

Linear and nonlinear Preferential Attachment

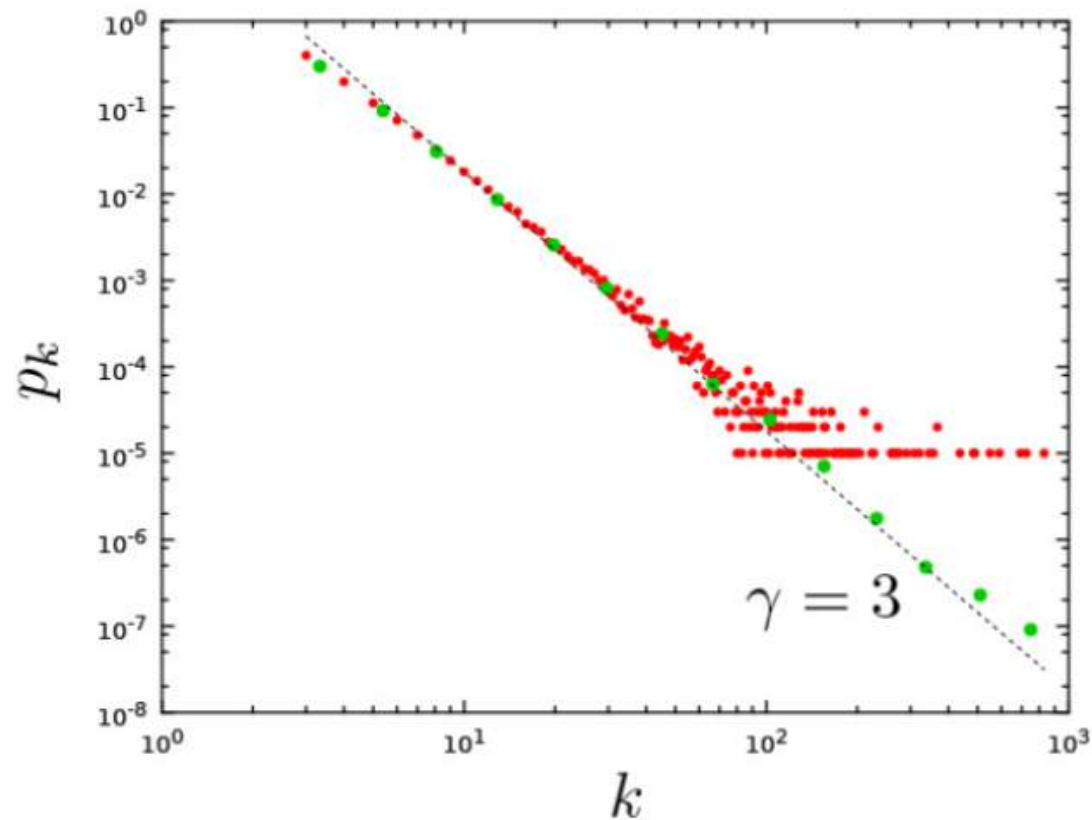
# Zipf's Law's Application

Jingjin Wei

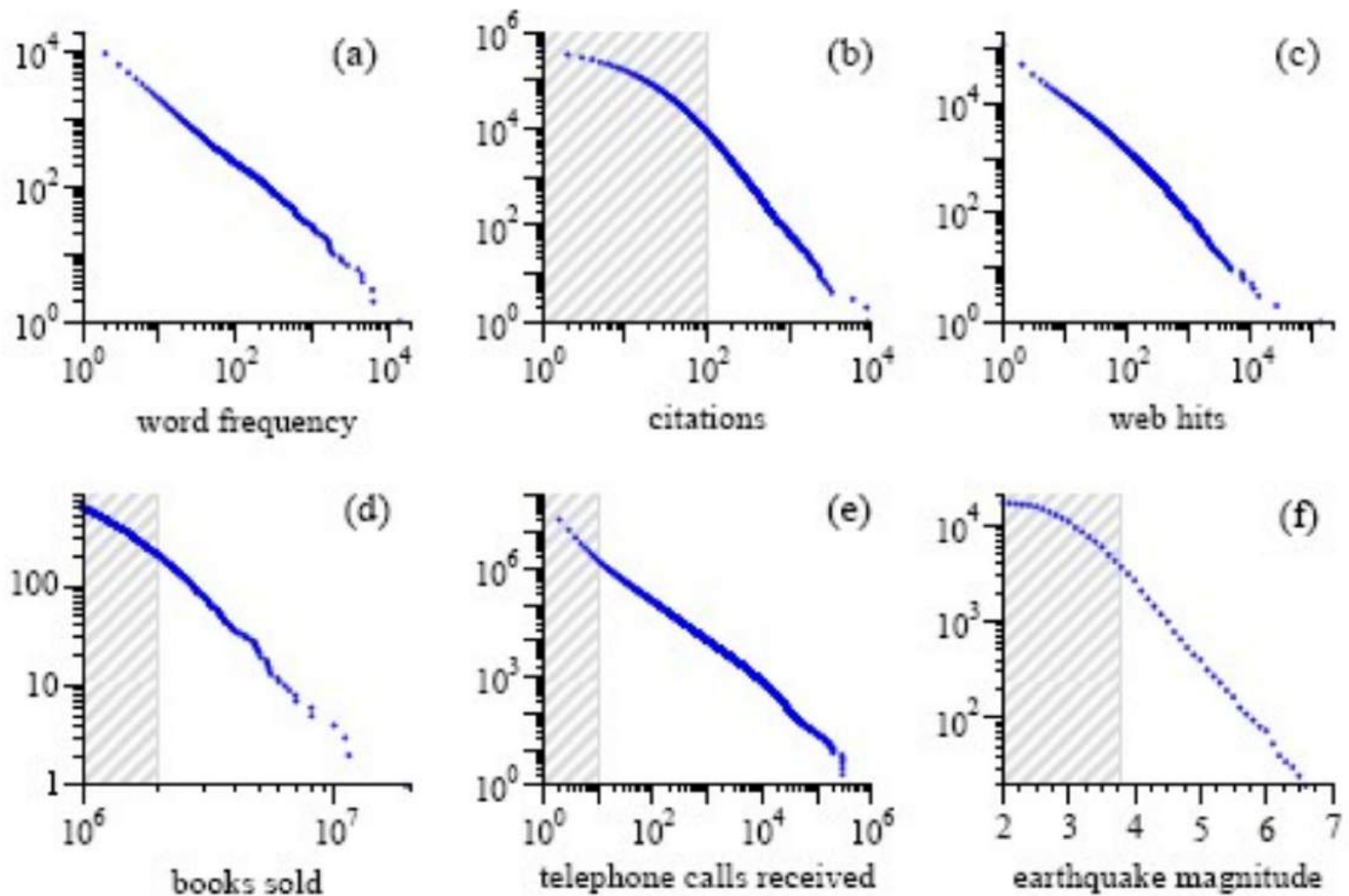
Department of Physics

# Motivation

- Degree Distribution of a scale-free network



# Motivation



# Structure

- A Quick Look at data
  - Resources of Data
  - Graph display
- P.A and Zipf's Law
- Nonlinear P.A
- Discussion

