Explainable Models for Clinical Data Analysis

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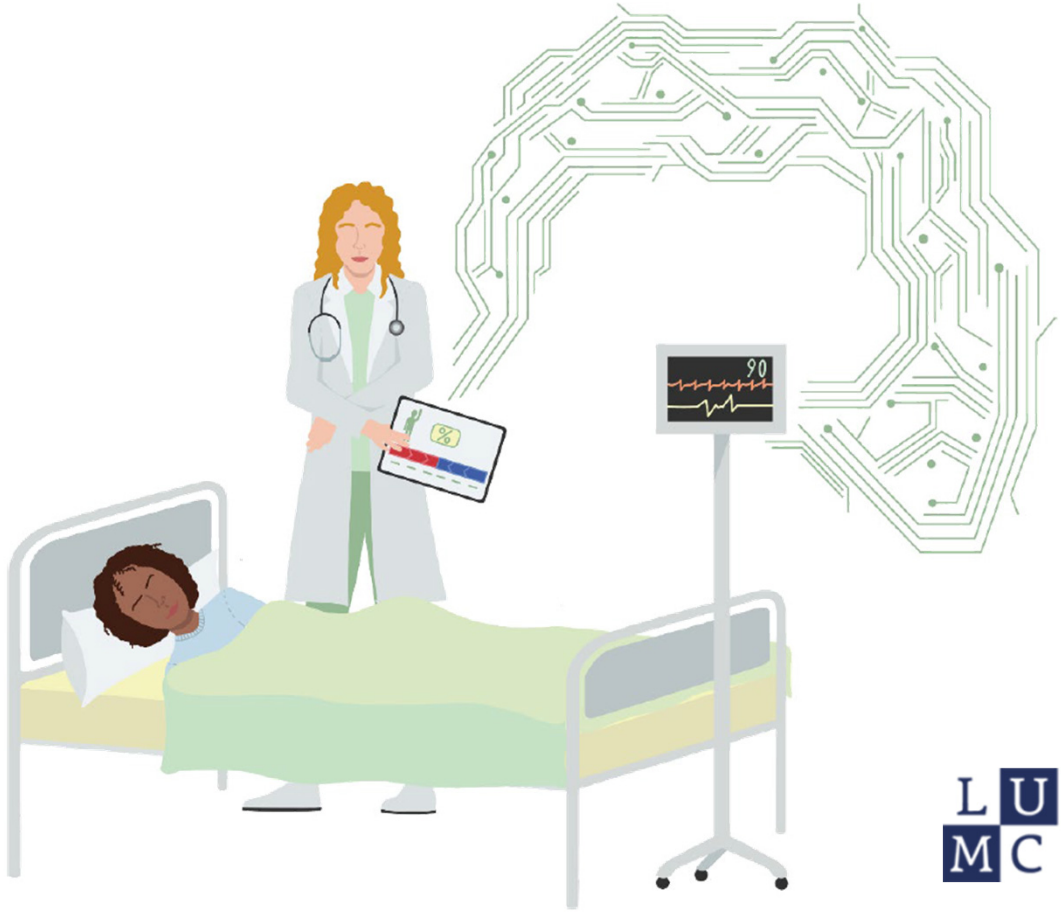
Interpretable machine learning
is becoming very important



Leiden University Medical Center

S.L. van der Meijden. Explainable AI for ICU Readmission. MSc thesis, LDE, 2021.

Key questions

What model to use?

What is a ‘good’ model?

How to learn a good model?

Does it work in practice?

