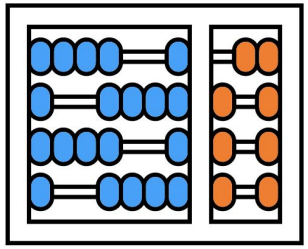


Instituto de Computação

UNIVERSIDADE ESTADUAL DE CAMPINAS

Capacitação profissional em tecnologias de Inteligência Artificial

Machine Learning Overview

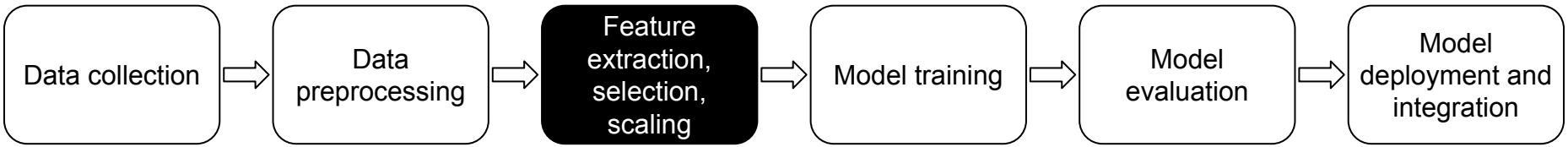
Prof. Edson Borin

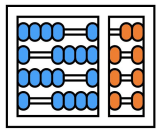
https://www.ic.unicamp.br/~edson

Institute of Computing - UNICAMP

ML Process

Feature extraction/selection/scaling

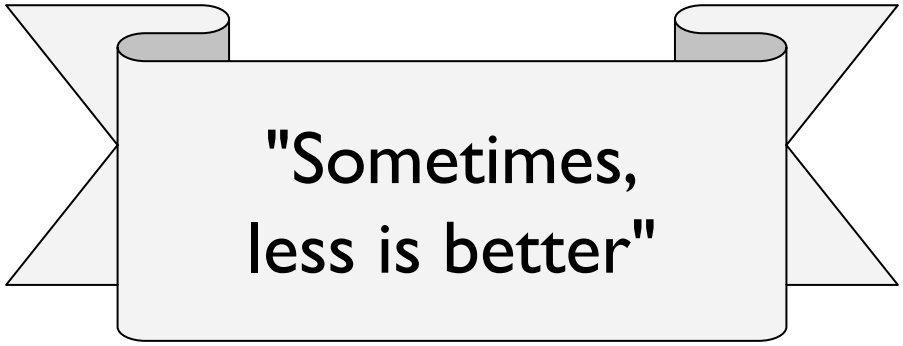


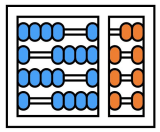


ML Process - Feature extraction/selection

Selecting the proper features to train a machine learning model:

- enables the machine learning algorithm to train faster
- reduces the complexity of a model and makes it easier to interpret
- improves the accuracy of a model if the right subset is chosen
- reduces overfitting





ML Process - Feature extraction/selection

Selecting the proper features to train a machine learning mod

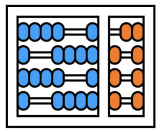
- enable ine learning algorithm to train
- it
- subset is chosen
- reduces overfitting

Main goal

have features that are

informative and **non-redundant**

"Sometimes,
less is better"



ML Process - Feature extraction/selection

Feature selection: identify the features that are most useful for the problem under examination

- Ex: find out that the *size* feature is more useful to predict a house *price* than the *color* feature

