Picking Intro

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Patterns in Games and Prices

- Obtain
- Scrub
- Explore
- Model
- iNterpret

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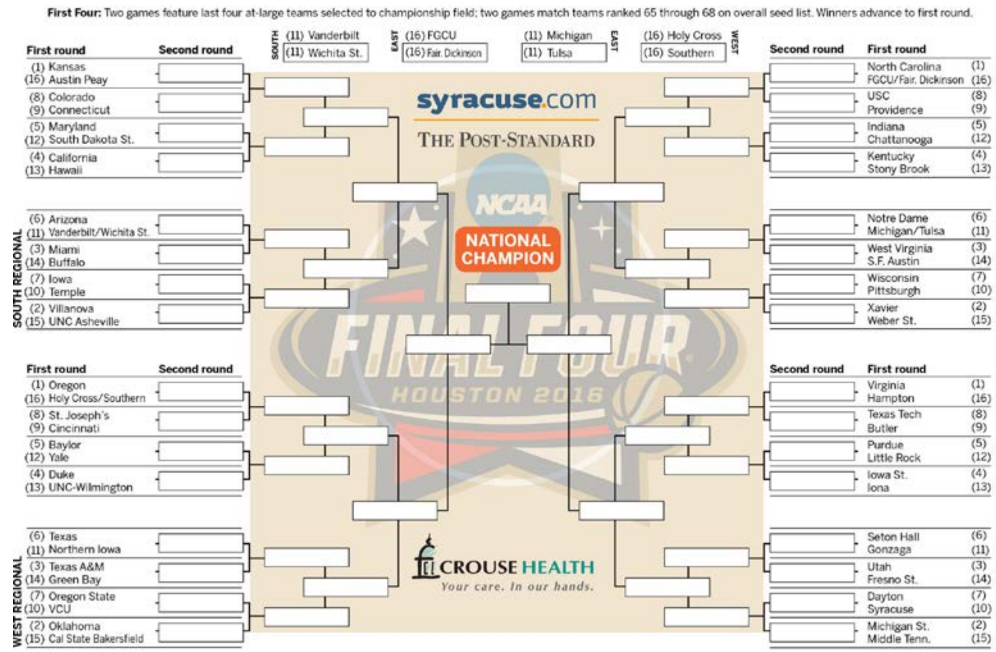
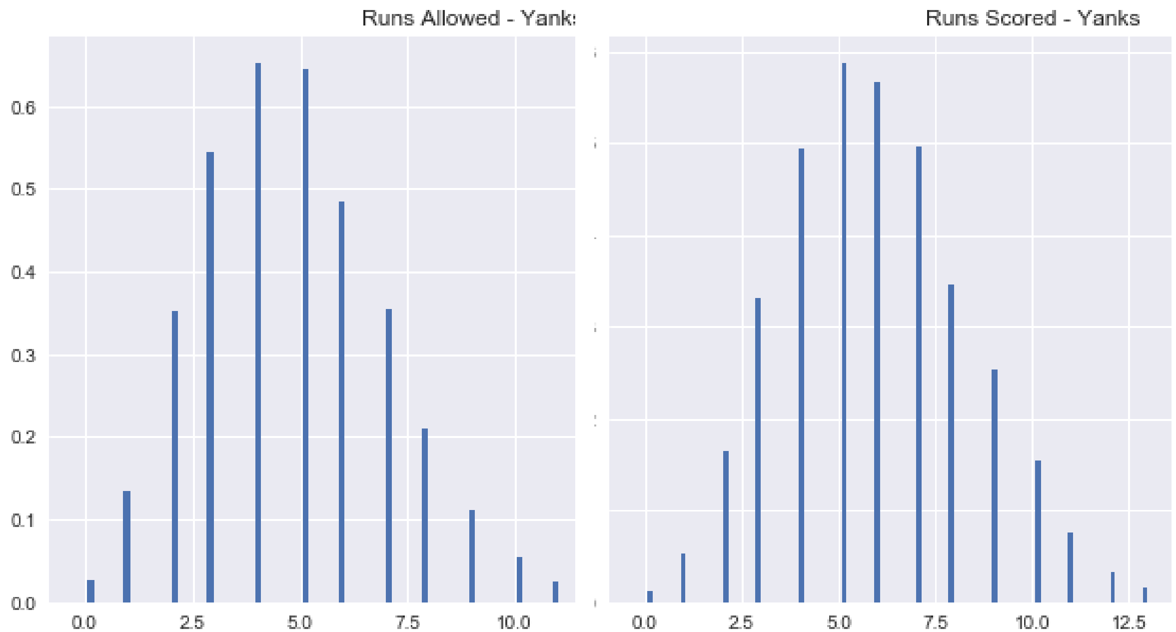
Our Challenge This Week?

Using Distributions to Pick a Winner



But How?



Runs Allowed - Yank:
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.0
2.5
5.0
7.5
10.0
Runs Scored - Yanks
0.0
2.5
5.0
7.5
10.0
12.5

Data Review

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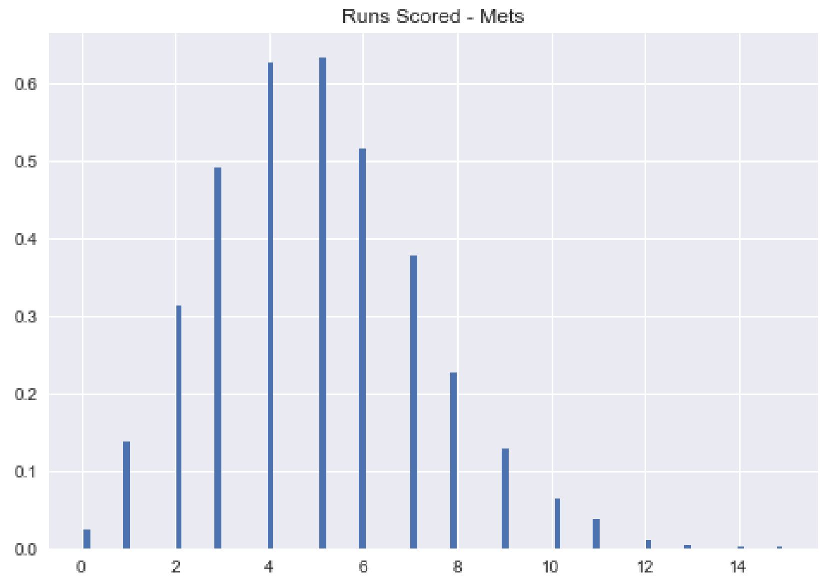
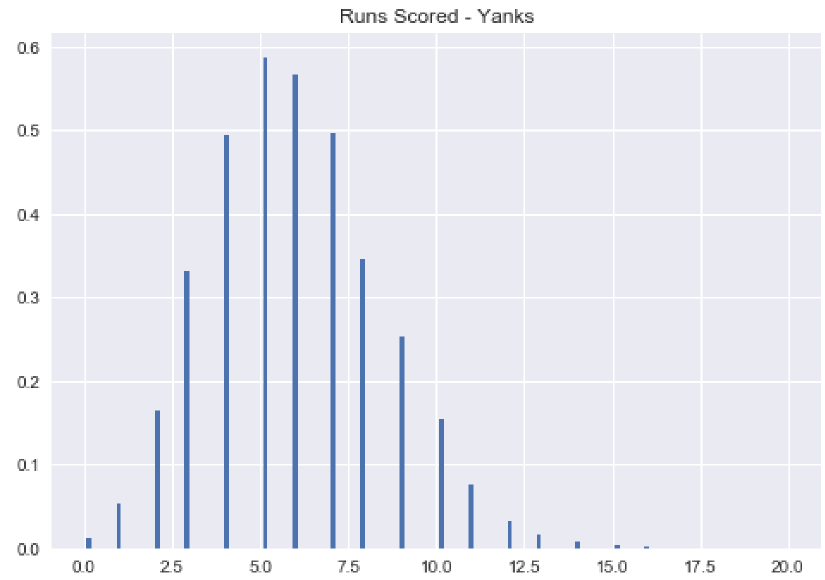
Runs Scored





