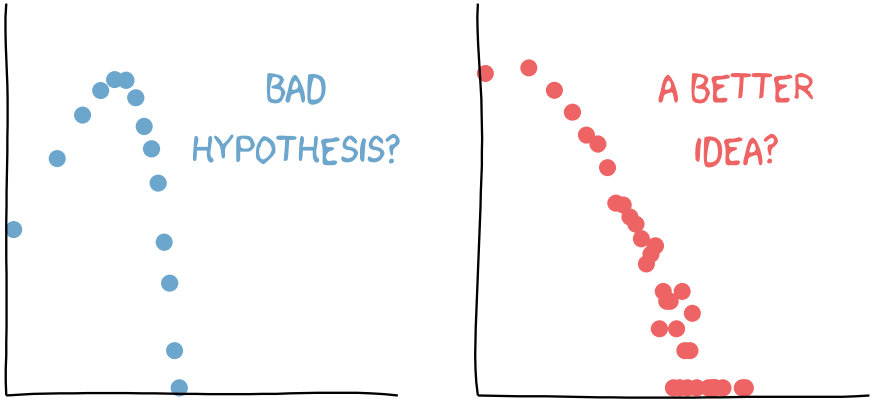
# How do I know if I am wrong?

## A provocation

## Research approaches to Rock Art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# Summary

- The Rashomon effect
- Modelling approaches to the past
- Null-Hypothesis vs Model Selection
- Example: large-scale trade within the Roman Empire

# Archaeological debates

# Archaeological debates

A fertility goddess?

Pornography?

A selfie?

A marriage token?

