Using Delay Logs and Machine Learning to Support Passenger Railway Operations

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TAL TRANSIT ANALYTICS LAB

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Photo Credit: Tony Yeung

Logs, Events, and Incidents

ID	Topic or Cause	Delay	Location	
1	Platform Overshoot	3 min	Oakville	**Incident 1**
2	Broken Switch	18 min	Oshawa	**Incident 2**
3	Priority to Other Train	6 min	Guildwood	
4	Passenger Volume	5 min	Danforth	
5	Passenger Assist Alarm	10 min	Pickering	**Incident 3**

Map Credit: Natural RX (Wikimedia)

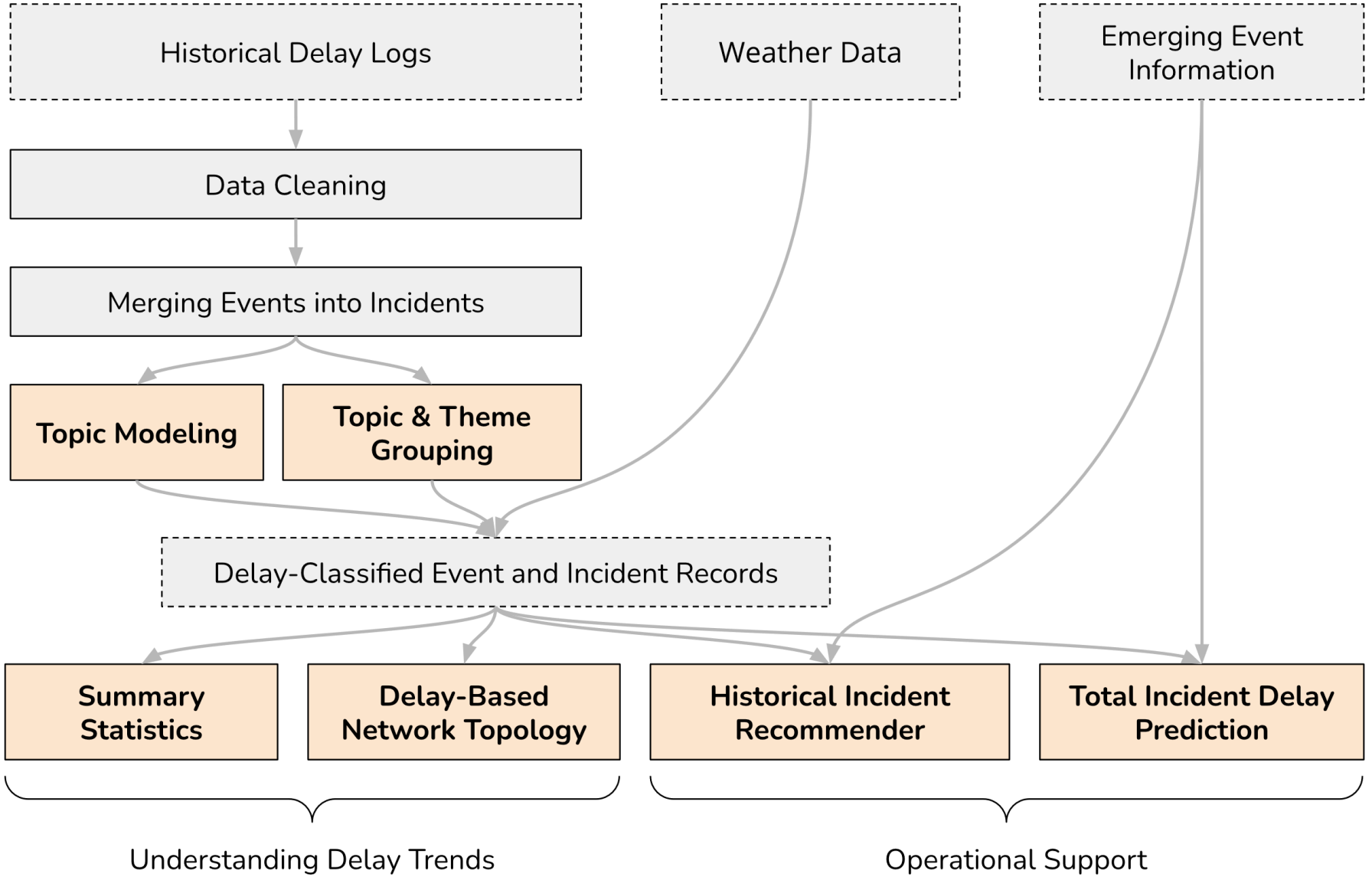
Research Questions

- **Where** do delays occur on the railway network?
- What types of delays are **most common** or **largest**?
- How are delays **connected** on the network?
- Can we provide **historical context** to an emerging incident?
- Can we make **predictions** about emerging incidents?