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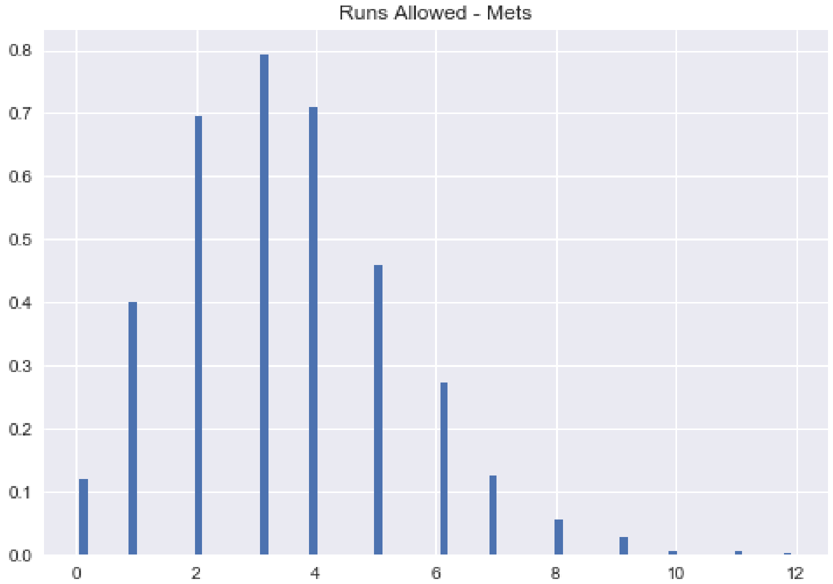
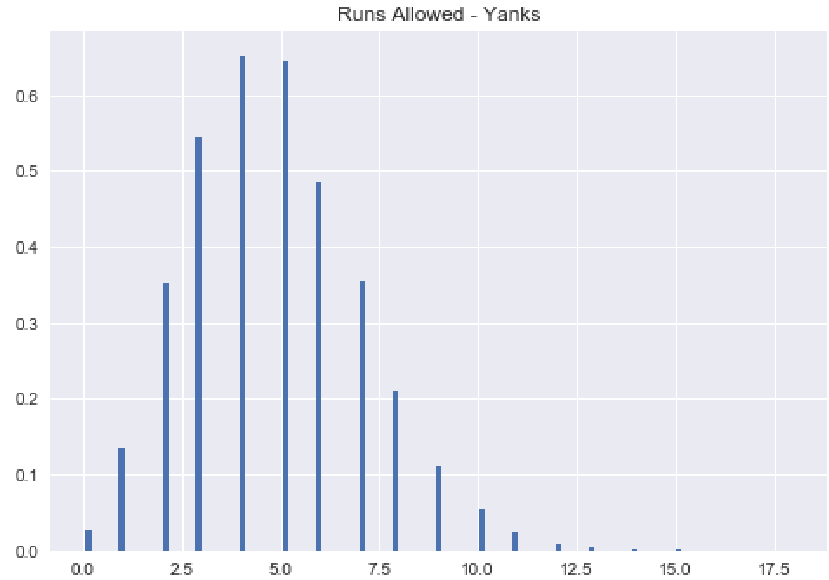
Runs Allowed





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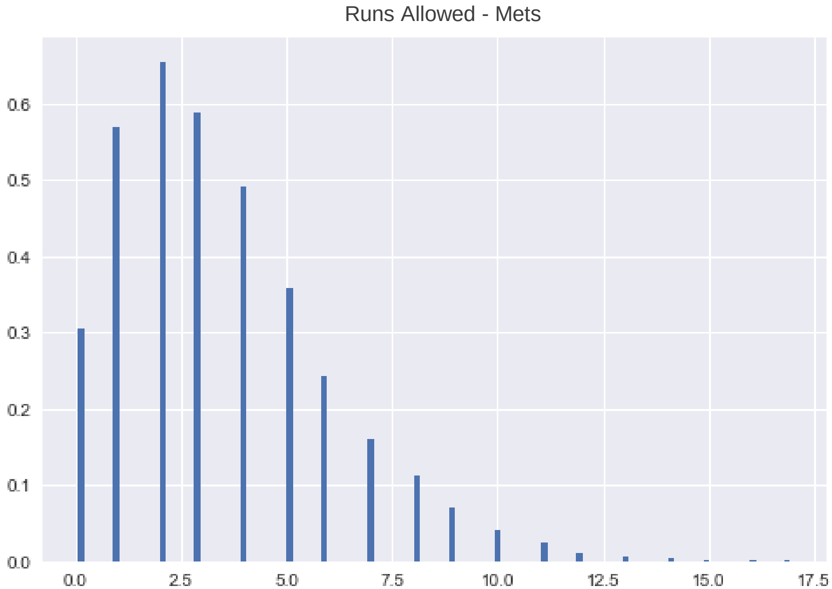
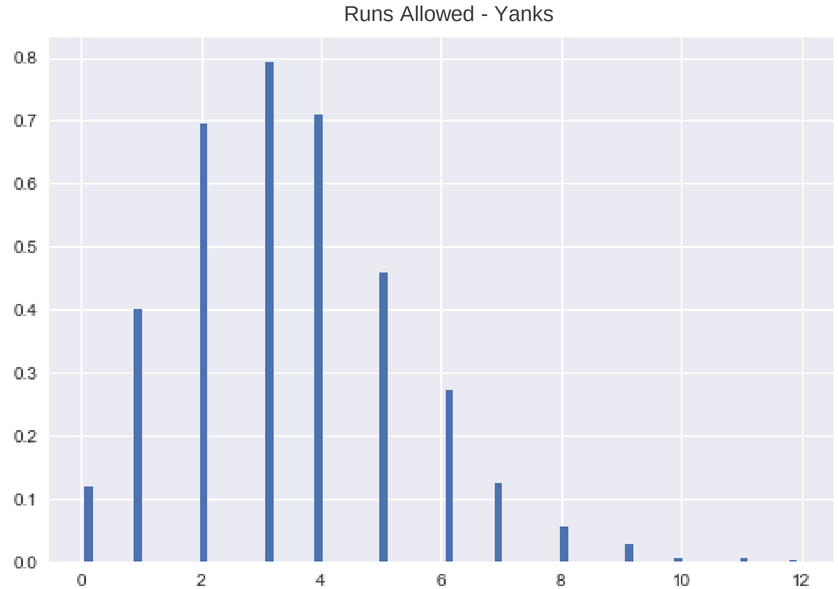
Scoring Distributions