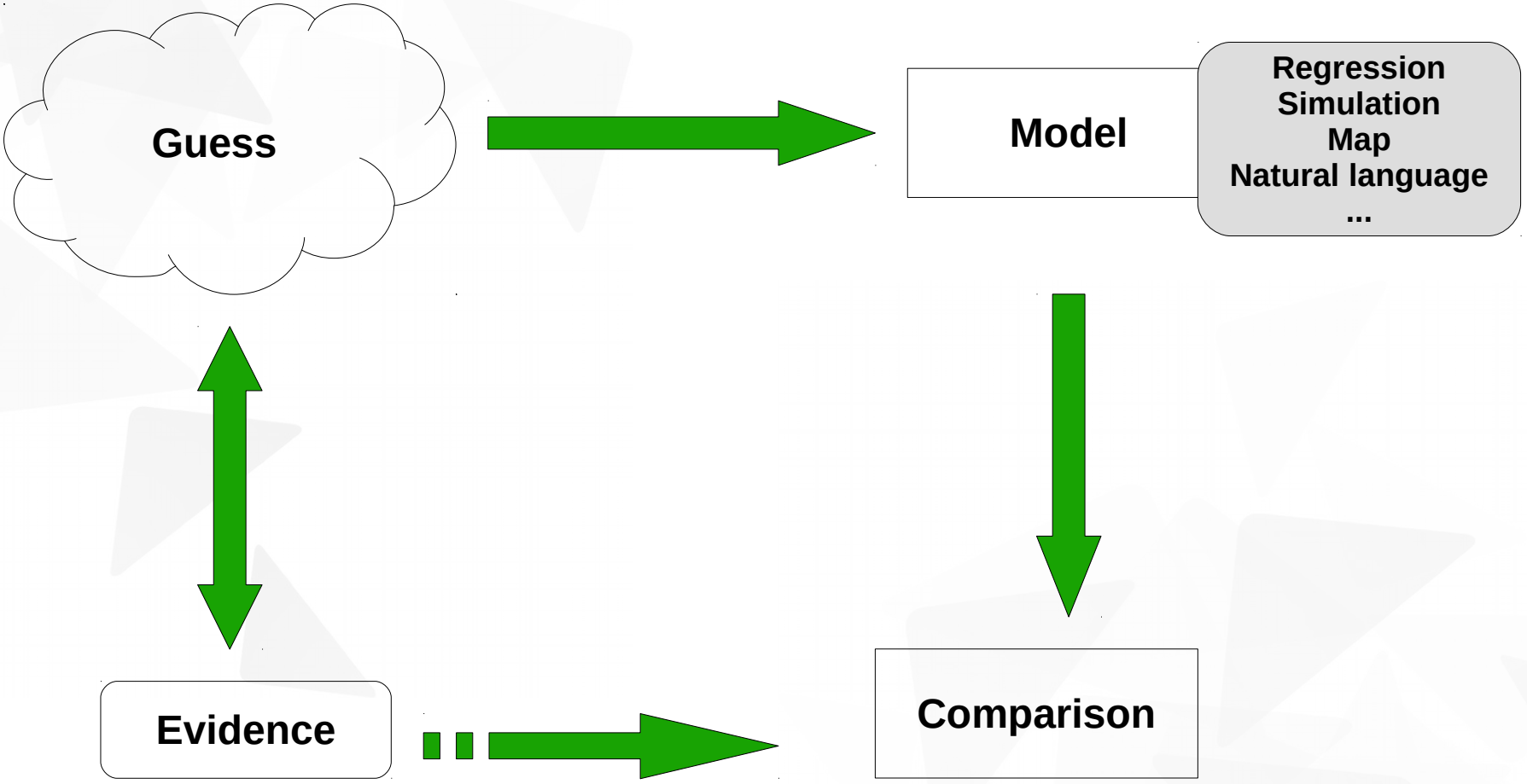
# Rashomon effect

- Different contradictory explanations for a given event
- This principle is called **Rashomon effect**
- A lack of evidence inhibits the rejection of wrong hypotheses

# The challenge of equifinality

Can we **evaluate** how good are our explanations considering the **uncertainty** of archaeological data?

# The scientific method



# Comparing explanations and data

- The classical way to test an **explanation** is to compare against a null hypothesis
- If we can **reject** the null hypothesis then our explanation is plausible
- This method needs both hypotheses to be:
  - complete
  - mutually exclusive

# The most famous quote in science...

"all models are wrong, but some are useful"

George Box

# A different approach

What if we start comparing hypotheses?

# ...with a little twist

"all models are wrong, but some are useful"

George Box

"while a model can never be *truth*, a model might be ranked from very useful, to useful, to somewhat useful to, finally, essentially useless."

Burnham & Anderson

# The structure of the Roman economy

- The «debate» on the structure of the Roman economy has generated multiple hypotheses over 100 years

- A model selection framework can quantify to plausability of each hypothesis considering the archaeological evidence

# A model selection framework

1) Define competing hypotheses

2) Collect evidence

3) Translate hypotheses to models

4) Measure the quality of each model

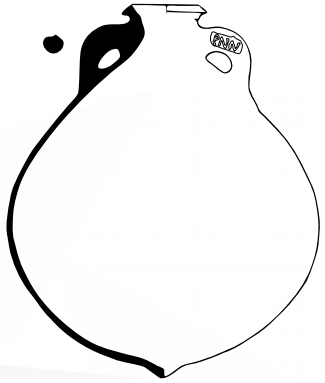
# Competing models of olive oil production

- M1 - Balanced model (Poblome et al., 2013)
  *All producers have similar size*
- M2 – Concentration of land ownership (Allanson, 1992)
  *Small producers absorbed by bigger agents*
- M3 – Free market structure (Axtell, 2001)
  *Self-organized dynamics*

