W4995 Applied Machine Learning

Introduction

01/18/17

Andreas Müller

Scikit-learn Development

http://scikit-learn.org/dev/developers/contributing.html

Logistics

CAs: Akshay, Aarshay, Rohan, Sheallika

Office Hours

- Andreas Müller (lecturer) Wednesday 2pm-4pm, 410 Mudd
- Akshay Khatri (CA) Fridays 2pm-4pm, CS TA Room
- Aarshay Jain (CA) Mondays 2pm-4pm, CS TA Room
- Sheallika Singh (CA) Thursdays 3:20pm-5:20pm CS TA Room
- Rohan Pitre (CA) Thursday 5:20pm-7:20pm CS TA Room
  [This week on Friday same time!]

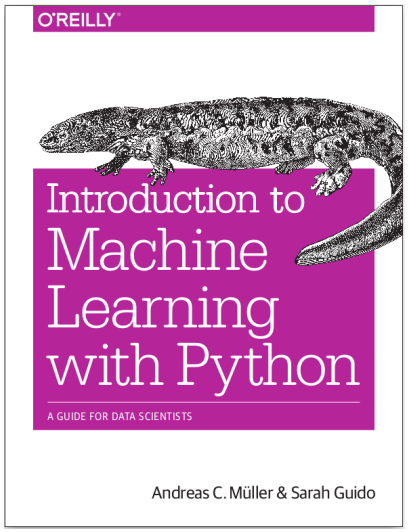
Logistics

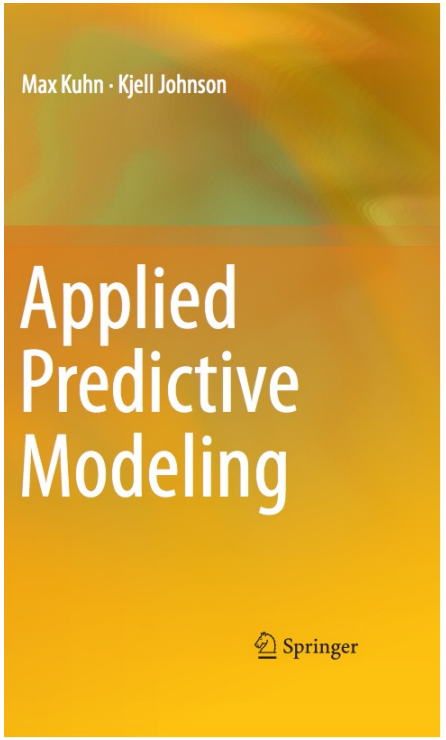
- Course website:

  https://amueller.github.io/applied_ml_spring_2017/

- Five homeworks, all programming
- Grade: 60% homeworks, 20% first exam, 20% second exam

Books


O'REILLY
Introduction to
Machine
Learning
with Python
A GUIDE FOR DATA SCIENTISTS
Andreas C. Müller & Sarah Guido


Max Kuhn · Kjell Johnson
Applied
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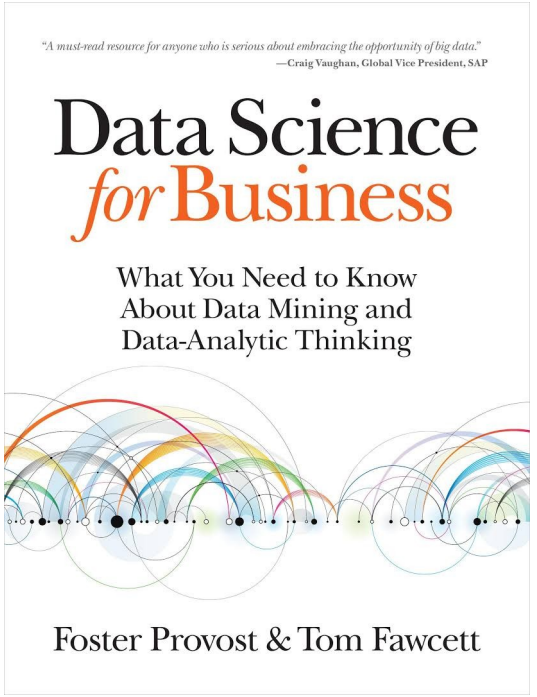
Modeling
Springer