# Resources of Data

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## THE WORLD FACTBOOK

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### COUNTRY COMPARISON :: AREA

Area compares the sum of all land and water areas delimited by international boundaries and/or coastlines.

DOWNLOAD DATA

RANK	COUNTRY	(SQ KM)	DATE OF INFORMATION
1	<a href="#">RUSSIA</a>	17,098,242	
2	<a href="#">CANADA</a>	9,984,670	
3	<a href="#">UNITED STATES</a>	9,826,675	
4	<a href="#">CHINA</a>	9,596,960	
5	<a href="#">BRAZIL</a>	8,514,877	
6	<a href="#">AUSTRALIA</a>	7,741,220	
7	<a href="#">INDIA</a>	3,287,263	
8	<a href="#">ARGENTINA</a>	2,780,400	
9	<a href="#">KAZAKHSTAN</a>	2,724,900	
10	<a href="#">ALGERIA</a>	2,381,741	

factbook/rankorder/rankorderguide.html

## Structure

- **A Quick Look at data**
  - Resources of Data
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- P.A and Zipf's Law
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- Discussion

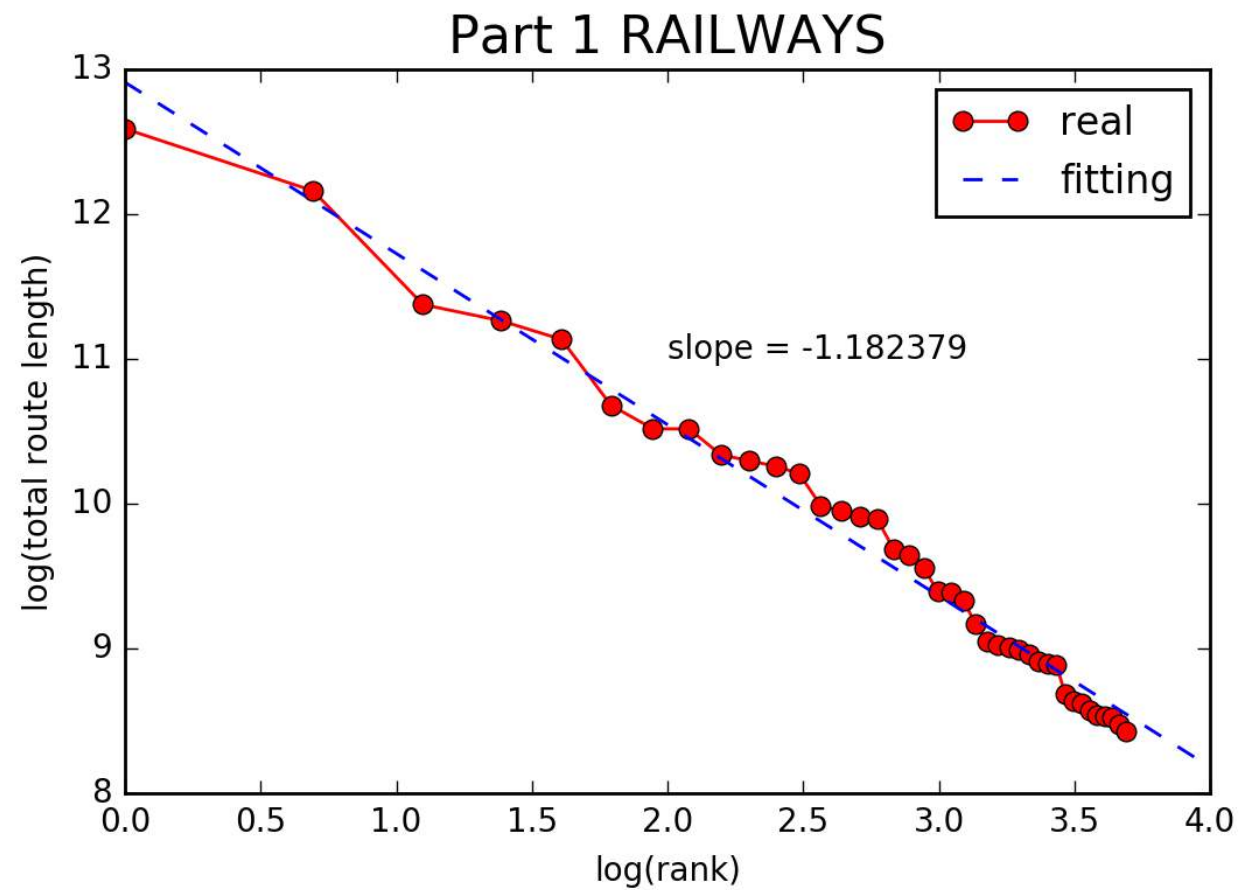
## Areas Chosen

- Railways
- Population
- Roadways
- Area
- Internet Users
- GDP (Purchasing Power Parity)

