Homework 6
Network Dynamics Analysis

Juan Pablo Royo Sales & Francesc Roy Campderrós

Universitat Politècnica de Catalunya

December 13, 2020

Contents

1 Introduction

In this homework we have analyzed Network Dynamics (Network Dynamics) on different models proposed for this work. The main goal of this work is to identify the best model which fit on both aspects of Network Dynamics, Degree Distribution (Degree Distribution) and Growth of Vertex Degree over time (Time Growth Degree). The following sections are going to show the results obtained and after that the discussion about the methodology used for the analysis and some conclusions at the end.

All the models that we have generated for the analysis of Barabasi-Albert model (Barabasi-Albert model) over time have been done using **C++** Language and you can find the source code of this solution under `code/main.cpp`.

The solution of this work is divided as follows:

- **code**: Under this folder you are going to find *C++* code for simulating and generating the different networks using the different strategies: Growth + Preferential Attachment (G Pref Attachment), Growth + Random Attachment (G Random Attachment) and No Growth + Preferential Attachment (NG Pref Attachment), as well as the *R* scripts for generating plots and doing graph analysis.
- **code/data**: Data Generated for each strategy
- **report**: This report in Latex and PDF format.

2 Results

2.1 Degree Distribution Analysis

2.1.1 Growth + Preferential Attachment

Parameter	Value
M	200002
N	100002
MAX	1105
M/N	1.99
N/M	0.50
MP	37263.76
C	205119.83

Table 1: Data Analysis over Growth + Pref Attachment

Distribution	Estimation
Displaced Poisson	1.59
Displaced Geometric	0.50
Zeta Gamma	2.29
Zeta Truncated	103002

Table 2: Estimation of Parameters: Growth + Pref Attachment

Distribution	AIC Value
Displaced Poisson	253849.2
Displaced Geometric	33974.32
Zeta Gamma 3	17100.8
Zeta Gamma	**0**
Zeta Truncated	1.966677

Table 3: AIC Selection: Growth + Pref Attachment

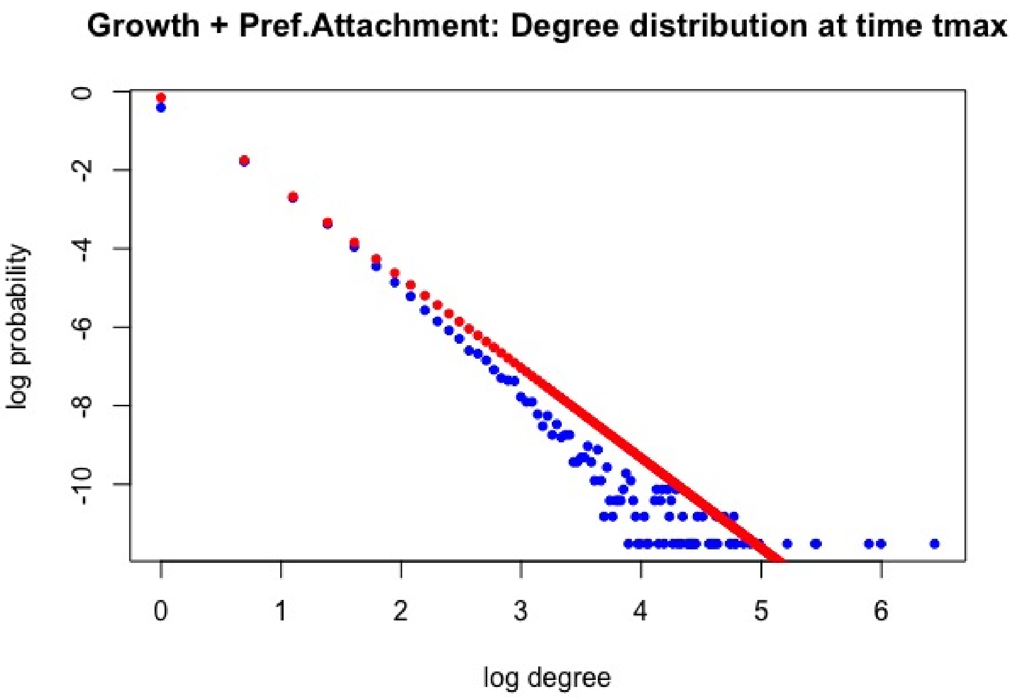

Figure 1: Degree t_{max} Growth + Pref Att with Zeta $\Gamma = 3$

2.1.2 Growth + Random Attachment

Parameter	Value
M	200002
N	100002
MAX	16
M/N	1.99
N/M	0.50
MP	50775.59
C	136242.14

Table 4: Data Analysis over Growth + Random Attachment

Distribution	Estimation
Displaced Poisson	1.59
Displaced Geometric	0.50
Zeta Gamma	2.07
Zeta Truncated	103002

Table 5: Estimation of Parameters: Growth + Random Attachment

Distribution	AIC Value
Displaced Poisson	82119.5
Displaced Geometric	**0**
Zeta Gamma 3	64197.51
Zeta Gamma	24921.01
Zeta Truncated	24922.54

