

# SONYC: Monitoring, Analysis and Mitigation of Urban Noise Pollution

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N.Y. / REGION

# New York Becomes the City That Never Shuts Up

By WINNIE HU JULY 19, 2017

Richard T. McIntosh has never heard such a racket outside his window.

Traffic roars through his neighborhood on the Upper East Side of Manhattan at all hours. The whine of refrigerated grocery trucks by the curb makes things worse. And construction of a new apartment tower across the street forces him to flee his own home. There is the deafening rat-a-tat of jack hammers and the incessant banging and high-pitched wail of construction equipment that echoes in his head.

“I’ve had two years of absolute violation of my right to peace and quiet,” said Mr. McIntosh, a television producer who has lived on the Upper East Side for more than five decades. “I think it’s against the Geneva Conventions to have this much noise.”

New York City has never been kind to human ears, from its screeching subways and honking taxis to wailing police sirens. But even at its loudest, there were always relatively tranquil pockets like the Upper East Side that offered some relief from the day-to-day cacophony of the big city. Those pockets are vanishing. As the city grows more crowded, with a record 8.5 million residents and a forest of new buildings, finding respite from loud cellphone chatter, rooftop parties, backhoes digging foundations, or any other aural assault has become harder and harder.

In other words, New York is really living up to its reputation as the city that never sleeps.

# Noise impact

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Estimated **9 of 10** adults in **NYC** exposed to **harmful** levels of **noise**



