

The confection



m&m's
(185g)



Jelly Belly
(100g)



Chocolate Raisins
(200g)

Stuff Inf2b students wrote

Number M&Ms: ~~185~~ 204
 Number Jelly Belly: ~~146~~ 146
 Num. choc-raisin blobs: ~~87~~ 87

Number M&Ms: ~~185~~ 185
 Number Jelly Belly: ~~180~~ 180
 Num. choc-raisin blobs: ~~190~~ 190

Number M&Ms: ~~240~~ 240
 Number Jelly Belly: ~~150~~ 150
 Num. choc-raisin blobs: ~~130~~ 130

Number M&Ms: ~~247~~ 247
 Number Jelly Belly: ~~75~~ 75
 Num. choc-raisin blobs: ~~89~~ 89

Number M&Ms: ~~70~~ 70
 Number Jelly Belly: ~~83~~ 83
 Num. choc-raisin blobs: ~~100~~ 100

Number M&Ms: ~~150~~ 152 202 82
 Number Jelly Belly: ~~70~~ 72
 Num. choc-raisin blobs: ~~150~~ 132 102

Number M&Ms: ~~168~~ 168
 Number Jelly Belly: ~~98~~ 98
 Num. choc-raisin blobs: ~~139~~ 139

Number M&Ms: ~~84~~ 84
 Number Jelly Belly: ~~52~~ 52
 Num. choc-raisin blobs: ~~133~~ 133

F33 | M3

Number M&Ms: 90
 Number Jelly Belly: 80
 Num. choc-raisin blobs: ~~80~~
 or more likely the average of all other guesses...
 Full name: _____
 (to award prize only)

Number M&Ms: 231.25
 Number Jelly Belly: 87.5
 Num. choc-raisin blobs: 133.34
 Full name: ANON
 (to award prize only)