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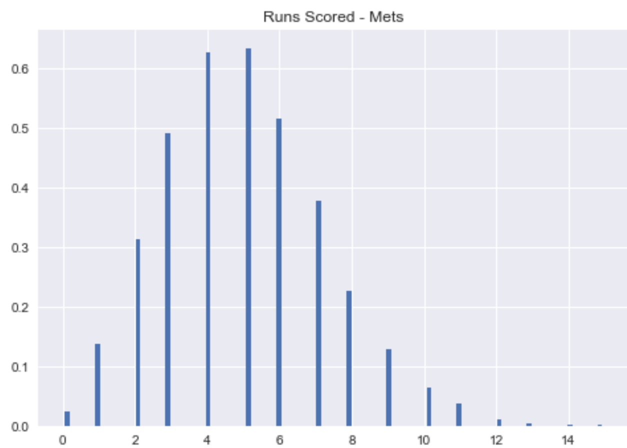
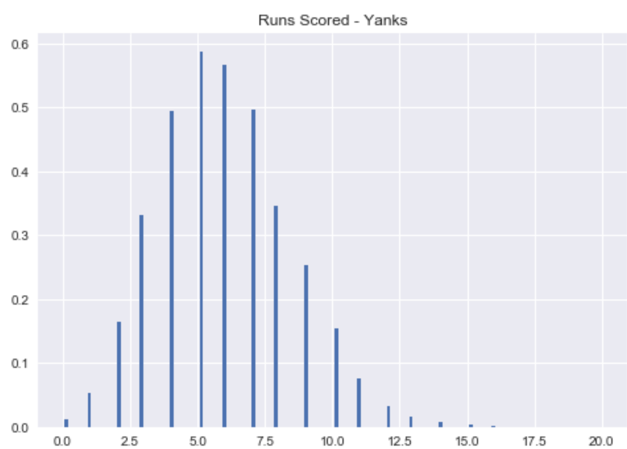
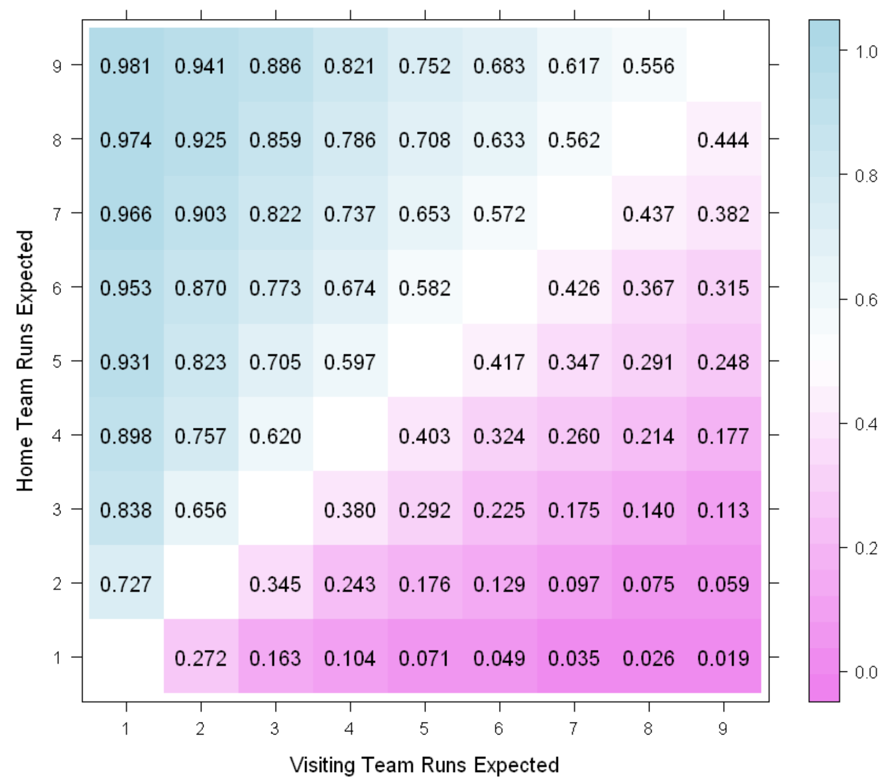
Picking Winners







Poisson Distribution

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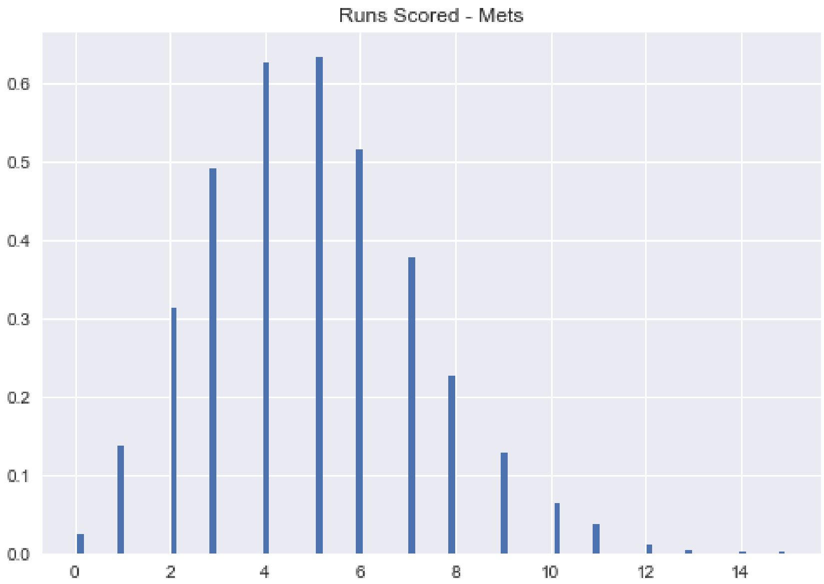
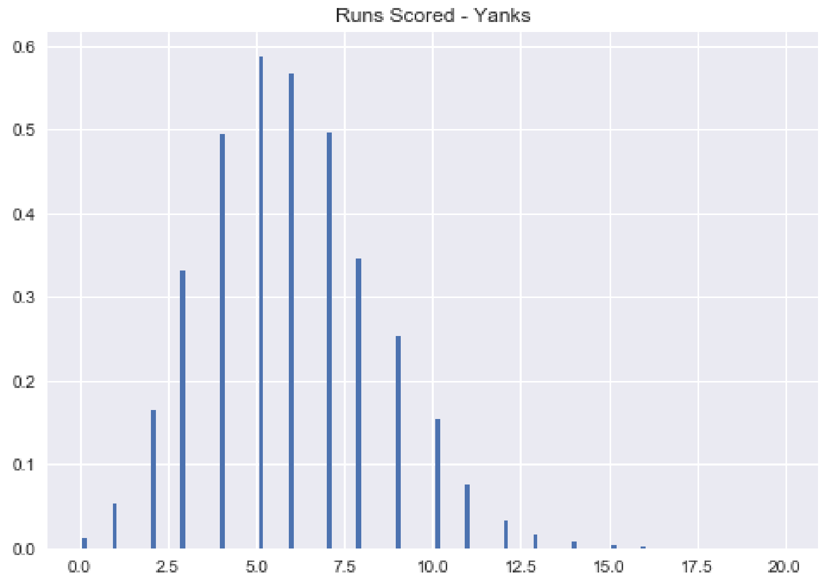
Simulating Runs Scored





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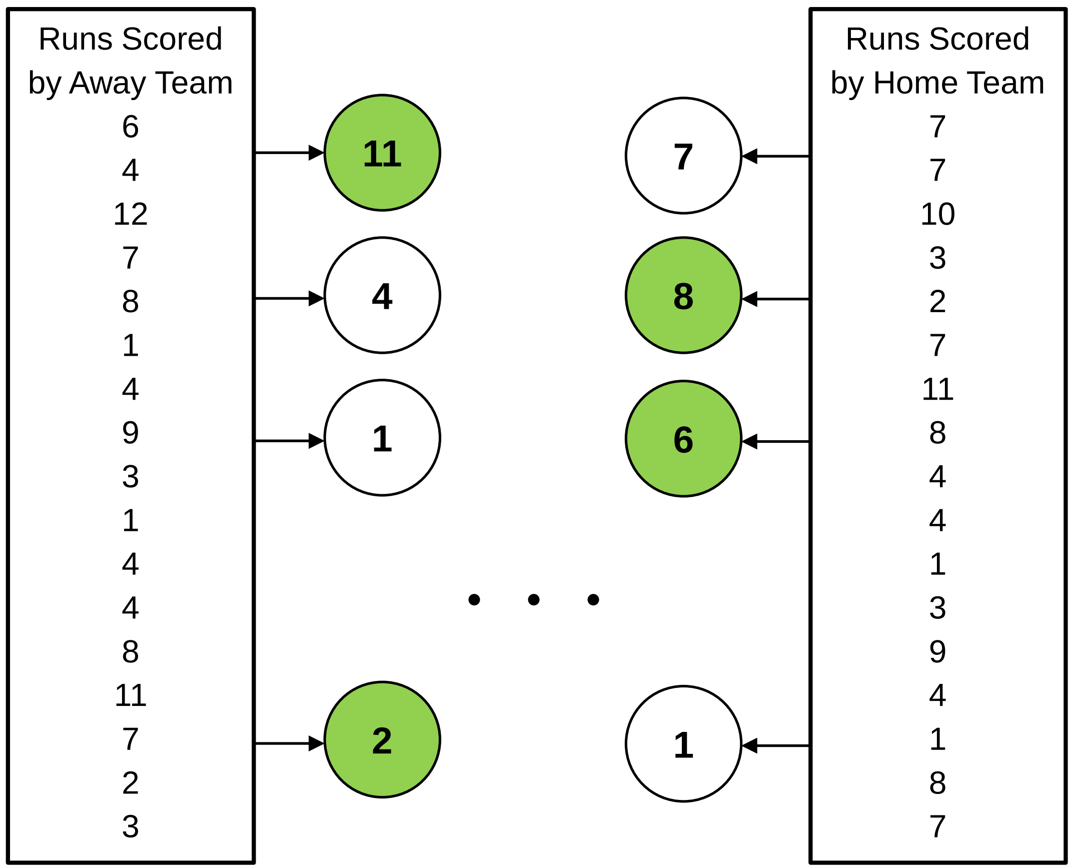
Sports Simulation