Noise pollution **can result in:**

SLEEP LOSS



STRESS



HEARING LOSS



REDUCED  
PRODUCTIVITY



LEARNING  
IMPAIRMENT



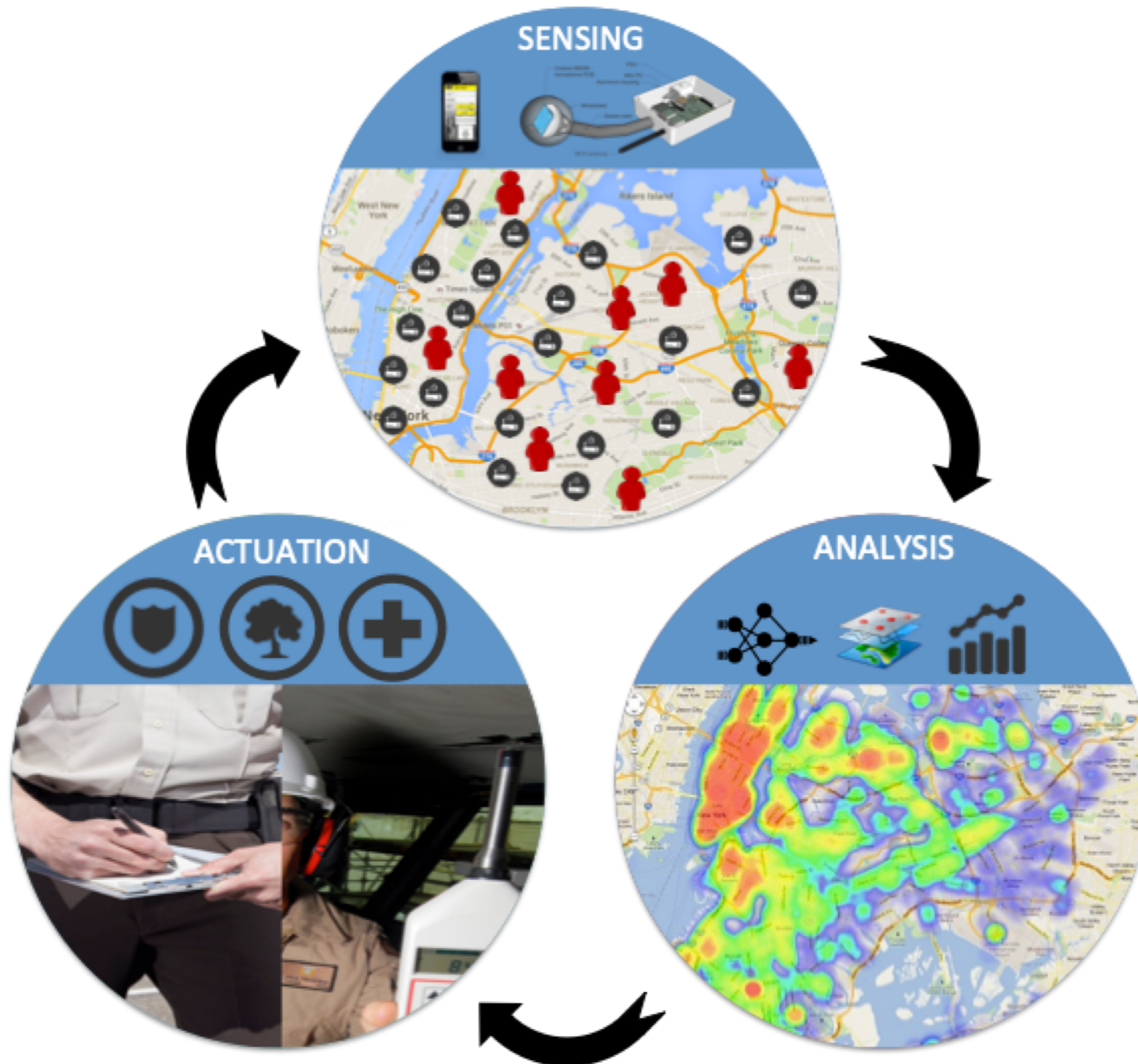
# SONYC

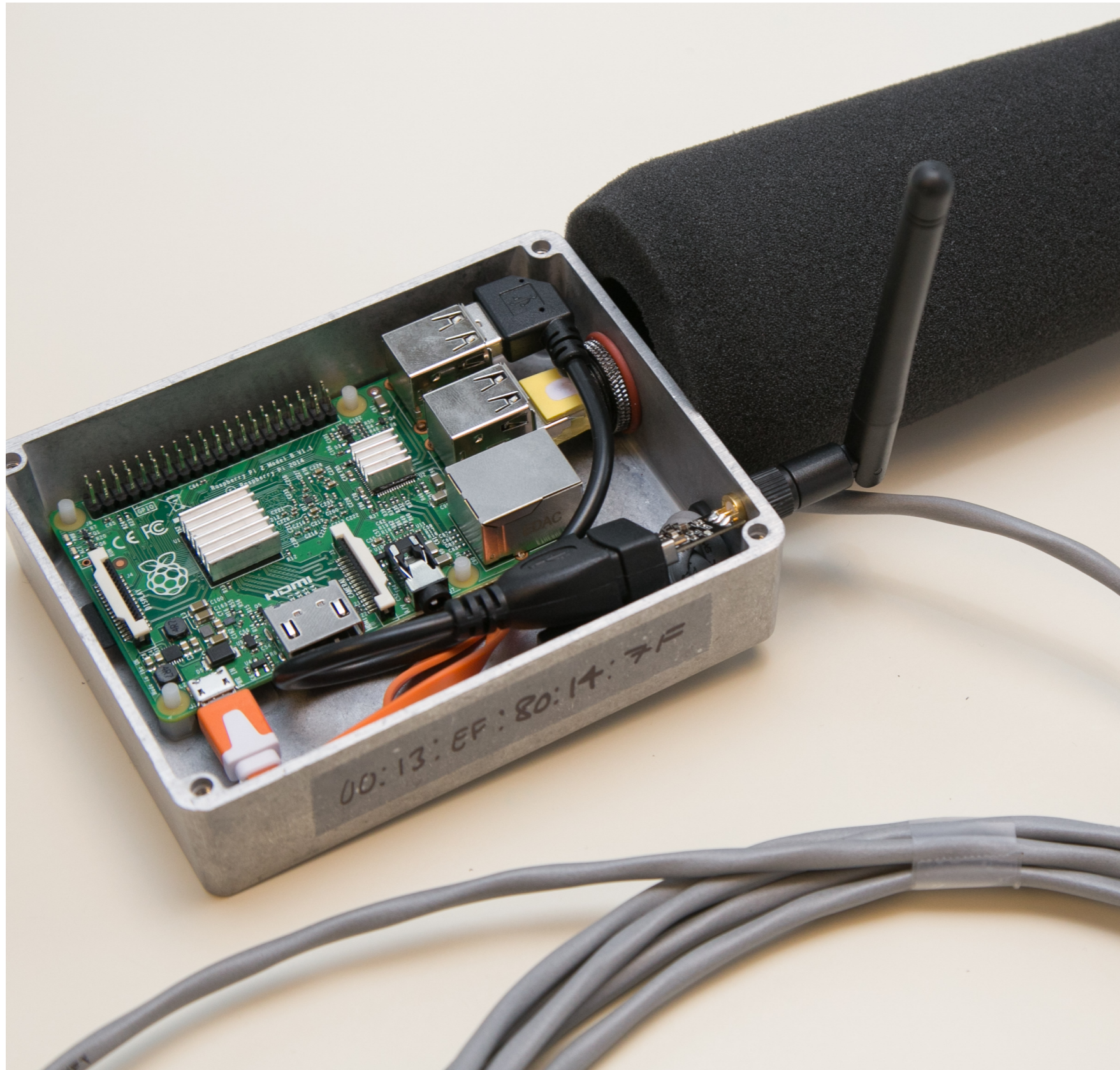
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CPS solution aimed at reducing  
urban noise pollution

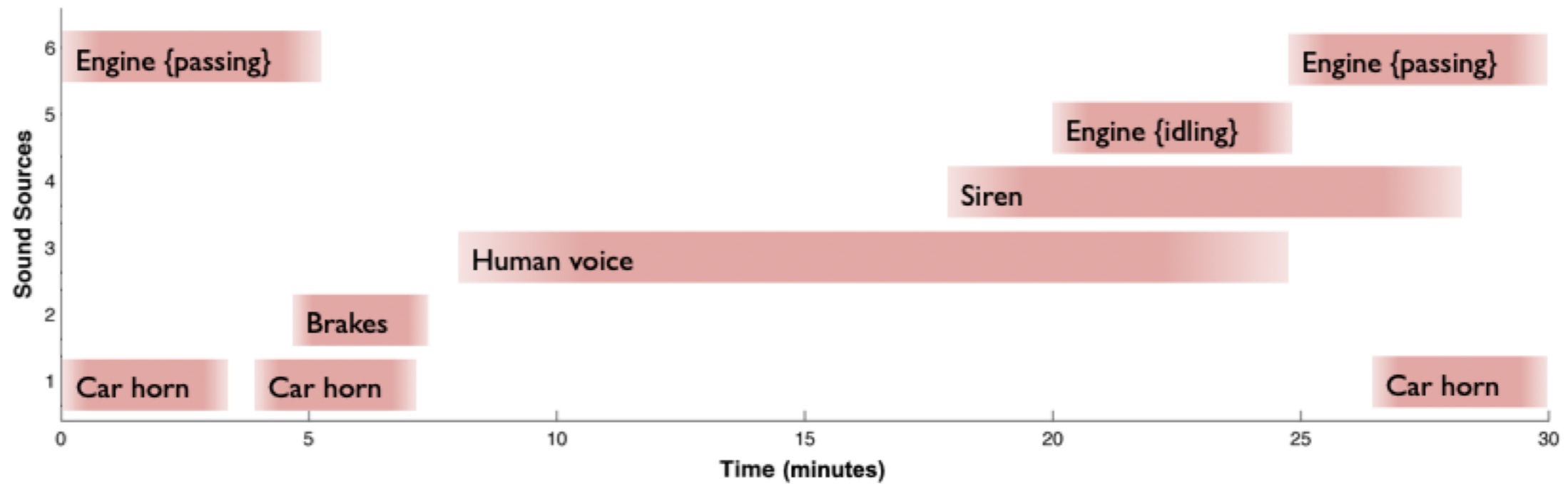
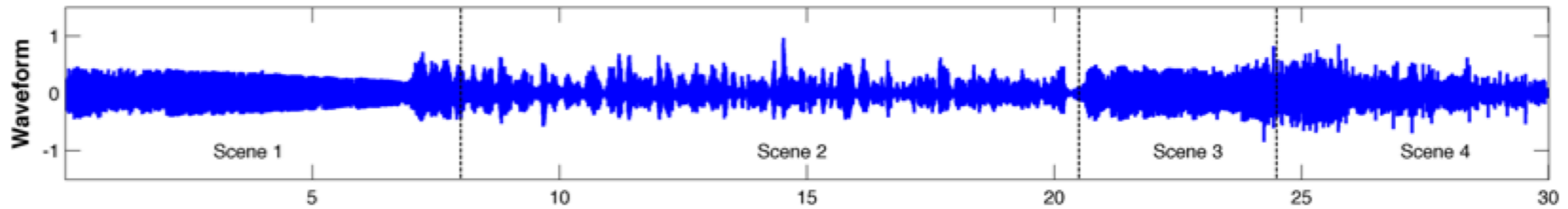
# SONYC