$$\rho = 1 \frac{g}{cm^3}$$

. 5 cm³ each

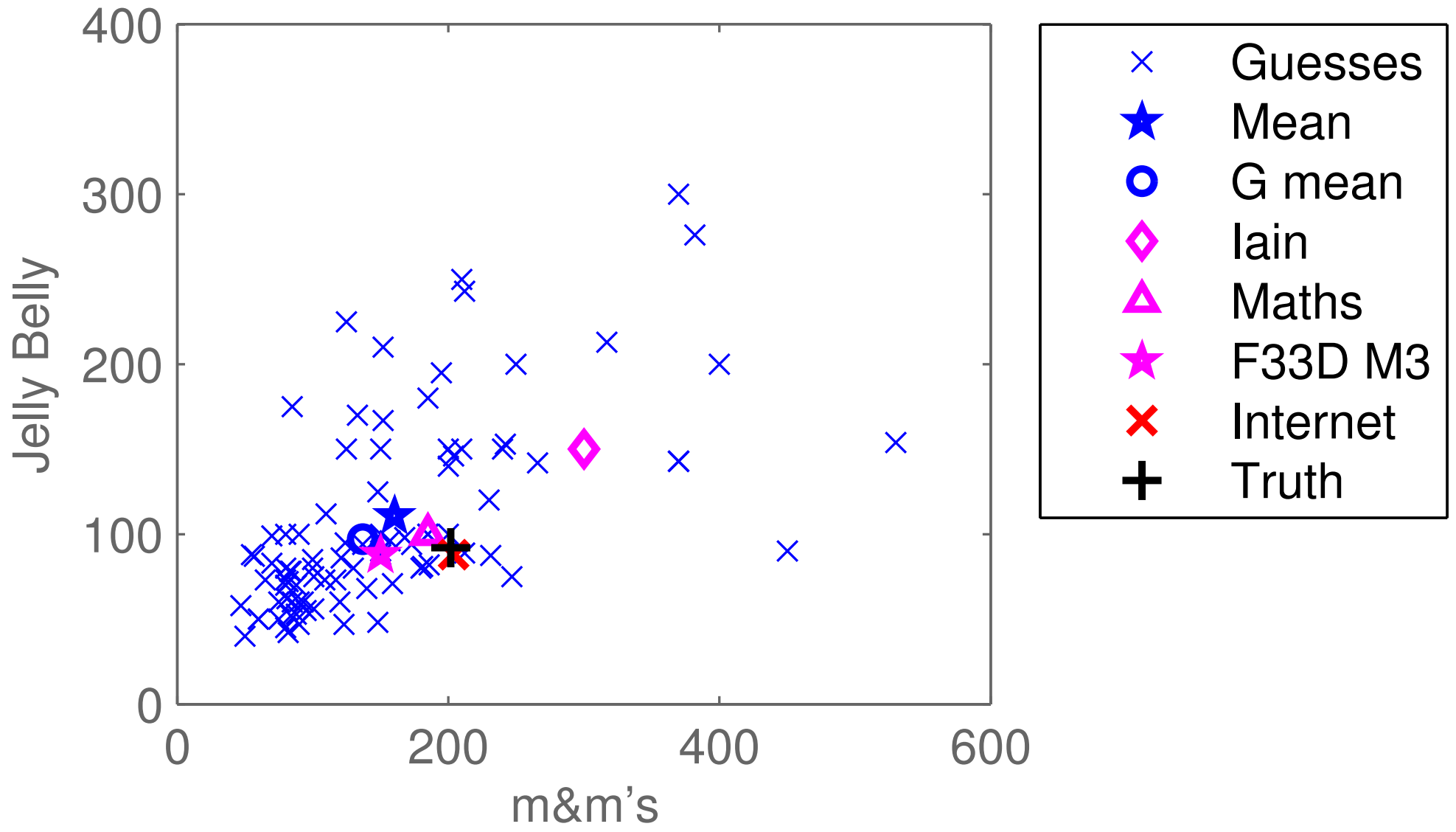
$$\rho = \frac{m}{V} \Rightarrow m = \rho V$$

$$\rho = 1.7 \frac{g}{cm^3}$$

$$m \frac{1}{cm^3} = \frac{1.7 g}{1.5} = .5$$

$$\frac{1.87}{.1}$$

A 2D space



For 3D and more, check out the code on the website.

The importance of guessing

<http://StreetFightingMath.com/>

Dimensional Analysis

$$C = AB$$

$N \times D \quad N \times K \quad K \times D$



$$\bar{C}_{ij} = \frac{\partial Z}{\partial C_{ij}}$$

$$\bar{A}_{ij} = \frac{\partial Z}{\partial A_{ij}}$$

① Physical units

$m \cdot kg$ m kg
 \downarrow \downarrow \swarrow
 $C = a b$

$$\bar{a} = \frac{\partial Z}{\partial a} = \frac{\partial Z}{\partial C} \frac{\partial C}{\partial a}$$
$$= \bar{C} b$$