Simulation Results

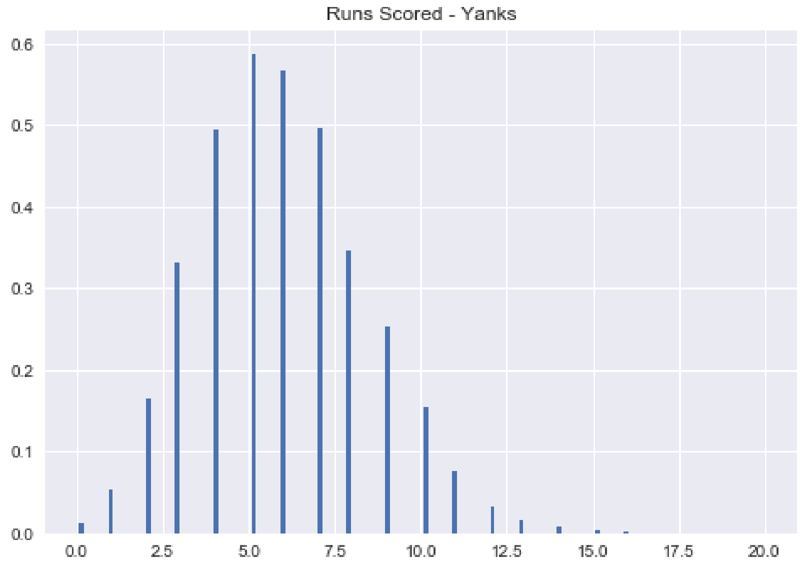


Source: Adapted from Miller (2005).

Poisson Distribution

- Good approximation for count responses

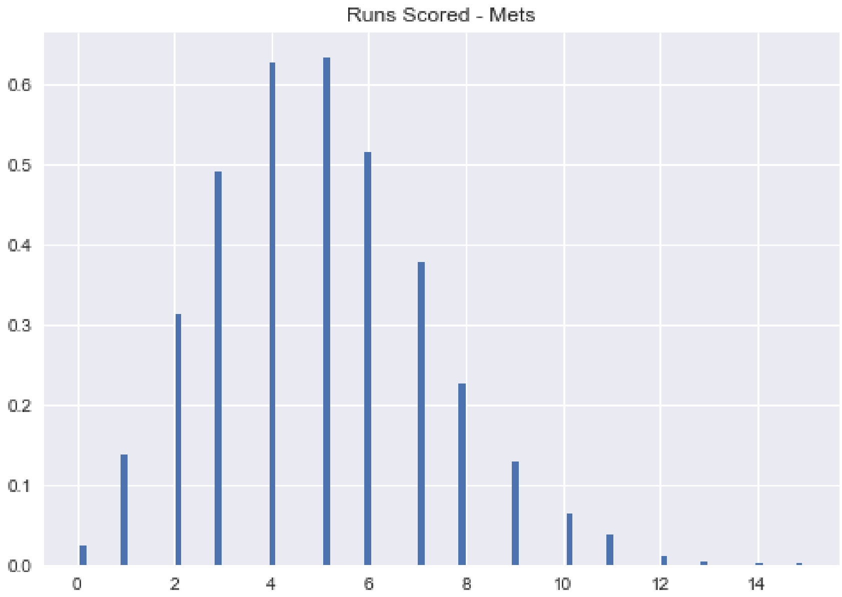
$$P(Y = y) = \frac{e^{-\mu}\mu^{y}}{y!}$$



- Occurrence of events during certain time interval
- Arrival rate problems

Poisson Distribution (cont.)

```
MetAwayScore =
np.random.poisson(4.97, 10000)

MetAwayDefend =
np.random.poisson(3.45, 10000)

YankHomeScore =
np.random.poisson(5.97, 10000)

YankHomeDefend =
np.random.poisson(4.84, 10000)

plt.hist(MetAwayScore, bins='auto',
rwidth = .5, normed=True)

plt.title("Runs Scored – Mets")
plt.show()
```



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Negative Binomial Distribution

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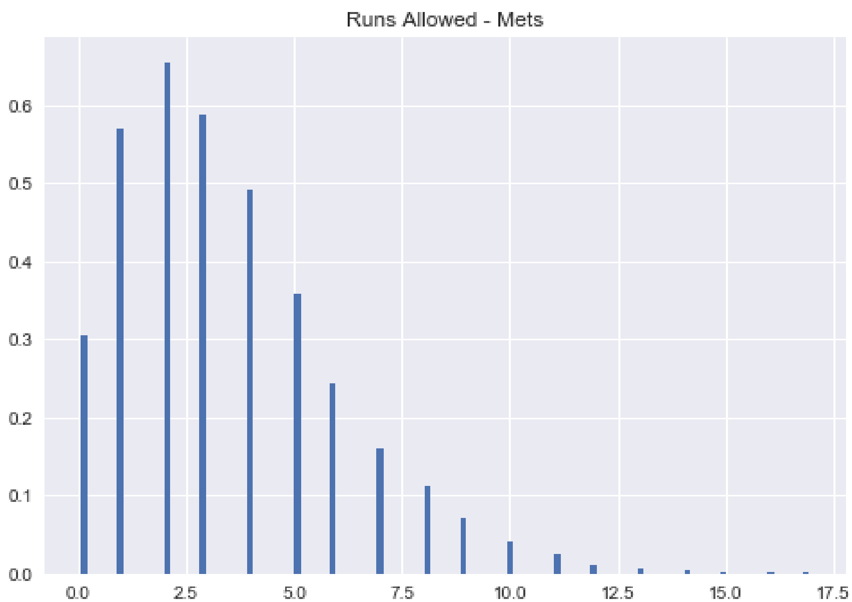
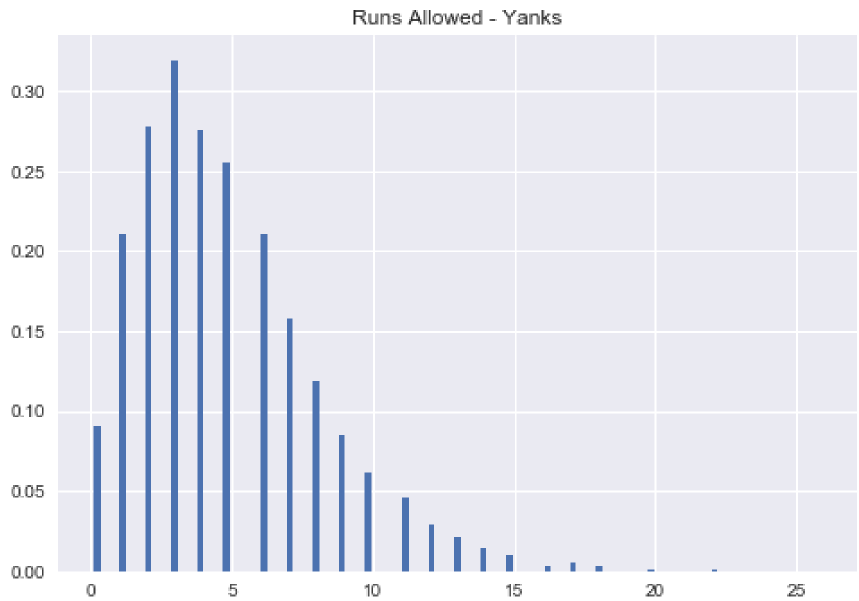
Simulating Runs Allowed