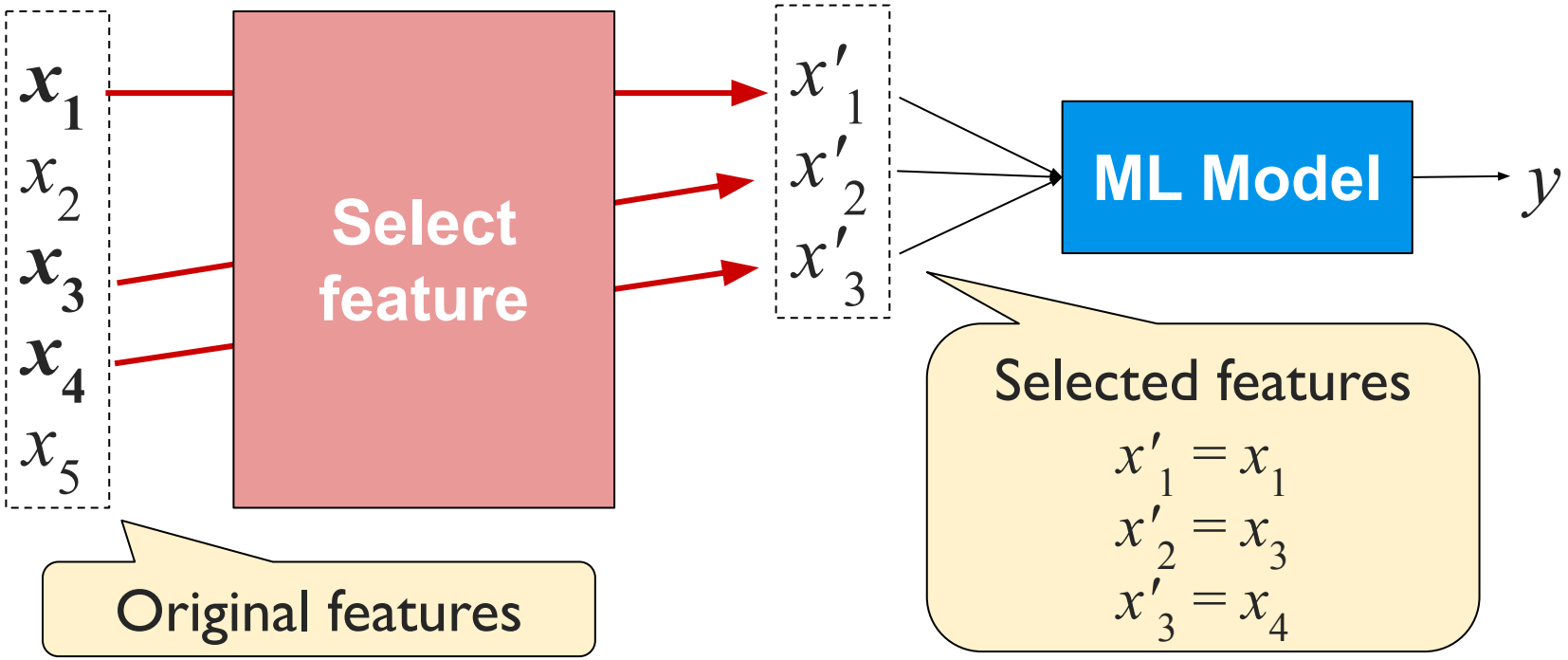
Feature extraction: Derive (create) new features based on the existing ones

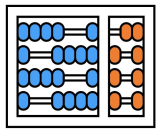
- Ex: transform individual features (e.g., square them), or combine multiple features (e.g. by multiplying them) to create new features

ML Process - Feature extraction/selection

Feature selection: identify the features that are most useful for the problem under examination

Approach using feature selection



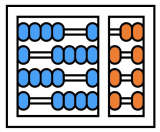


ML Process - Feature extraction/selection

Feature selection: identify the features that are most useful for the problem under examination

Common approaches for feature selection:

- Filter methods
- Wrapper methods
- Embedded methods



ML Process - Feature extraction/selection

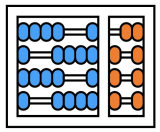
Filter methods: features are selected based on statistical test scores that measure their correlation with the outcome variable (label)

Common methods:

- Pearson correlation coefficient
- Chi-square coefficient
- Mutual information

Limitations:

- Relationship between features is not considered => tend to select redundant features



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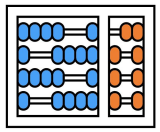
Model agnostic

Selection of features is independent of ML algorithm.



ML Process - Feature extraction/selection

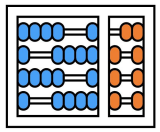
Wrapper methods: measure the usefulness of a subset of feature by actually training a model on it

Common methods:

- Forward Selection
- Backward Elimination
- Recursive feature elimination (RFE)

Limitations:

- Requires training a new model for each subset => huge number of computations
- Best feature set is usually associated with a specific type of model



ML Process - Feature extraction/selection

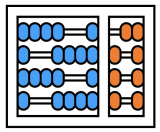
Embedded methods: consider feature selection as a part of the model training.

