On the Statistical Distribution of Object-Oriented System Properties

Israel Herraiz, Polytechnical University of Madrid, Spain

Daniel Rodriguez, University of Alcala, Spain

Rachel Harrison, Oxford Brookes University, UK

International Workshop on Emerging Trends in Software Metrics (WETSoM), 3 June 2012

Outline

Introduction

- Power laws
- Lognormal
- Double Pareto

Experimental Work

- Distribution of the OO Metrics

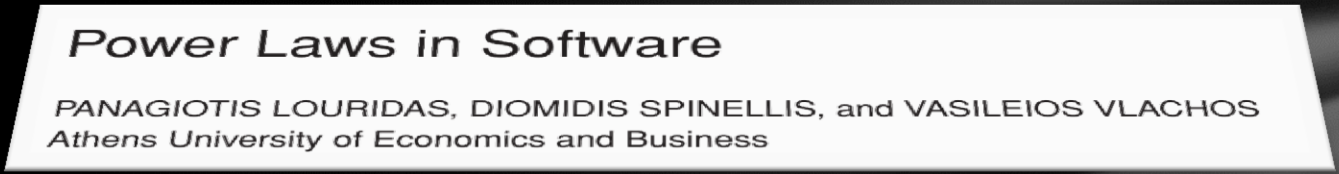
Conclusions and future work

Power laws are everywhere

Termed the signature of human activity

Power laws found in different fields

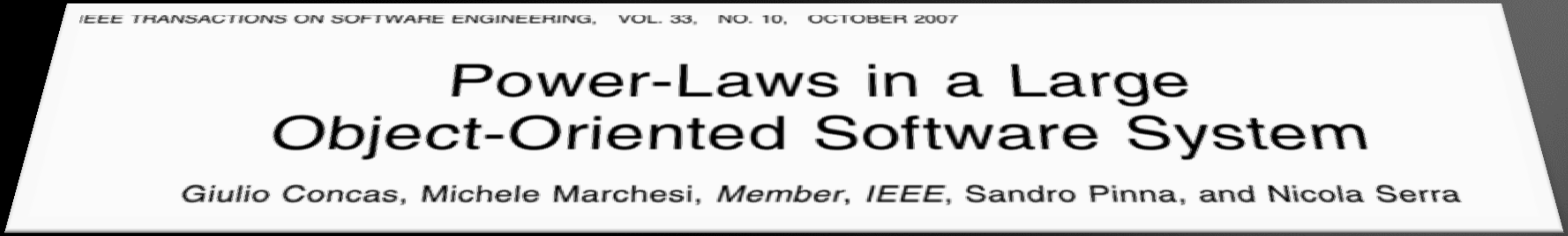
- Including software



Power Laws in Software

PANAGIOTIS LOURIDAS, DIOMIDIS SPINELLIS, and VASILEIOS VLACHOS
Athens University of Economics and Business

- And of course, Object-Oriented Systems
  - However, some CK metrics are not a power law, but lognormal