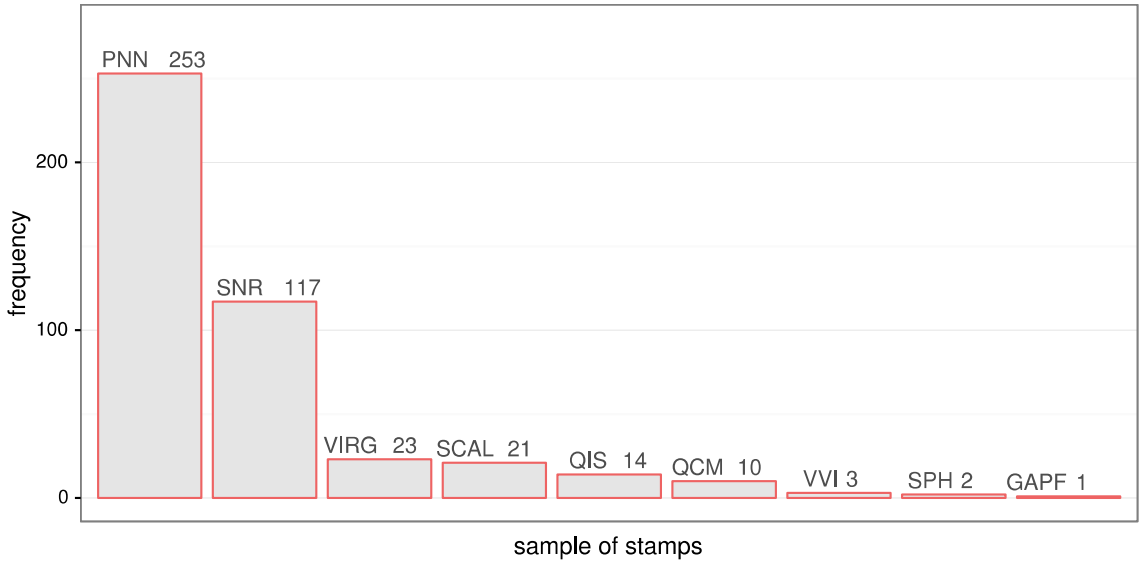
# Dataset

- The stamps found in olive oil amphorae will be used as proxy-data of the producer