Example: Regularization method

- Lasso regression: $\text{Cost Func.} = \text{LSq}_\theta(X,Y) + \sum |\boldsymbol{\theta_i}|$

Limitations:

- Specific to model (e.g., embedded into the cost function)

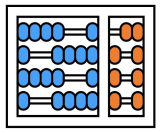


ML Process - Feature extraction/selection

Feature selection: Main benefits

Benefits:

- Simplify models to make them easy for users to interpret
- Reduce the model training time
- Avoid dimension explosion
- Improve model generalization and avoid overfitting



ML Process - Feature extraction/selection

Feature extraction: Derive (create) new features based on the existing ones

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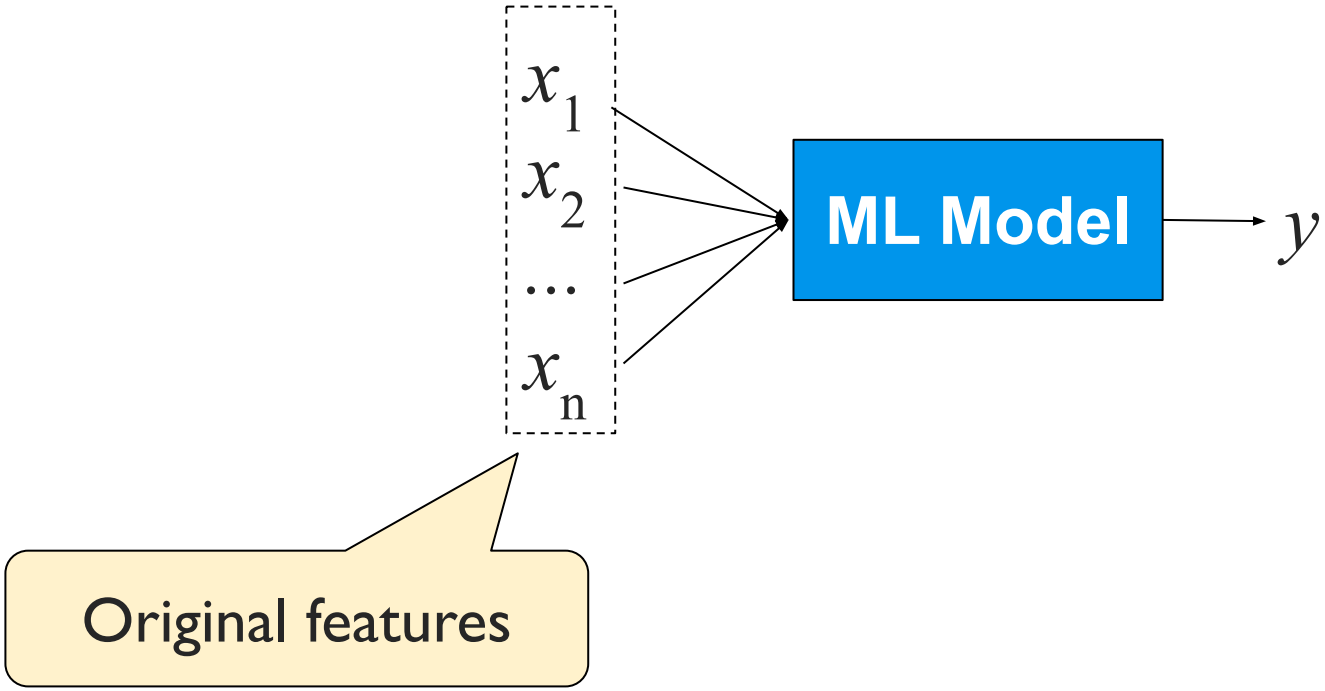
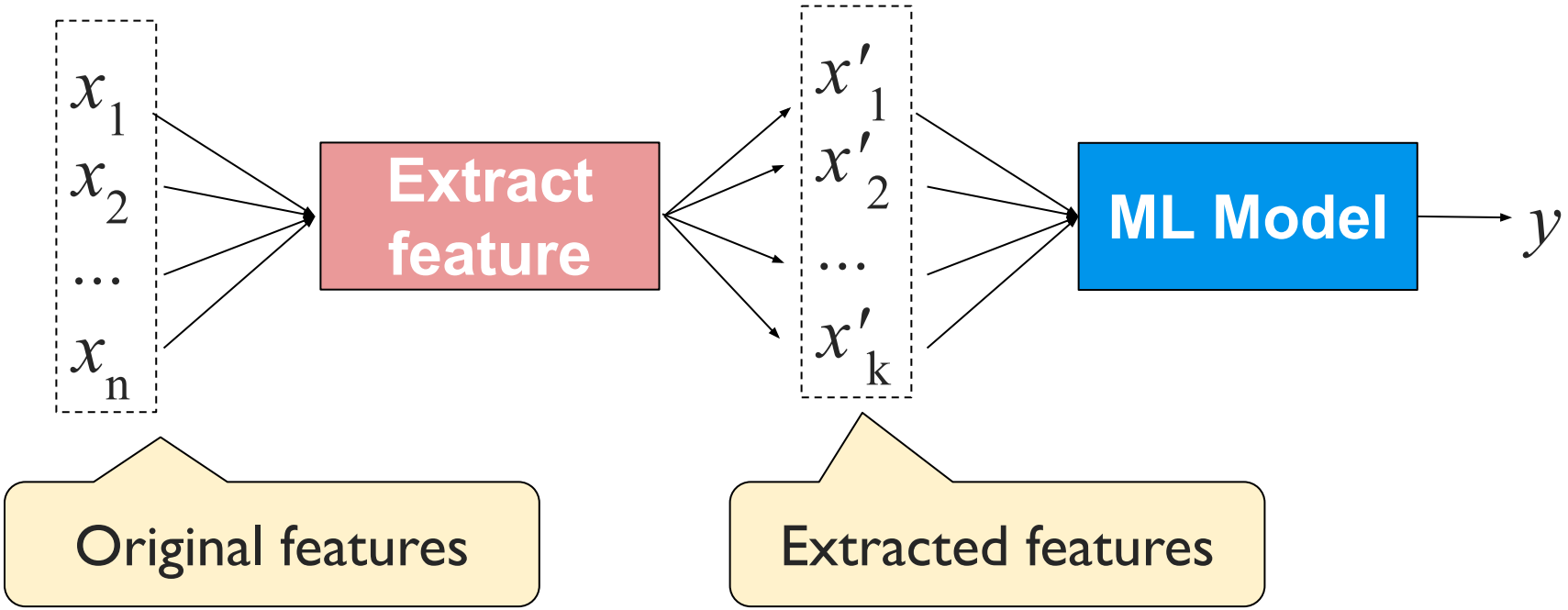
Approach without feature extraction