"A must-read resource for anyone who is serious about embracing the opportunity of big data."
—Craig Vaughan, Global Vice President, SAP
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for Business
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About Data Mining and
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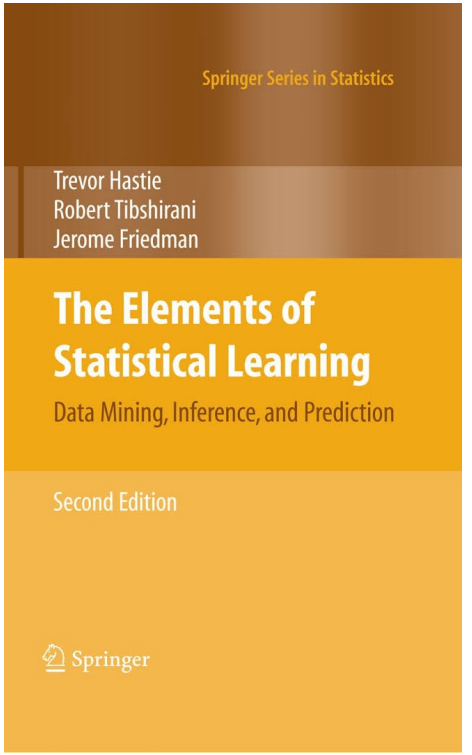
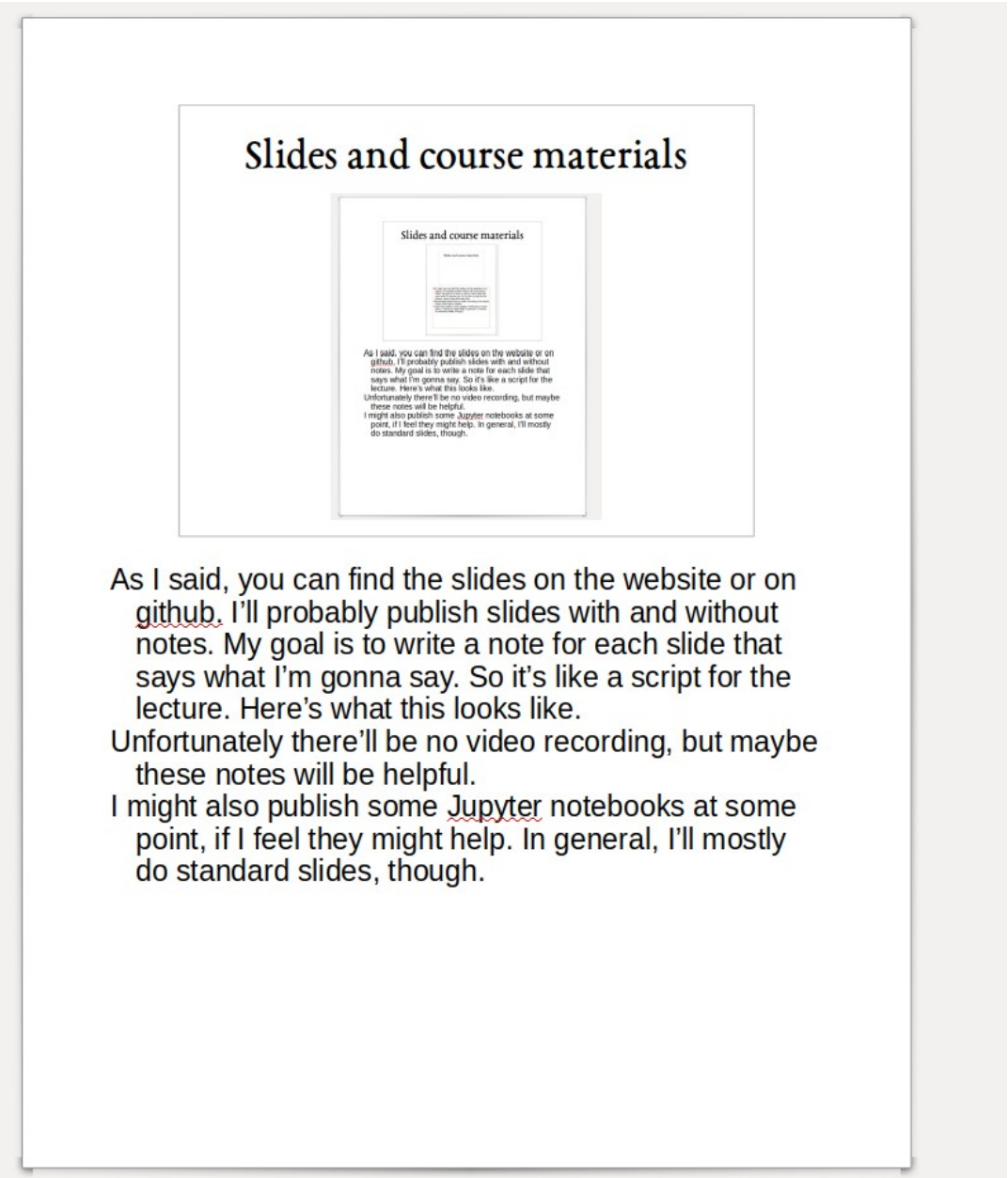
Foster Provost & Tom Fawcett