Goal is to **support** the dispatchers and operators

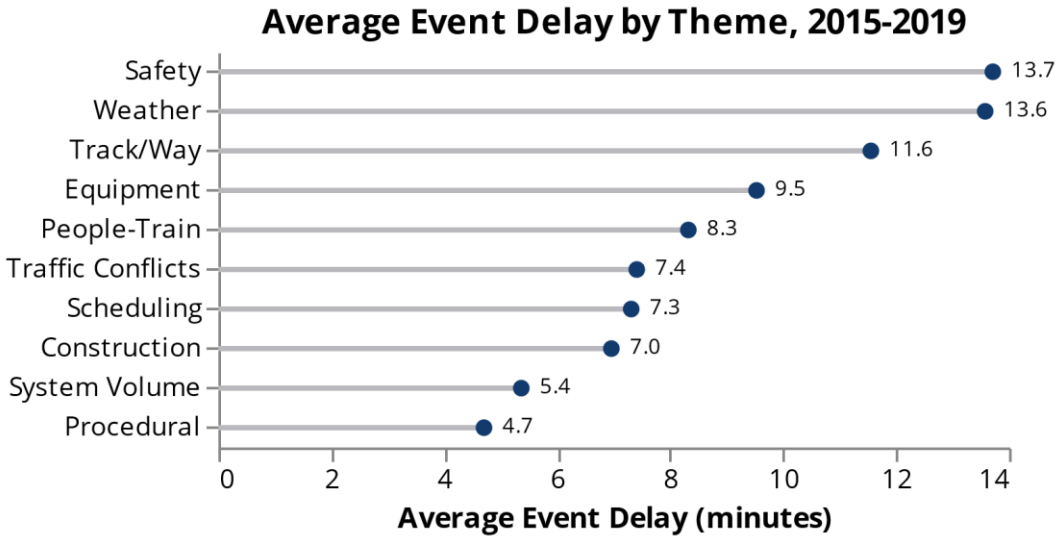
Photo Credit: Udayaditya Barua

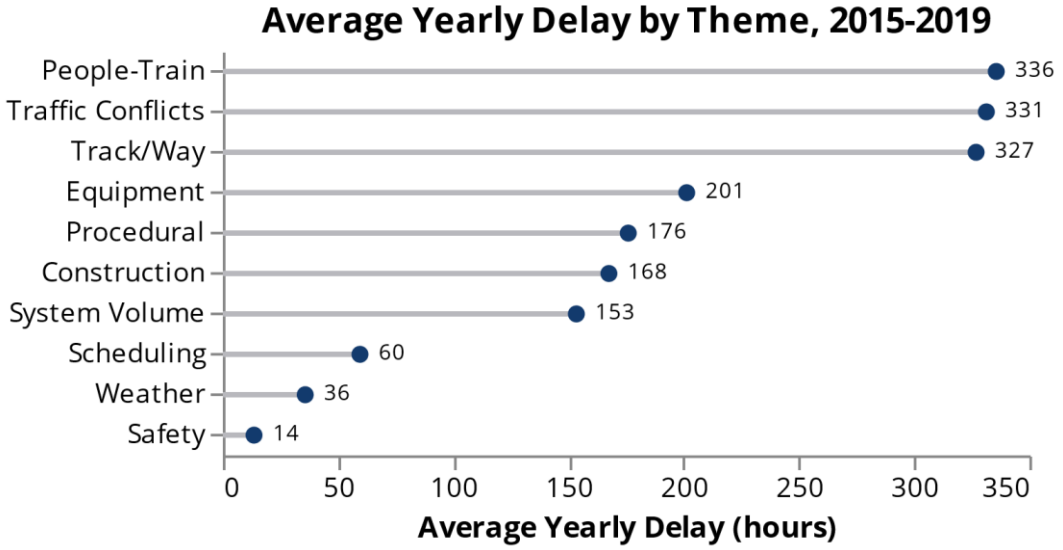
Modelling and Predicting Rail Delays

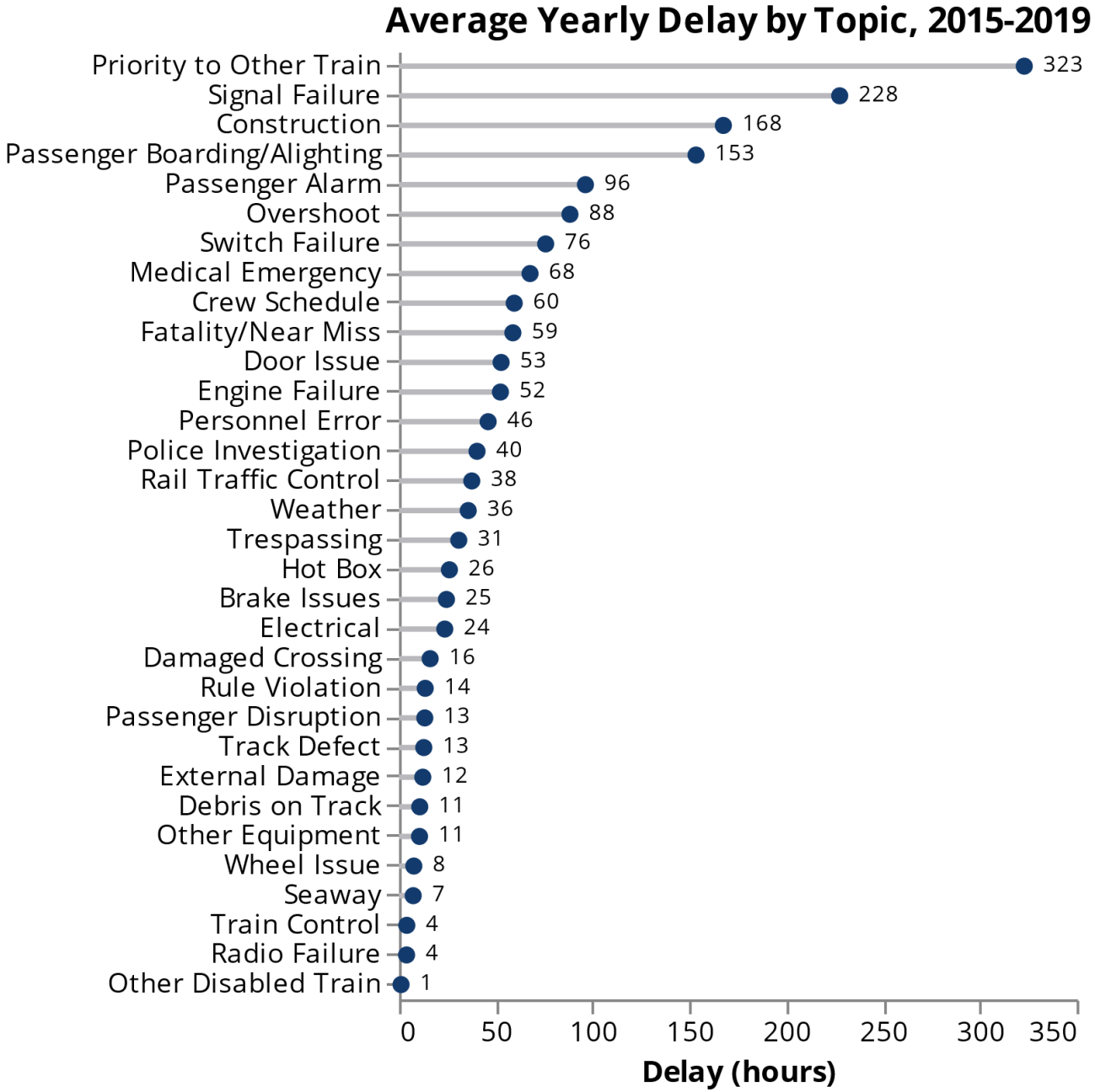


Summary Stats

70,904 categorized delays, 2015-2019







Unfolding of an event

D. Spatcher: [Train A] was held 30 minutes at Union Station waiting delayed [Train B] to clear Newmarket sub.

T. Rainer: [Another Railway Dispatcher] reports crossover is not locking normal or reverse at Snider South. All trains through will have to take pass stop authority with one switch in hand. [Railway Maintainer] advised no ETA yet.