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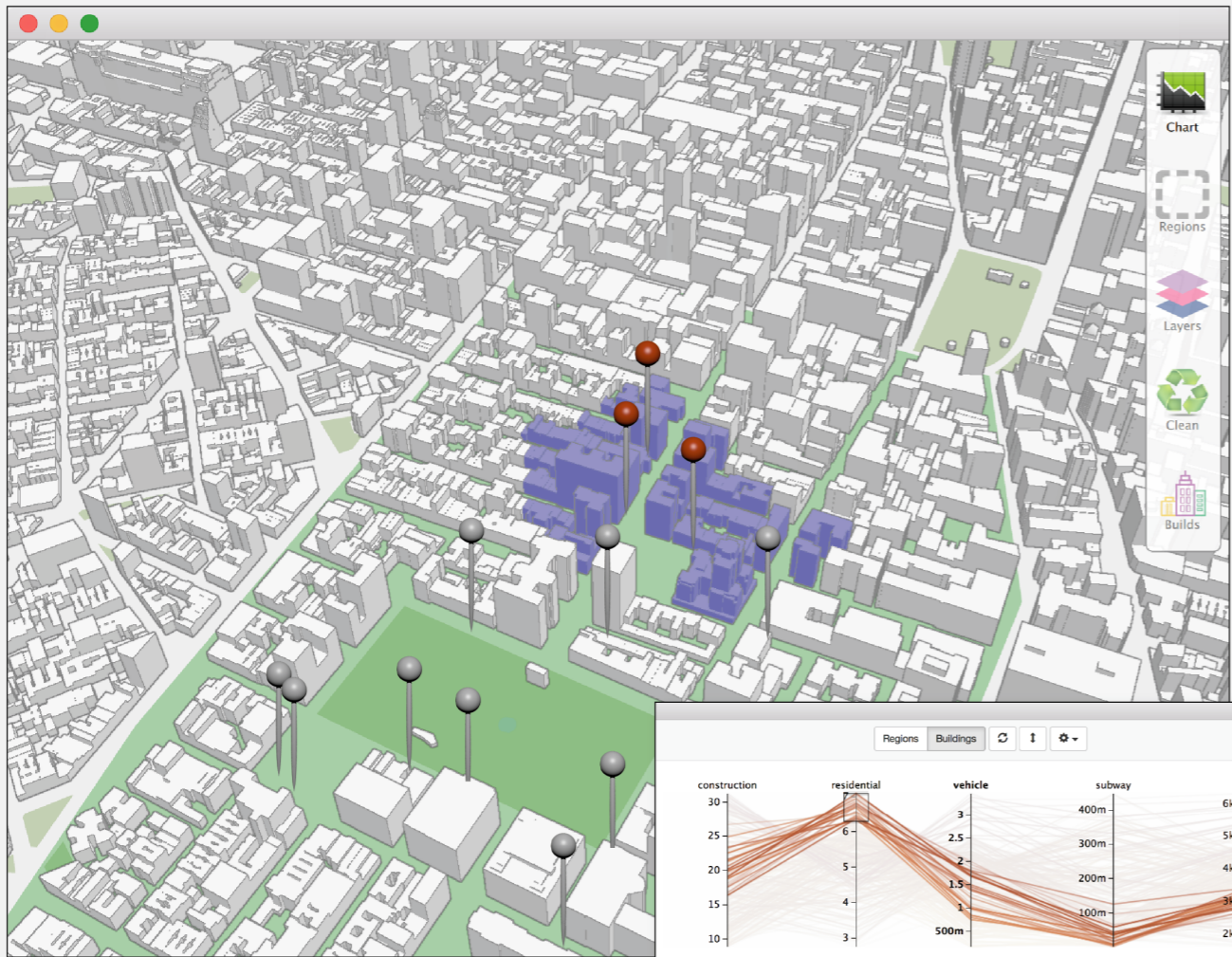