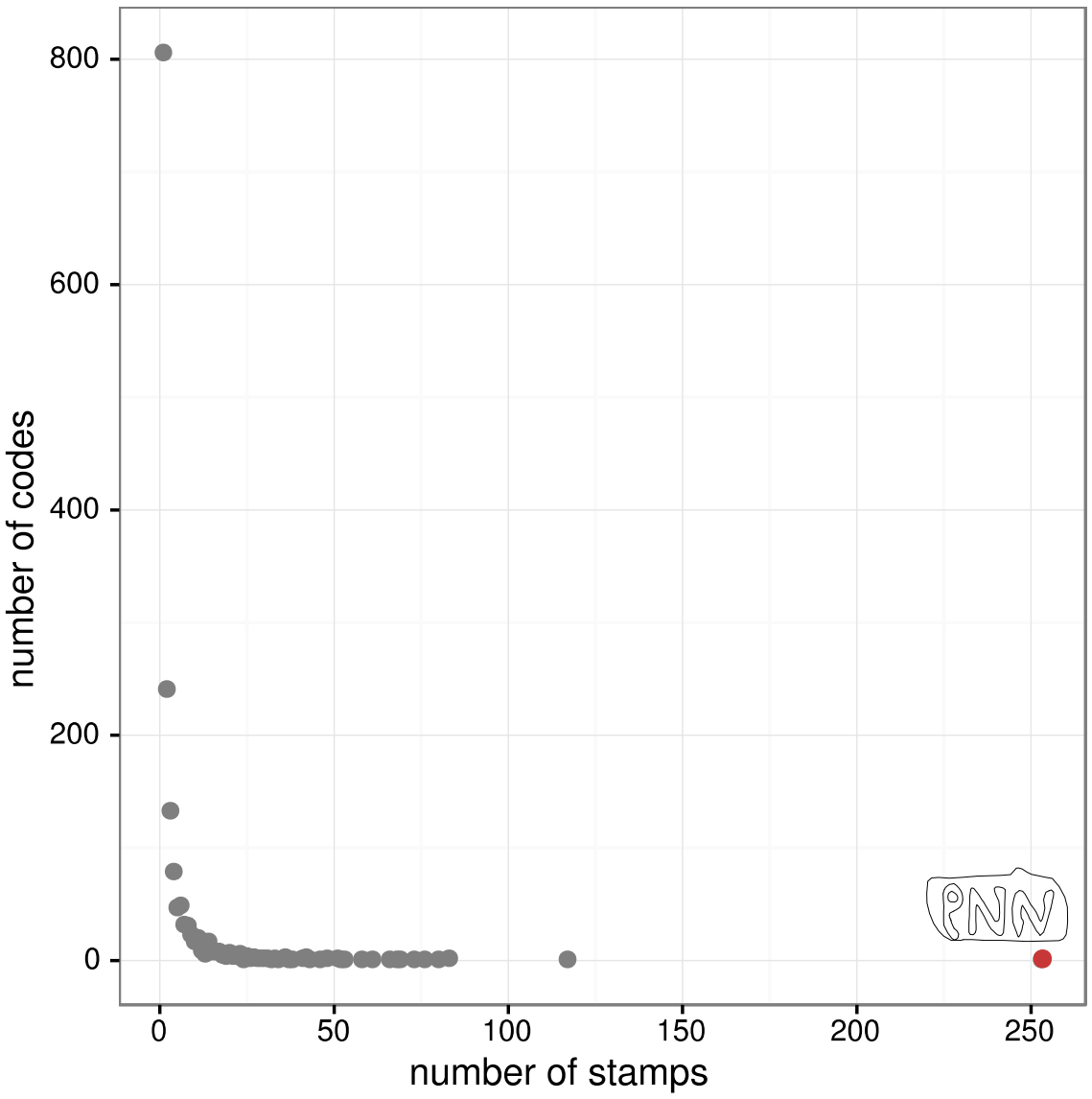




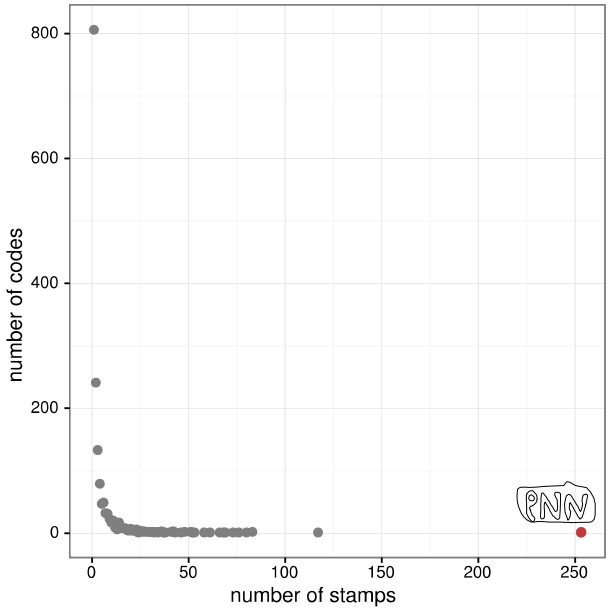

- Frequency distributions indicate relevance within the market

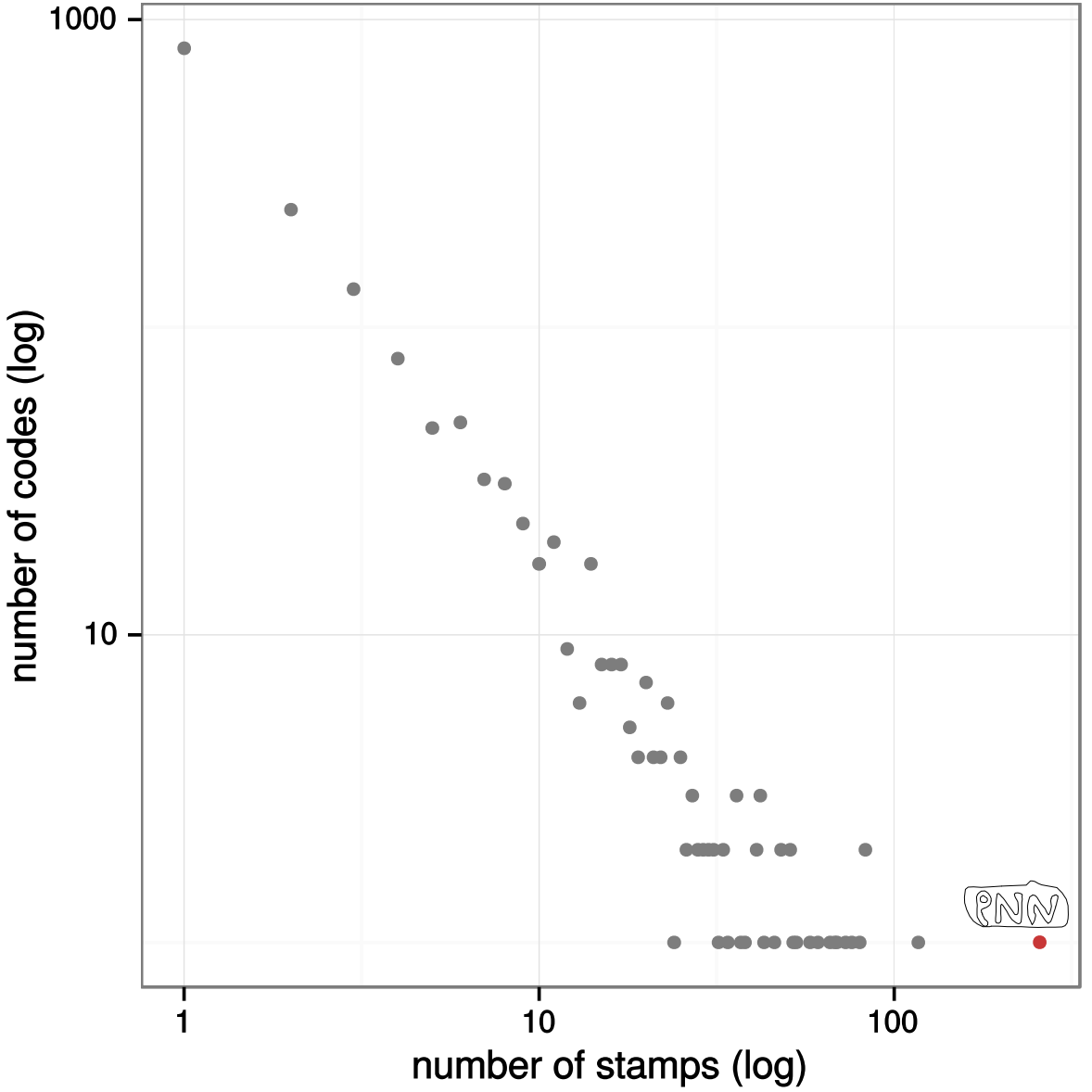


