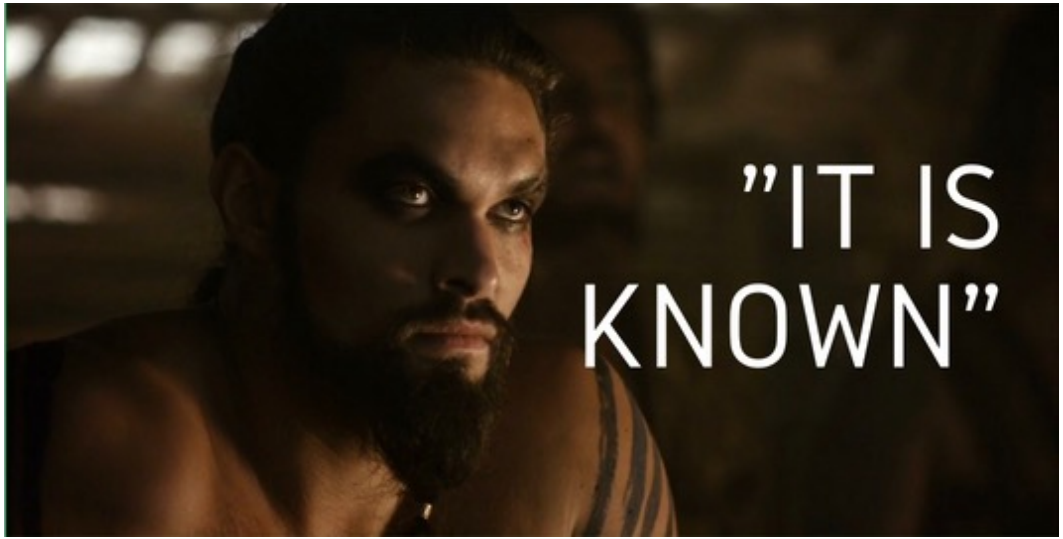
COST TEATIME
Data Analysis

Dr. Steven R. Talbot

Preclinical Data Science
Institute for Laboratory Animal Science
Hannover Medical School



- tradition
- a priori*
- authority
- science

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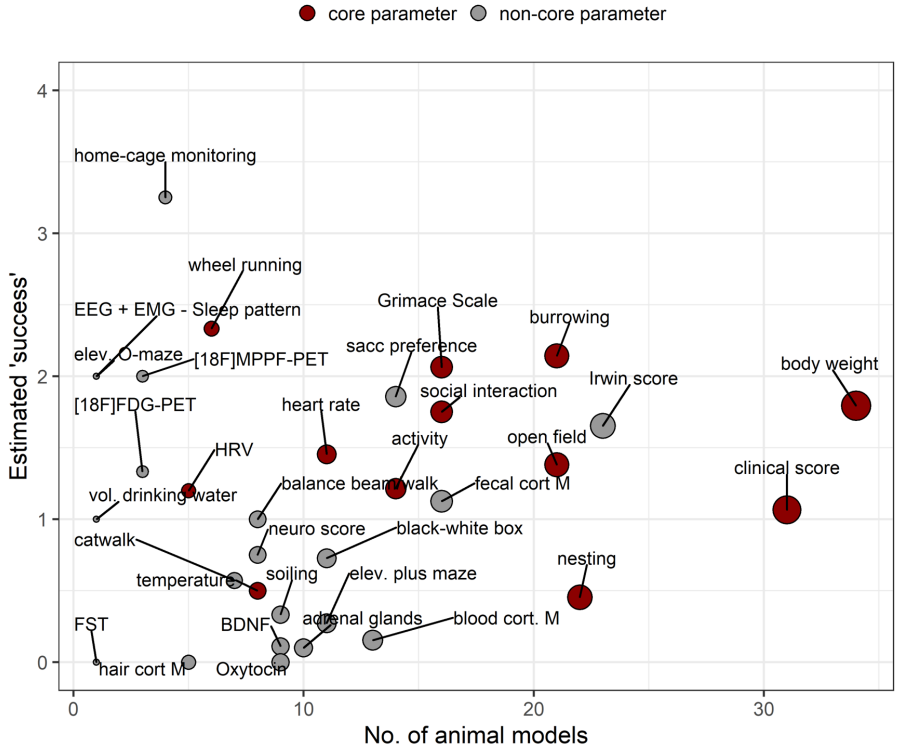
* deductive reasoning

Source:https://www.mindfulroanoke.org/blog/2018/7/2/it-is-knownor-is-it-scientific-research-by-francis-c-dane [26.02.2024].

SEVERITY ASSESSMENT IN ANIMAL BASED RESEARCH

DFG Deutsche Forschungsgemeinschaft



- Variable indicator „performance“
- Search for „best“ parameters is futile
- Context is required

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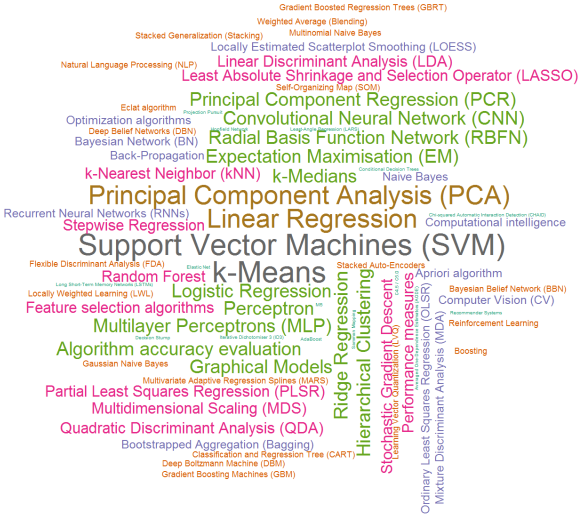