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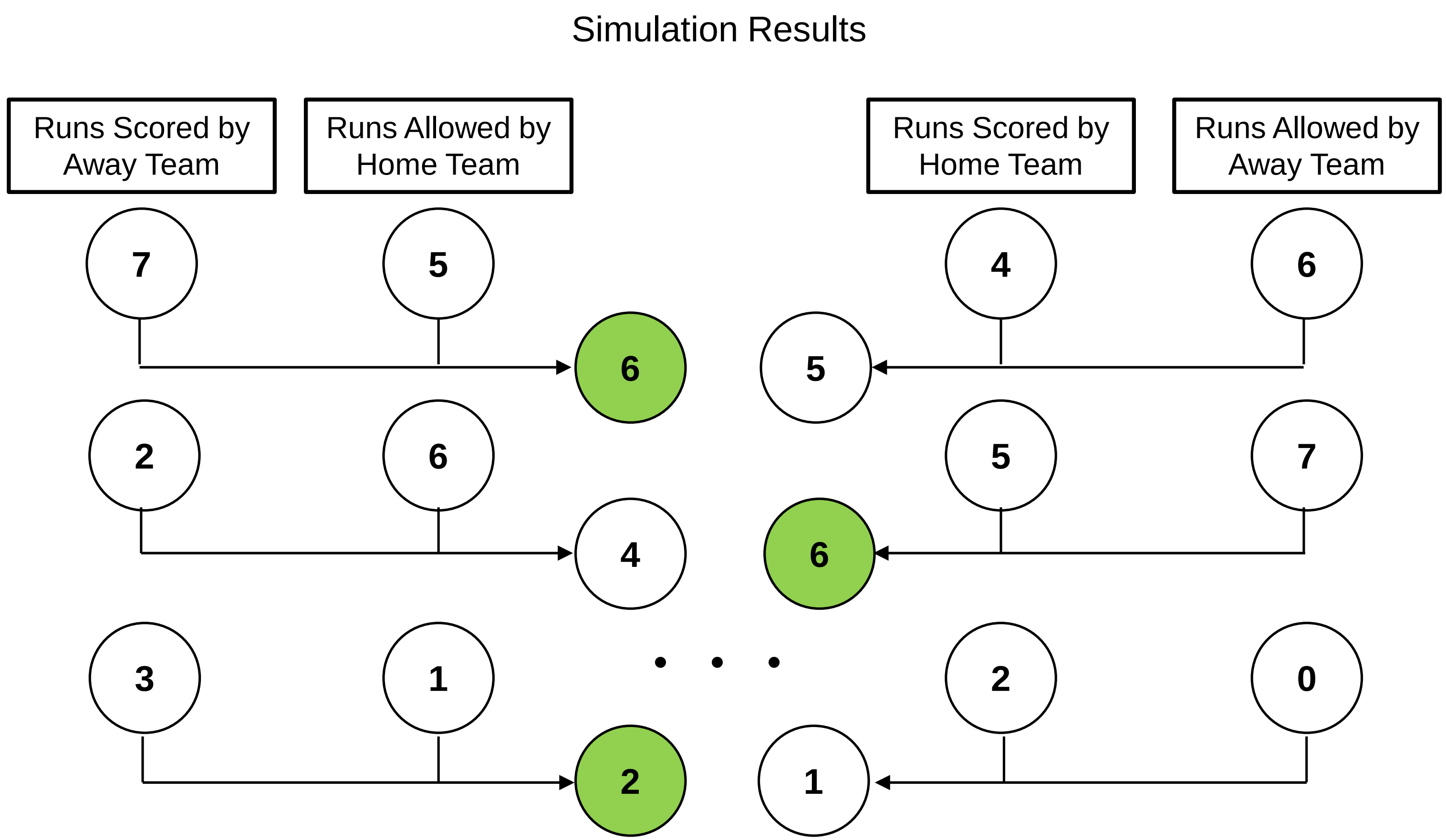
Sports Simulation

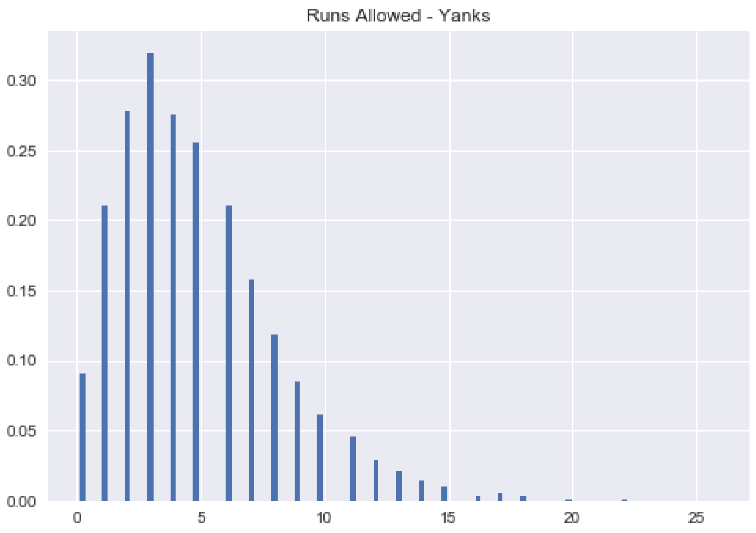


Source: Adapted from Miller (2005).