54 sensors, 3 NYC boroughs: 60 years of noise data

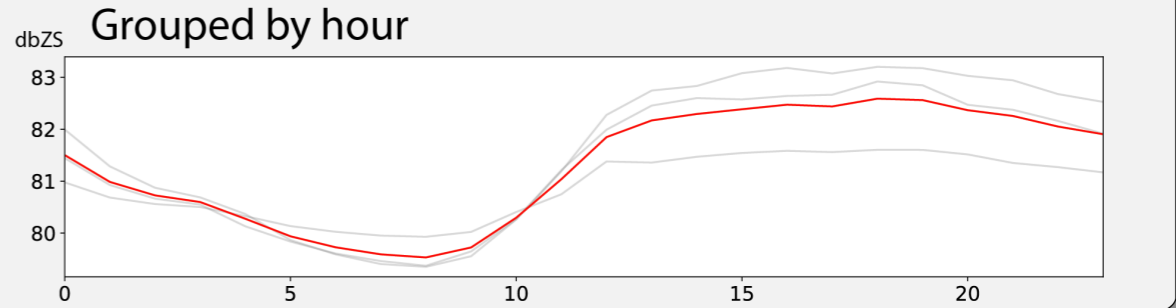
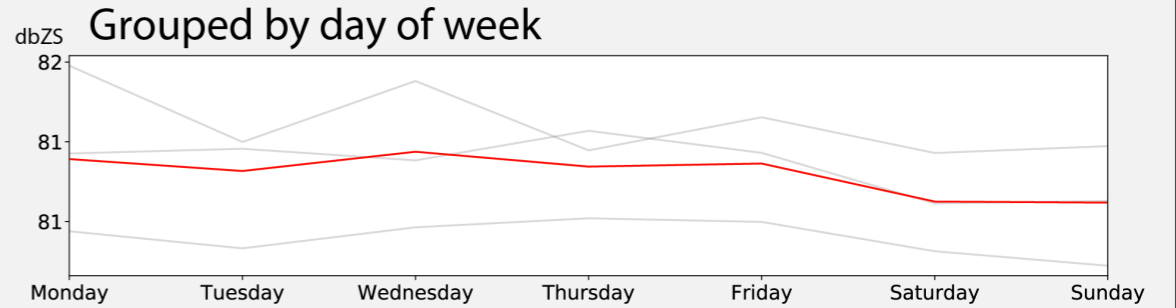
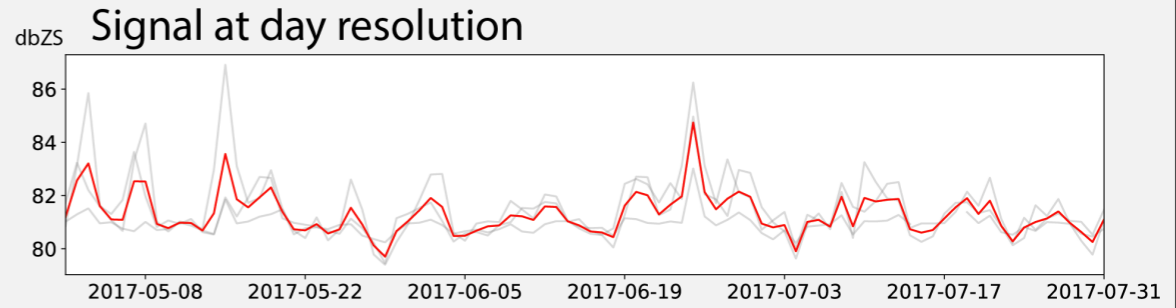
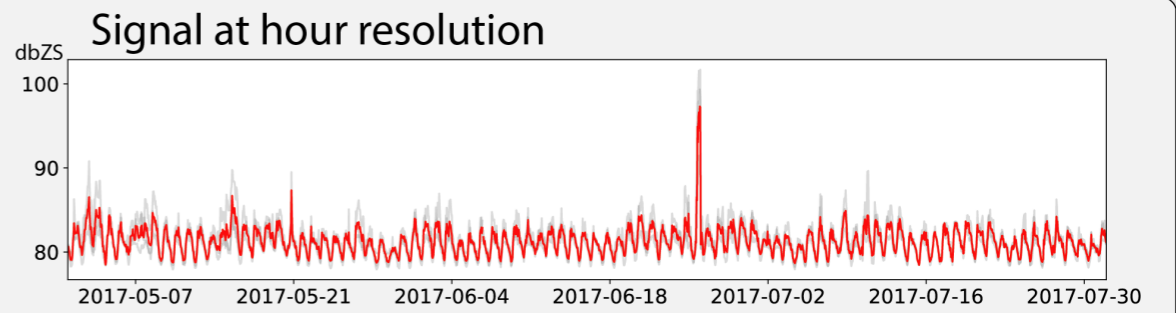


Deep Machine Listening

Automatic noise source ID



	construction	residential	vehicle	subway	taxi							
110 - 1005740	78742	4684	21.347	232	480	0.483	6.699	0.008	3084.351	1	0.845	1899
111 - 1005740	169060	8589	19.950	342	480	0.712	6.373	0.029	3218.684	10	0.720	1900
112 - 1005740	213827	10585	21.347	429	480	0.894	6.699	0.008	3084.351	8	0.845	1900
113 - 1005730	201340	7424	18.789	254	480	0.529	6.423	0.038	3131.765	2	0.993	1899
114 - 1005730	2371500	168806	19.718	1191	1000	1.191	6.751	0.011	2981.063	444	1.033	1923
116 - 1005730	166064	5052	18.789	296	480	0.617	6.423	0.038	3131.765	7	0.993	1900
119 - 1005730	148857	5774	18.789	285	480	0.615	6.423	0.038	3131.765	1	0.993	1901
120 - 1005740	153276	7178	19.950	259	480	0.540	6.373	0.029	3218.684	7	0.720	1900



Large-scale noise analysis and visualization



Demo

# Lots of sensor network data: so what?

- Crowd-sourced annotations

The screenshot shows the Sounds of New York City (SONYC) interface. At the top left is the SONYC logo and the text "Sounds of New York City (SONYC)". Navigation links include "ABOUT", "CLASSIFY", "TALK", and "COLLECT". A green banner displays the message: "Great work! Looks like this project is out of data at the moment! See the results or dismiss this message". The main content area features a spectrogram with a "FINISHED!" badge in the top left corner. Below the spectrogram is a video player with a progress bar at 0:00 / 0:10 and a volume icon. A notification at the bottom right of the spectrogram says "You should sign in!". To the right of the spectrogram is a "TASK" panel with a "TUTORIAL" tab. The "TASK" panel lists eight categories: "Small group talking", "Person shouting", "Crowd", "Amplified speech", "Dog barking/whining", "Artificial/Interference Noise", "Other/unknown human or animal vocalization sound", and "Other/unknown sound". It shows "Showing 8 of 8" and a "Clear filters" link. A green "Done" button is at the bottom of the task panel. At the bottom center, there is a link to "SWITCH TO DARK THEME".