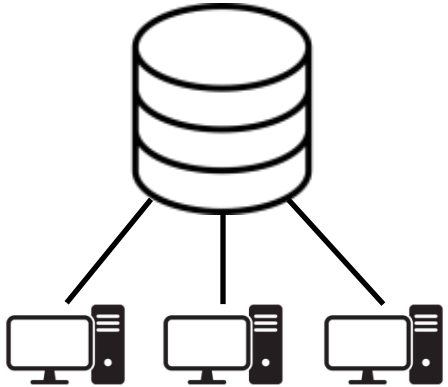

Data Science Methods

Data Management

Applications

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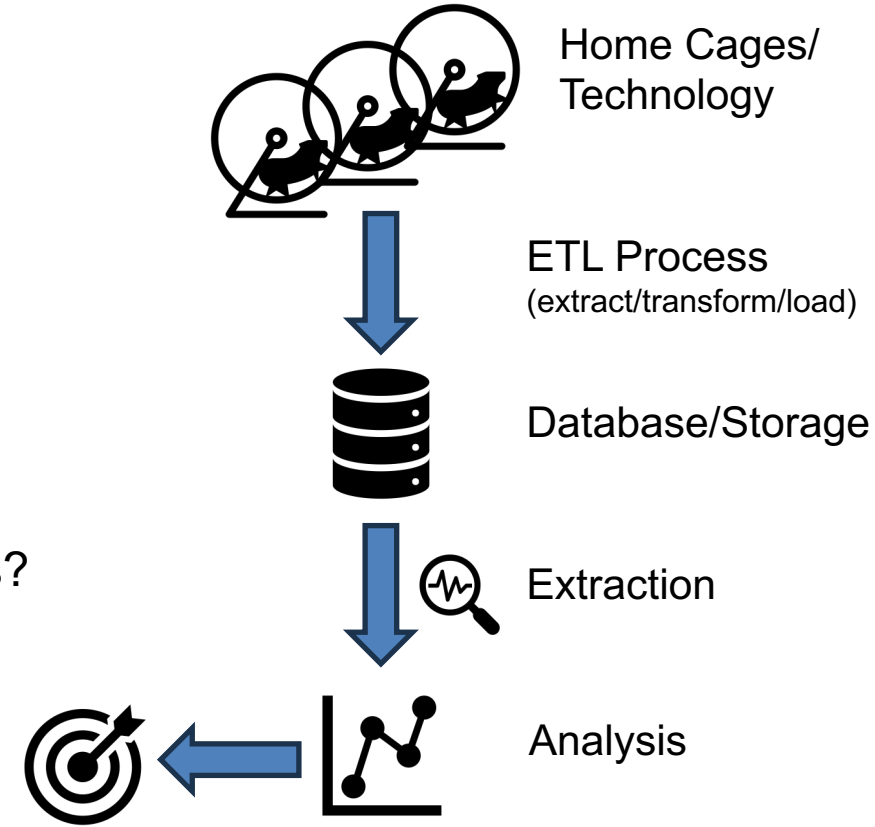
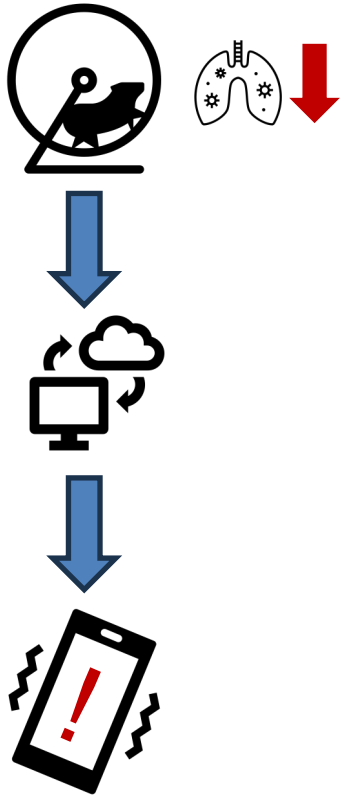
Challenges

- Do the Home Cages work?
- Do they provide ‘relevant’ data?
- Where do we get the data from?
- How do we get the data?
- How do we harmonize the data?
- How do we harmonize time stamps?
- How do we analyse the data?
- …



Possible ideas

- Behaviour / Welfare Assessment
- Real-time / near real-time / retrospective analyses
- Display in an application (mobile phone, Dashboard etc.)



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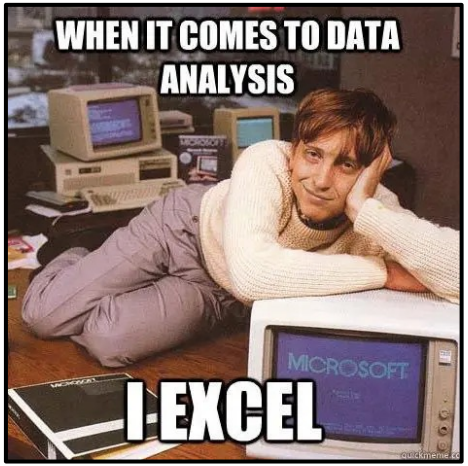
Data Analysis

- Measurements/data are required
- Sampling, controls, errors must be considered
- Validation (instruments, procedures, results, …)
  - internal / external
  - precision, accuracy, etc.



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https://datasciencedojo.com/blog/data-science-memes/. [21.05.2024].

Data Analysis

- Univariate / multivariate / multidimensional
- Cross-sectional / time-ordered data
  - cross-sectional: measured at ONE time period
  - time-ordered: measured over time (time series)

https://finance.yahoo.com/. [21.05.2024]

Data Analysis

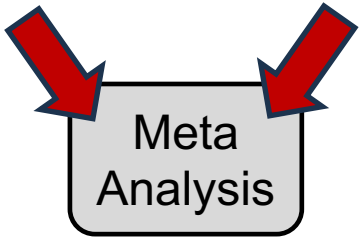
Options

Inferential statistics

- Tests: t-test, ANOVA, etc.
- Generalized & mixed models
- …
- (Bayesian statistics)
  probabalistic!

Machine / Deep Learning

- Classification / Regression
- SVMs, L(Q)DA, LogReg, (…)
- Neural Networks
- …



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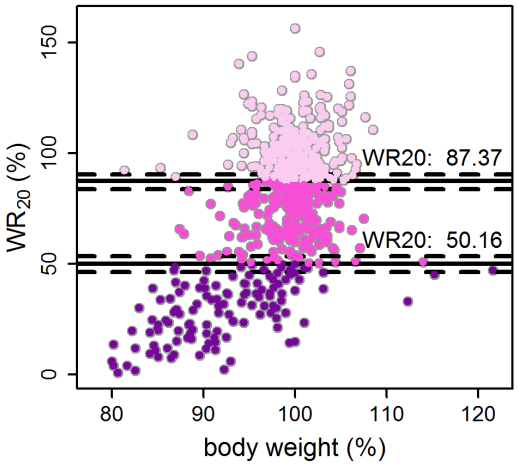
Data Analysis