# Structure

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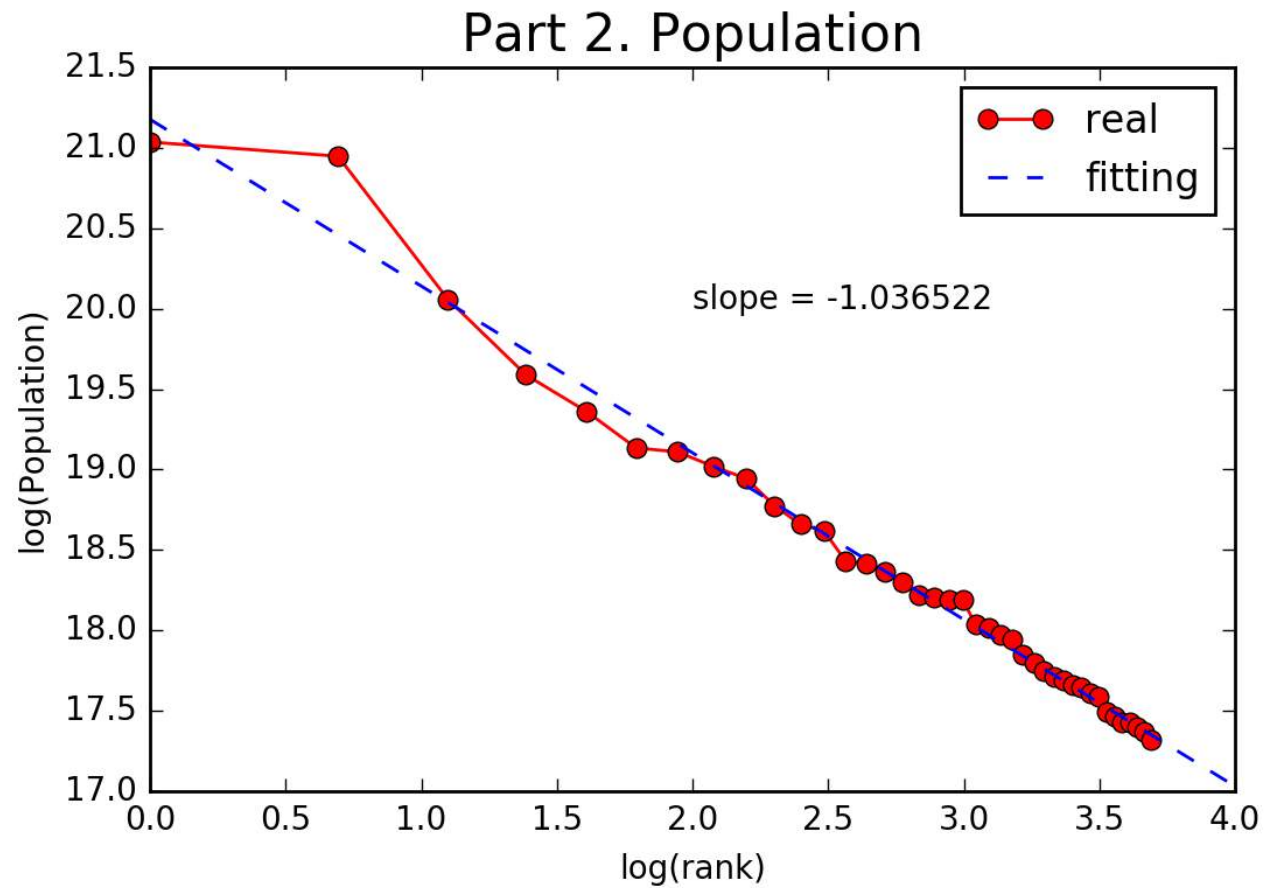
# Areas Chosen - Railways



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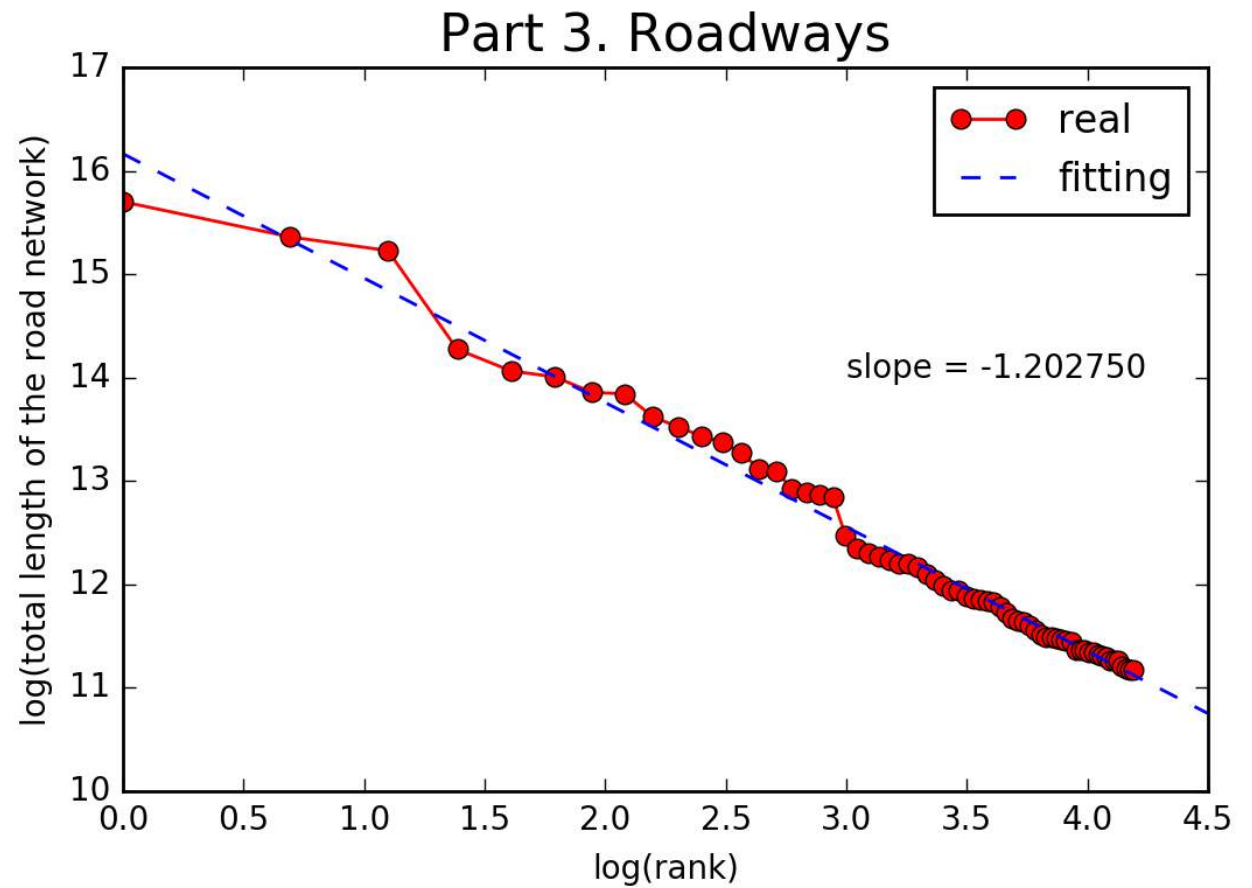
# Areas Chosen - Population