T. Rainer: [Train C] was delayed 15 minutes en route to Snider due to switch issue with crossover at Newmarket sub.

D. Spatcher: [Train D] was delayed 13 minutes at Aurora GO due to late arrival [Train C].

Photo Credit: Udayaditya Barua

Topic Modelling

...was delayed 6 minutes at **Clark**son GO due to **oper**ational **issue**. Heavy **passeng**er off**load**ing.

...5 minutes **depart**ing **Danforth** GO due to a **platf**orm 5ft **overs**hoot...

...**cancel**led acct ... **run**ning on T-2 due to **congest**ion **result**ing from **severe** **weather**

overshoot	platform	reverse	required	foot	*Platform overshoot*
alarm	false	coach	problem	priority	*Priority passenger alarm*
via	late	wait	follow	train	*Following a late VIA train*
wait	volume	exhibition	crew	heavy	*Heavy volumes at Exhibition GO*
switch	pnr	signal	issue	advise	*Switch/Signal maintenance issue*

Connectin

Two locations ar

Union Station-Aldershot G
Union Station-Oshawa G
Union Station-Danforth G
Union Station-Guildwood G
Union Station-Scarborough G
Union Station-Oakville G
Brant-Aldershot G
Union Station-Exhibition G
Port Credit GO-Credi
Parkdale-Par

314

300 320 340

Top 10

Union Station
Aldershot GO
Oshawa GO
Pickering GO
Danforth GO
Scarborough GO
Oakville GO
Guildwood GO
Scott St
Rouge Hill GO
68

0 500

ty Locations

2549
2102

2,000 2,500

ty

Degree

How much a n

“influencer” wi

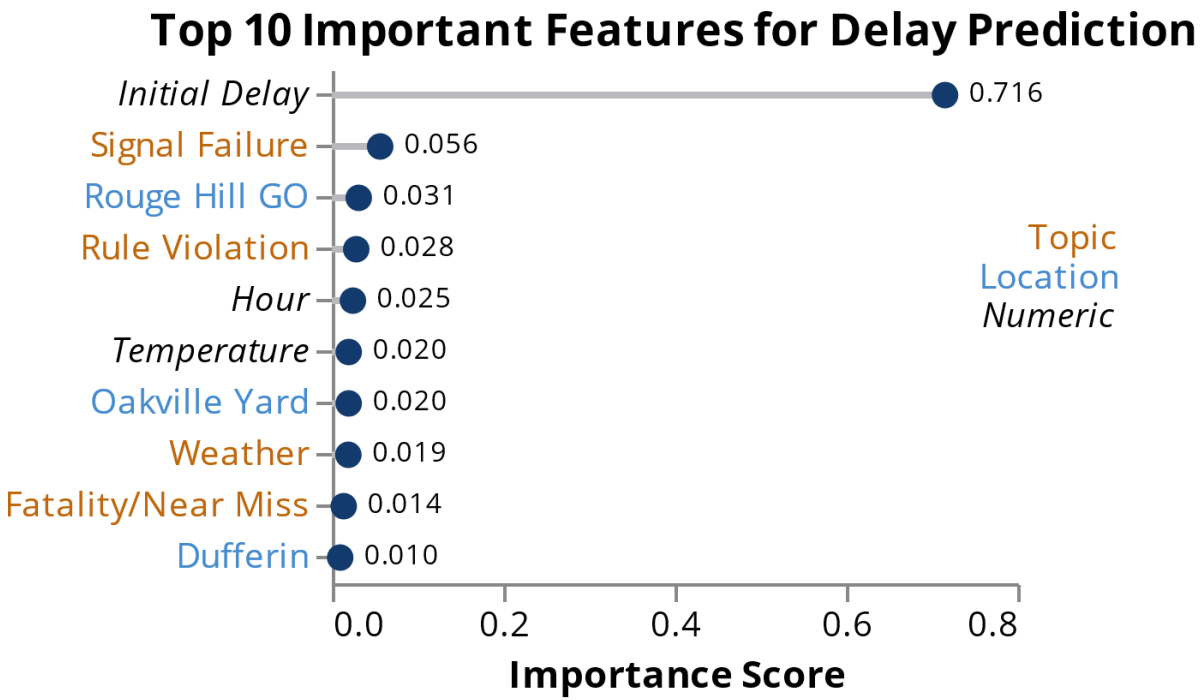
s a “bridge”