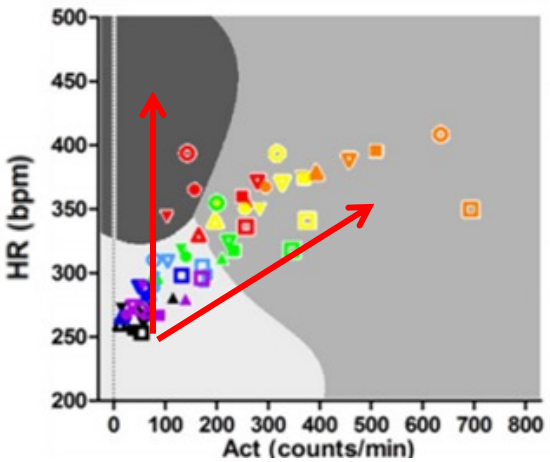
Clustering



- correlation matters
- classification (severity gradings)
- specific thresholds

Häger et al., PLOS ONE (2018)

Machine Learning



- ‚severity vectors' matter
- multidimensionality
- predictions possible

Wassermann et al., Front Neurosci (2020)

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Single Vector Data

(univariate data)

https://github.com/mytalbot/COST_Data_Analysis_2024

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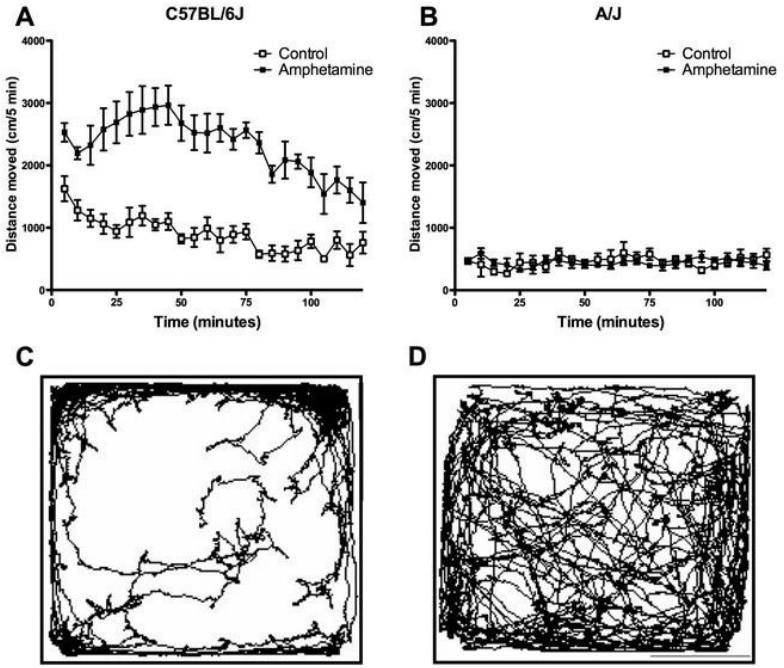
Data Analysis



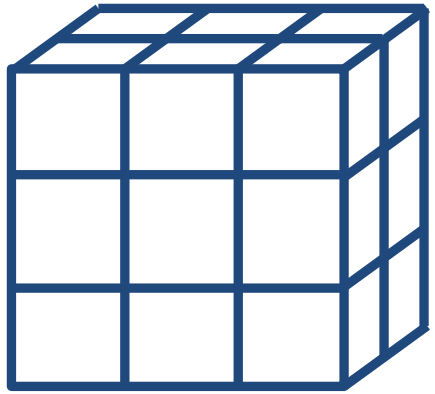
Open Field Protocol

Gould, T.D., Dao, D.T., Kovacsics, C.E. (2009). The Open Field Test. In: Gould, T. (eds) Mood and Anxiety Related Phenotypes in Mice. Neuromethods, vol 42. Humana Press, Totowa, NJ. https://doi.org/10.1007/978-1-60761-303-9_1.

- strains (B6, A/J)
- groups (control, Amphetamine)
- time

How do we analyse this?

Multidimensional Data



Severity Assessment

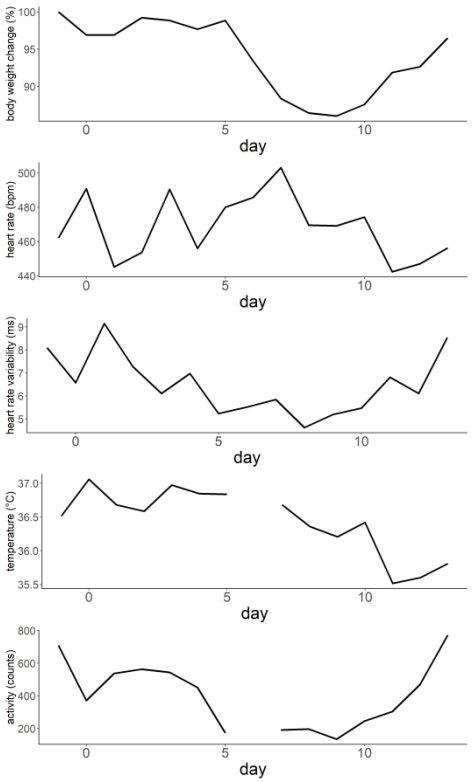
Body weight change (%)

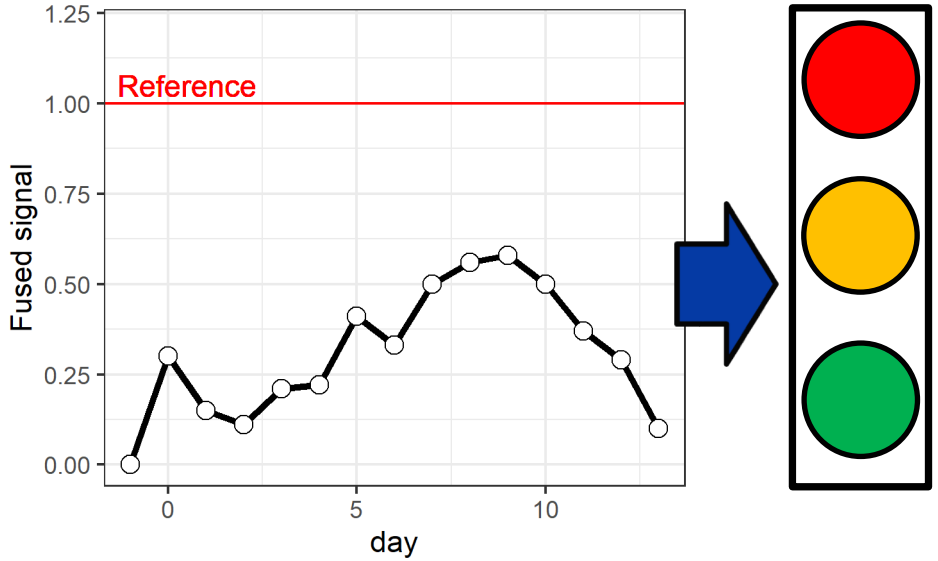
Heart rate (bpm)

Heart rate variability (ms)

Temperature (°C)

Activity (counts)





Animal status?