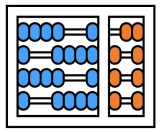


ML Process - Feature extraction/selection

Feature extraction: Derive (create) new features based on the existing ones

Approach using feature extraction



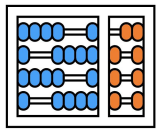


ML Process - Feature extraction/selection

Feature extraction: Derive (create) new features based on the existing ones

Approaches for feature extraction:

- Create new features
  - Ex: Feature cross, kernel-tricks…
- Dimensionality reduction techniques
  - Focus on reducing dimensionality by combining existing features into a smaller set of new features
  - Ex: Isomap, UMAP, PCA, Autoencoder, …

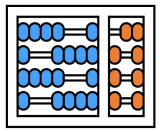


ML Process - Feature extraction/selection

Feature scaling:

Many ML algorithms do not perform well when the input numerical attributes have very different scales

- Ex: #bedrooms vs. house price



ML Process - Feature extraction/selection

Feature scaling:
Many ML algorithms do not perform well when the input numerical attributes have very different scales

- Ex: #bedrooms vs. house price

Two common approaches

- min-max scaling (a.k.a. normalization)
  - Normalize data to the interval [0-1]
- standardization
  - Subtract the mean value and divide by the standard deviation

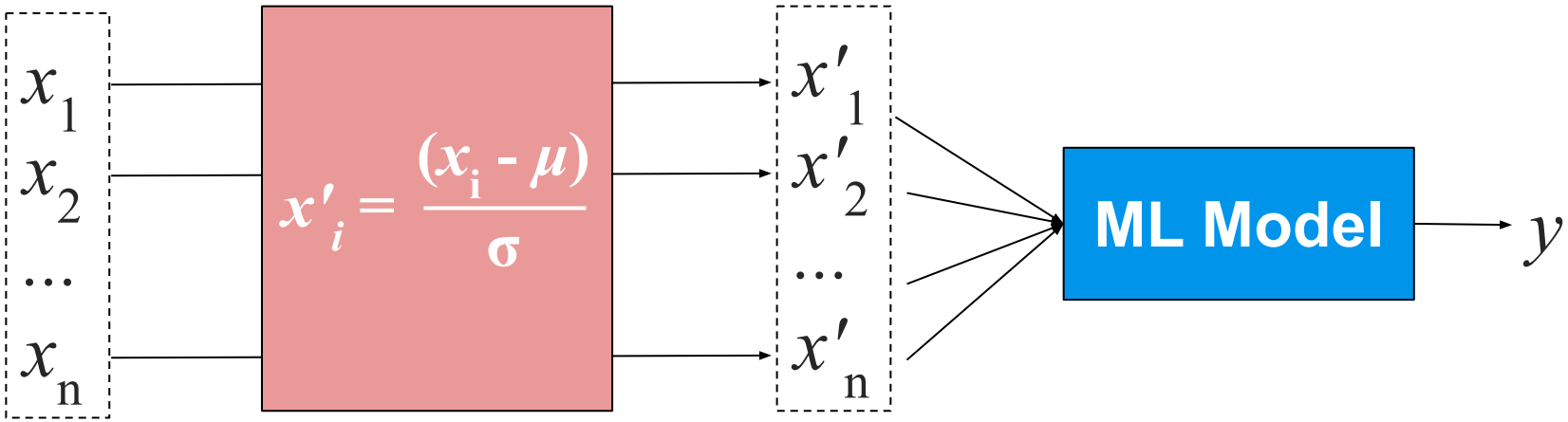
ML Process - Feature extraction/selection

Feature scaling:

Many ML algorithms do not perform well when the input numerical attributes have very different scales

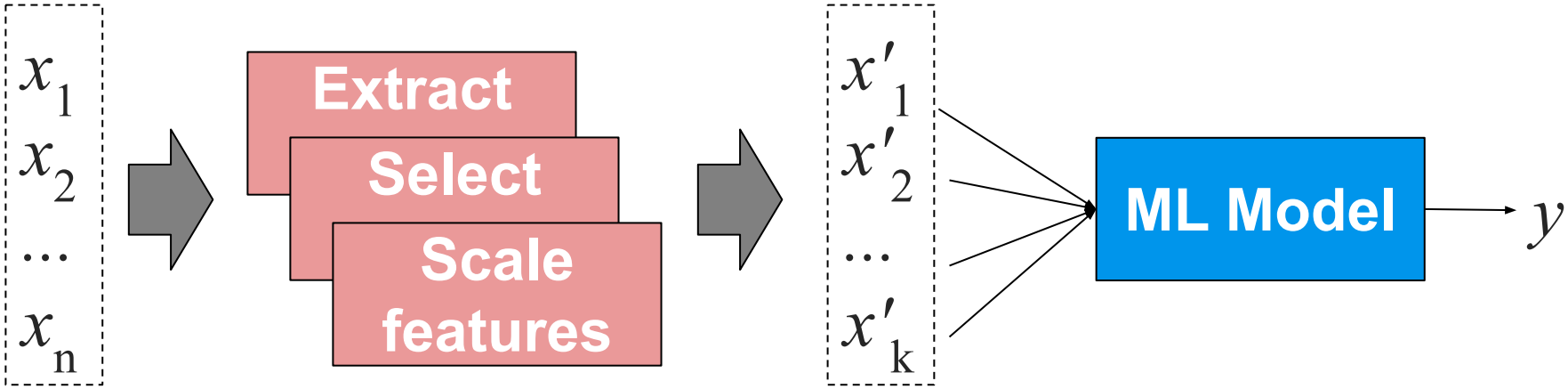
- Ex: #bedrooms vs. house price

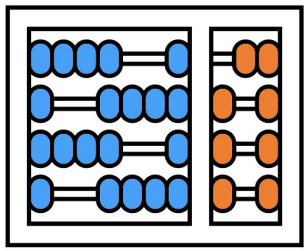
Approach using feature scaling (standardization)



ML Process - Feature extraction/selection

Feature extraction/selection/scaling: Techniques to improve the set features used on the machine learning model!





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