

# Projects

- Goals
  - Do something you enjoy, find something interesting
  - Go beyond class, be creative, feel like a Graduate student
- Types
  - Data exploration and inference
  - Fundamental data-science paper review
  - P&S engagement - new topic, problems, demo, game
- Guidelines
  - One or two students per project
  - Due Sunday after exam week, at noon
  - Roughly 20 hours per project member
  - Please innovate

# Deadlines

- **Thursday 10/30**
  - Tentative project type, topic, and team ( $\leq 2$ ) selection
  - Google form, will send link
- **Sunday 11/9**
  - Final selection, including a 250-word plan
  - Google form
- **Sunday 12/14, noon**
  - Projects due, please upload earlier if possible

# Data Exploration

- Pick interesting dataset
- Identify important question or inference task
- Visualize and understand data
- Shed light on question or task
- Use something learned in class
- Can use techniques beyond this class
- Be creative
- Examples ↓

# kaggle.com

- Platform hosting diverse datasets and competitions
  - Wine review
  - Pollution data
  - Speed dating
  - TMDB 5,000 movies
  - ....

# Wine

- 10 Features (cost, rating, region, winery, variety,...)
- Most correlated features
- Most predictive feature for rating
- Predict rating based on features

# Speed Dating

- Self descriptions, peer descriptions, 2nd dates
- Most / least popular interest
- Most / least correlated features
- Correlation between data and likelihood of 2nd date
- Predict probability of 2nd date
- Dataset

# Bit Coin

- Time, price, volume, per minute
- Correlate price, time, and volume
- Predict price based on previous minutes
- Long-term prediction
- Dataset

# California Housing Prices

- Housing Data in a California district from 1990 census
- Identify relevant features: rooms, bedrooms, ocean proximity
- Predict median value of houses using regression
- Dataset

# Walmart Sales

- Walmart weekly sales data from 45 US stores
- Sales trends during the year, holiday period
- Correlate with temperature, fuel price, consumer price index
- Regression with these features and sales volume to predict sales
- Dataset

# Used Cars Database

- Cars on German eBay
- Regression to identify depreciation rates of each model
- Compare different models
- Hypothesis: manual and automatic transmission depreciate same
- Dataset

# Climate Change

- 1.6 billion temperature measurements
- Hypothesis: Temperatures at two periods have same mean
- Is climate change real?
- Dataset

# Traffic Data

- CA Traffic data <http://pems.dot.ca.gov>
- Visualized: [http://trafficpredict.com/current\\_traffic/?location=los-angeles](http://trafficpredict.com/current_traffic/?location=los-angeles)
- Model traffic flow between SD and LA
- Predict traffic patterns
- Find best routes
- Estimate travel times

# Data-Exploration Report

- 3-4 pages, well written, pdf, Google Colab, Jupyter notebook
- Describe data
- Problem and why it is interesting
- Preprocess data
- Model and methodology
- Visualization
- Insights gained
- Code
- On your own, cite all external resources

# Paper Review

- Select insightful paper
- Read, understand, write report
- Eight papers ↓, you can choose others

# Some Paper Examples

- PCA I
  - Zou, Hui, Trevor Hastie, and Robert Tibshirani. "Sparse principal component analysis." *Journal of computational and graphical statistics* 15.2 (2006): 265-286.
- PCA II (Applications in Bioinformatics)
  - Ma, Shuangge, and Ying Dai. "Principal component analysis based methods in bioinformatics studies." *Briefings in bioinformatics* 12.6 (2011): 714-722.
- Bayesian I
  - Tipping, Michael E. "Sparse Bayesian learning and the relevance vector machine." *Journal of machine learning research* 1.Jun (2001): 211-244.
- Bayesian II (Applications in Neuroscience)
  - Darlington, Timothy R., Jeffrey M. Beck, and Stephen G. Lisberger. "Neural implementation of Bayesian inference in a sensorimotor behavior." *Nature neuroscience* (2018): 1.
- Regression I
  - Tibshirani, Robert. "Regression shrinkage and selection via the lasso." *Journal of the Royal Statistical Society. Series B (Methodological)* (1996): 267-288.
- Regression II (Applications in Bioinformatics)
  - Wu, Tong Tong, et al. "Genome-wide association analysis by lasso penalized logistic regression." *Bioinformatics* 25.6 (2009): 714-721.
- Hypothesis Testing I
  - Javanmard, Adel, and Andrea Montanari. "Confidence intervals and hypothesis testing for high-dimensional regression." *The Journal of Machine Learning Research* 15.1 (2014): 2869-2909.
- Hypothesis Testing II
  - Malek, A., Katariya, S., Chow, Y., & Ghavamzadeh, M. (2017, April). Sequential multiple hypothesis testing with type I error control. In *Artificial Intelligence and Statistics* (pp. 1468-1476).

# Paper-Review Report

- 3-4 pages, pdf, well written
- Emphasize concepts over formulas
- Own work
- Cite all external resources
- Include
  - Abstract summary
  - Problem addressed
  - Significance
  - Ideas
  - Contributions
  - Results and visualization
  - Implications

# P&S Engagement

- Review new topics
  - Theoretical or applied
  - Describe topic, importance
- Problems
  - 10-15, at least 5 in Python, include solutions
  - If taken from elsewhere, state source
- Demo
- Game
- Interesting, exciting, fun
- Interesting to  

# General

- Quarter gets hectic, start early
- Ethics: collaborate, own work, cite
- Opportunity: learn, improve, creative, excel, show skills
- Objective: taste of grad school, different, personal, new
- Remember: 20 hours, don't expect masterpiece, don't 

# Sample Projects

- Files/Projects
  - Five past projects
  - This overview