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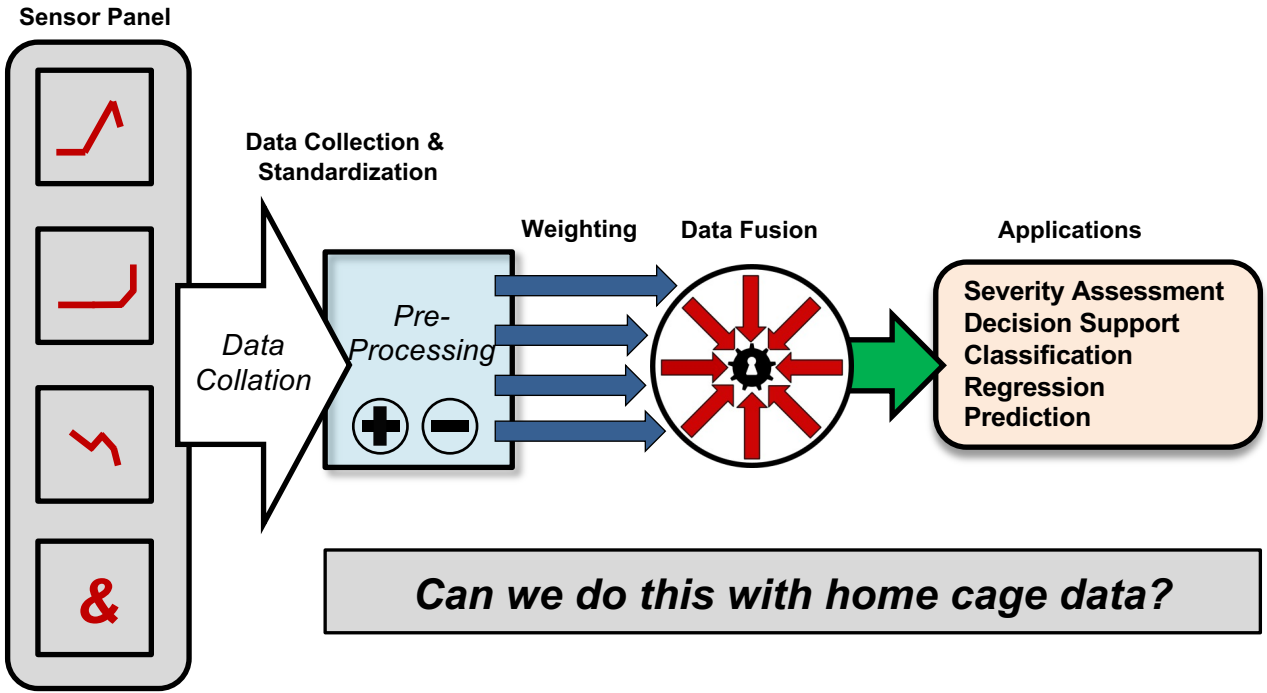
Sensor/Data Fusion



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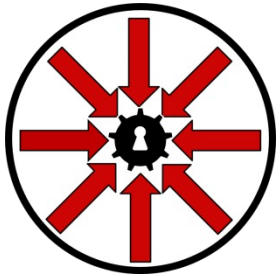
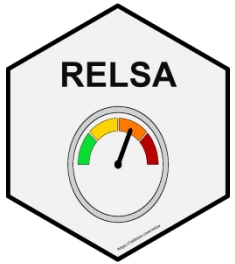
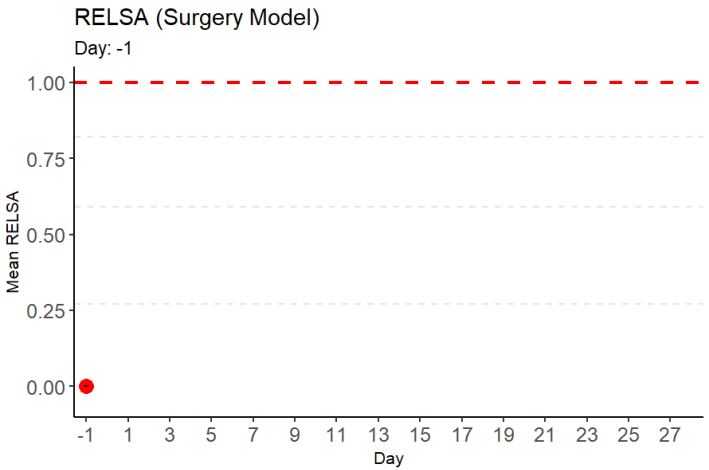
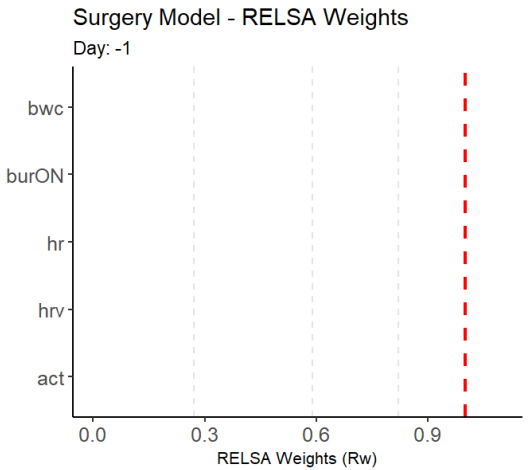
Data Fusion





Relative **S**everity
Assessment Score





Relative Severity Comparisons & Mapping

Talbot et al., Front Vet Sci. (2022)

bwc	body weight change (%)
burON	burrowing over night (g)
hr	heart rate (bpm)
hrv	heart rate variability (ms)
act	activity (counts)