IEEE TRANSACTIONS ON SOFTWARE ENGINEERING, VOL. 33, NO. 10, OCTOBER 2007

Power-Laws in a Large Object-Oriented Software System

Giulio Concas, Michele Marchesi, *Member, IEEE*, Sandro Pinna, and Nicola Serra

The lognormal – power law controversy

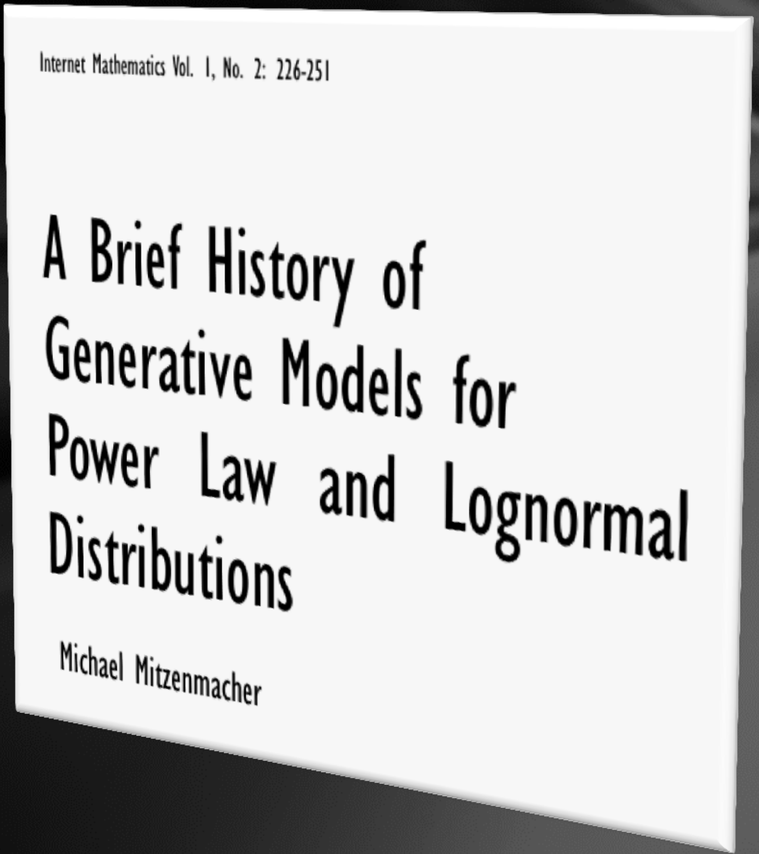
Some properties that appear to be a power law can sometimes be described by a lognormal

- And the other way around

It has happened in every field where power laws have been identified

OO Metrics - Power laws or lognormal?

- Mitzenmacher stated that in many of the controversies between power and lognormal distributions, there is a missing third party:
- The Double Pareto Distribution
- A mixture between power law and lognormal distributions



Internet Mathematics Vol. 1, No. 2: 226-251

A Brief History of Generative Models for Power Law and Lognormal Distributions

Michael Mitzenmacher

Object-Oriented Metrics

OO Metrics - Power laws or lognormal?

Mitzenmacher stated that in many of the controversies between power and lognormal distributions, there is a missing third party:

- The Double Pareto Distribution
- A mixture between power law and lognormal distributions

Can OO metrics be described using a Double Pareto distribution?

We measured 69 Java projects of the Qualitas Corpus repository

- Data for each project ncludes source code, JAR files (compiled versions of the source code), documentation and meta-data about the project, with some basic metrics and a classification of the project.
- `http://qualitascorpus.com/`

Used all Chidamber & Kemerer metrics

- **ckjm** tool — Chidamber and Kemerer Java Metrics
- `http://www.spinellis.gr/sw/ckjm/`