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Rule-based models
in the zoo

Inherently explainable!
(vs posthoc)

IF $\{backbone = no\}$ THEN $\Pr(invertebr.) = 0.55$
$\Pr(bug) = 0.45$

ELSE IF $\{breathes = no\}$ THEN $\Pr(fish) = 0.93$
$\Pr(reptile) = 0.07$

ELSE IF $\{feathers = yes\}$ THEN $\Pr(bird) = 1.00$

ELSE IF $\{milk = no\}$ THEN $\Pr(reptile) = 0.50$
$\Pr(amphibian) = 0.50$

ELSE THEN $\Pr(mammal) = 1.00$

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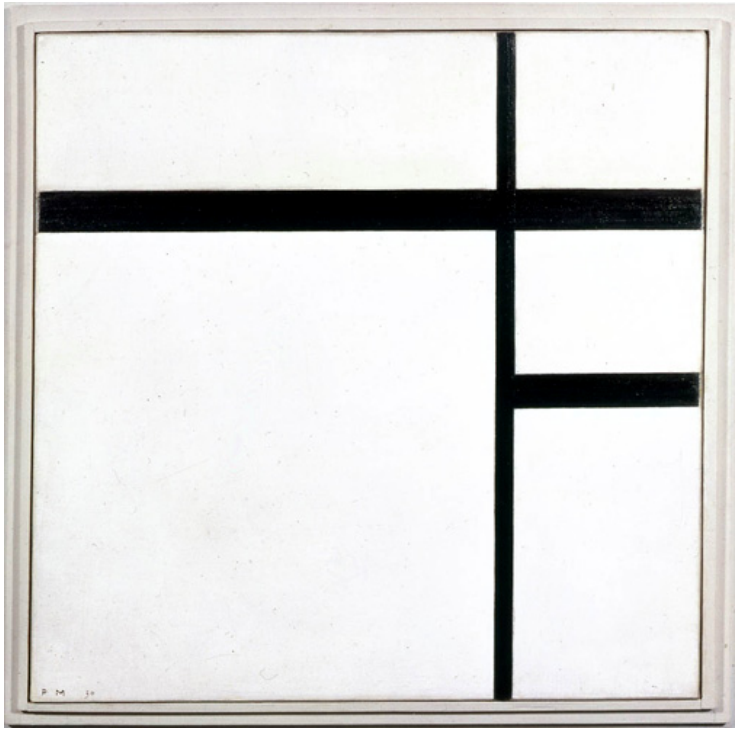
Information in data



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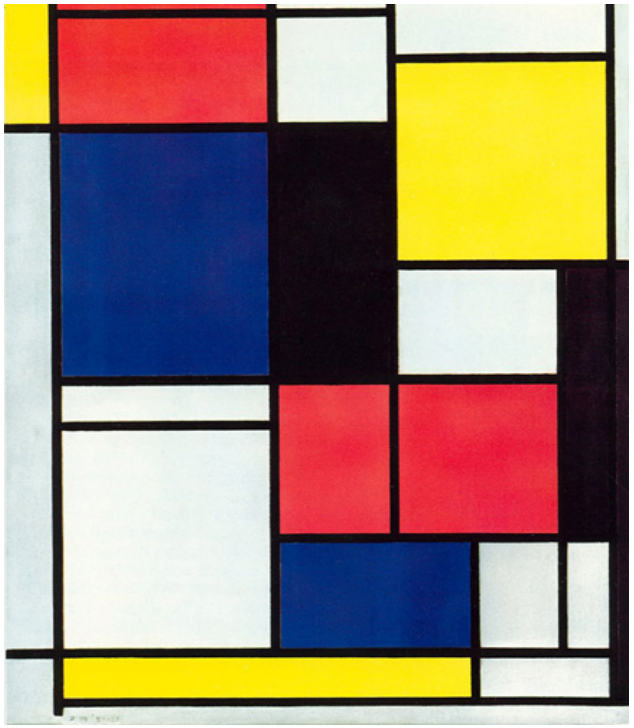