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# Areas Chosen - Roadways

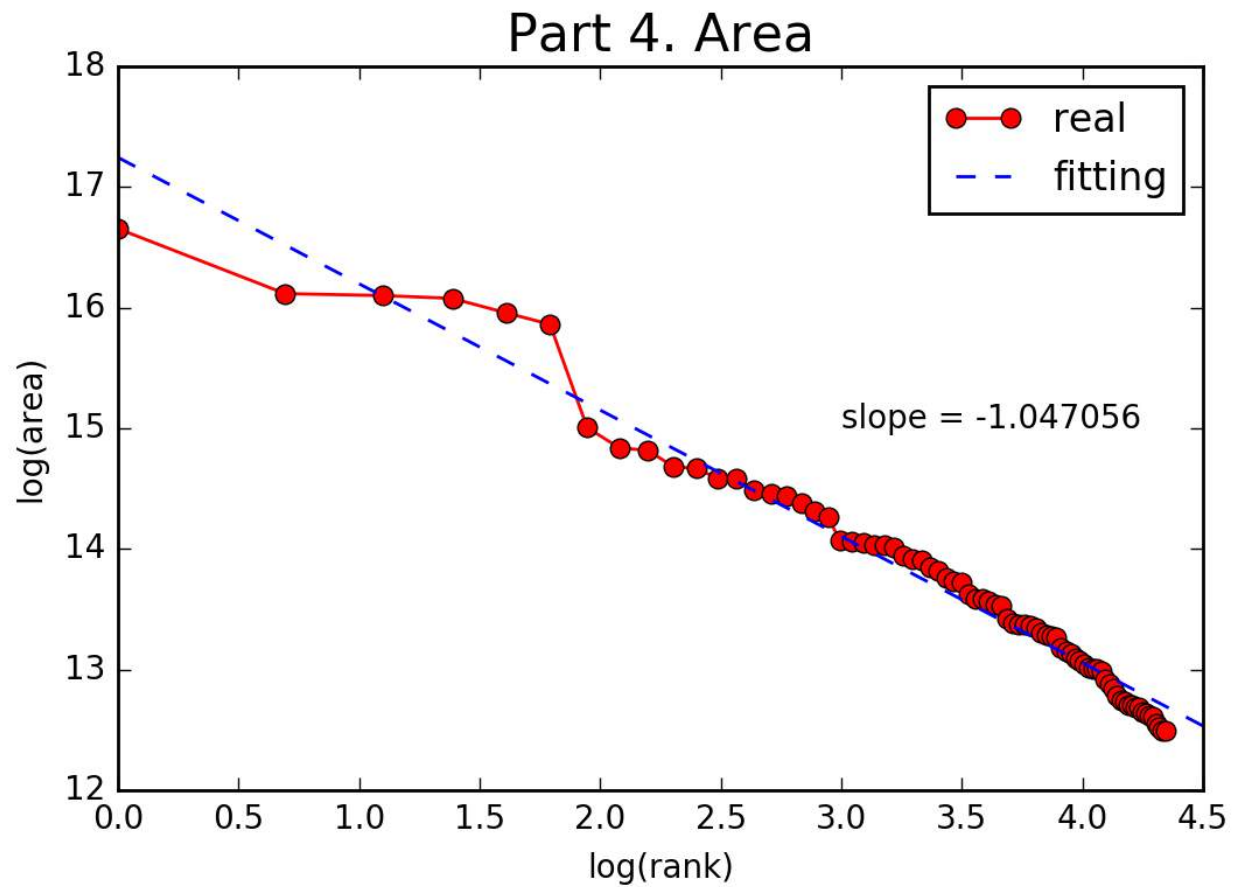




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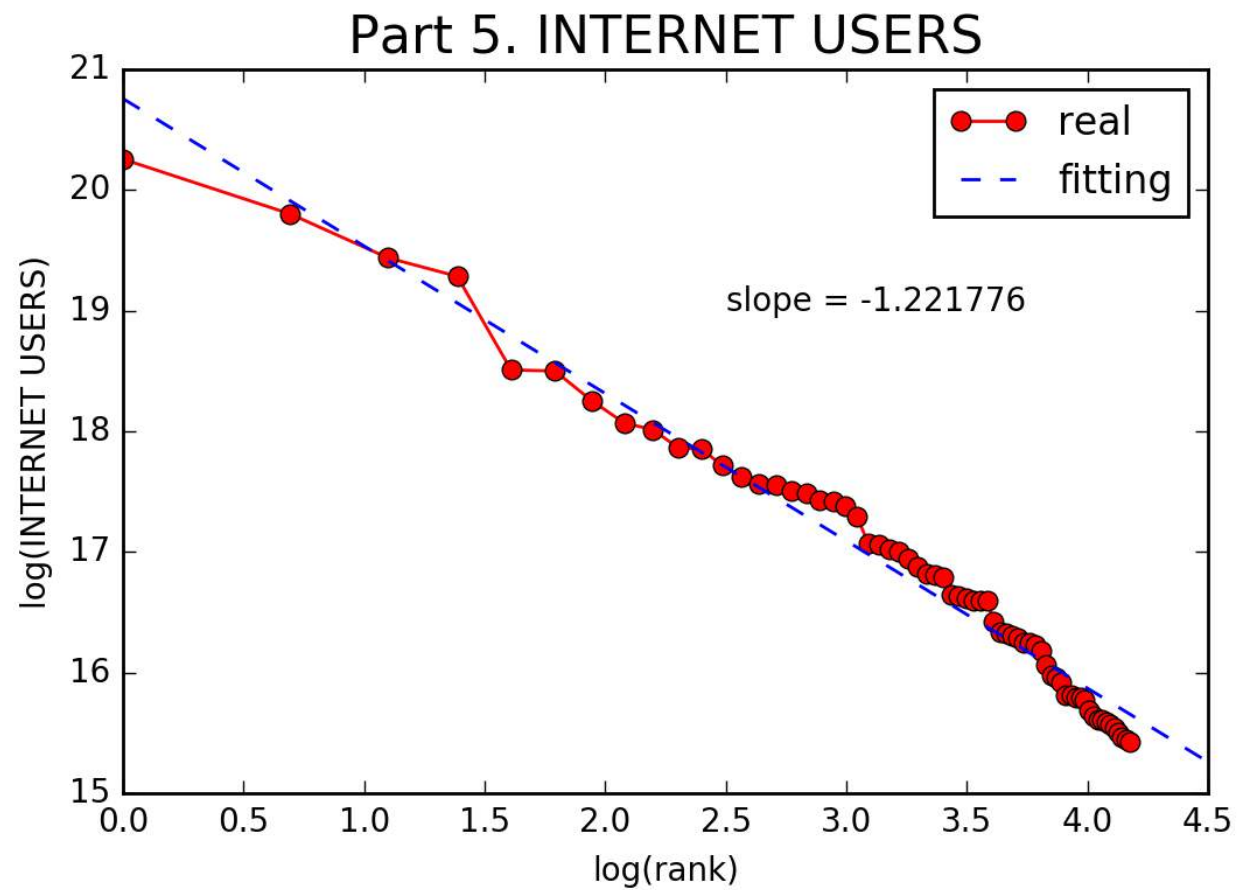
# Areas Chosen - Internet Users



