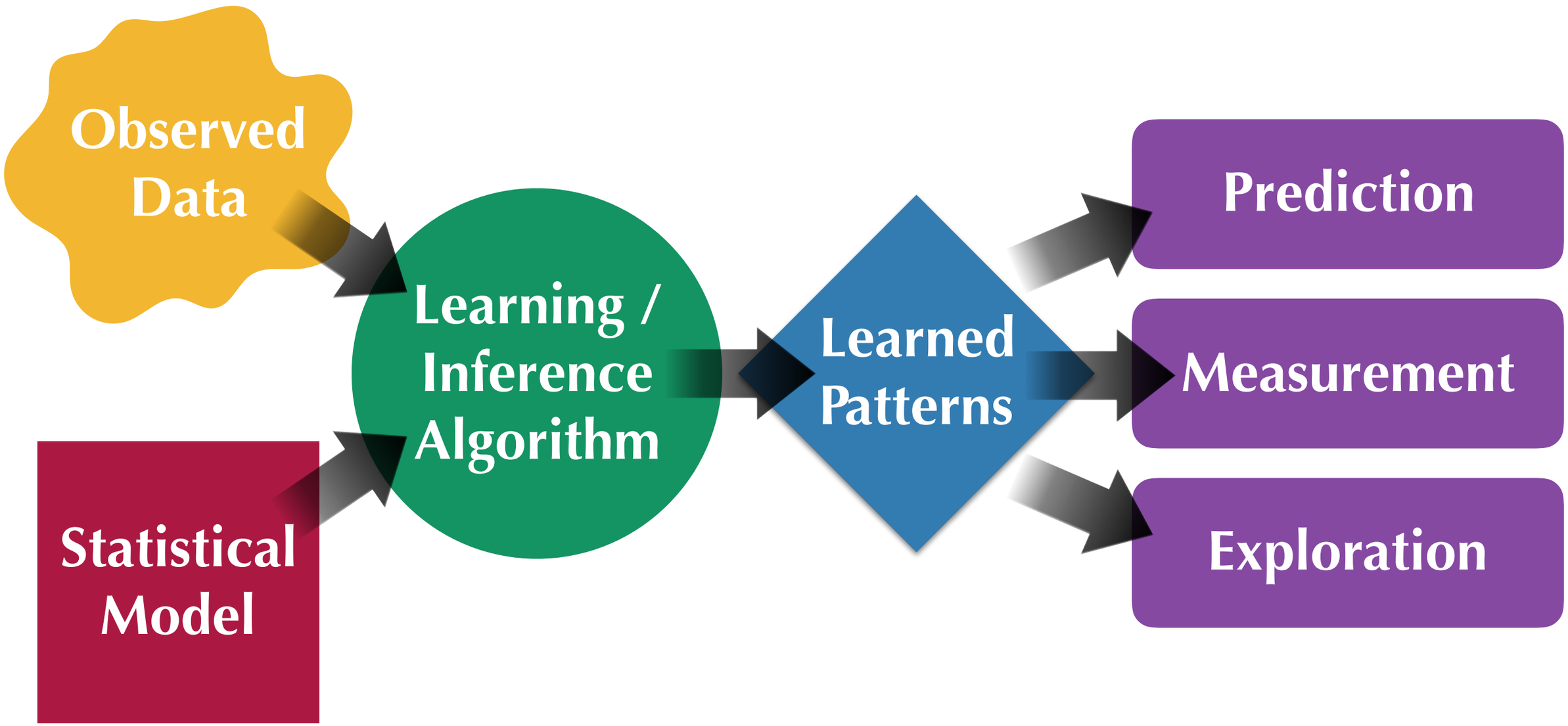
Introduction to **Machine Learning Methods**: What you Need to Know to **Conduct** and **Interpret** Research with ML

Allison J.B. Chaney
ajbc.io/MLintro

DUKE FUQUA SCHOOL OF BUSINESS

What is Machine Learning?



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How do I want to use ML?

Prediction

Does person *A* belong to segment *B*?

What will revenue be if we change *X*?

Measurement

What products are perceived as *Y*?

How many people care about idea *M*?

Exploration

How many communities in network *N*?

What themes exist in reviews for *P*?