# Frequency distribution



# Frequency distribution (logarithmic)



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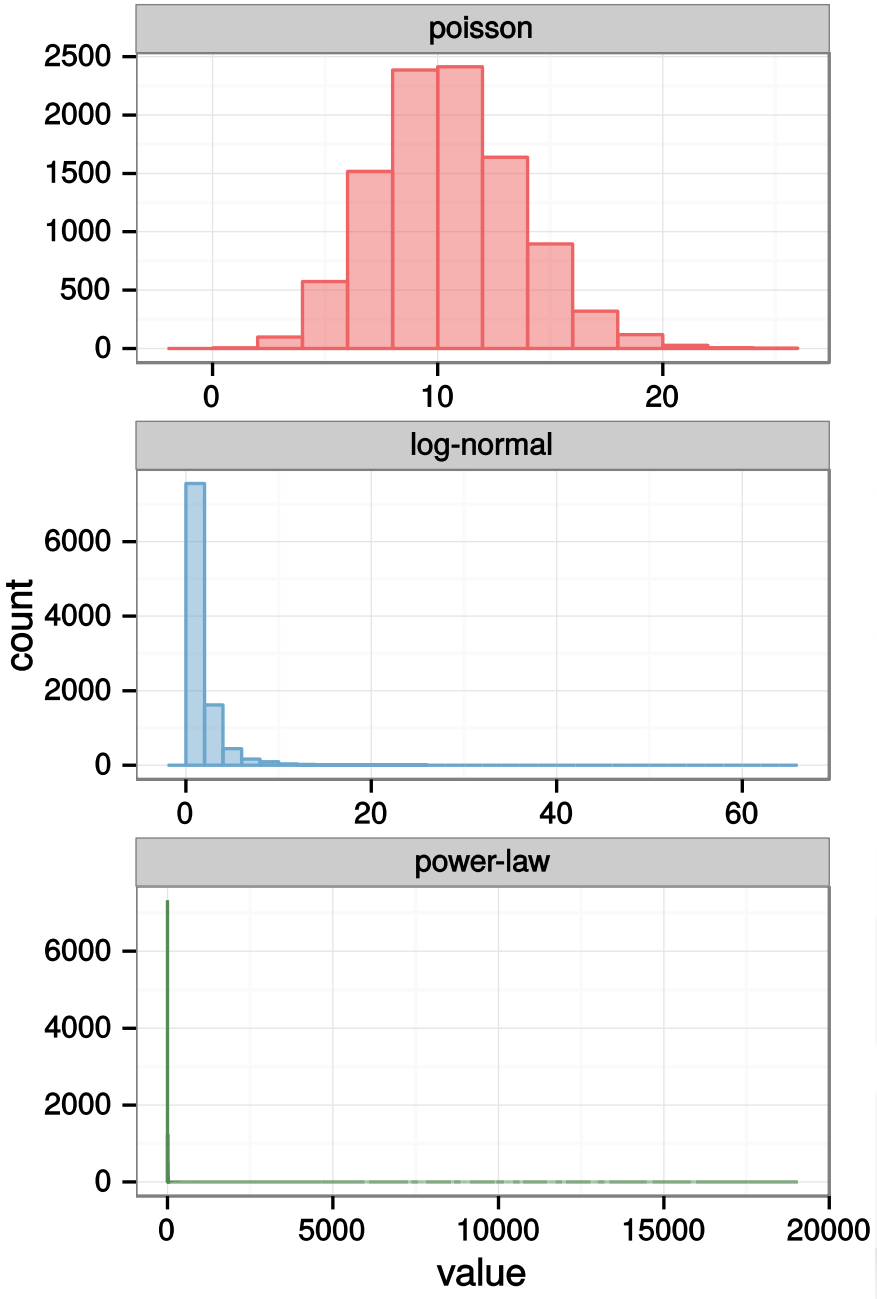
# Translation to formal models