# Structure

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- P.A and Zipf's Law
- Nonlinear P.A
- Discussion

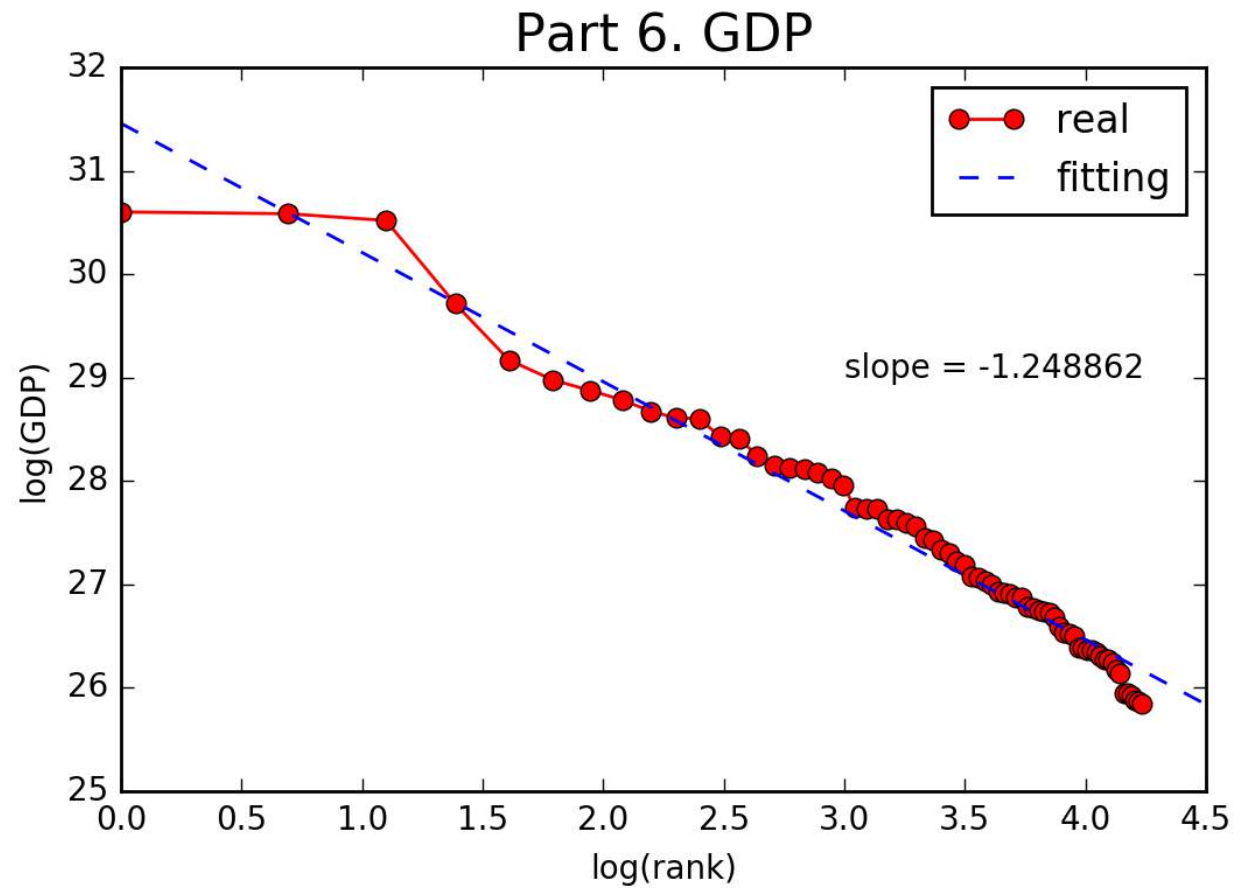
# Areas Chosen - Railways



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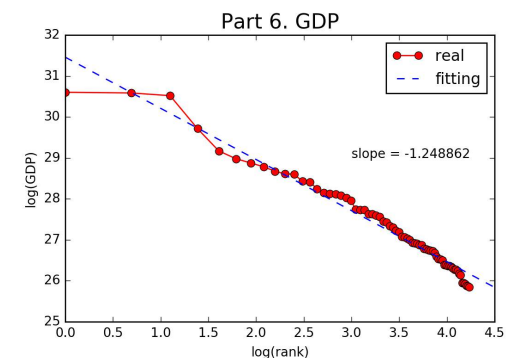
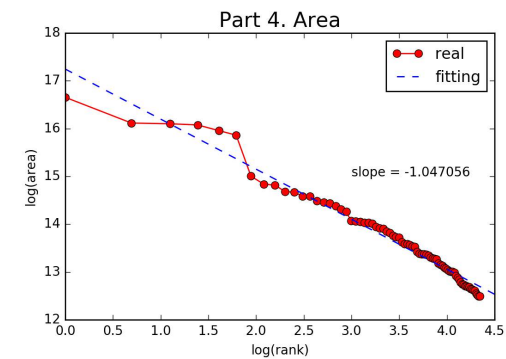
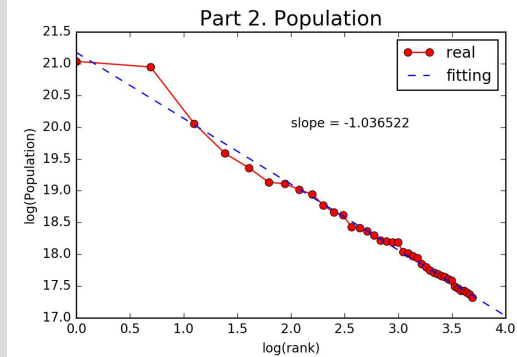
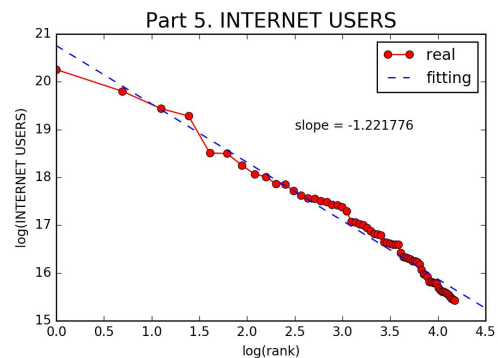
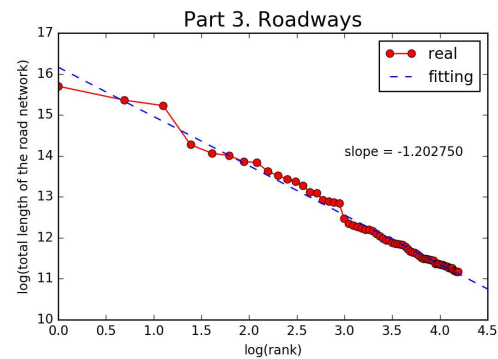
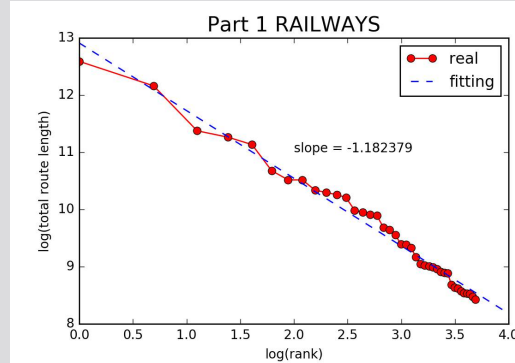