Negative Binomial

- Alternative approximation for count responses

$$P(Z = z) = \binom{z-1}{k-1} p^k (1-p)^{z-k}$$



- Generalization of Poisson distribution
- Rare event problems

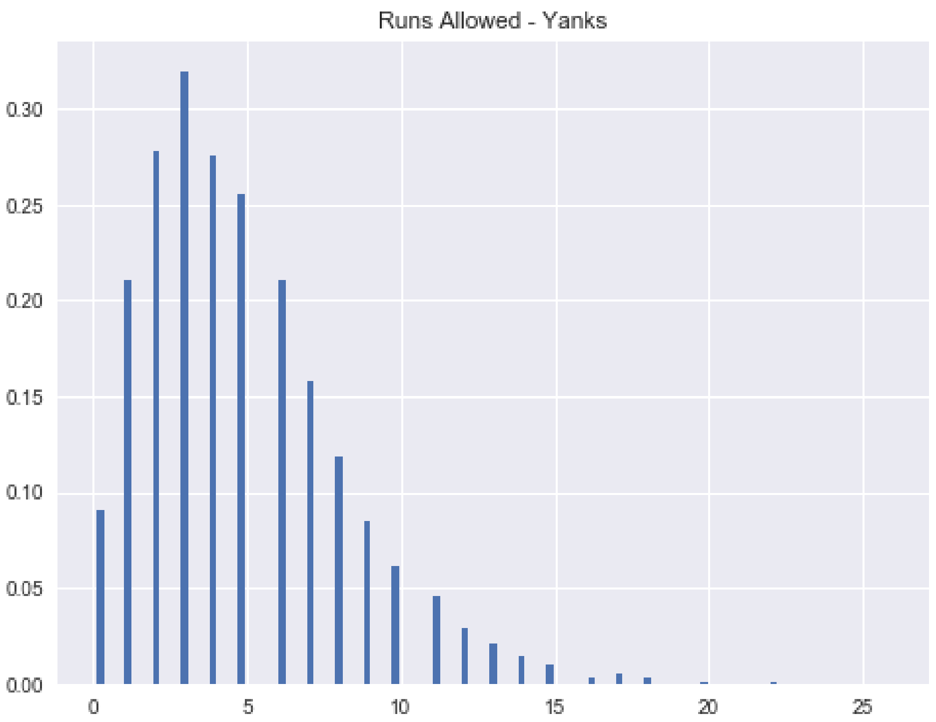
Negative Binomial

- Alternative approximation for count responses

$$P(Z = z) = \binom{z-1}{k-1} p^k (1-p)^{z-k}$$

- Generalization of Poisson distribution

- Rare event problems



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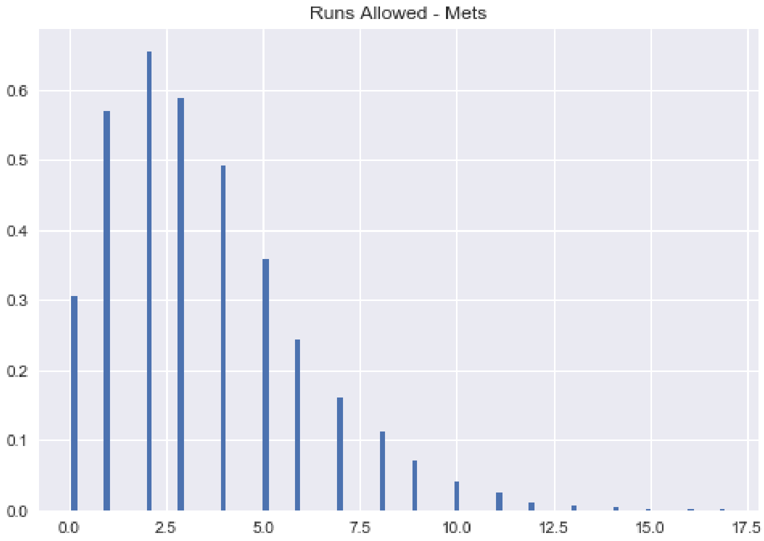
Negative Binomial (cont.)

```
MetAwayScore =
np.random.negative_binomial(4, mas, 10000)
MetAwayDefend =
np.random.negative_binomial(4, mad, 10000)
YankHomeScore =
np.random.negative_binomial(4, yhs, 10000)
YankHomeDefend =
np.random.negative_binomial(4, yhd, 10000)

plt.hist(MetAwayScore, bins='auto', rwidth = .5,
normed=True)
plt.title("Runs Scored – Mets")
plt.show()
```



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Applications

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Additional Applications

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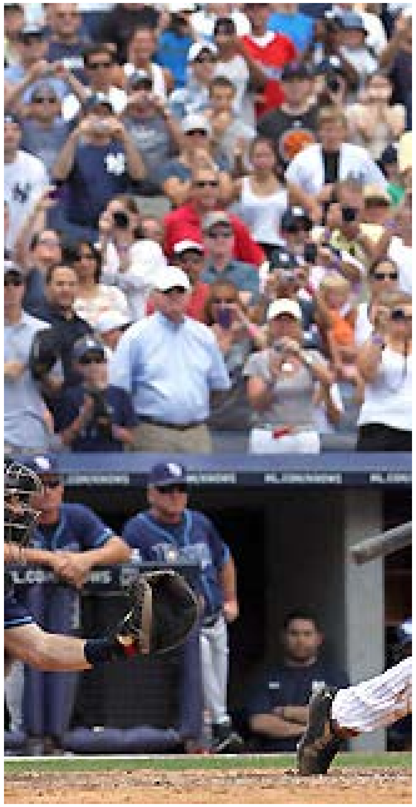
Baseball Prospectus

- Predicting performance before the season
  - Nate Silver
  - PECOTA
- Variations
  - Military war games
  - Film releases
  - Associate performance



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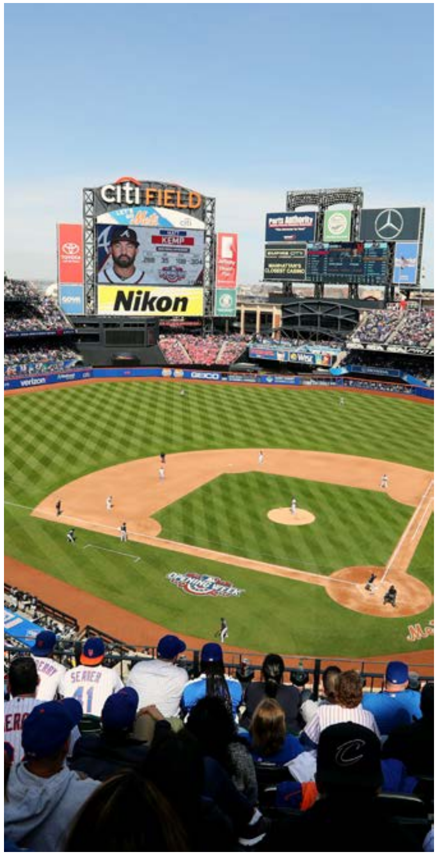
Moneyball Problem

- Calculating the value of a player
  - Billy Beane
  - Individual summary stats applied to team performance
- Variations
  - Associate performance
  - Client conversion
  - Customer lifetime value



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Coaching Problems

- Utilizing player performance
  - Microanalysis of game
  - Sabermetrics
- Variations
  - Football
  - Basketball

Bowl Championship Series

- Predicting team performance against unknown opponent
  - Strength of schedule
  - Ensemble approaches
- Variations
  - March Madness
  - Product deployment
  - Recommendation engine

Billy Waters Problem

- Predicting the winning team in the next game?
  - Human expertise
  - Simulation
- Variations
  - March Madness
  - Film release
  - Product deployment

Picking II Intro

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Patterns in Games and Prices

- Obtain
- Scrub
- Explore
- Model
- iNterpret

Our Challenge Now?

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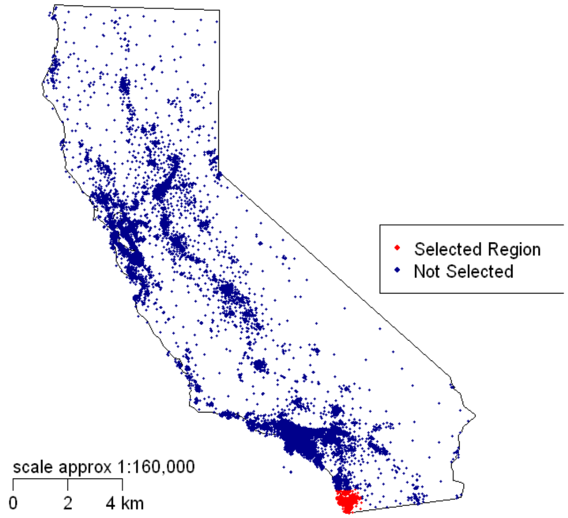
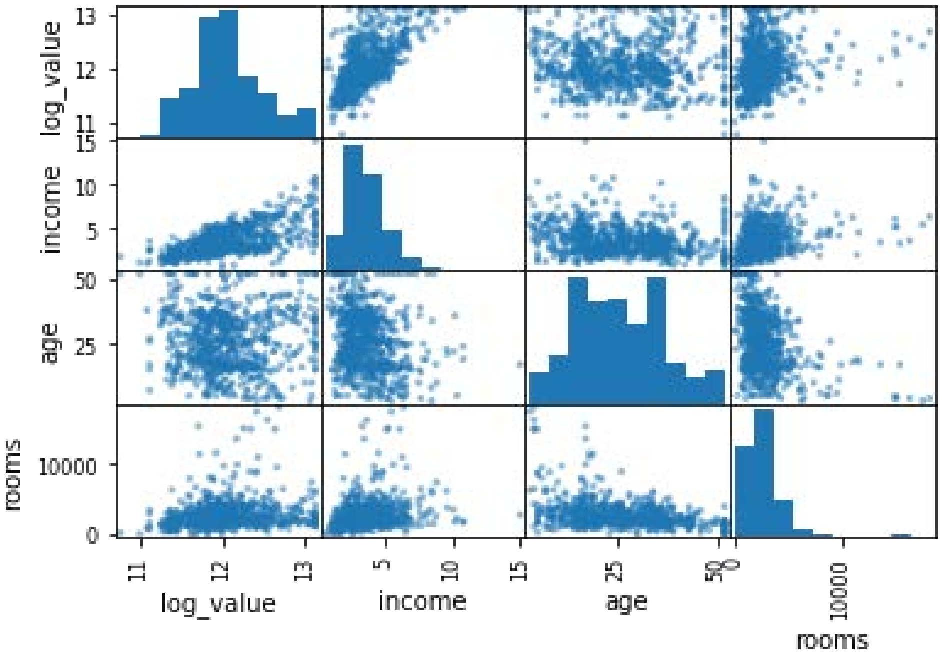
Modeling Housing Prices

But How?