Outline

Part 1: Overview of Machine Learning

- Survey of model types
- Algorithms
- Software

Outline

Part 2: Case Studies (Methods and Challenges)

- **K-means Clustering** and **Choosing K**
- **Topic Models** and **Data Processing & Exchangeability**
- **Matrix Factorization** and **Evaluation Metrics**
- **Decision Trees & Ensemble Methods** and **Overfitting & Model Selection**
- **Deep Learning** and **Learning Rates**

Part 1:
Overview of Machine Learning

Types of ML Models

Supervised vs. Unsupervised

Types of ML Models

Supervised vs. Unsupervised

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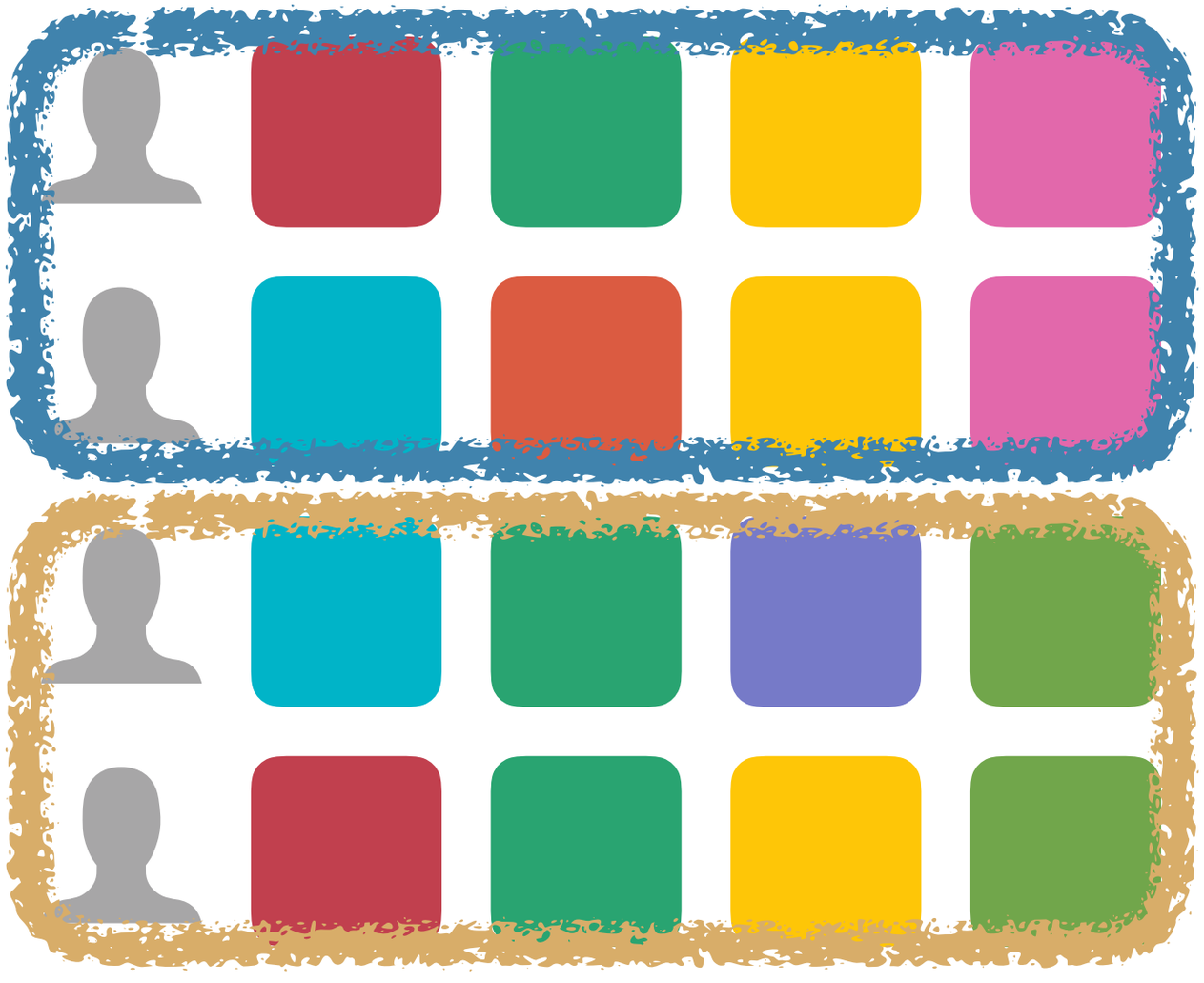
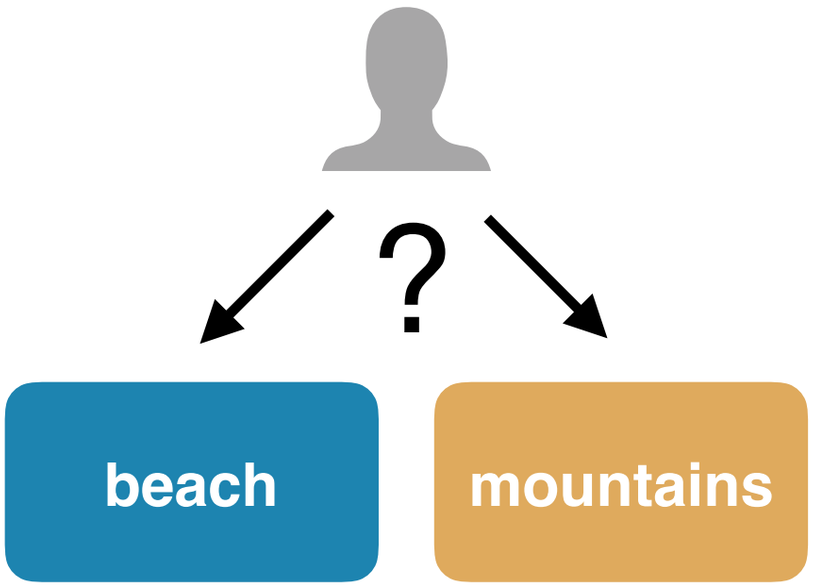
Types of ML Models