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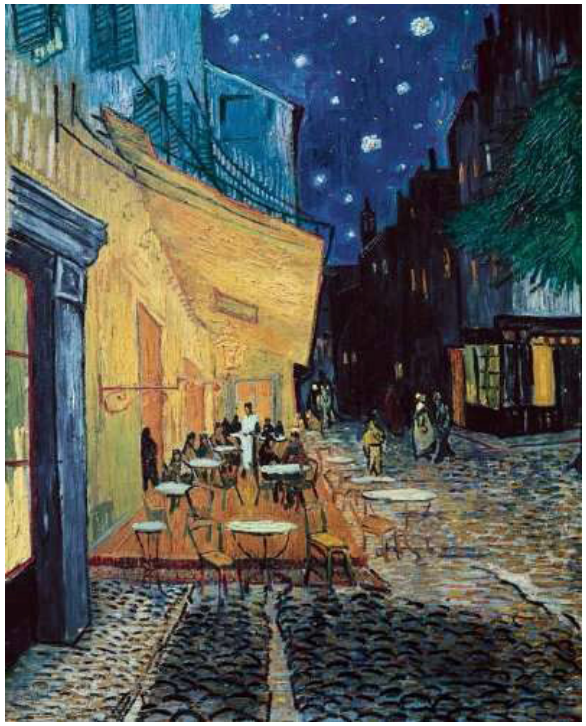
Information in data



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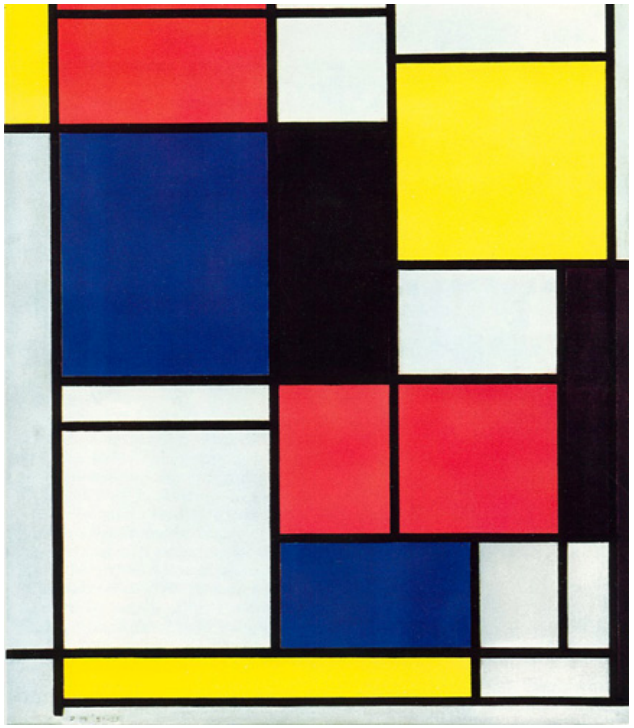

JPEG file: 87 Kb

Learning from data

↔

Compression

"If you have learned something of interest, you have implicitly also compressed the data."

– Grünwald 2007

(paraphrased)

Using compression for learning

Occam's razor

No overfitting, automatically!

Can use **interpretable models**

Tailored to task

Can also be used **beyond prediction**

Prediction is "easy"!

Rigorous approach to many tasks in data mining and machine learning

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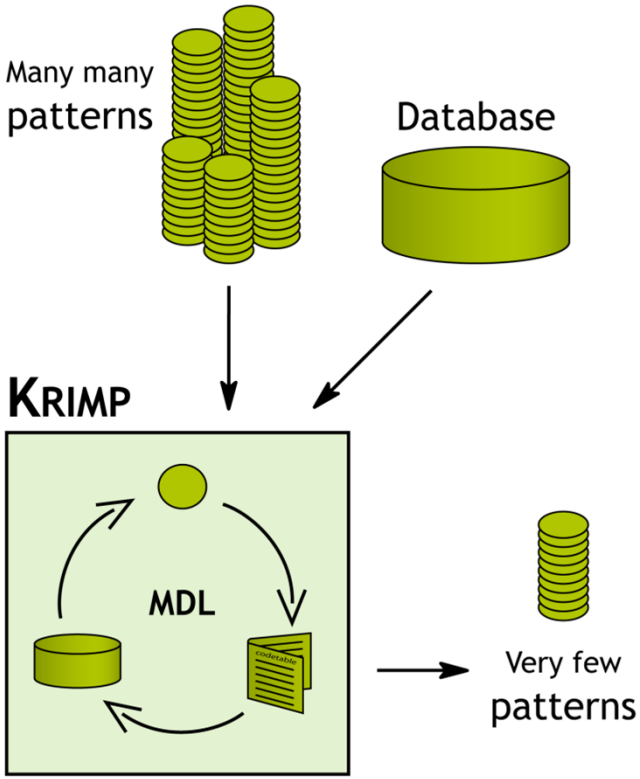
Pattern-based models through compression