SONYC Sounds of New York City (SONYC) ✓

ABOUT CLASSIFY TALK COLLECT

Great work! Looks like this project is out of data at the moment!  
[See the results](#) or [dismiss this message](#)

FINISHED!

TASK TUTORIAL

Small group talking	Dog barking/whining
Person shouting	Artificial/Interference Noise
Crowd	Other/unknown human or animal vocalization sound
Amplified speech	Other/unknown sound

Showing 8 of 8 Clear filters

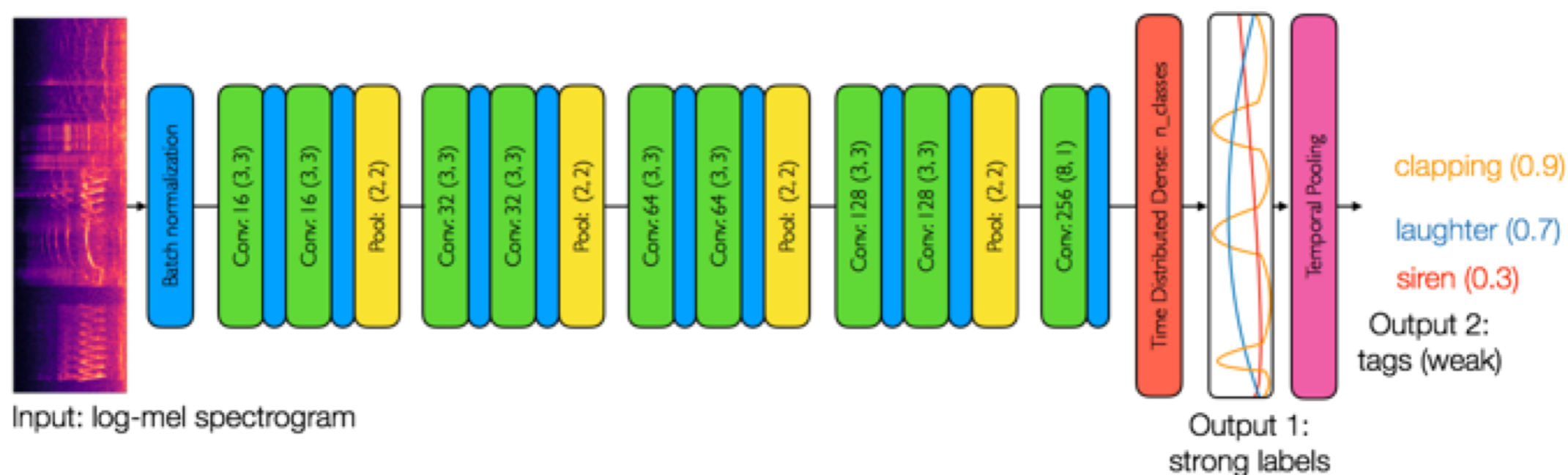
Done

You should sign in!

SWITCH TO DARK THEME

# Lots of sensor network data: so what?

- Multiple-instance learning using auto-pooling



- $\alpha = 0 \Rightarrow$  mean pooling
- $\alpha = 1 \Rightarrow$  softmax pooling
- $\alpha \rightarrow \infty \Rightarrow$  max pooling
- $\alpha \rightarrow -\infty \Rightarrow$  min pooling

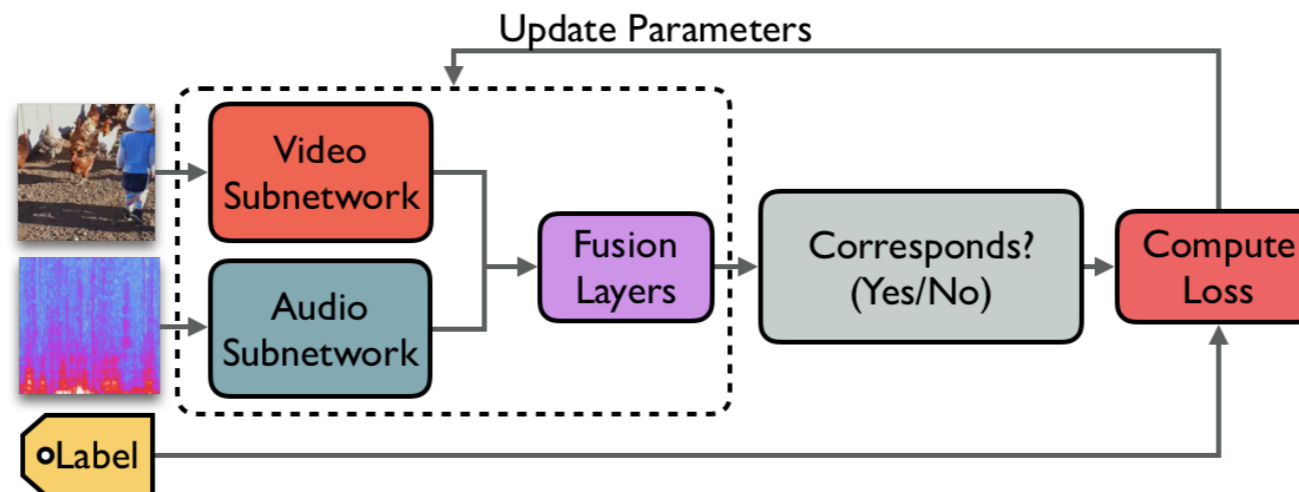
- Multi-label? each class gets its own  $\alpha$

$$\hat{P}_\alpha(Y | X) = \sum_{x \in X} \hat{p}(Y | x) \left( \frac{\exp(\alpha \cdot \hat{p}(Y | x))}{\sum_{z \in X} \exp(\alpha \cdot \hat{p}(Y | z))} \right)$$