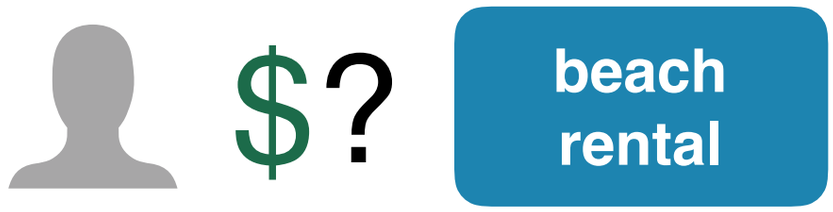
Supervised vs. **Unsupervised**



Types of ML Models

Discrete vs. Continuous





Types of ML Models

One Useful Grouping

	discrete	continuous
supervised	**classification**	**regression**
unsupervised	**clustering**	**dimensionality reduction**

Algorithms

	discrete	continuous
supervised	**classification**	**regression**
unsupervised	**clustering**	**dimensionality reduction**

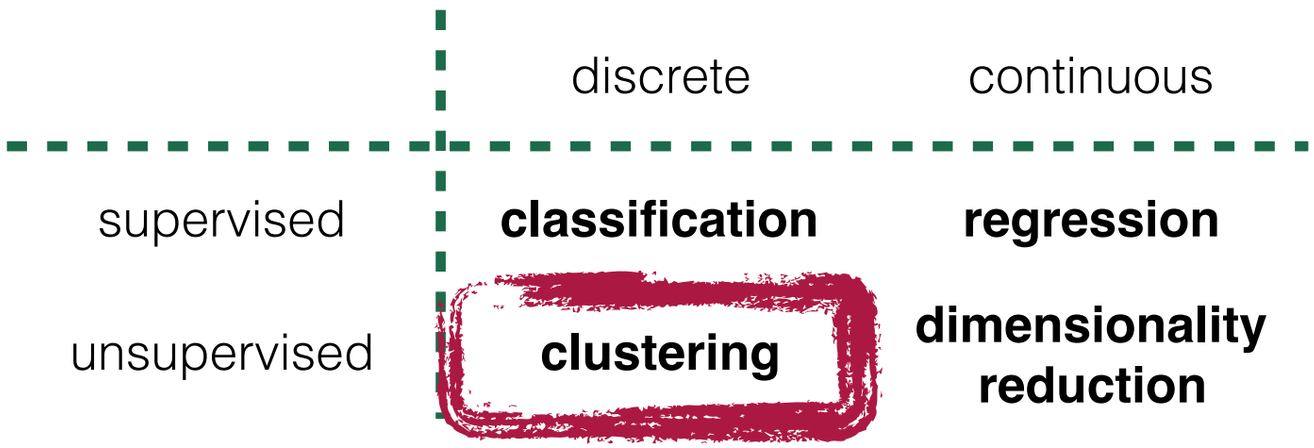
- Neural Networks / Deep Learning
- Decision Trees / Random Forests
- Boosting (ensemble method)
- Support Vector Machines
- ...