Springer Series in Statistics
Trevor Hastie
Robert Tibshirani
Jerome Friedman
The Elements of
Statistical Learning
Data Mining, Inference, and Prediction
Second Edition
Springer

Slides and course materials



What and Why of Machine Learning

What is machine learning?

Andreas Mueller
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SHORTCUTS
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EXPLORE
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Pokes
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Offers
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CREATE
Ad · Page · Group · Event · Fundraiser

Juliana Vanderlee is watching Tom Price's confirmation hearing.
6 mins ·

All of these people are literally some of the worst possible choices for their positions.

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2

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Cédric Archambeau and 1 other

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190K people talking about this
Pierce Brosnan
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7,615,868 likes
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Facebook Engineering
8,548,617 likes
Mark Zuckerberg
84,629,591 followers

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CrossFit Icke Outdoo... tomorrow

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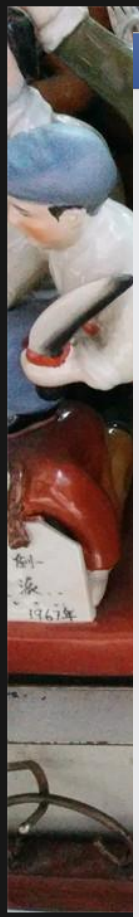

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Andreas Mueller added 8 new photos.
June 6 at 5:07pm

Bye bye hong kong

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and 6 others like this.

Looks like such a vibrant city! I bet it was awesome
June 6 at 7:39pm · Like

Write a comment...