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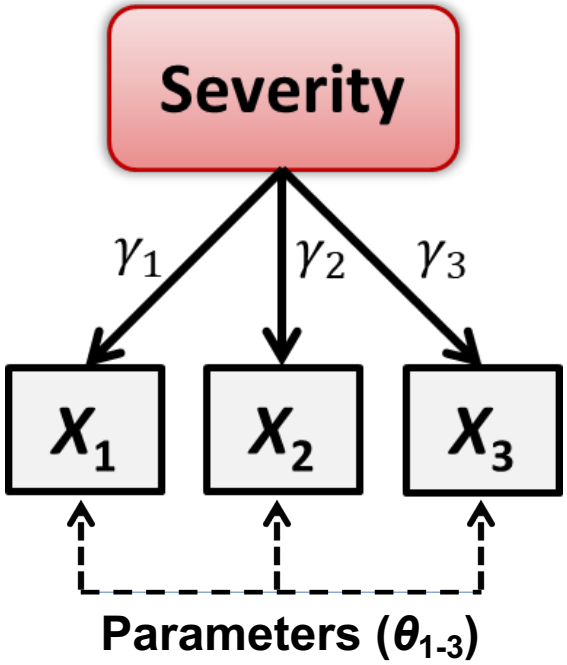
Sensor/Data Fusion



Time complicates things…

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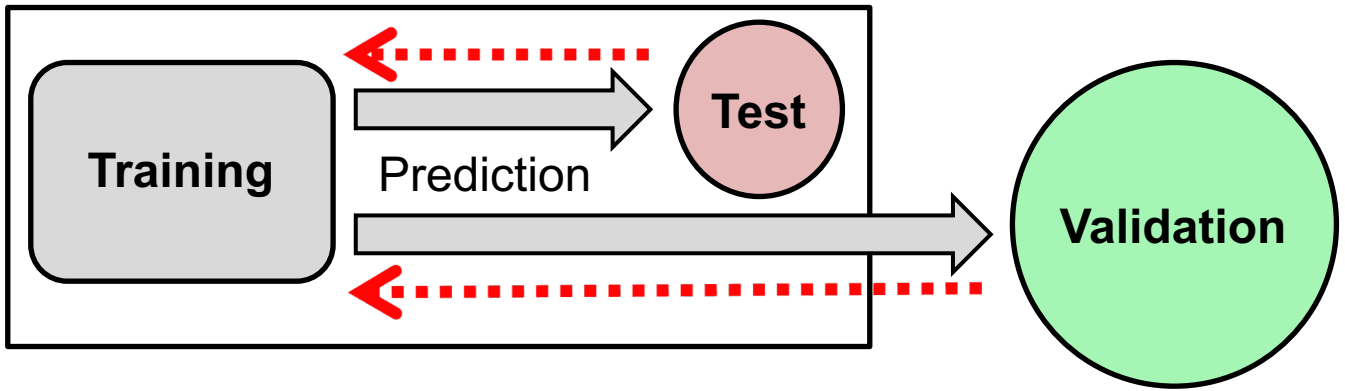
Machine Learning

The concept of „learning“

Generalizability



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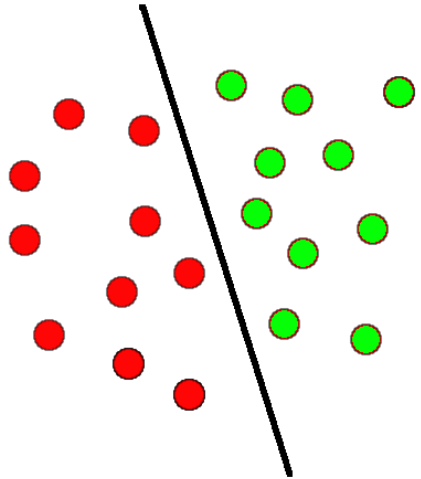
Support Vector Machine



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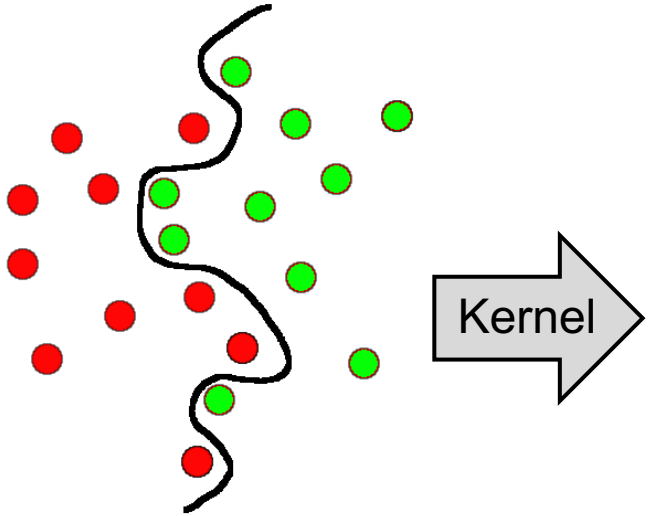
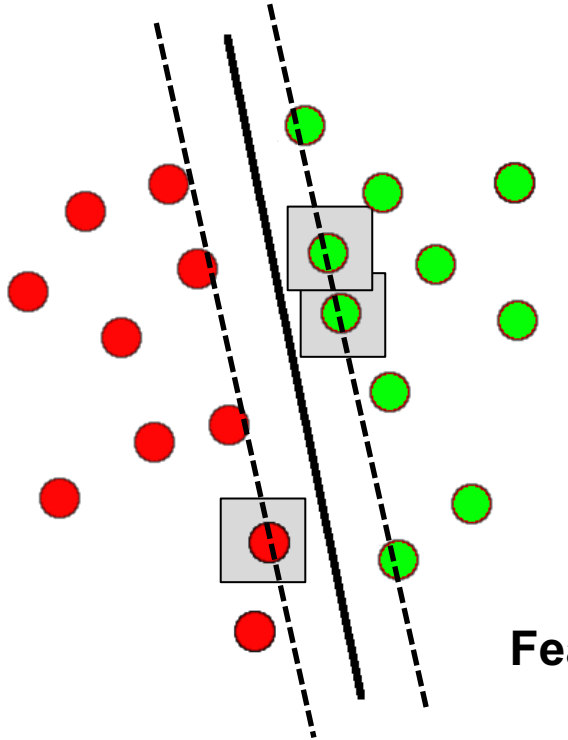
Support Vector Machine