Algorithms

	discrete	continuous
supervised	**classification**	**regression**
unsupervised	**clustering**	**dimensionality reduction**

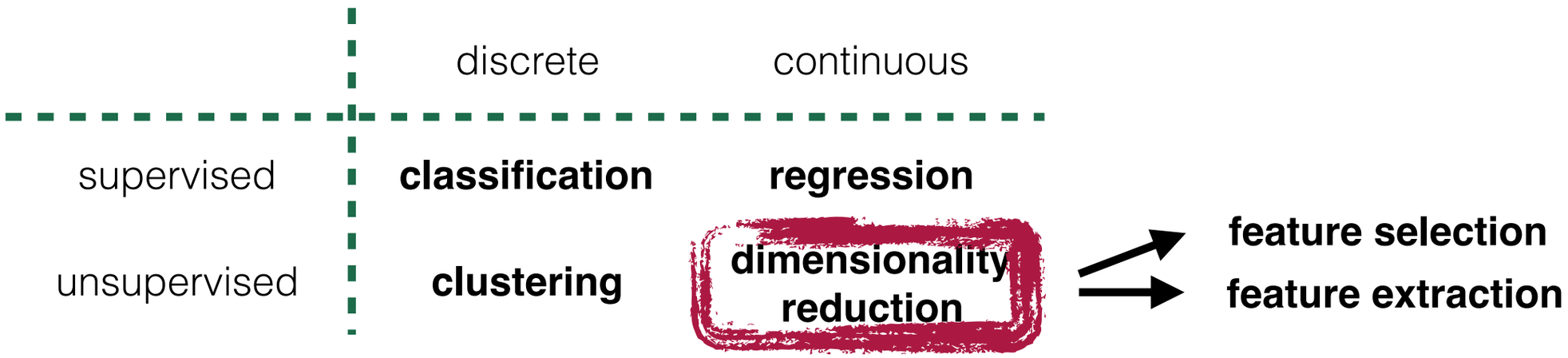
- Least squares
    - Regularization: Ridge, LASSO, ElasticNet
- Neural Networks & Support Vector Machines (again!)
- …

Algorithms



- *k*-means & fuzzy *k*-means (centroid-based)
- Expectation–Maximization (EM) using Gaussian Mixture Models (GMM) (distribution-based)
- DBSCAN (density-based)
- ...

Algorithms

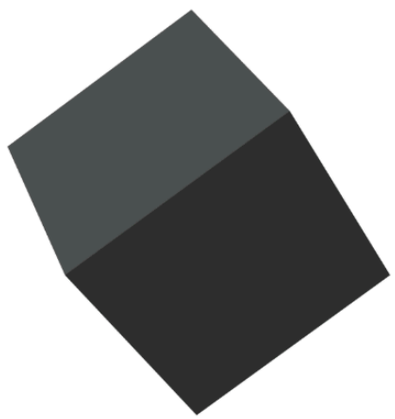


- Principal component analysis (PCA)
- Non-negative matrix factorization (NMF)
- Linear discriminant analysis (LDA)
- Autoencoder (neural network variant)
- ...

Software

VOWPAL WABBIT

Edward



https://scikit-learn.org/stable/
https://www.tensorflow.org/
http://edwardlib.org/
http://hunch.net/~vw/
https://cran.r-project.org/web/views/MachineLearning.html
...