# Areas Chosen - GDP



# Structure

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# Areas Chosen



# Preferential Attachment and Zipf's Law

- Zipf's Law

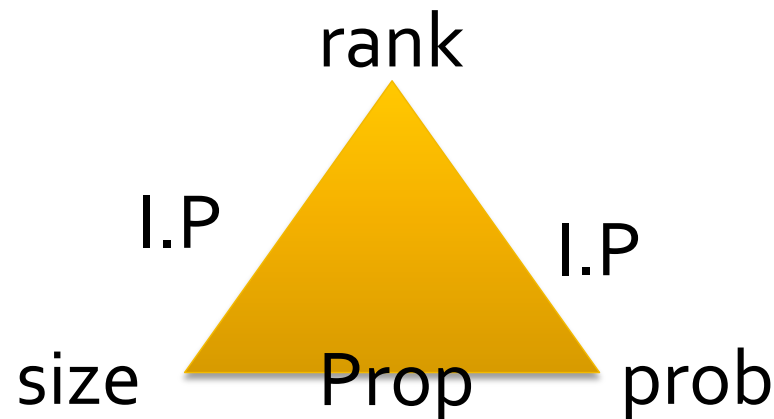
- Origin: English Study
- Prob I.P Rank
- 'Size' I.P Rank

$$P(r) = 0.1/r$$
$$= c_1 \cdot r^{-1}$$

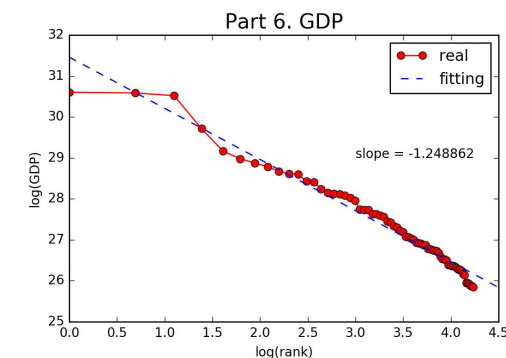
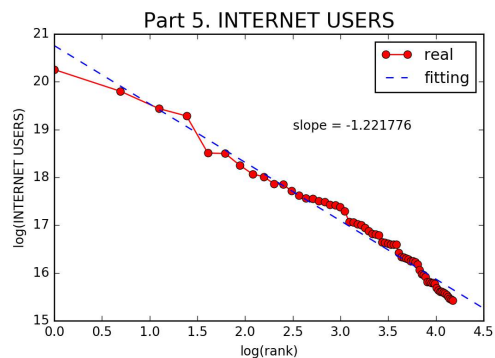
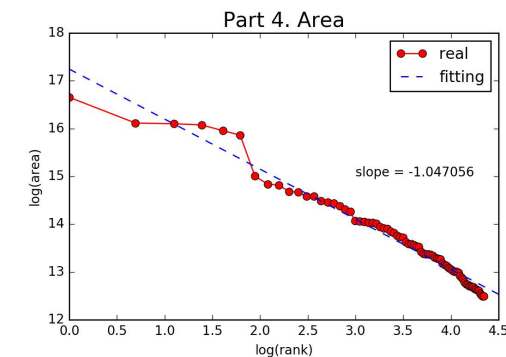
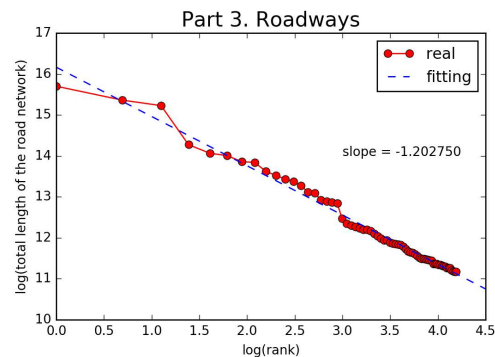
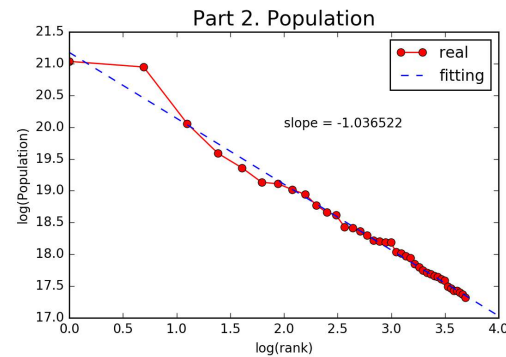
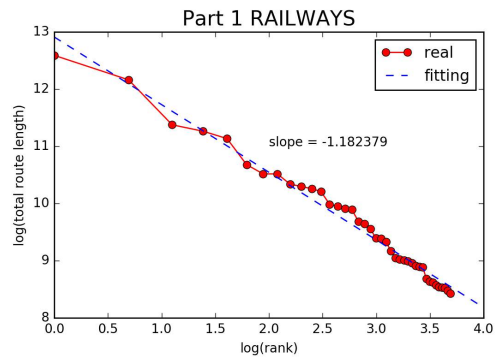
- Preferential Attachment