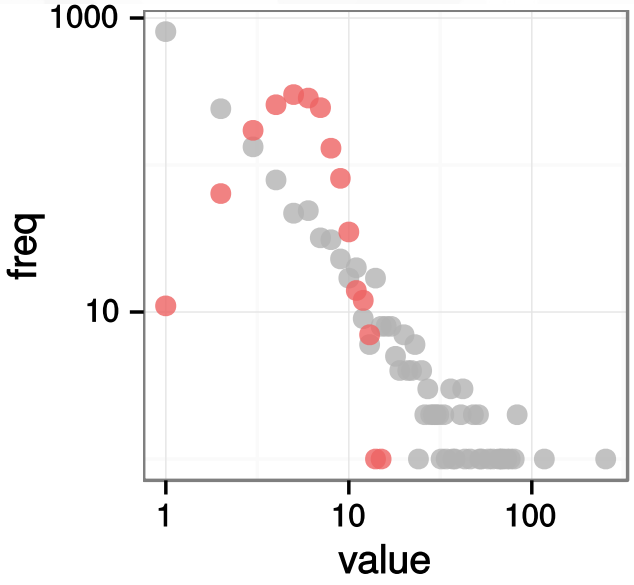
- M1 – Balanced
  *Poisson distribution*
- M2 – Concentration
  *Log-normal distribution*
- M3 – Free market
  *Power-law distribution*

The models are then best fitted to data using Bayesian inference



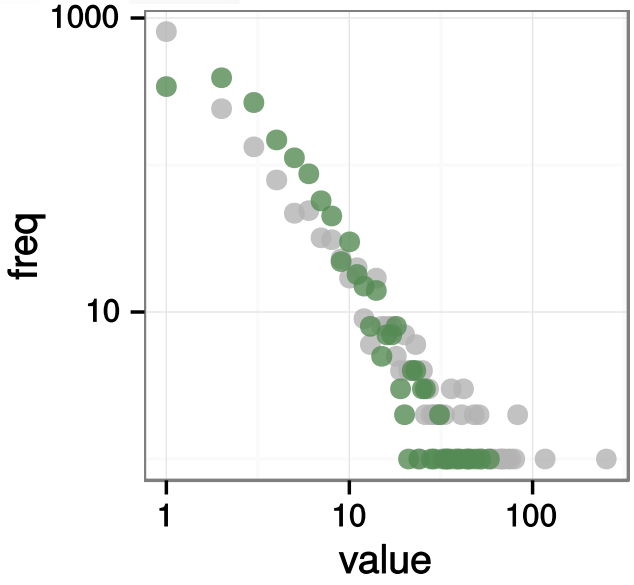
# Measuring “wrongness”

M1 - Balanced



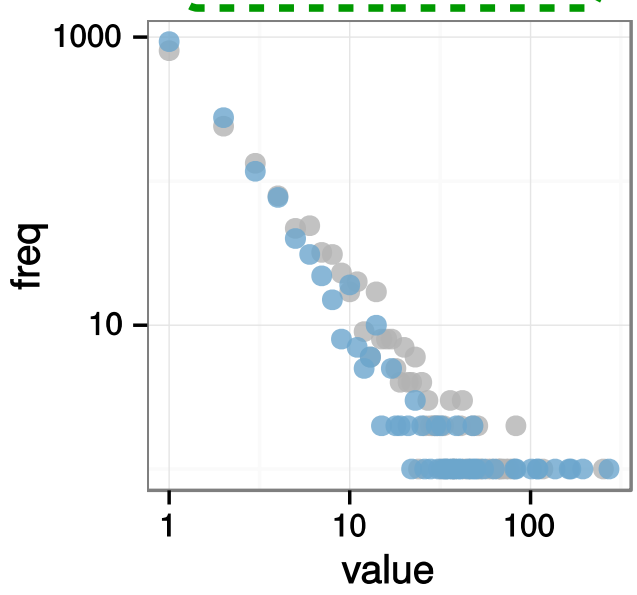

DIC = 18394

M2 - Concentration




DIC = 7208

M3 – Free market




DIC = 5061

DIC → Deviance Information Criterion

# Some questions

- Can all hypotheses be transformed into formal models?
- Under what extent can we know if we are wrong without using quantitative approaches?
- What models are better suited to answer the research questions of the Scotland Rock Art Project with the collected evidence?