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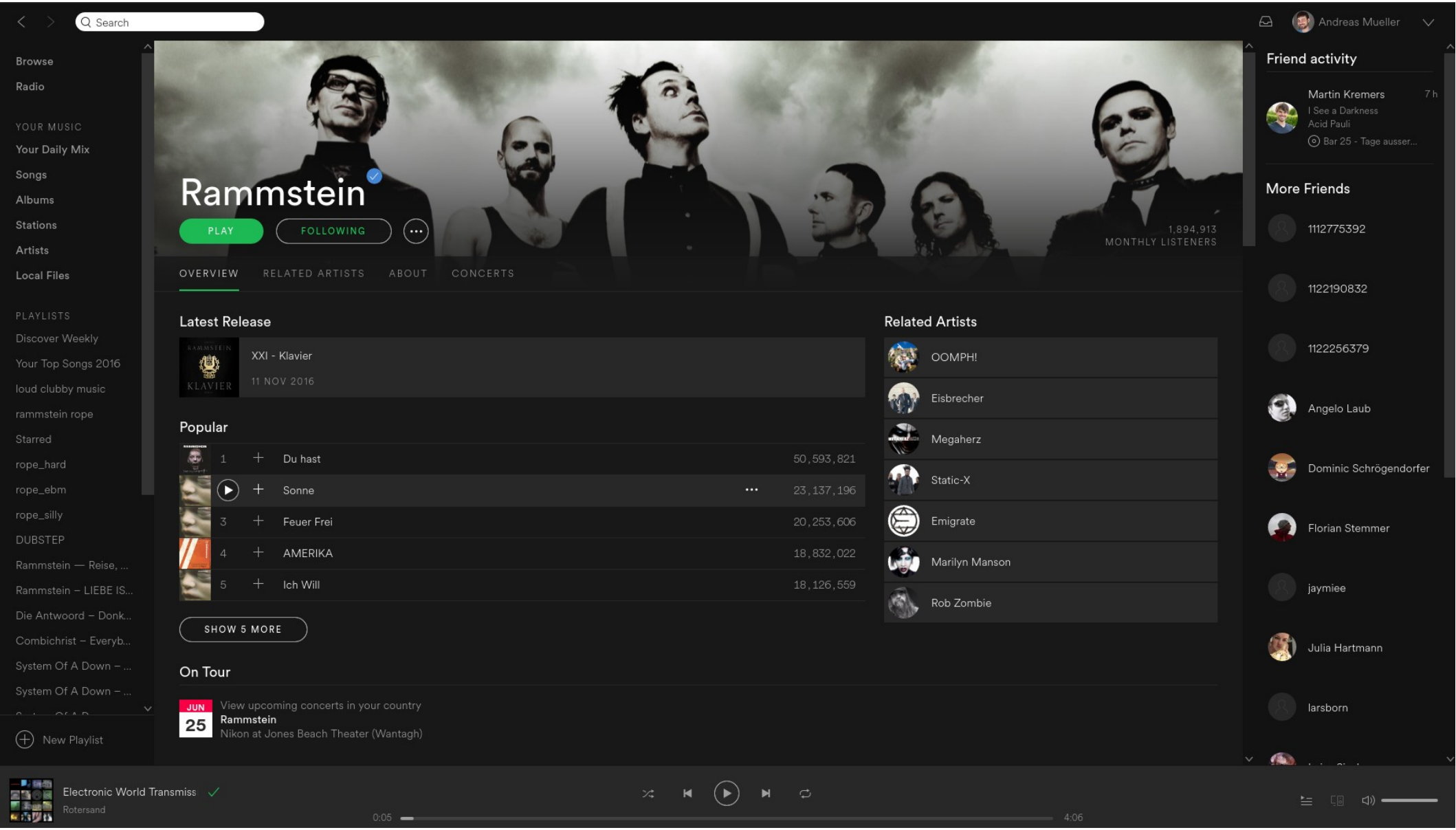
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Rammstein
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CONCERTS
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Sonne 23,137,196
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4 AMERIKA 18,832,022
5 Ich Will 18,126,559
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Julia Hartmann
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4:06

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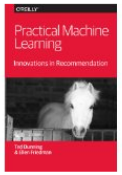
LOOK INSIDE! **Machine Learning Resources**
Find tips and tricks with these featured titles on machine learning, algorithms, sensors, and more. Learn more

Related Searches: artificial intelligence, data mining, machine learning python.



Practical Machine Learning: Innovations in Recommendation by Ted Dunning and Ellen Friedman (Apr 17, 2014)

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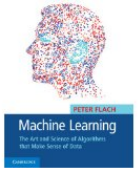

Machine Learning: The Art and Science of Algorithms that Make Sense of Data by Peter Flach (Nov 12, 2012)

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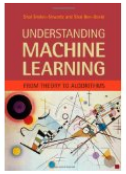

Understanding Machine Learning: From Theory to Algorithms by Shai Shalev-Shwartz and Shai Ben-David (May 19, 2014)