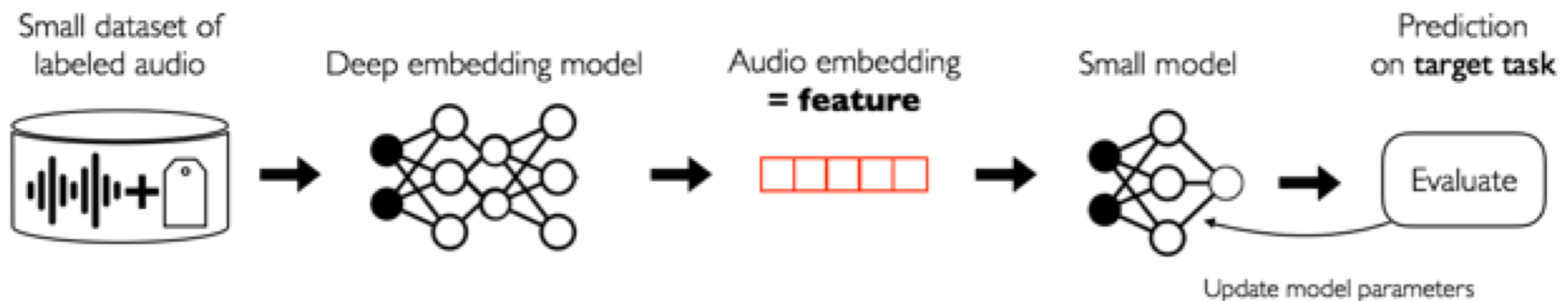
# Lots of sensor network data: so what?

- Self-supervised embedding learning

Step 1: train embedding model on **surrogate task**

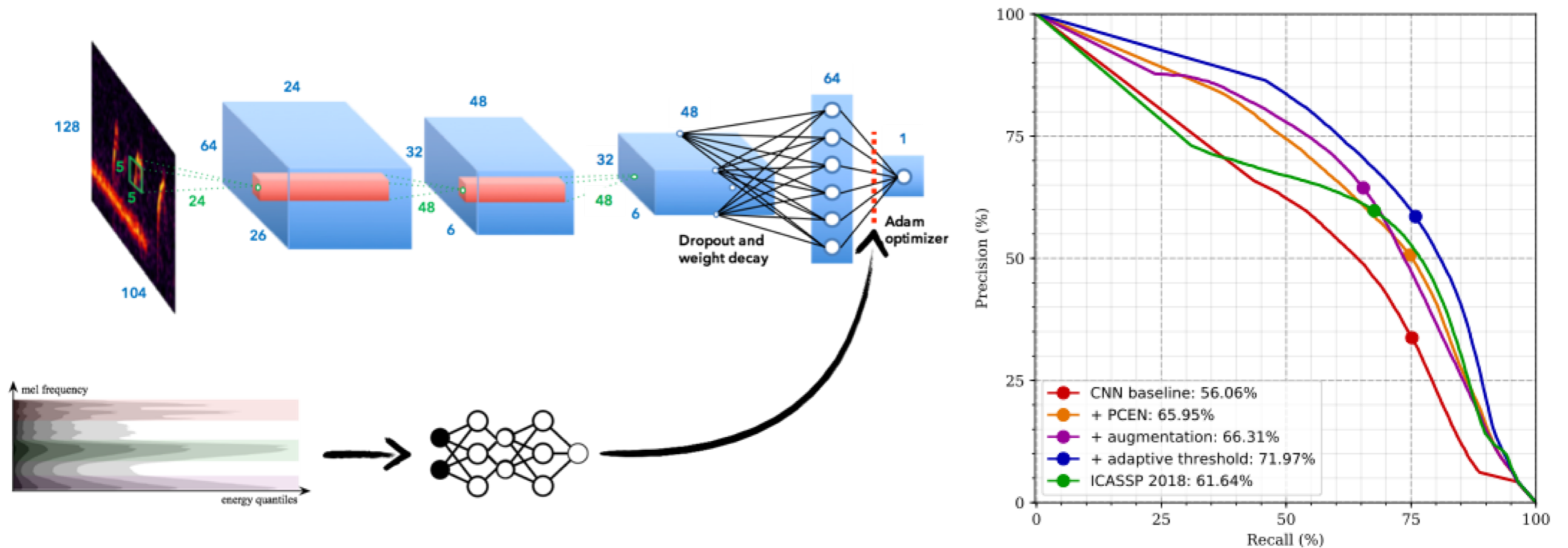


Step 2: use embedding to train "downstream" model on **target task**



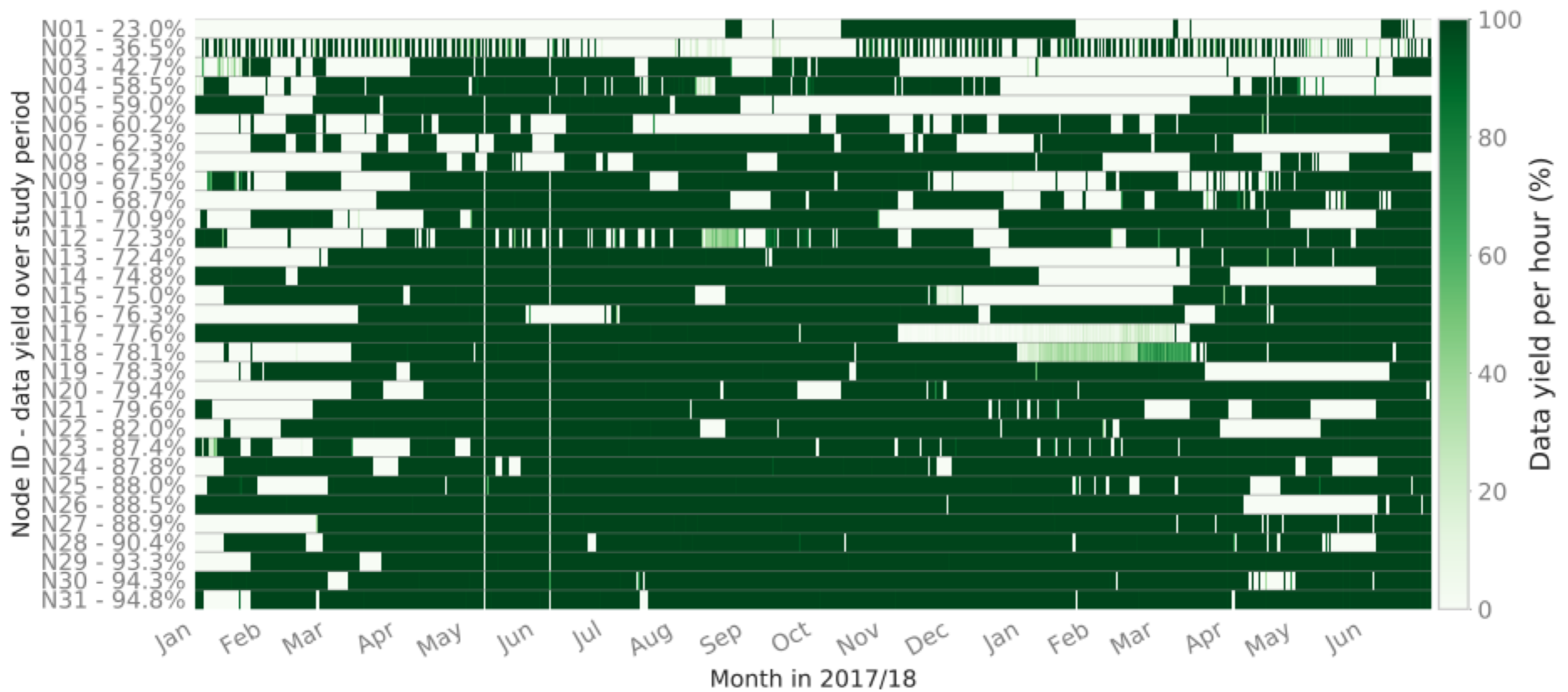
# Lots of sensor network data: so what?