Units of $\frac{\partial Z}{\partial a}$: $\frac{\text{cost}}{m}$

$$\bar{C} = \frac{\partial Z}{\partial C} : \frac{\text{cost}}{m \cdot kg}$$

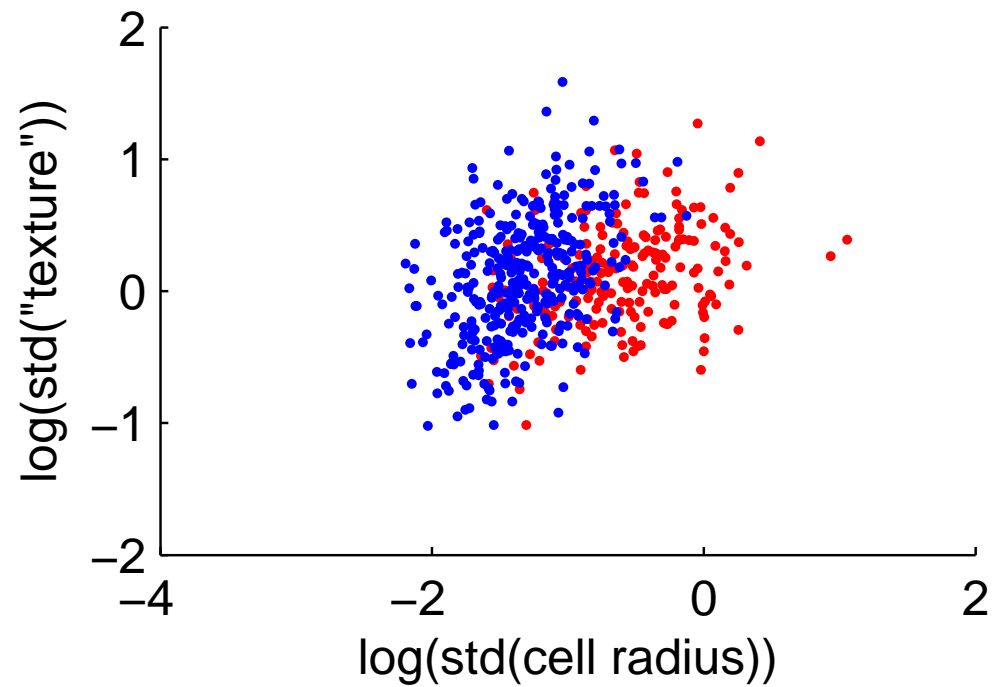
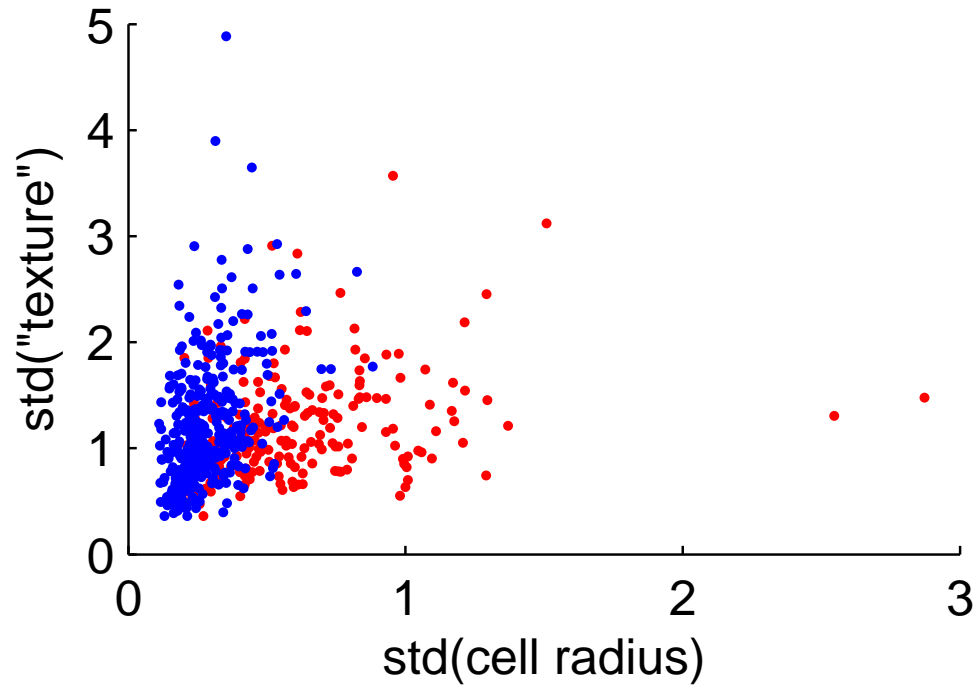
② Match sizes of arrays

$$\bar{A} = \bar{C} B^T ?$$

$N \times K \quad N \times D \quad D \times K$

\rightarrow write test case.