Kernel

Original Space



Feature Space

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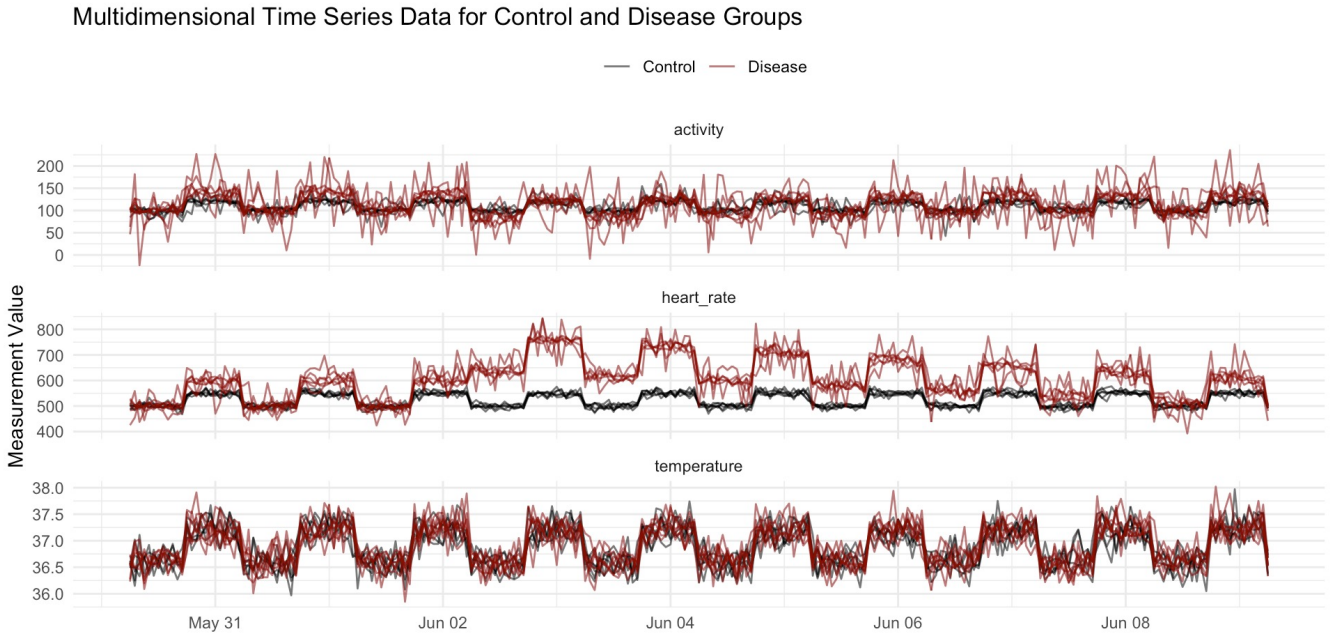
Artificial Home Cage Data



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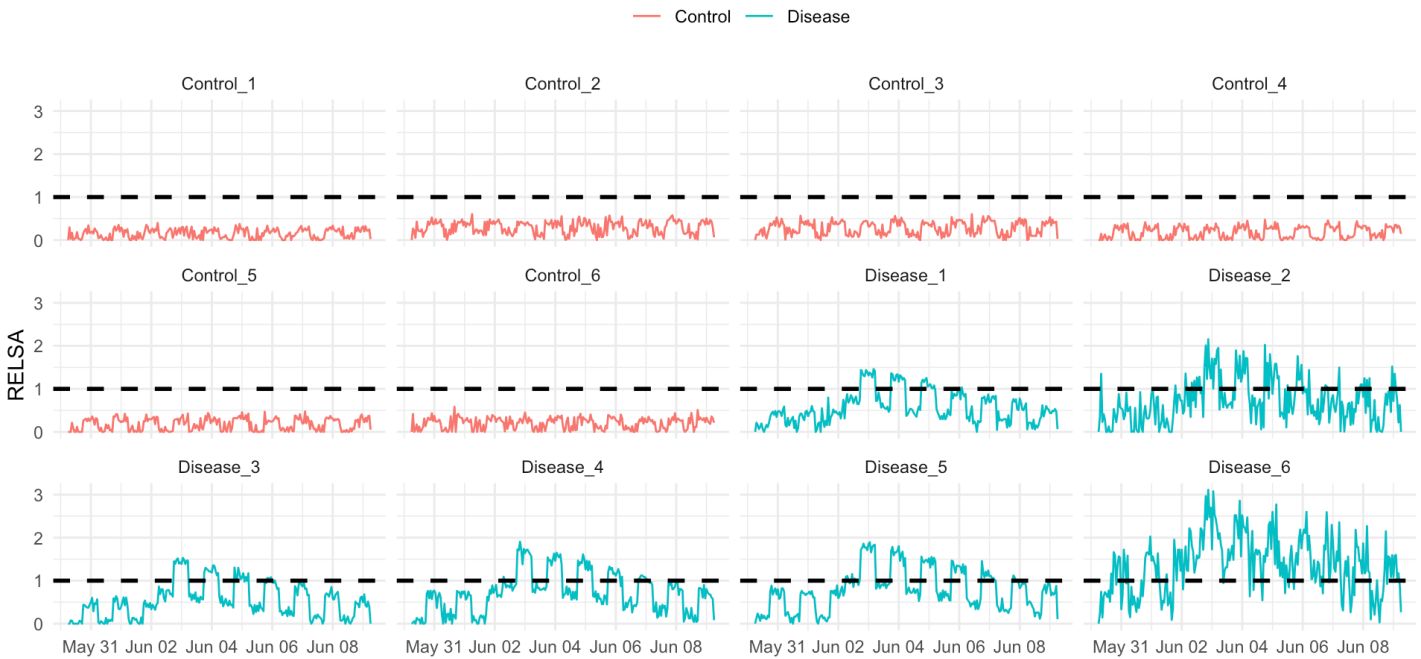
RELSA Results