Fitted power law and lognormal distributions to different ranges of the data

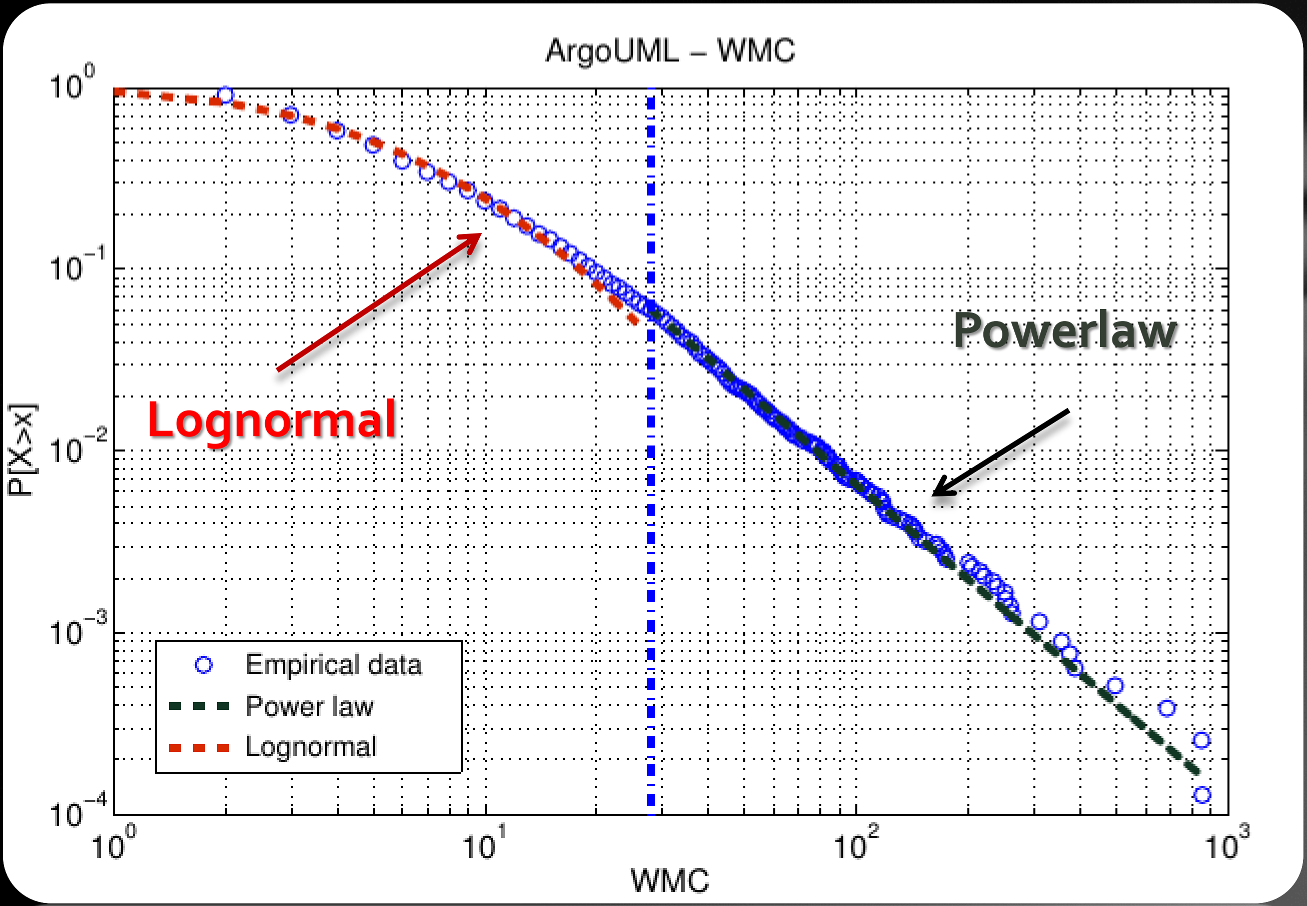
- Used the procedure recommended by Clauset et al.
- `http://tuvalu.santafe.edu/~aaronc/powerlaws/`

Procedure is easily replicable with all necessary scripts and data available from the first author Web page:

- `http://mat.caminos.upm.es/~iht/wetsom2012/`

Some results

Typical pattern of a Double Pareto distribution



ArgoUML – WMC

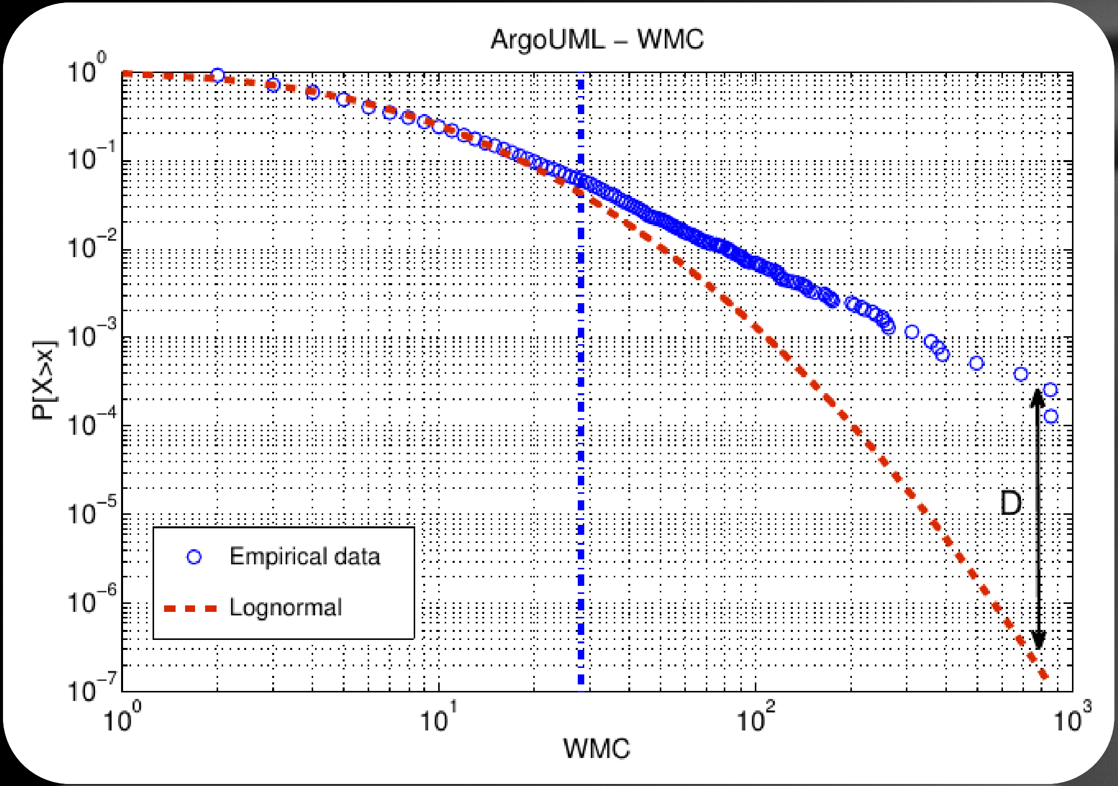
Lognormal

Powerlaw

The case of WMC

This metric has been found to be both good described by lognormal and power law

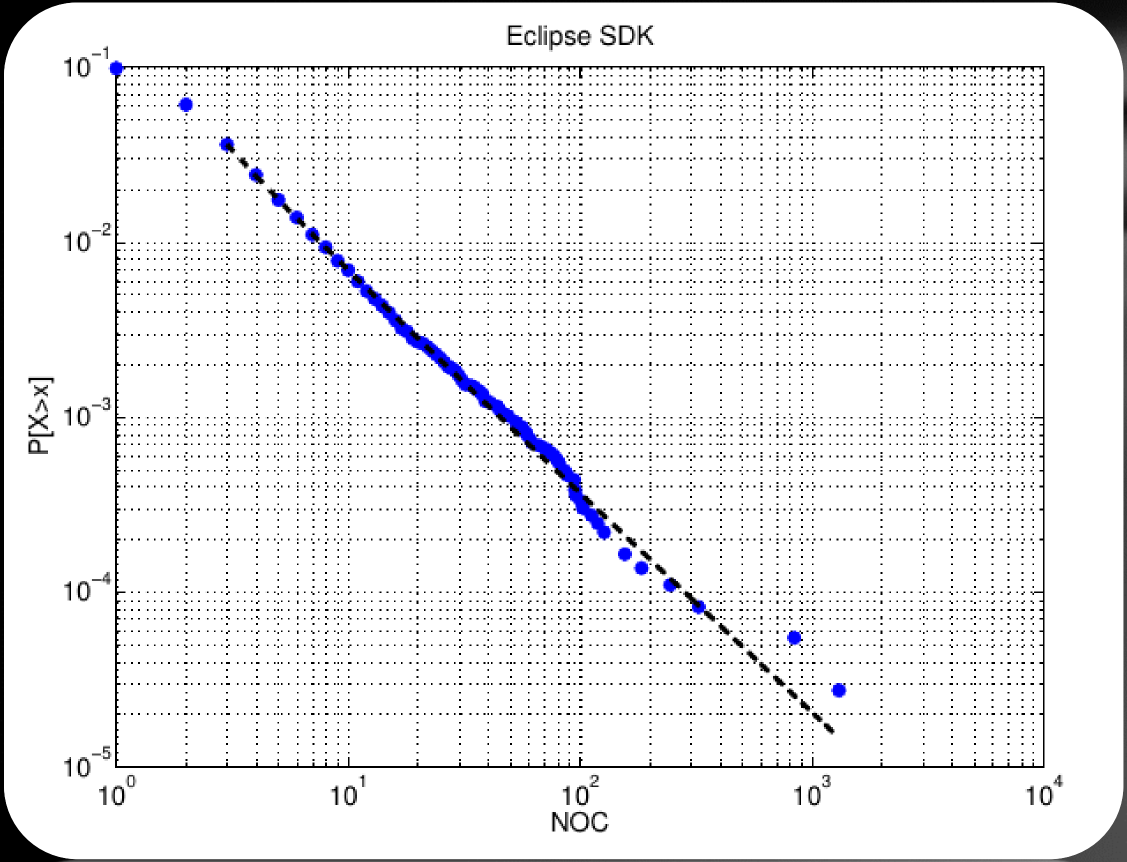
But lognormal alone is not a perfect fit



However

Some metrics are very well fitted by Power laws

- Not a trace of Double Pareto



In summary

We have three groups of metrics

- Double Pareto
  - WMC, CBO, RFC
- Power laws
  - NOC, LCOM
- Not fitted by either double Pareto or Power laws