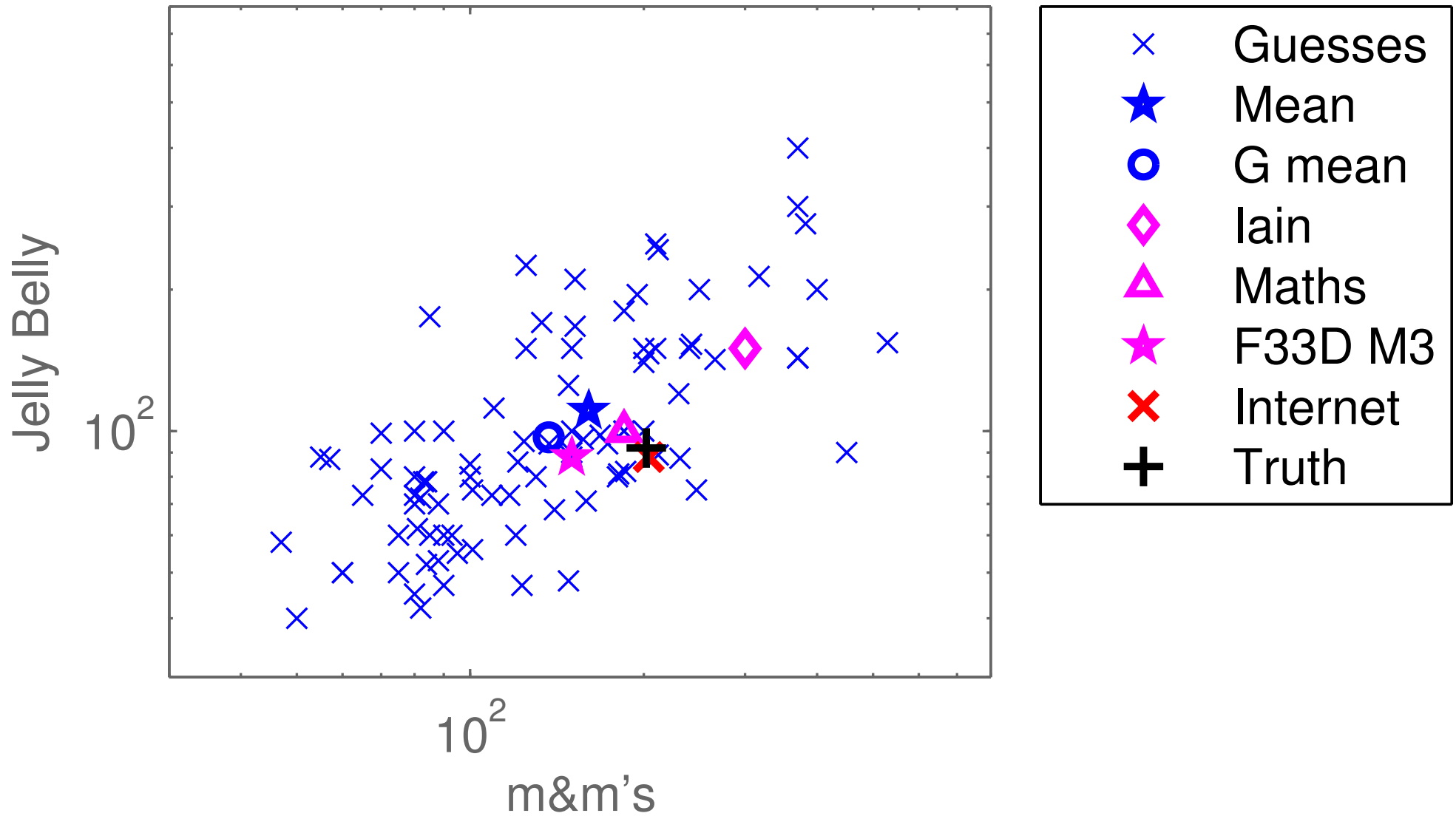
Often log-transform +ve data



Wisconsin breast cancer data