- Rich gets richer

$$P_i = k_i / \sum k_i$$
$$= c_2 \cdot k_i$$



# Linear?

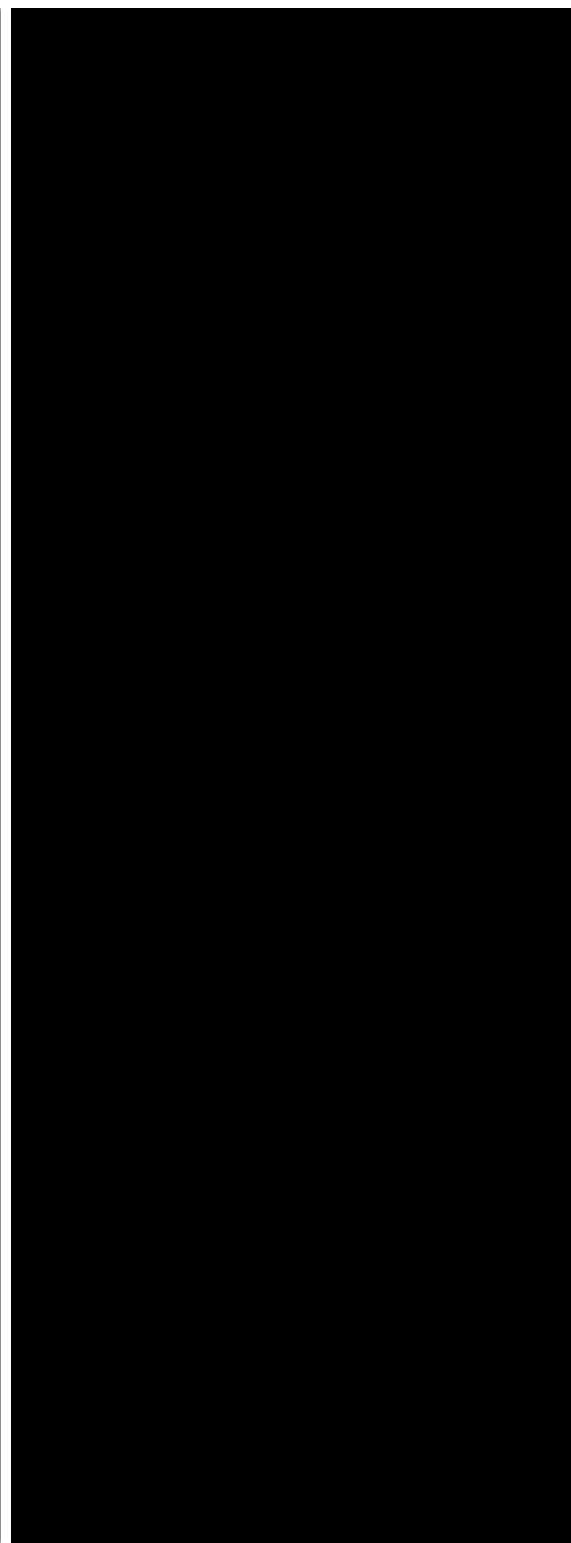
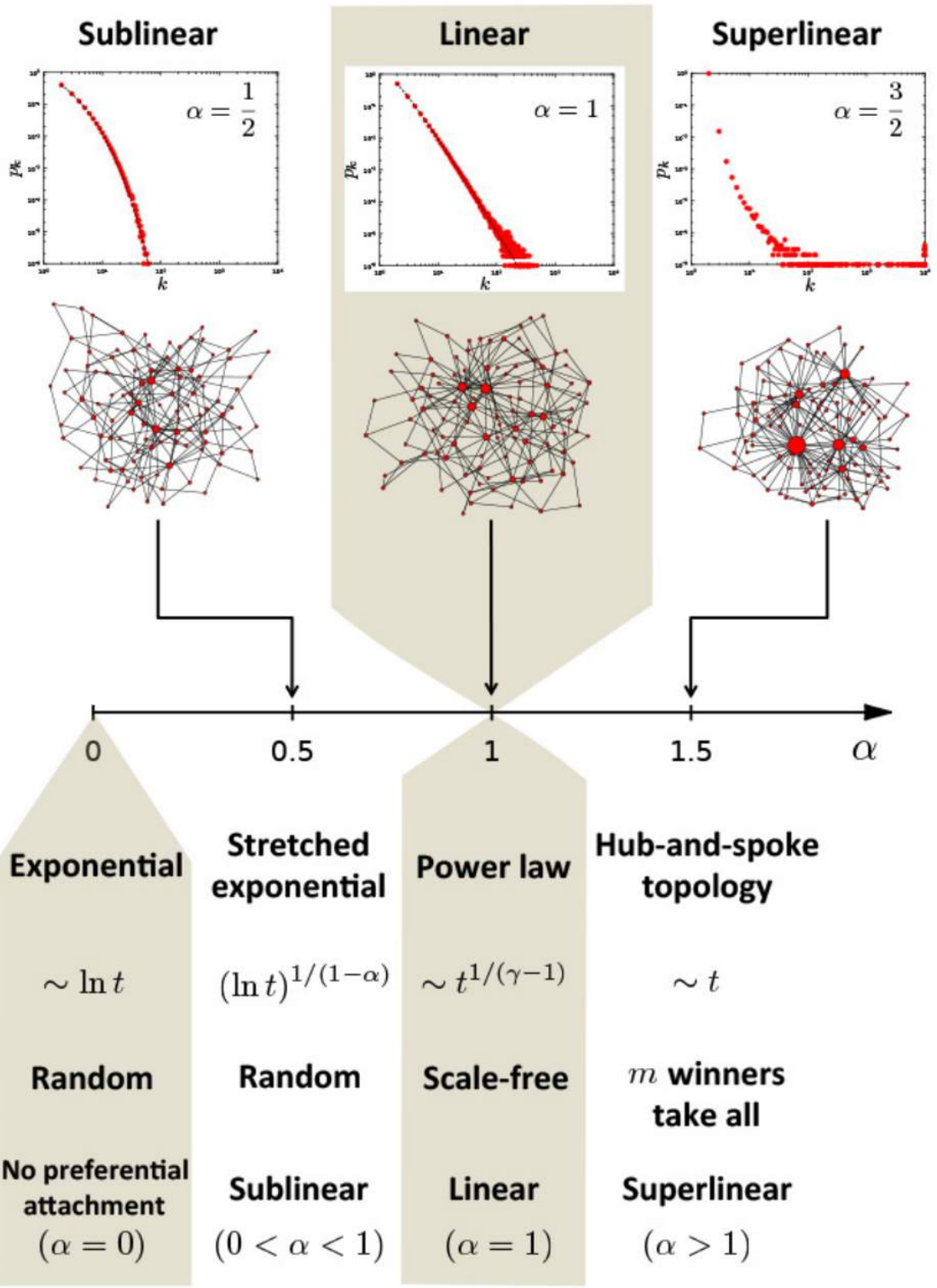