Selected Region
Not Selected
scale approx 1:160,000
0
2
4 km


log_value
income
age
rooms

Data Review II

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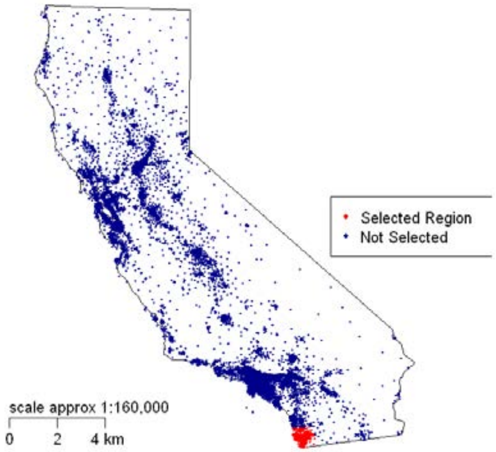
Housing Data



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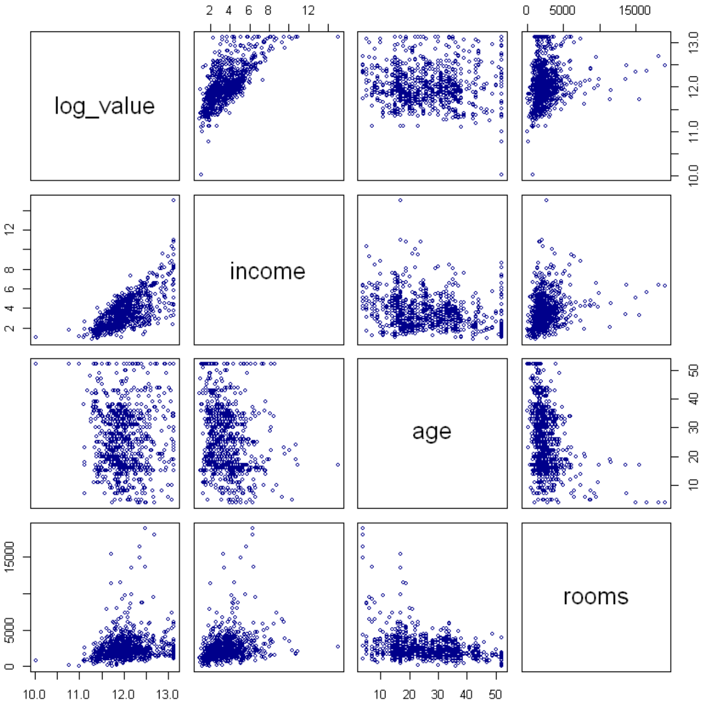
Feature Correlation



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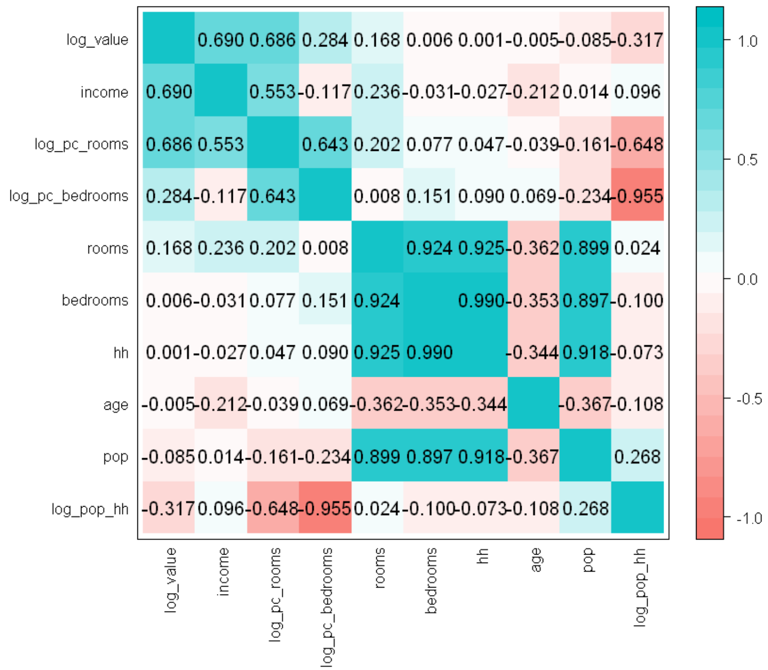
Feature Correlation (cont.)



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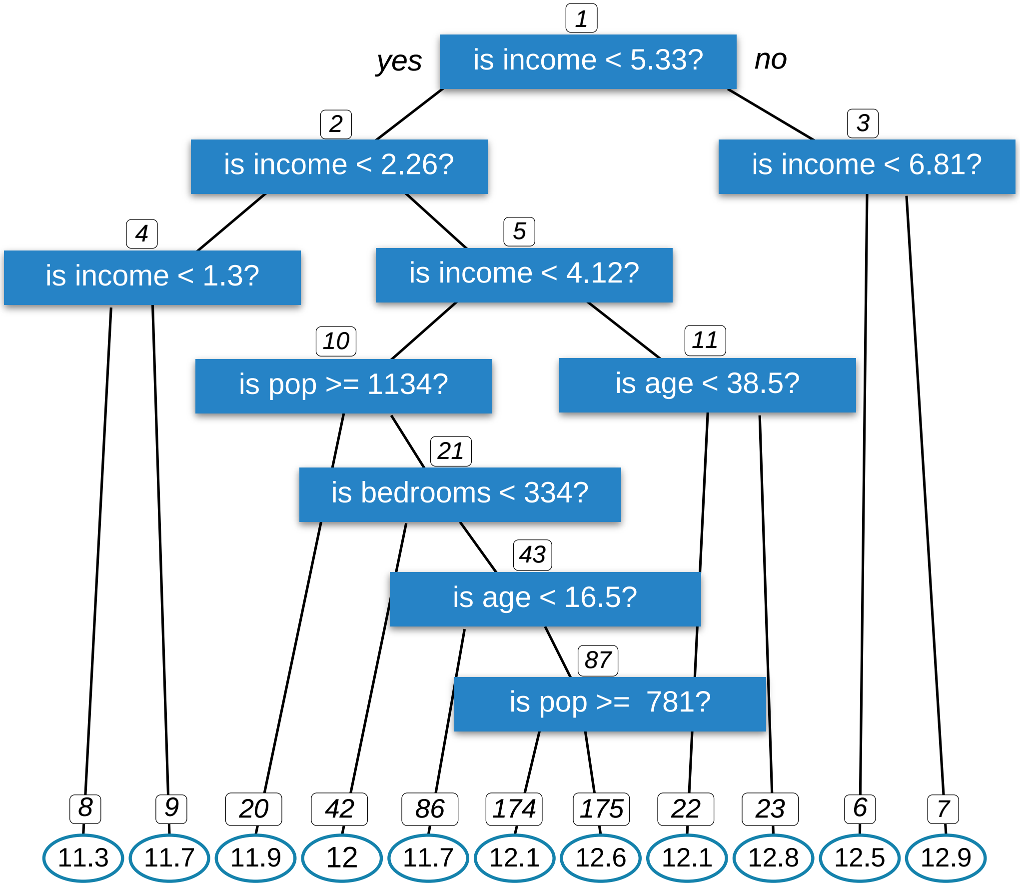
Picking Values