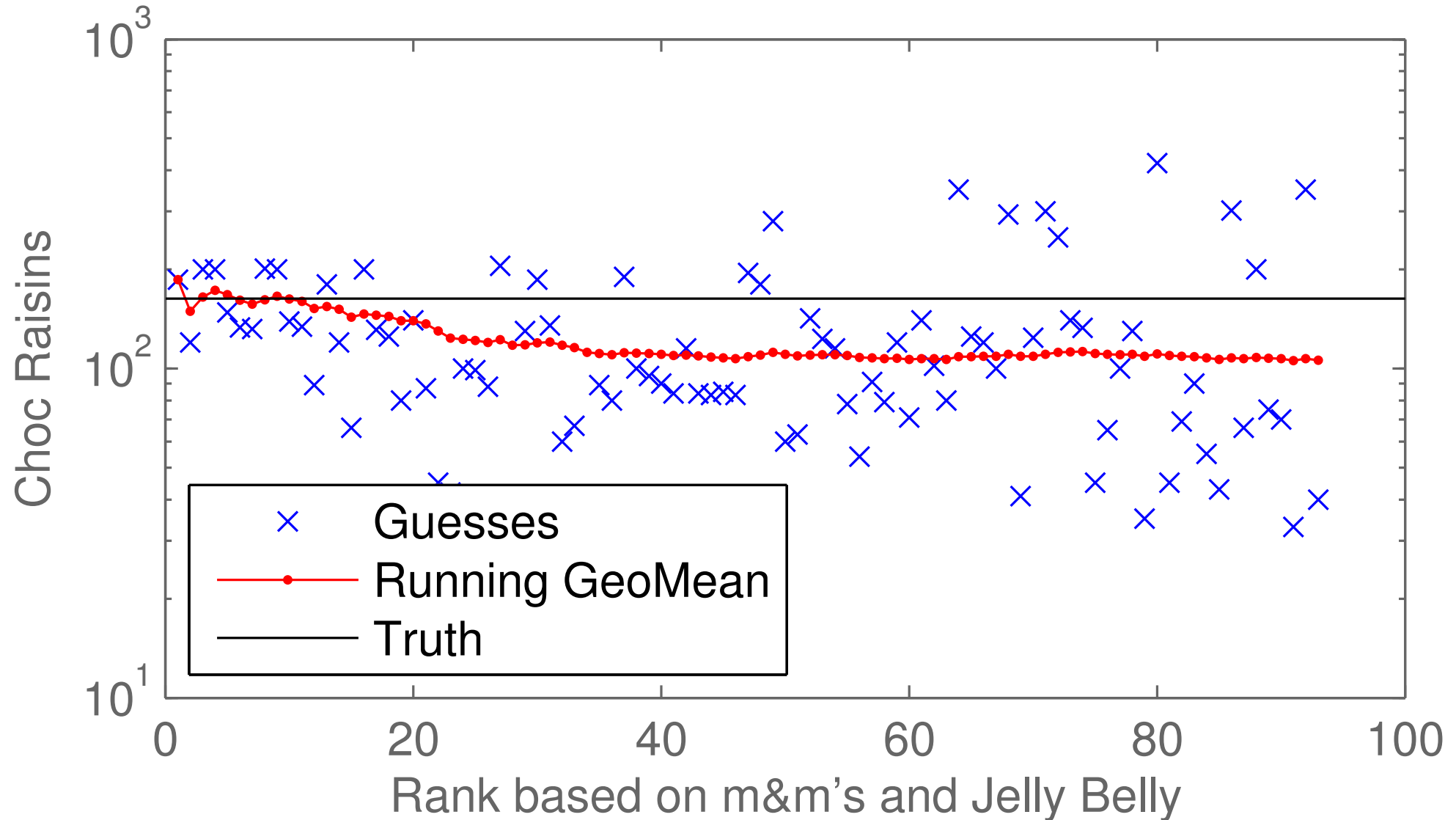
UCI ML repository

Count guesses on log-scale



Were some people just lucky?