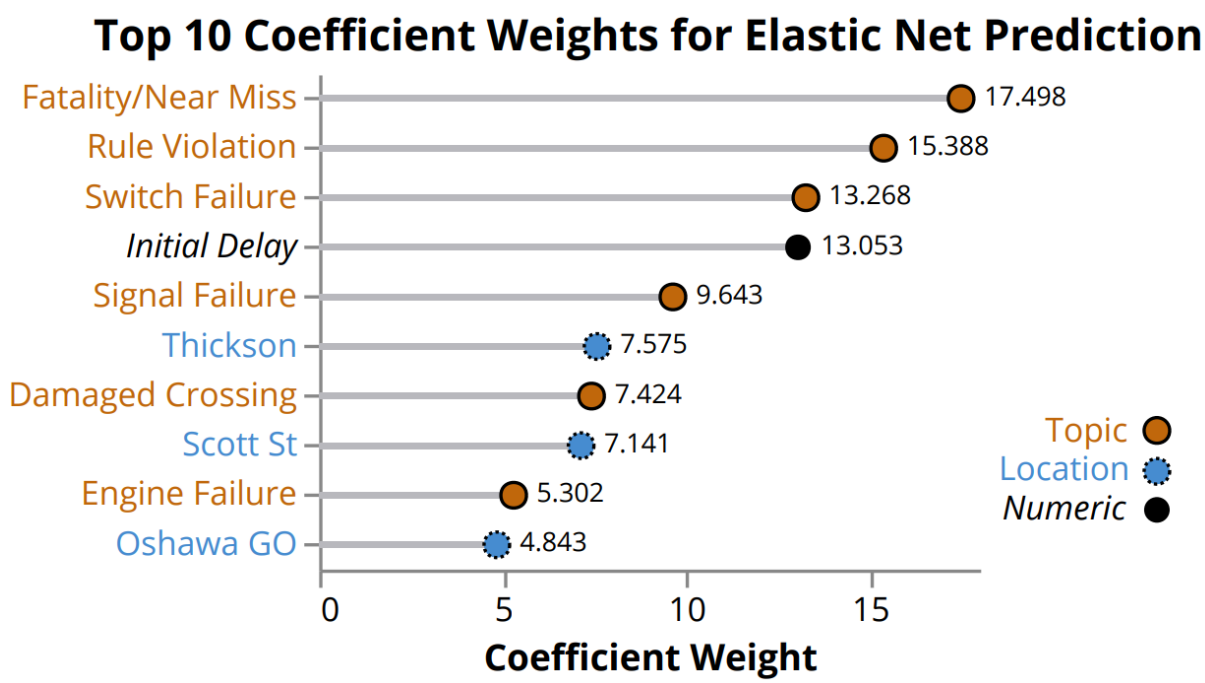
“Recommending” Historical Events

Find similar previous events that lend context to the current situation

Topic	Location	Vis	Temp	Time	
signal failure	oshawa	good	normal	morning	**Emerging Event**
signal failure	**oshawa**	poor	**normal**	**morning**	**Historical Events**
switch failure	**oshawa**	**good**	hot	midday	
signal failure	brampton	**good**	**normal**	evening	
priority to other train	**oshawa**	**good**	**normal**	afternoon	
overshoot	burlington	poor	cold	**morning**	

Making Predictions





Prediction Method	NRMSE-σ
Random Forest Regression	**0.88**
Elastic Net	**0.87**
Departure Delay	1.06
Median Delay	1.02
Mean Delay	1.00

Future Work

- Combining delay logs and location-based data (GPS)
- Studying network effects and delay propagation
- Using historical incidents to run response scenarios
- Developing on-the-fly prescriptive methods
- Simulating the network and applying realistic disruptions

Questions?

Thank you to Metrolinx!

Photo Credit: Udayaditya Barua