

Rapid rule out of heart attacks in the emergency department using machine learning

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Problem overview

- ▶ Patient seeks with chest pain ($\sim 10\%$ heart attack)
- ▶ Major possible actions at the ED
 - ▶ Send home... (what if?)
 - ▶ Send to appropriate ward... (passing on redundant work?)
 - ▶ Keep looking... (fills up the ED)
- ▶ Goal: **Faster** and/or **more accurate** triage

Disclaimer

- ▶ Not a replacement for the medical doctors
- ▶ ML models presented here rely on limited information – in practice broader picture considered
- ▶ Absence of heart attack does not imply that everything is nice and dandy

Background

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 - ▶ Blood samples
 - ▶ Electrocardiogram (ECG)

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- ▶ Key blood sample: Troponin-T (TnT)

- ▶ Two consecutive samples (min. 1 hour apart)
strong predictor of heart attack
(current practice in ED)

- ▶ First sample $< 5\text{ng/l}$ strong negative indicator

Research question

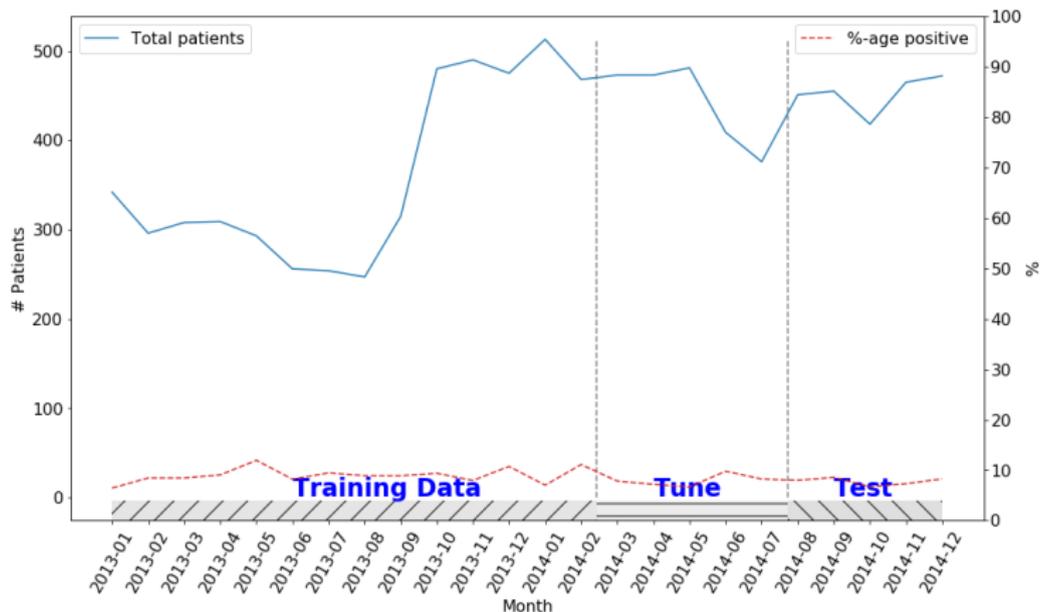
Can ECG data be used to rule out more patients
after only one blood sample?

Joint work with collaborators at LU

Data, inputs, and outcome

- ▶ Data
 - ▶ EXPECT study – Lund, Helsingborg (2013-2014)
- ▶ Inputs
 - ▶ Blood samples: TnT, Glucose, Creatinine, Haemoglobin
 - ▶ Age and gender
 - ▶ 12-lead ECG (10s raw signal or 1.2s median beat)
- ▶ Outcome
 - ▶ Heart attack or 30d mortality

Patient Distribution



- ▶ $n = 9,519$, 8.6% positive outcome
- ▶ Chronologically split: training (50%), tune (25%), and test (25%)

Models

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 - ▶ Neural network with above + CNN over median ECG (median beat; **NN-CNN-Beat**)

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- ▶ Objective
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- ▶ Models tuned such that
 - ▶ 99.5% of patients ruled out **do not have** positive outcome (NPV > 99.5%)
 - ▶ 99% of patients **with** positive outcome **not ruled out** (Sensitivity > 99%)

Results – ruling out

| | Tune | | | Test | | |
|-------------|-------------|-----|----------|-------------|-----|----------|
| | Sensitivity | NPV | Fraction | Sensitivity | NPV | Fraction |
| TnT-BL | | | | | | |
| LogReg | | | | | | |
| NN | | | | | | |
| NN-CNN-Raw | | | | | | |
| NN-CNN-Beat | | | | | | |

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| NN-CNN-Beat | 99.5 | 99.9 | 51.8%+ | 99.5 | 99.9 | 55.0%+ |

- ▶ More than 50% can be ruled out after first TnT sample, while maintaining required levels of safety

Conclusion

- ▶ Increase in rule-out after one blood sample
- ▶ ECG beneficial
- ▶ Work in progress. Needs further validation.
- ▶ Future work
 - ▶ Yet faster rule out?
 - ▶ Faster rule in?
 - ▶ Include additional data

Questions

Thank you

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