Ranking by past performance



Ensemble of Models

Two motivations:

- ① Reduce over-fitting
- ② Reduce under-fitting

Example ①

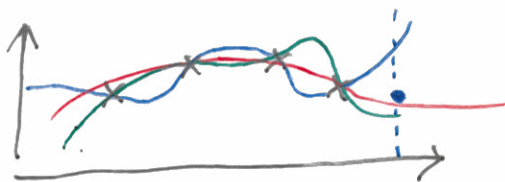
Bayesian model averaging:

$$p(y|\underline{x}, \mathcal{D}) = \int p(y|\underline{x}, \underline{w}) p(\underline{w}|\mathcal{D}) d\underline{w}$$

$$\approx \frac{1}{S} \sum_{s=1}^S p(y|\underline{x}, \underline{w}^{(s)})$$

$$\underline{w}^{(s)} \sim p(\underline{w}|\mathcal{D})$$

↑
Ensemble of S predictors.



Another way of ensembling: Bagging

Bootstrap aggregation

You have N training examples

Training time:

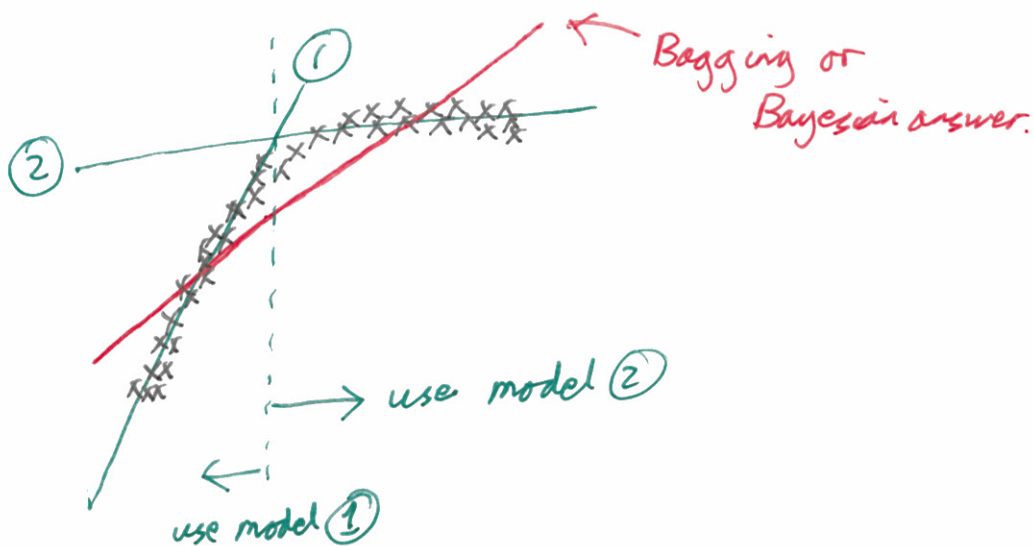
for $s = 1 \dots S$:

Bootstrap: create a new dataset with N datapoints sampled with replacement from training data.

Fit your model \rightarrow predictor s

Test time:

Average predictions.



② Model Combination

$$p(y|x, \theta) = \sum_{s=1}^S \underbrace{p(y|x, z=s, \theta)}_{\text{Any regression model}} \underbrace{p(z=s|x, \theta)}_{\text{classifier}}$$

$s \in \{1, 2, \dots, S\}$
↓

"Mixture of experts"

→ Fit θ , regularize
Bayesian, Bagging,

For the papers I mentioned, see the typeset notes.