Part 2:
Case Studies

Outline

Part 2: Case Studies (Methods and Challenges)

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Let’s head over to a Jupyter notebook…

Take Care!

Define the problem before choosing an ML method.

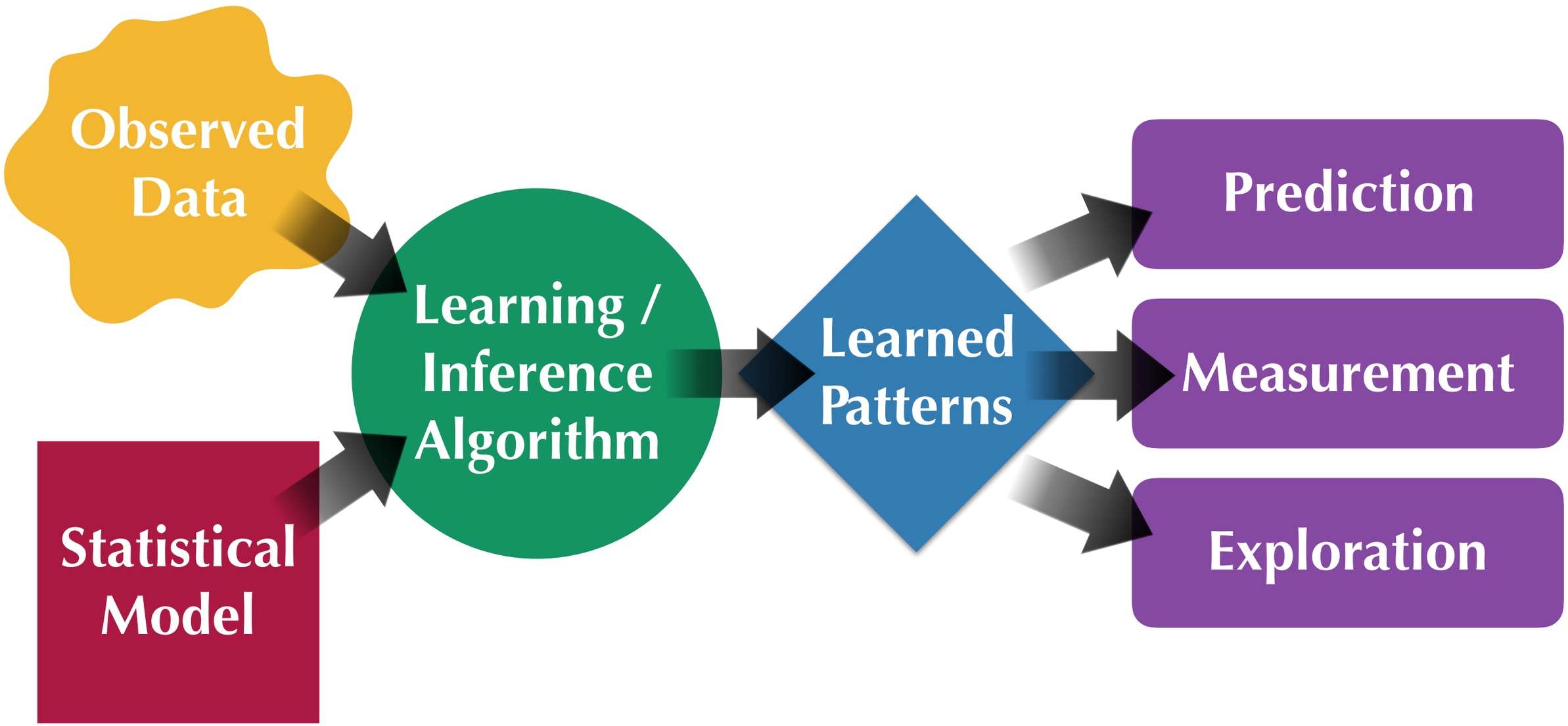
Be critical of ML model assumptions. Are a method's assumptions acceptable in the context of your work?

Ask yourself: What is the source of your data? What biases might be created by the data-generating process or your curation of the data?

Beware of tuning parameters, train/validate/test splitting, evaluation metrics, and overfitting.

What are you comparing against? Will a simple method do better?

Conducting and Interpreting Research with ML



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