- Context-adaptive neural networks



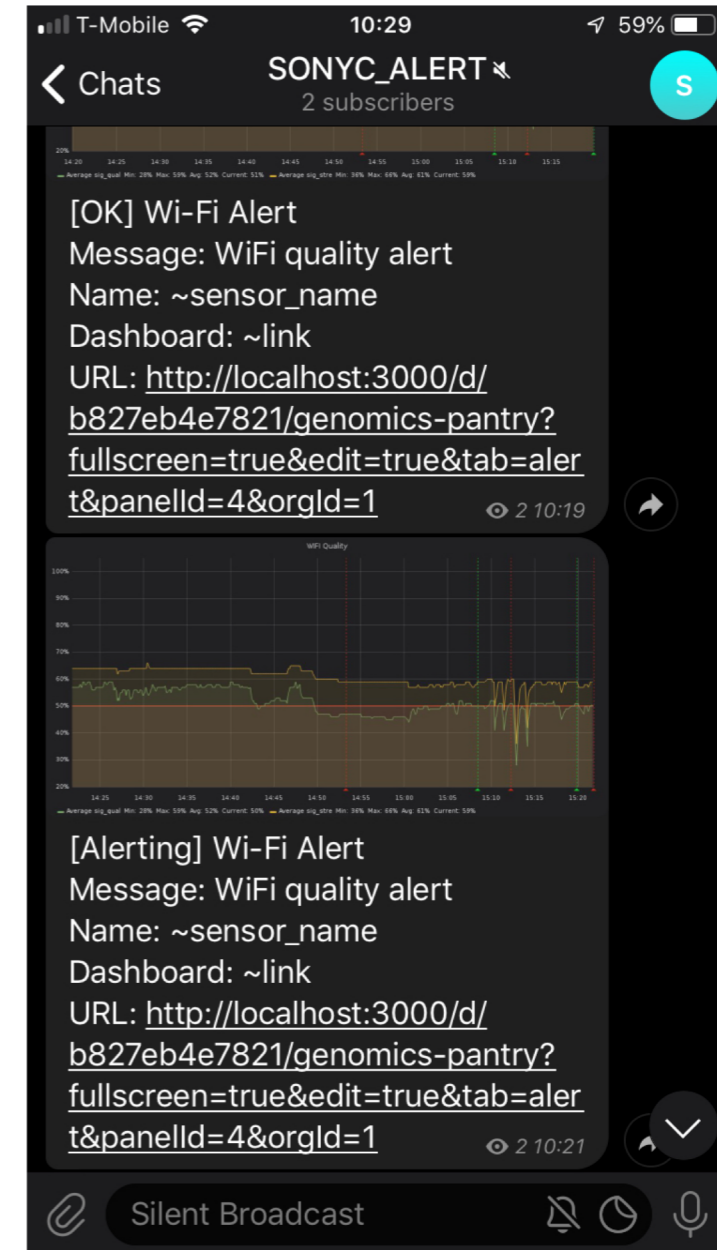
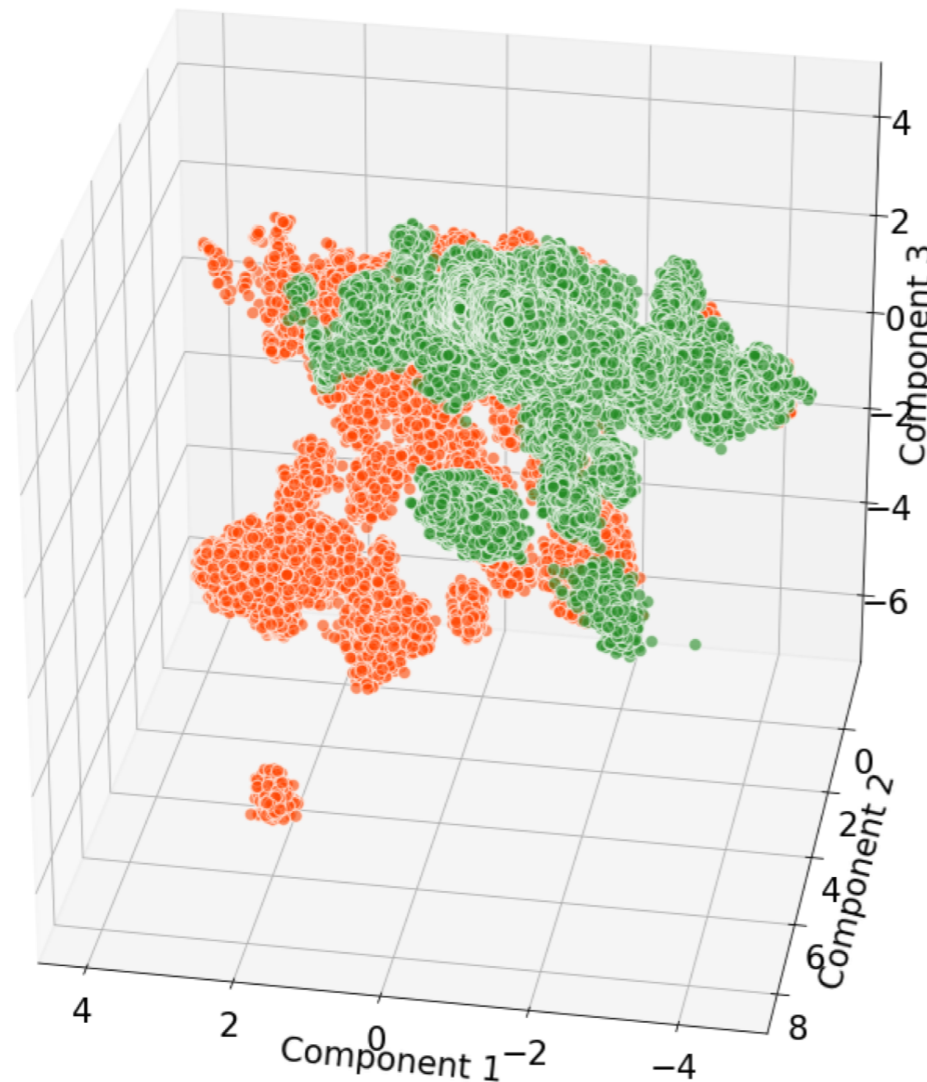
# Lots of sensor network data: so what?