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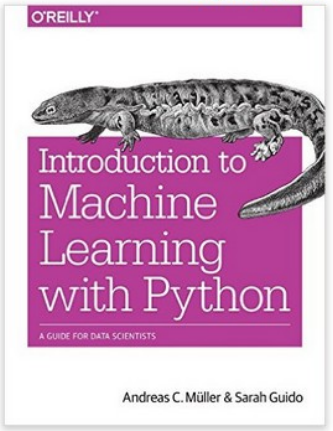
Introduction to Machine Learning with Python: A Guide for Data Scientists 1st Edition

by Andreas C. Müller (Author), Sarah Guido (Author)

★★★½☆ 9 customer reviews

Look inside



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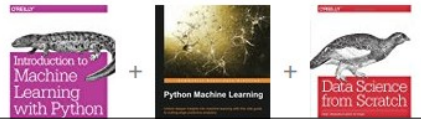

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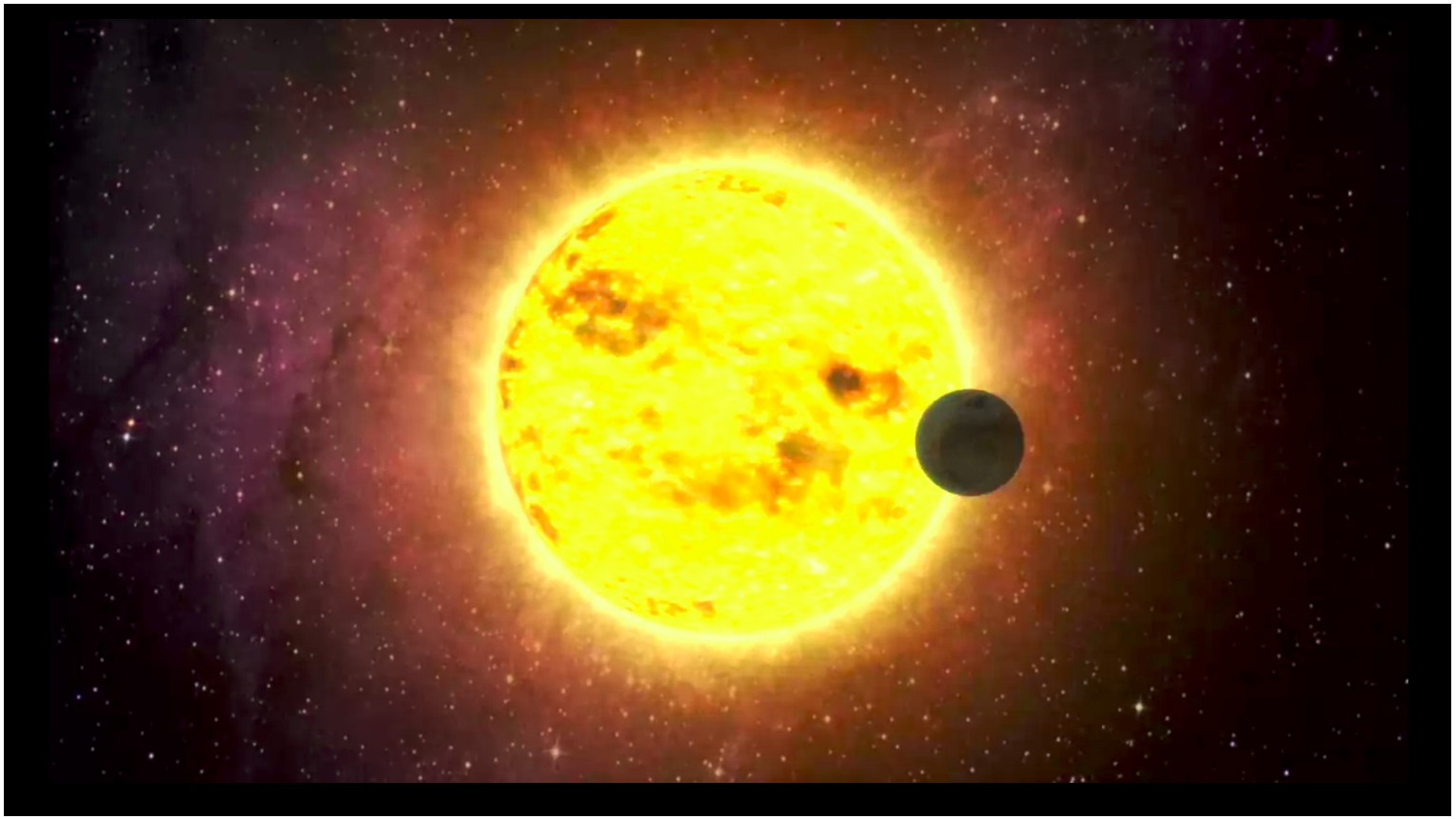