  - DIT - This metric is generally composed of low values for this type of analysis

Is it really a Double Pareto?

One reviewers concern about our fitting procedure

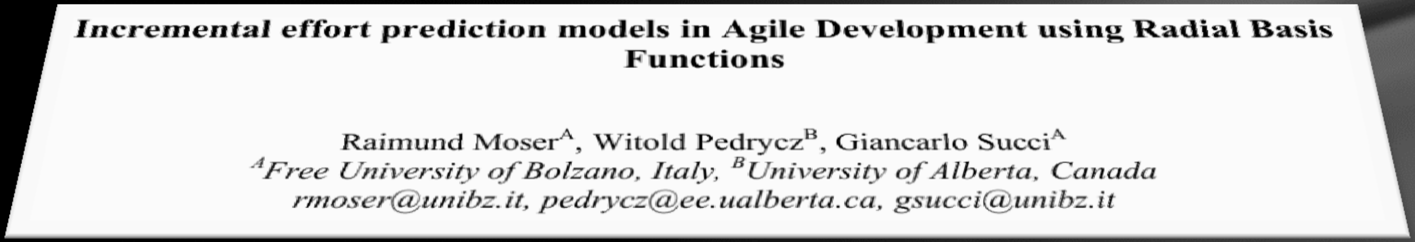
- We think the shape of the graph is very clear and typical of a double Pareto
- In all the cases, a lognormal alone deviated for very large values of the metric
- It only affects the value of the parameters of the distribution, not the fact that the distribution describes the data
- We have now developed a new fitting procedure
    - We will obtain some new results soon using this new procedure

So what?

Why is interesting to know the distribution of the CK metrics suite?