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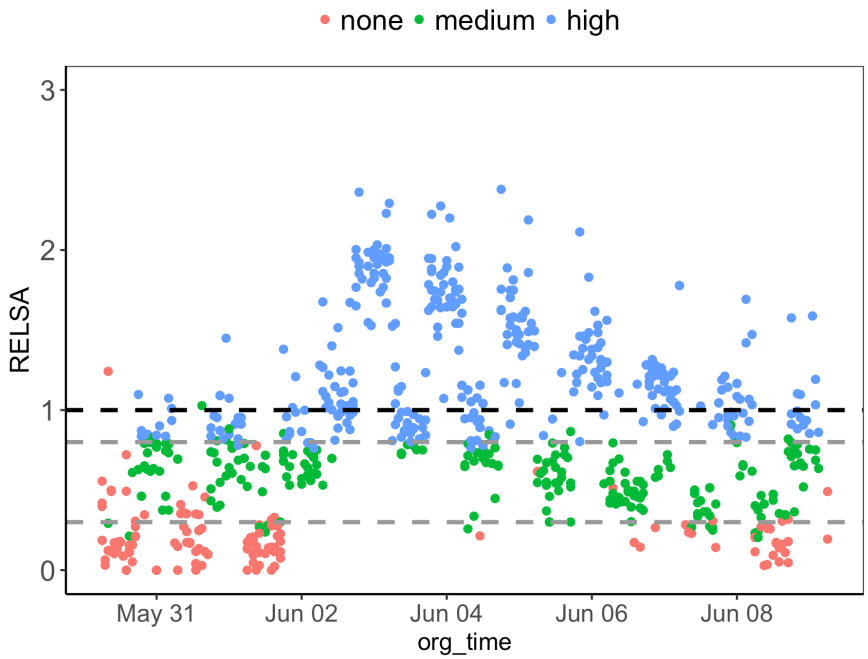
SVM for Biomarker Search



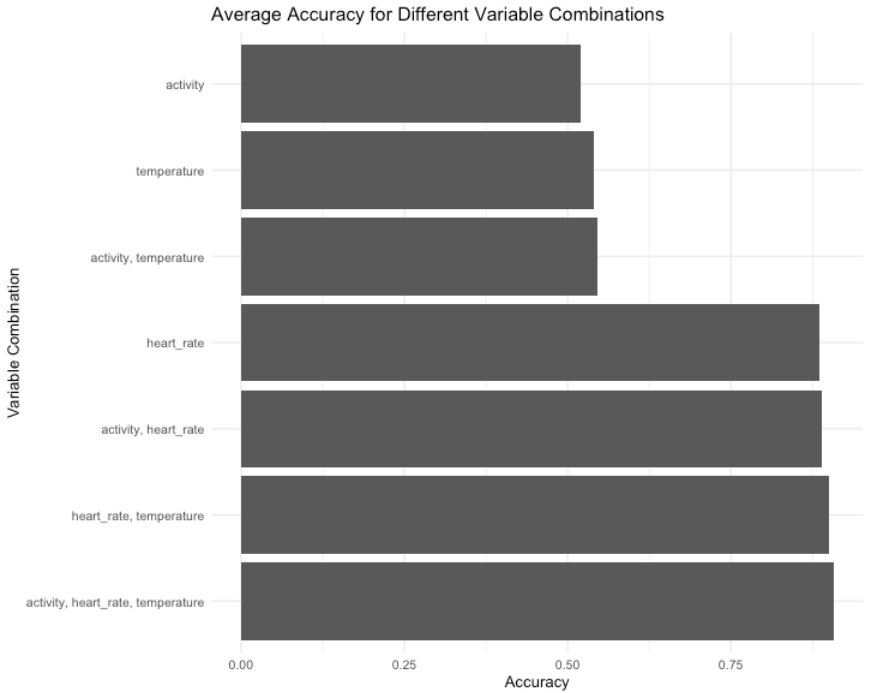
Classes for SVM classification

- RELSA < 0.3 –> ‘none’
- RELSA >= 0.3 & <= 0.8 –> ‘medium’
- RELSA > 0.8 –> ’high

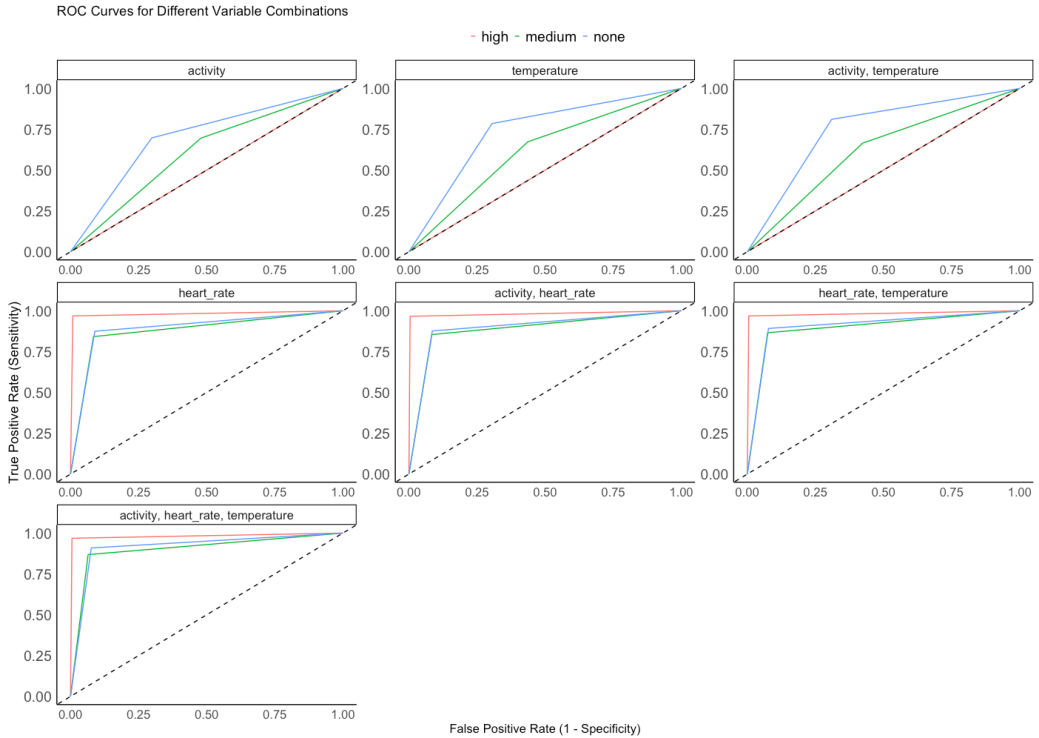
- Classification performance?
- Which measurements worked ‘best’?
- Biomarker potential?