Types of machine learning:

- supervised
- unsupervised
- reinforcement

Supervised Learning

$$(x_i, y_i) \propto p(x, y) \quad \text{i.i.d.}$$

$$x_i \in \mathbb{R}^n$$

$$y_i \in \mathbb{R}$$

$$f(x_i) \approx y_i$$

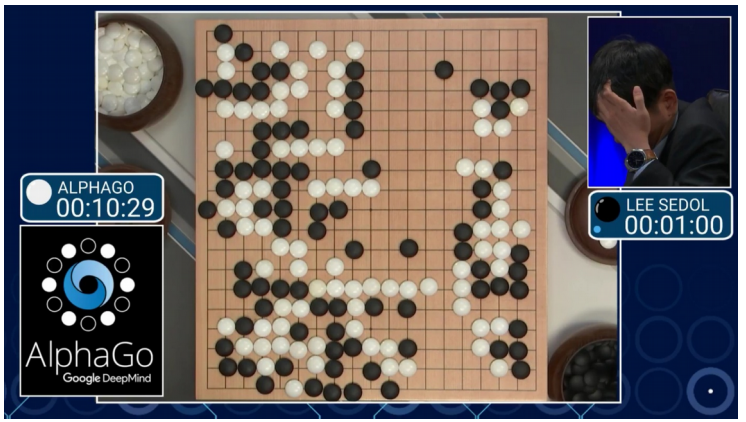
Examples of Supervised Learning

Unsupervised Learning

$$x_i \propto p(x) \quad \text{i.i.d.}$$

Learn about p

Reinforcement Learning



Explore & Learn

Other kinds of learning

- Semi-Supervised
- Active Learning
- Forecasting
- ...


THE REVOLUTION
WILL NOT BE
SUPERVISED

Classification and Regression

Classification:

- y discrete

Will you pass?

Regression:

- y continuous

How many points will you get in the exam?

Generalization

Not only $f(x_i) \approx y_i$

Also for new data: $f(x) \approx y$

Relationship to Statistics

Statistics

- Model first
- Inference

Machine Learning

- Data first
- Prediction
- Generalization

Relationship to Statistics

Statistics

- Model first
- Inference

Machine Learning

- Data first
- Prediction
- Generalization

Guiding principles in machine learning

Goal considerations

The cost of complex systems

Data driven first: yes! (or maybe)
Machine Learning first: No!

Thinking in Context!
What is the baseline?
What is the benefit?

Thinking in Context!
What is the baseline?
What is the benefit?

Good and bad substitutes

Communicating Results

Explainable Results

These recommendations are based on items you own and more.

view: **All** | New Releases | Coming Soon

1. 

R for Data Science: Import, Tidy, Transform, Visualize, and Model Data
by Hadley Wickham (January 5, 2017)
Average Customer Review: ★★★★★ (4)
In Stock

List Price: ~~$39.99~~
Price: $32.91
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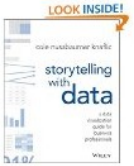
2. 

Storytelling with Data: A Data Visualization Guide for Business Professionals
by Cole Nussbaumer Knaflic (November 2, 2015)
Average Customer Review: ★★★★½ (137)
In Stock

List Price: ~~$39.95~~
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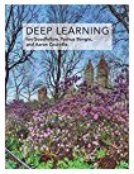
3. 