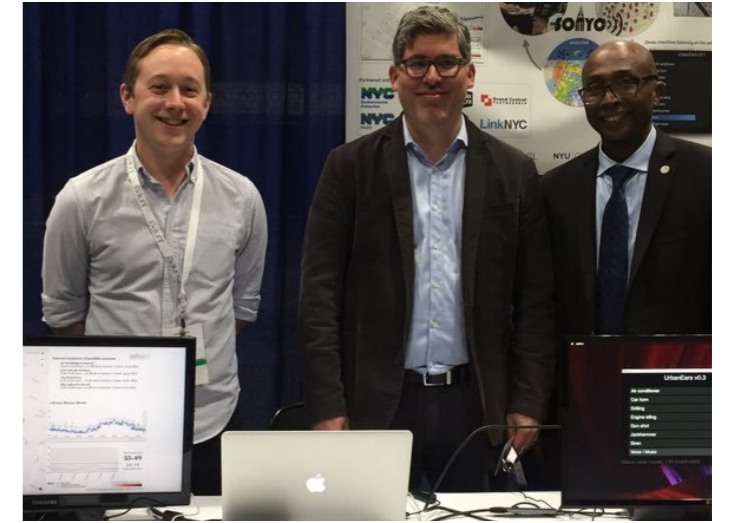
- The reality of running a sensor network



# Lots of sensor network data: so what?

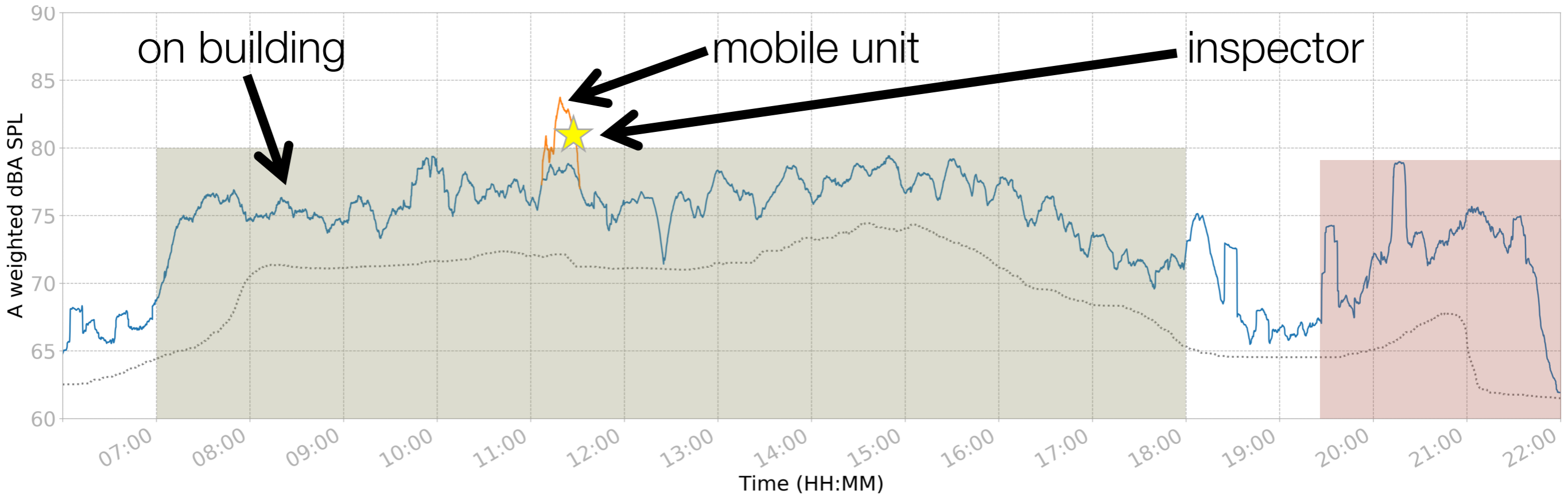
- Status data: normal vs pre-failure
- Classifier trained on 18 mo. of network data





DEP partnership: building deployments, mobile sensor, focused studies





Thanks!



<https://wp.nyu.edu/sonyc/>



In partnership with:

