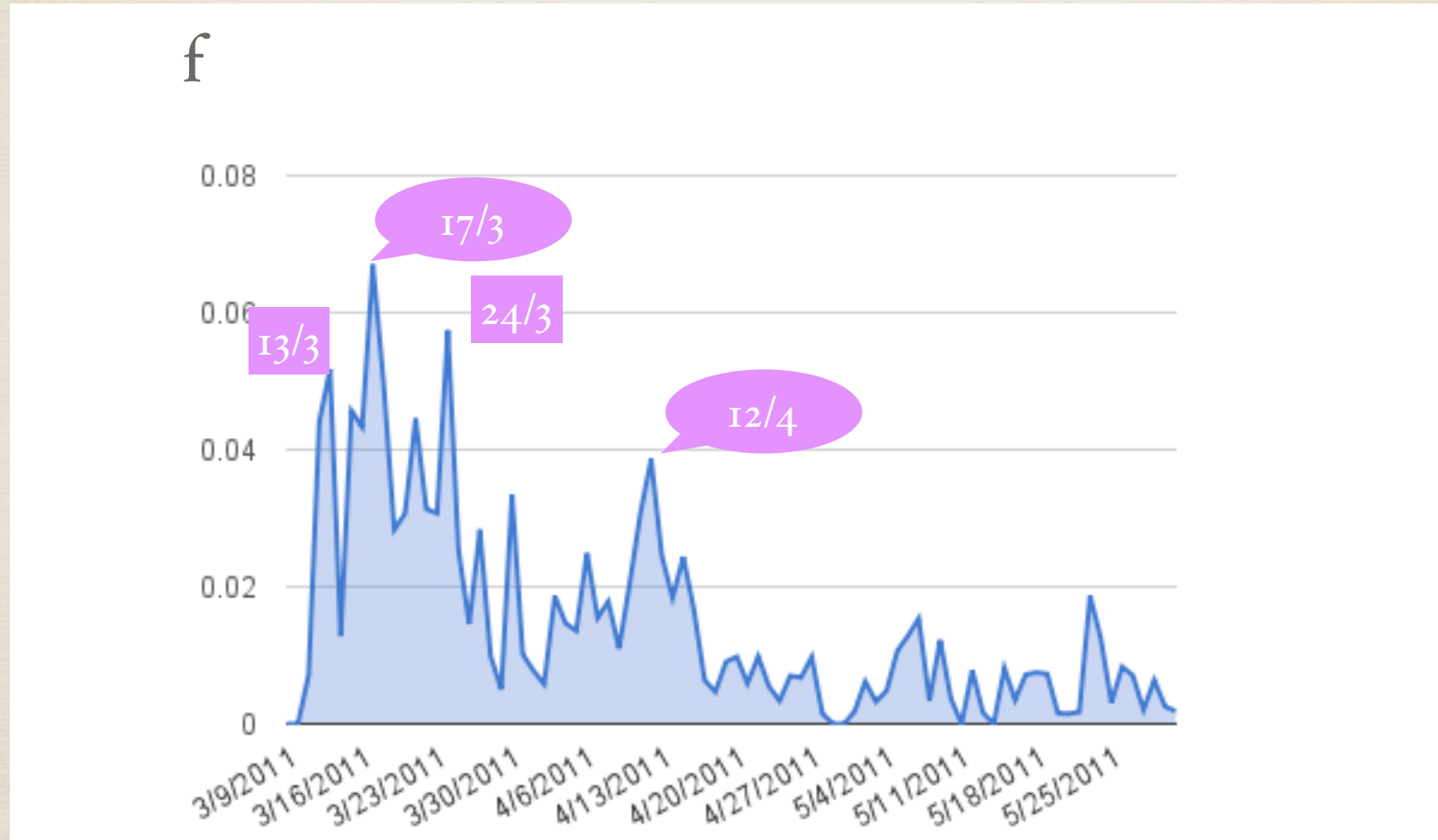
12-03-2011T01:00:18 Wow. I've never seen a convenience store depleted of food before, even during the Great Handgun quake. At least I got toilet paper.

RESULTS

RADIATION EVENT

Results

Radiation event - English tweets



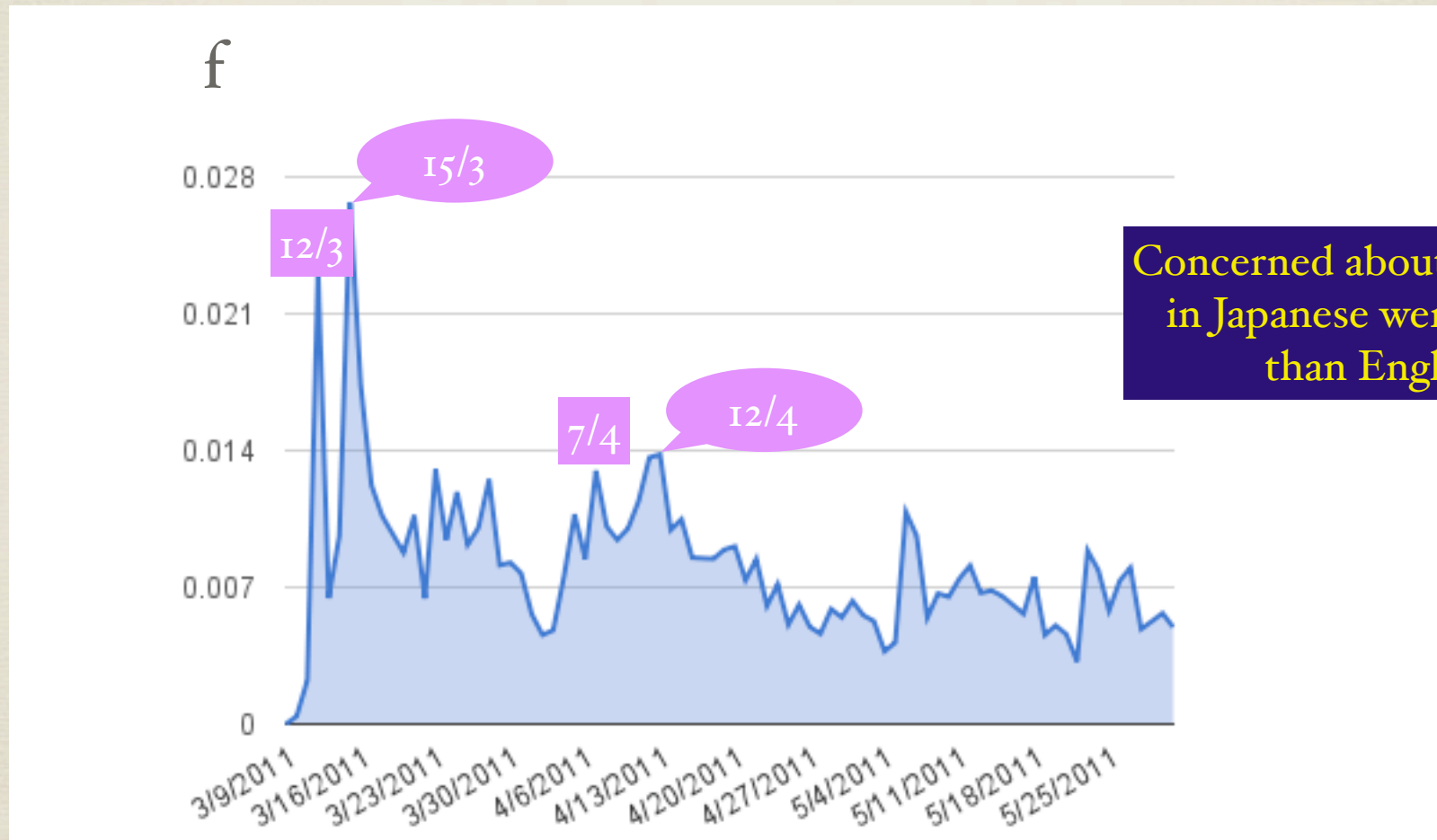
12th March, 15:36JST: Massive hydrogen explosion on the outer structure of the unit 1.

14th March, 11:01JST: The unit 3 reactor building explodes, injuring six workers.

15th March, 20:00JST: A major part of the fuel in reactor 2 drops to the bottom of the reactor pressure vessel. Radiation levels at the plant rise significantly but subsequently fall back. Radiation equivalent dose rates of 400 millisieverts per hour (400 mSv/h) are observed at one location in the vicinity of unit 3.

Results

Radiation event - Japanese tweets



12th March, 15:36JST: Massive hydrogen explosion on the outer structure of the unit 1.

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Tweets concerned about radiation

Concerned about the nuclear problem

11-04-2011T23:21:09 Earthquakes, tsunamis, radiation what else yougot? Exploding Fuji? Let me get out my folding umbrella... #fb #quaketrash talk #backchannel

11-04-2011T23:51:09 This is the "New Normal" life after 3/11. Always fearing how the situation of nuclear plant is #prayforjapan

12-04-2011T00:08:01 Nuclear Agency Japan has increased the level of nuclear disaster to level 7 as the worst, which equal to Chernobyl #Fukushimasradiation

Concernred about radiation in relation to tap water in Tokyo

13-03-2011T07:06:37 People are asked to close window, door; not to use AC; use mask & not to drink tap water #Fukushimasradiation

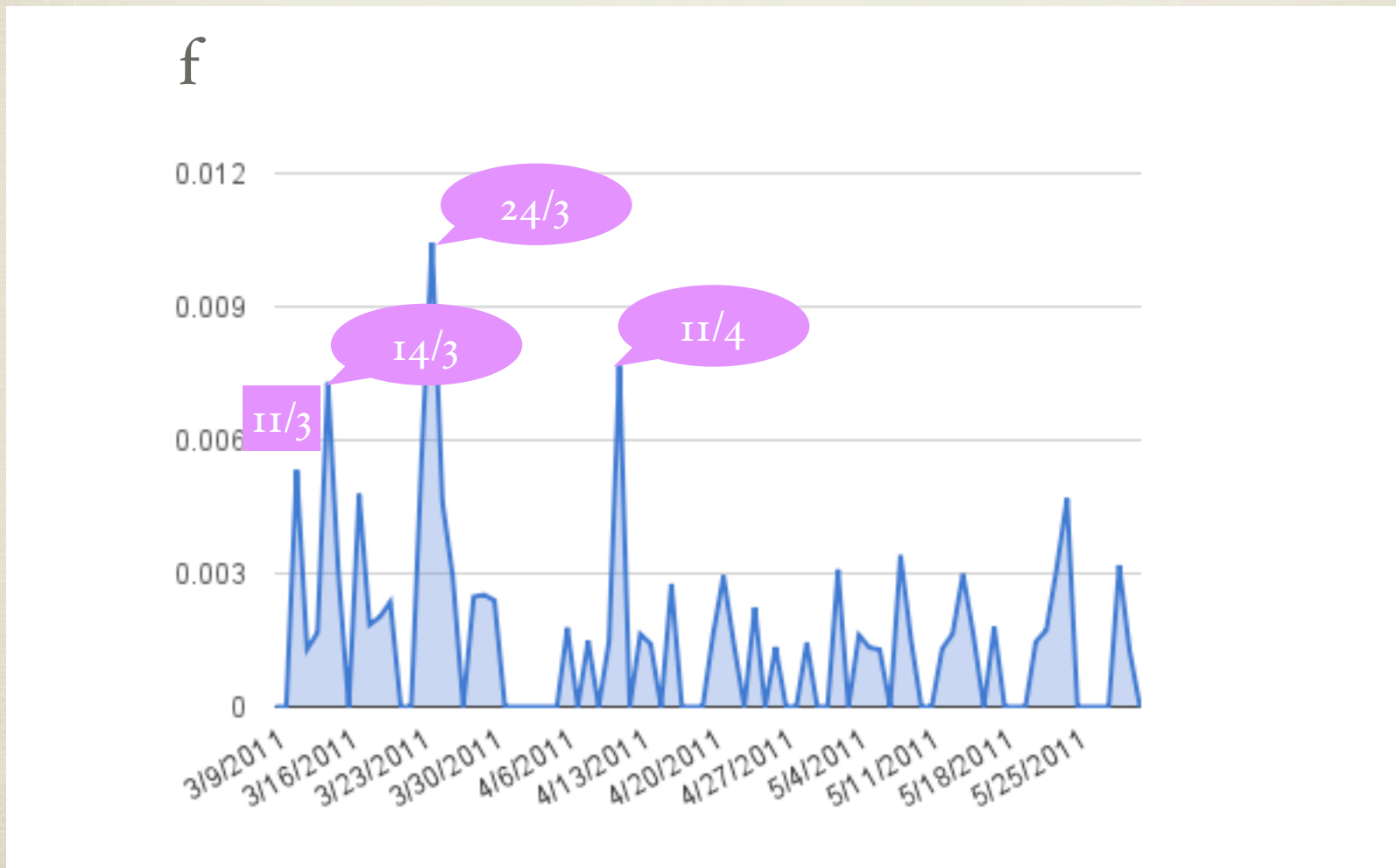
23-03-2011T06:18:50 210 becquerel iodine (normal 100 becquerel) discovered in Tokyo tap water. Infants are urged to avoid drinking it #Fukushimasradiation