Deep Learning (Adaptive Computation and Machine Learning series)
by Ian Goodfellow (November 18, 2016)
Average Customer Review: ★★★★★ (20)
In Stock

List Price: ~~$80.00~~
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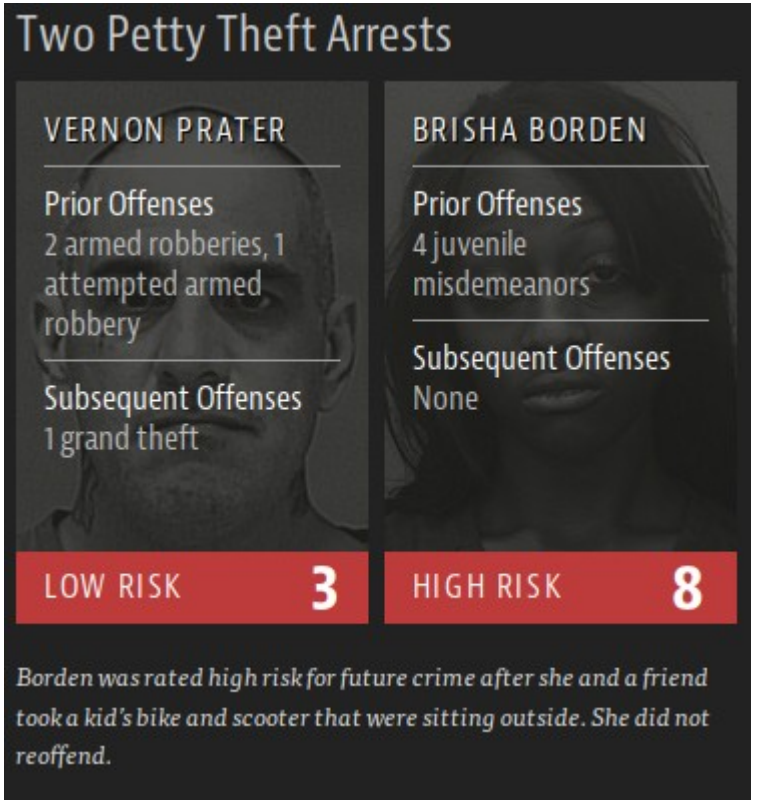


https://www.propublica.org/article/machine-bias-risk-assessments-in-criminal-sentencing

Ethics: It's in the application!

Data and Data Collection

Free vs Expensive Data

Free:

Predict observable events

- Stock market
- Clicks
- House numbers

Free vs Expensive Data

Free:

Predict observable events

- Stock market
- Clicks
- House numbers

Expensive:

Automate complex process

- Diagnosis
- Drug Trial
- Chip Design

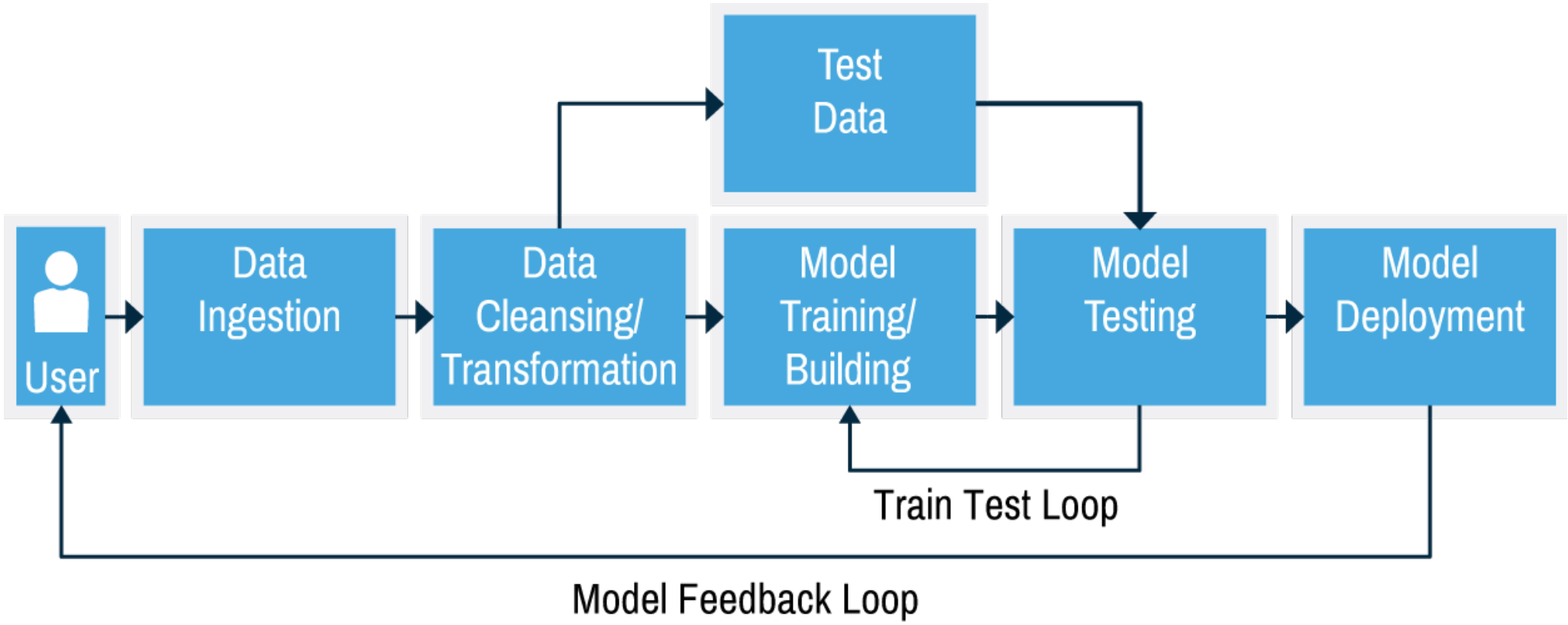
The cost (and benefit?) of BigData

Subsample to RAM (which can be 512gb)

Cornerstones of this Course

- Good software engineering practices
- Problem definition and success measures
- Feature engineering and data cleaning
- Strength and weaknesses of different algorithms
- Model selection best practices

The Machine Learning Work-Flow



Taken from MAPR https://www.mapr.com/ebooks/spark/08-recommendation-engine-spark.html

Overview of the course

Infrastructure and basic tools (Wk 2)

- Python, Jupyter
- git, github
- testing, documentation, continuous integration
- Writing fast Python
- Numpy, matplotlib, pandas, seaborn (?)

Exploratory analysis & Supervised learning (week 3)

- Visualization techniques
- Exploration questions
- Generalization in practice
- Nearest Neighbors, Nearest Centroid

Linear Models (Week 4)

- Regression:

  Linear regression, Ridge Regression, Lasso
- Classification:

  Linear SVM, Logistic Regression
- Penalties, complexity and features

Preprocessing And Feature Engineering (Week 5)

- Scaling, normalization
- Variable types
- Binning, discretization, aggregation
-

Feature Selection, Model validation (Week 6)

- Statistics for feature selection
- Model-driven feature selection
- Mutual-Information based feature selection
- Cross-validation
- Grid-Search

Week 7 & 8

- Non-linear support vector machines
- Support Vector regression
- Decision Trees
- Random Forests
- Gradient Boosting

Model evaluation and Introspection (Wk 10)

- Model interpretation
- Variable Importance
- Model evaluation metrics
- Imbalanced datasets
- Model debugging

Unsupervised learning (Week 11)

- Decomposition and dimensionality reduction:

  PCA, NMF, Sparse Coding, Manifold Learning

- Clustering:

  k-means, DBSCAN, Gaussian Mixture Models, Agglomerative Clustering, Spectral Clustering

Text Data (Week 12)

- N-grams and Bag of Words models
- Preprocessing text
- Word Vectors
- Text classification
- Topic models

Neural Networks (Week 13)

- Backpropagation
- Tensorflow
- Learning Algorithms and tuning them

Common Data Types (week 14 & 15)

- Image data and image tasks
- Convolutional neural networks for image analysis
- Time series data
- Forecasting and time-series models
- Gaussian Processes (?)