Effort prediction in agile methods

- Traditionally based on size metrics (LOC)
- Some modern techniques use CK metrics for effort prediction



Incremental effort prediction models in Agile Development using Radial Basis Functions

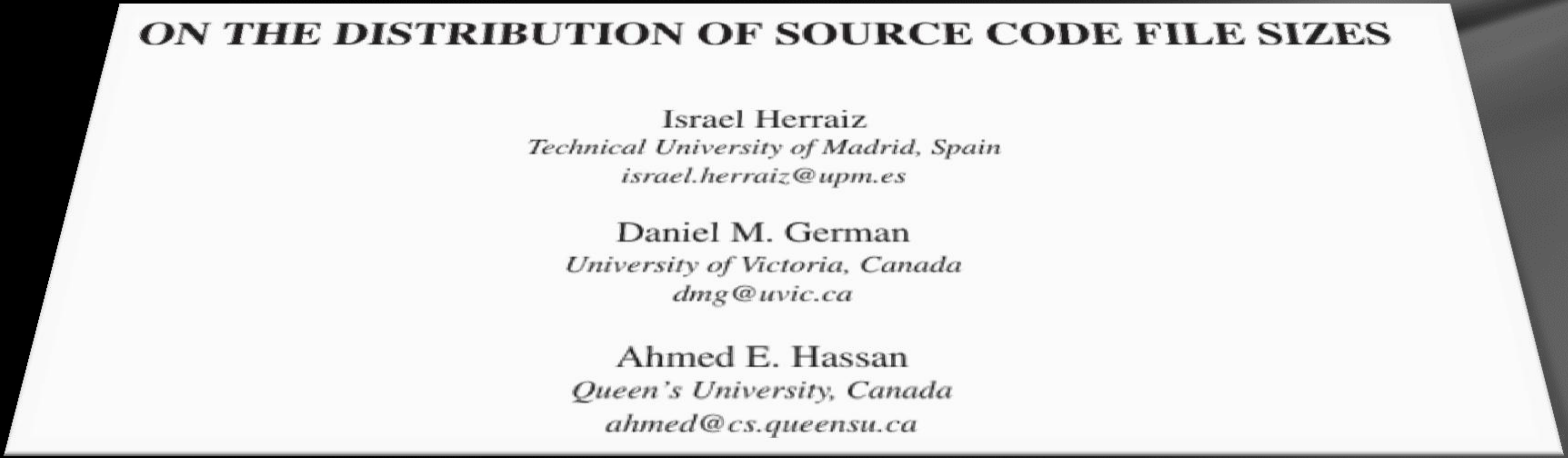
Raimund Moser[A], Witold Pedrycz[B], Giancarlo Succi[A]
[A]Free University of Bolzano, Italy, [B]University of Alberta, Canada
rmoser@unibz.it, pedrycz@ee.ualberta.ca, gsucci@unibz.it

Use CK metrics as predictors but discarded: NOC and LCOM

- Interestingly, the power law metrics. Why interestingly?
  - They only use those metrics that are subject to the “controversy”
  - That is, those which are in the border between power law, lognormal and double Pareto

And again, so what?

Effort prediction models that use double Pareto metrics but assume that the metric is lognormal will systematically underestimate the value of effort



ON THE DISTRIBUTION OF SOURCE CODE FILE SIZES

Israel Herraiz
Technical University of Madrid, Spain
israel.herraiz@upm.es

Daniel M. German
University of Victoria, Canada
dmg@uvic.ca

Ahmed E. Hassan
Queen's University, Canada
ahmed@cs.queensu.ca

Summary and Future Work

Some metrics are power law, some others lognormal or double Pareto

Some controversial metrics are being used for effort prediction models

Knowing the distribution can help devise new models and improve existing ones

But if the metric is assumed to be lognormal and it is not, the model will systematically underestimate

New release of the **Qualitas Corpus**

- Repeat with newer releases of the same case studies
- Repeat with more case studies

Fitting procedure

- We have developed a new fitting procedure
- Compare with our current approach
- Set once for all the double Pareto question

Results useful for effort prediction model builders

- That is, both practitioners and researchers