SVM for Biomarker Search

Combination	Accuracy
act	0.52
hr	0.88
temp	0.54
act, hr	0.89
act, temp	0.54
hr, temp	0.90
act, hr, temp	**0.91**



SVM for Biomarker Search



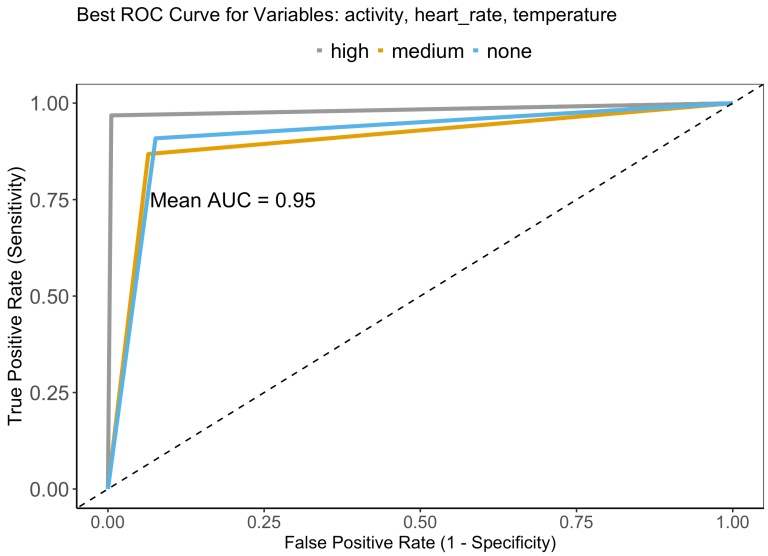
Contrasted by Class

Which one is the best?

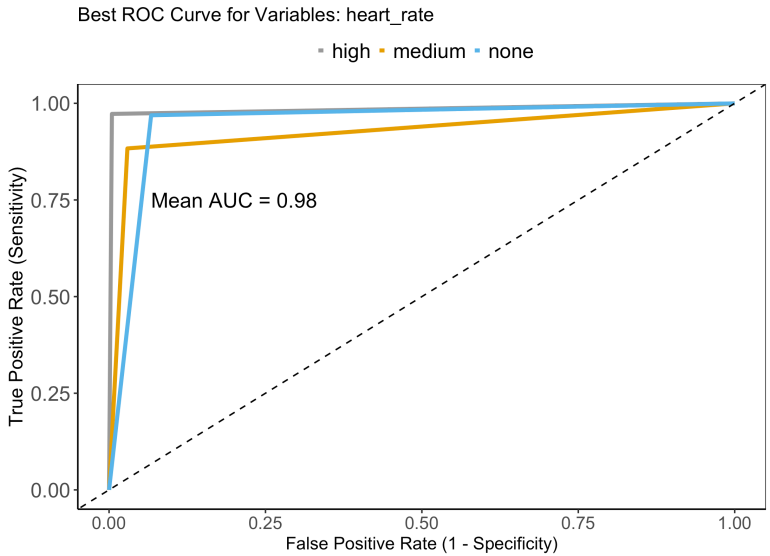
variables	AUC
act	0.672
temperature	0.687
act, temp	0.689
hr	0.930
act, hr	0.934
hr, temp	0.941
act, hr, temp	0.949

SVM for Biomarker Search

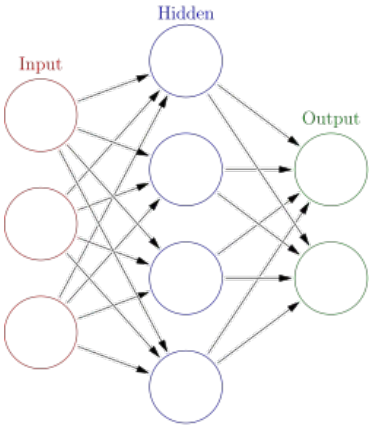
l_{time}= 1 hour



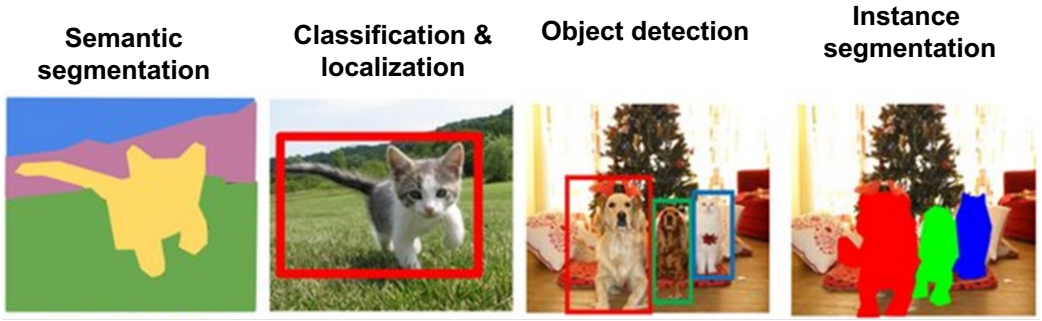
l_{time}= 6 hours



Neuronal Networks



What can we do with them?



- Classification / regression
- Feature detection
- Anomaly detecion
- Autoencoder
- …

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https://en.wikipedia.org/wiki/Neural_network_%28machine_learning%29. [30.05.2024].

Neuronal Networks

Automated Mouse Grimace Scale

- Marcin Kopaczka, Lisa Ernst, Justus Schock, Arne Schneuing, Alexander Guth, René H. Tolba, Dorit Merhof - Introducing CNN-Based Mouse Grim Scale Analysis for Fully Automated Image-Based Assessment of Distress in Laboratory Mice (Short Paper) In: Eurographics Workshop on Visual Computing for Biology and Medicine (VCBM).
- Lisa Ernst, Marcin Kopaczka, Mareike Schulz, Steven R. Talbot, Leonie Zieglowski, Marco Meyer, Stefan Bruch, Dorit Merhof and René H. Tolba- Improvement of the Mouse Grimace Scale set-up for Implementing of a Semi-automated Mouse Grimace Scale MGS Scoring (Part 1), Laboratory animals.
- Lisa Ernst, Marcin Kopaczka, Mareike Schulz, Steven R. Talbot, Birgitta Struve, Christine Häger, André Bleich, Mattea Durst, Paulin Jirkof, Margarete Arras, Roelof Maarten van Dijk, Nina Miljanovic, Heidrun Potschka, Dorit Merhof and René H. Tolba - Semi-automated generation of pictures for the Mouse Grimace Scale: A multi-laboratory analysis (Part 2), Laboratory animals.

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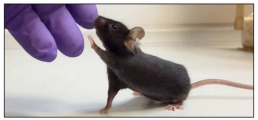

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DFG Deutsche Forschungsgemeinschaft German Research Foundation

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Thank you!

talbot.steven@mh-hannover.de

@atrophaeus