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Trees Forests

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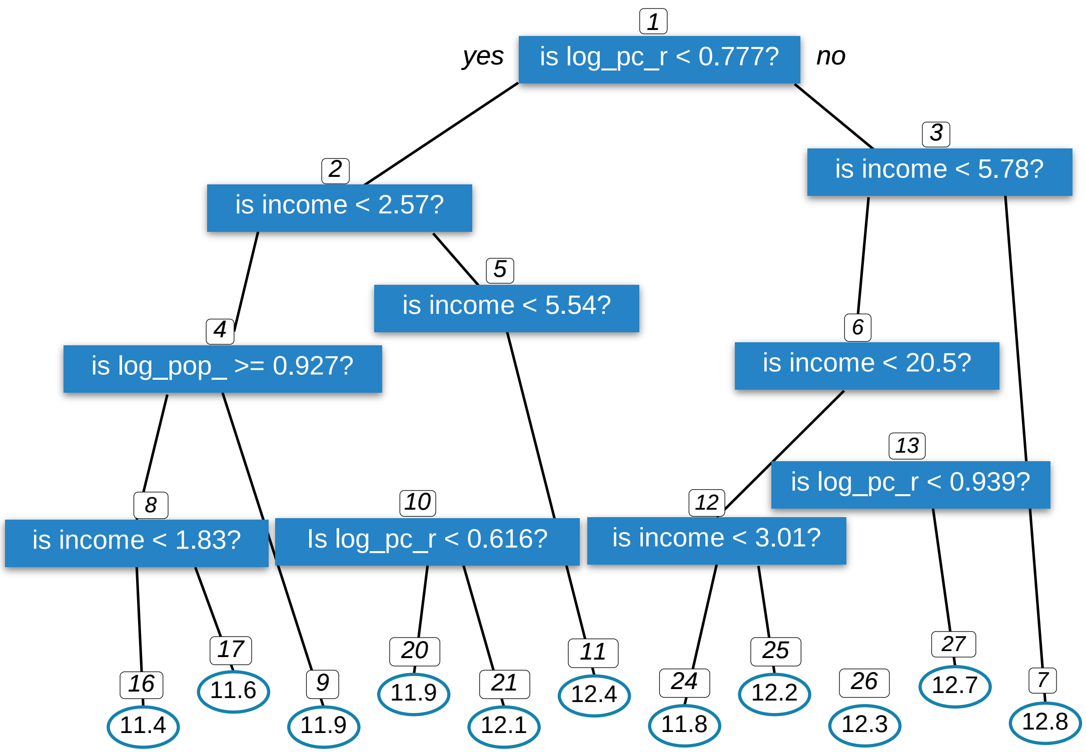
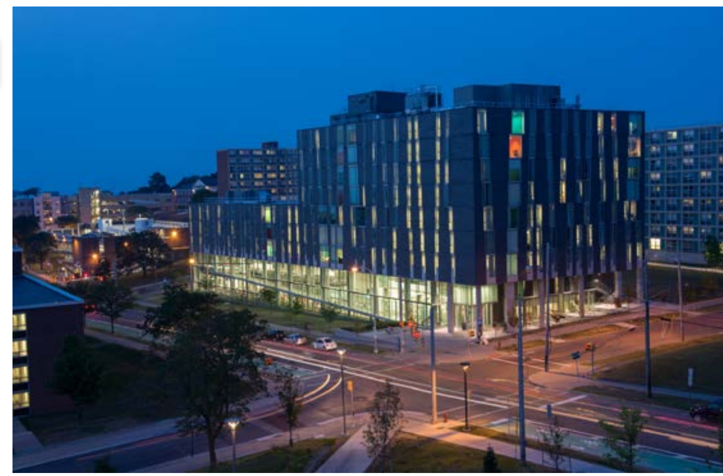
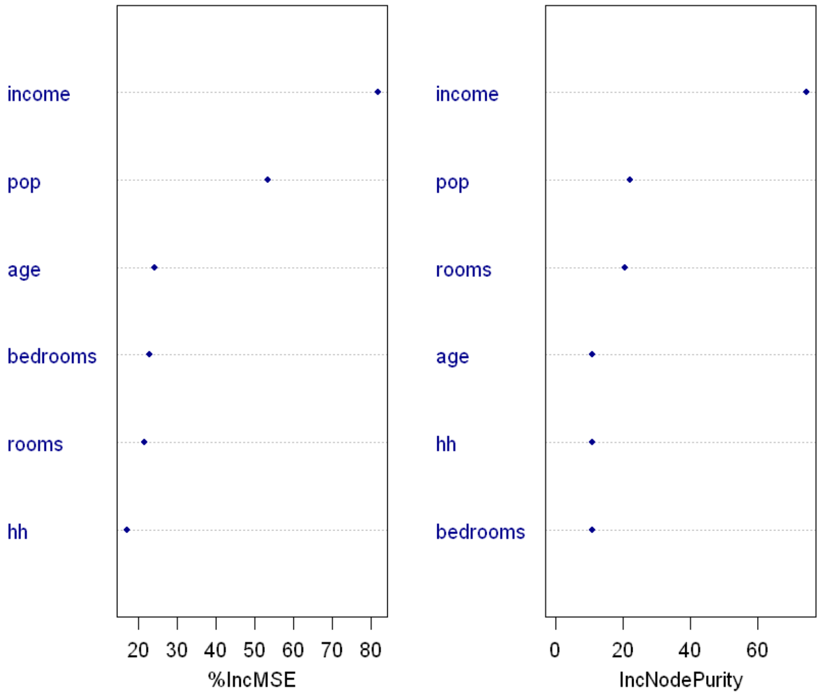
Picking a Tree in the Forest





Decision Trees

- Key advantage is interpretability
- Partition the space into simple regions to achieve best fit
- Pruning methods control the size of the tree



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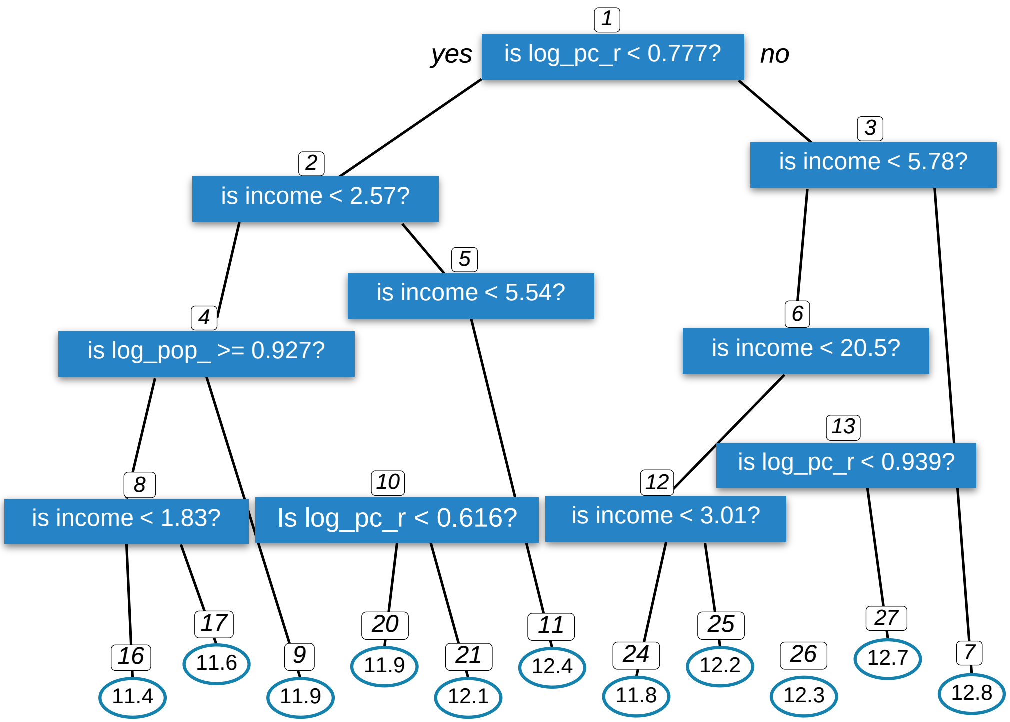
Random Forests

- Ensemble method using multiple decision trees
- Recursive partitioning on the training set
- Effective with large number of explanatory variables



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Random Forests (cont.)

- Provides interpretability through use of one tree from set
- Significant difference in performance between train and test indicates overfitting
- Individual explanatory variables can still be inferred