"The best set of patterns is that set of patterns that compresses the data best"



J. Vreeken, M. van Leeuwen & A. Siebes. Krimp: Mining Itemsets that Compress. In: *Data Mining and Knowledge Discovery* 23(1), 2011. [First article: SDM 2006]

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Discovering patient subgroups

Over 12,000 patients

- Only patients who survived and were not sent to another hospital

Outcome: readmission to ICU or MCU within 7 days after discharge from ICU

Can we find subgroups of patients with high or low readmission risk?

L. Yang, S.L. van der Meijden, M.S. Arbous & M. van Leeuwen. Probabilistic Rule Sets for ICU Readmission Risk Patient Subgroup Discovery. *To be submitted*.

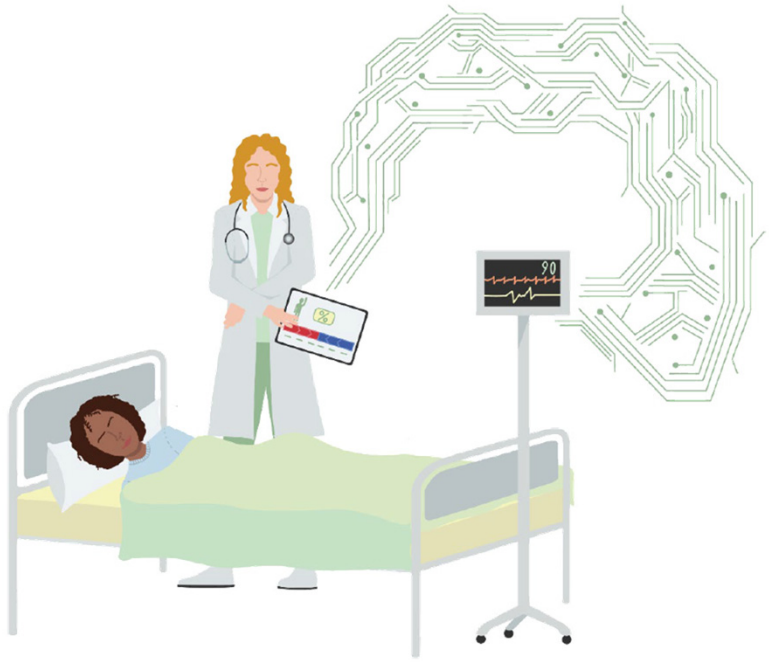
Discovering patient subgroups

	Random Forest	XGBoost	C4.5	TURS
ROC-AUC	0.735	0.752	0.539	0.705
# rules	-	-	249	5
Avg. rule length	-	-	16.8	2.0
Interpretable	-	-	✓	✓

L. Yang, S.L. van der Meijden, M.S. Arbous & M. van Leeuwen. Probabilistic Rule Sets for ICU Readmission Risk Patient Subgroup Discovery. *To be submitted*.

Interpretable ML for health care

Patient subgroup discovery at the ICU



+ **Distinct subgroups**
for informative decision support
+ **Interpretable models**
for intelligible subgroups
+ **Human-guided learning**
to incorporate expert knowledge

+ **Better patient care**
+ **Better access to health care**
+ **Better use of resources**

Explainable Models for Clinical Data Analysis

Pattern-based models are interpretable

No posthoc 'XAI' methods needed

Learn through **compression**

No tuning needed!

Yields **compact yet accurate** models

Complex models not always needed

eda.liacs.nl – www.patternsthatmatter.org