Field	Slope
Railways	-1.18238
Population	-1.03652
Roadways	-1.20275
Area	-1.04706
Internet Users	-1.22178
Gdp	-1.24886

# Nonlinear Preferential Attachment

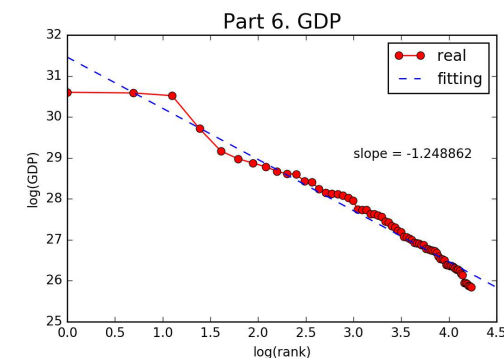
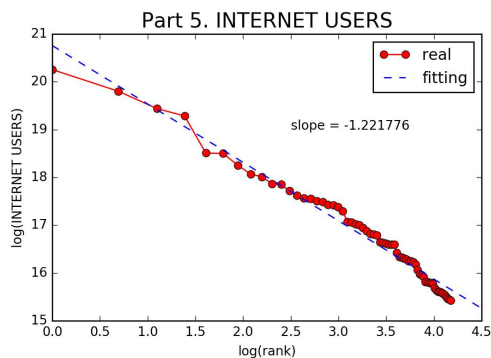
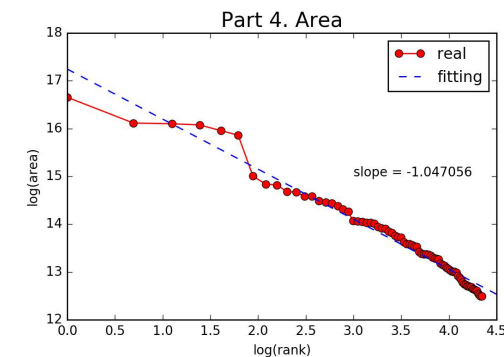
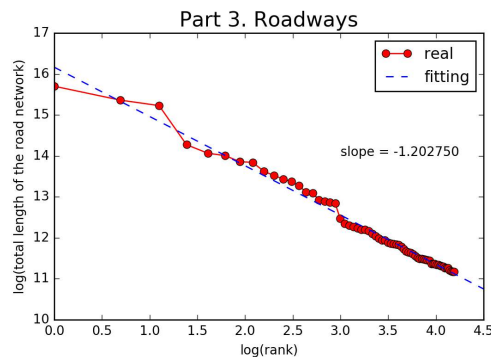
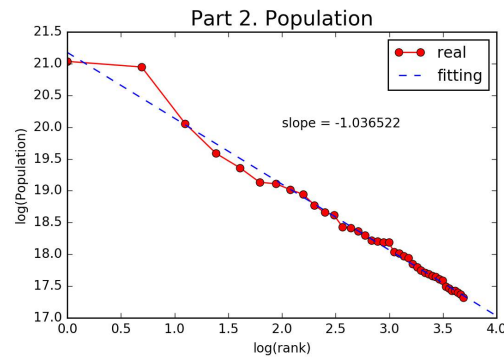
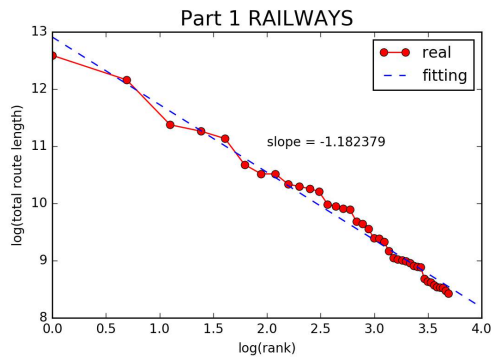
$$P_i = c_1 \cdot \text{rank}_i^{-\alpha} = c_2 \cdot k_i^\alpha$$

- Linear:  $\alpha = 1$
- Random:  $\alpha = 0$
  
- What for other values?





# Why Different?



Field	Slope
Railways	-1.18238
<b>Population</b>	<b>-1.03652</b>
Roadways	-1.20275
<b>Area</b>	<b>-1.04706</b>
Internet Users	-1.22178
GDP	-1.24886

# Discussion

- Area
- population
- Railways
- Roadways
- Internet Users
- GDP