RESULTS

ANXIETY EVENT

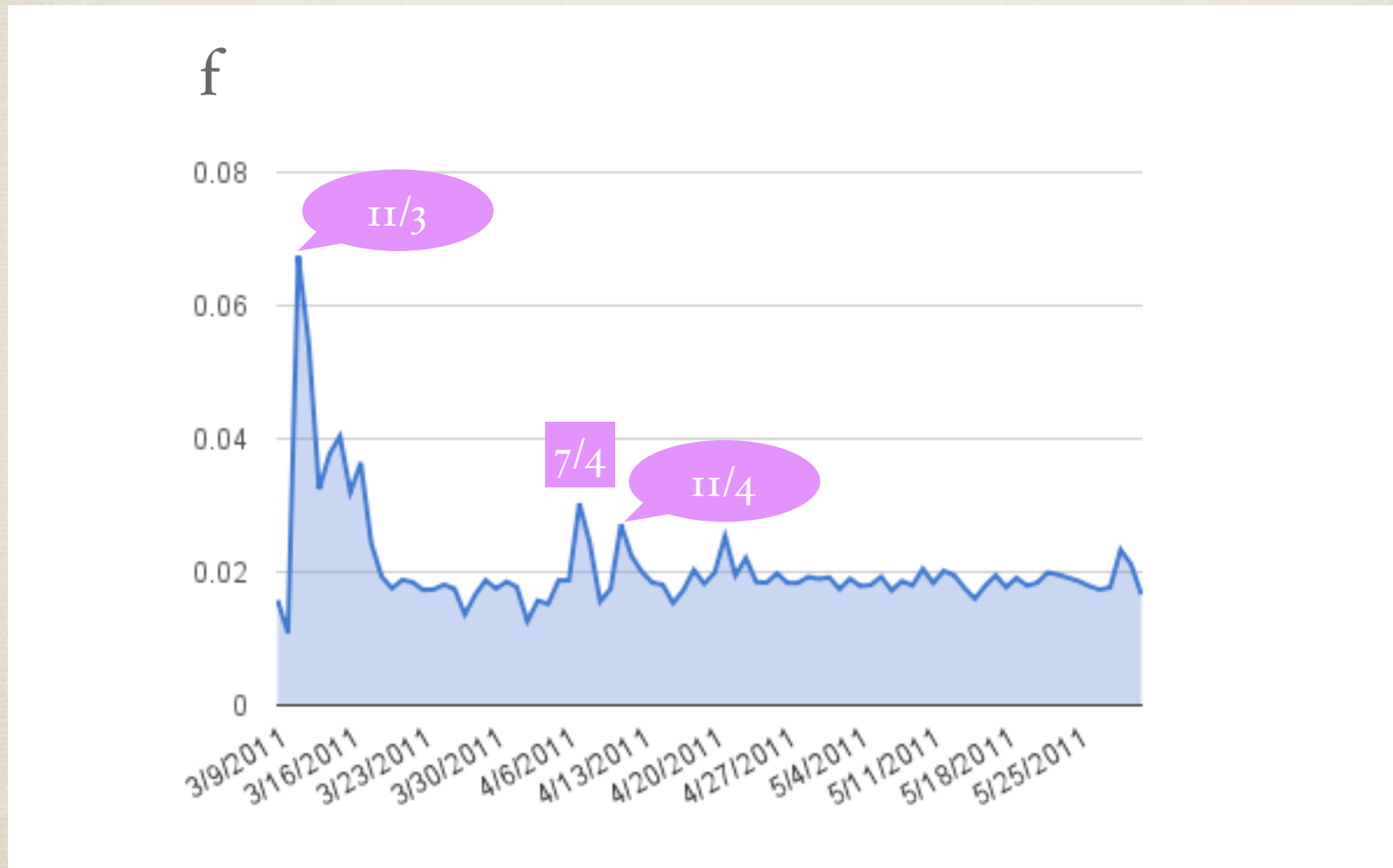
Results

Radiation event - English tweets



Results

Radiation event - Japanese tweets



This shows how Japanese people kept calm during the disasters.

Tweets concerned about anxiety

11-03-2011T06:58:49 nerves frayed out on the streets. everyone emptied out of buildings, on their phones, worried. some inspecting damage to buildings

11-03-2011T07:09:56 @<username> I'm okay, thx.
Worried about others...

11-03-2011T07:14:52 @<username> thanks ! Now Me and my family are ok. But worrying about my men...

Conclusions

- ◆ Close correspondence between Twitter data and earthquake events
- ◆ Strong correlation between English and Japanese tweets on the same events
- ◆ Tweets in the native language play important role in early warning
- ◆ Tweets showed how quickly Japanese people's anxiety returned to normal levels after the earthquake event

The results suggest that Twitter data can be used as an useful resource or tracking the public mood of populations affected by natural disasters as well as an early warning system

THANK YOU !

QUESTIONS WELCOME