Table 6: AIC Selection: Growth + Random Attachment

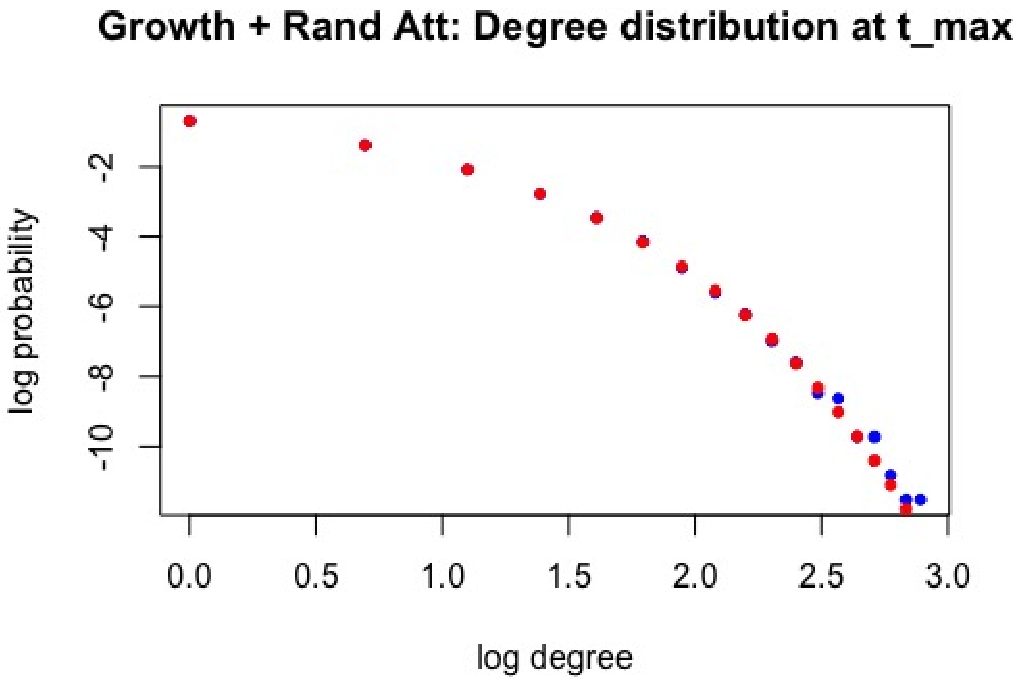

Figure 2: Degree t_{max} Growth + Pref Att with Displaced Geometric

2.2 Time Growth Degree Analysis

2.2.1 Growth + Preferential Attachment

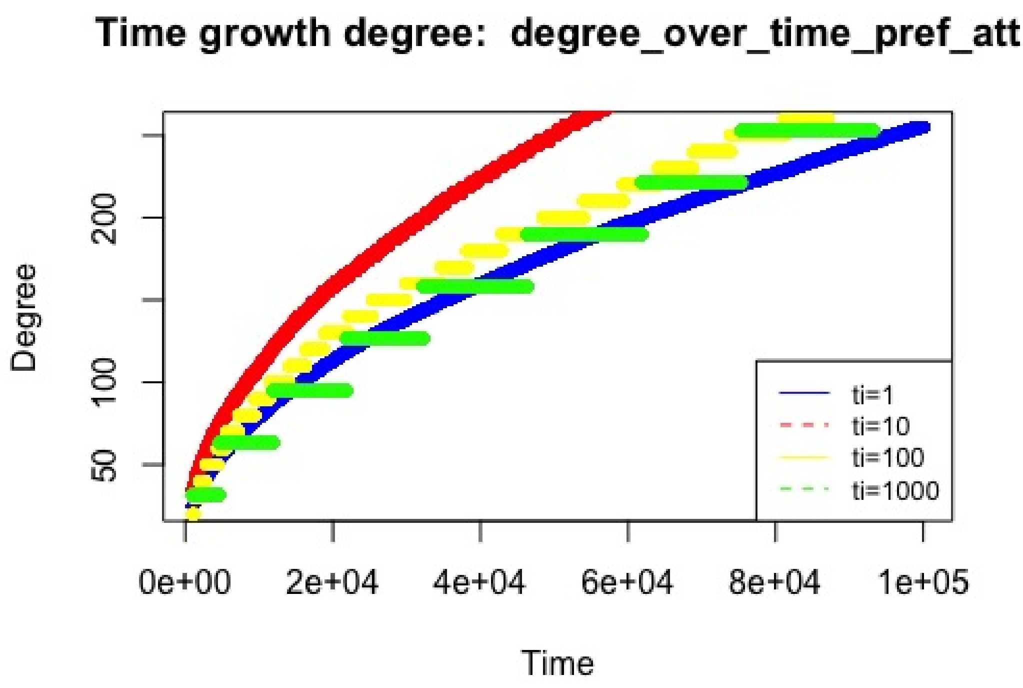

Figure 3: Time Growth Degree: Growth + Pref Att

Model	AIC Value
Model 0	827909.63
Model 1	98488.01
Model 2	98043.99
Model 3	696452.97
Model 4	869213.48
Model 0+	595689.50
Model 1+	95483.67
Model 2+	**82349.48**
Model 3+	696467.54
Model 4+	869216.84

Table 7: AIC Selection: Growth + Preferential Attachment over Time Degree

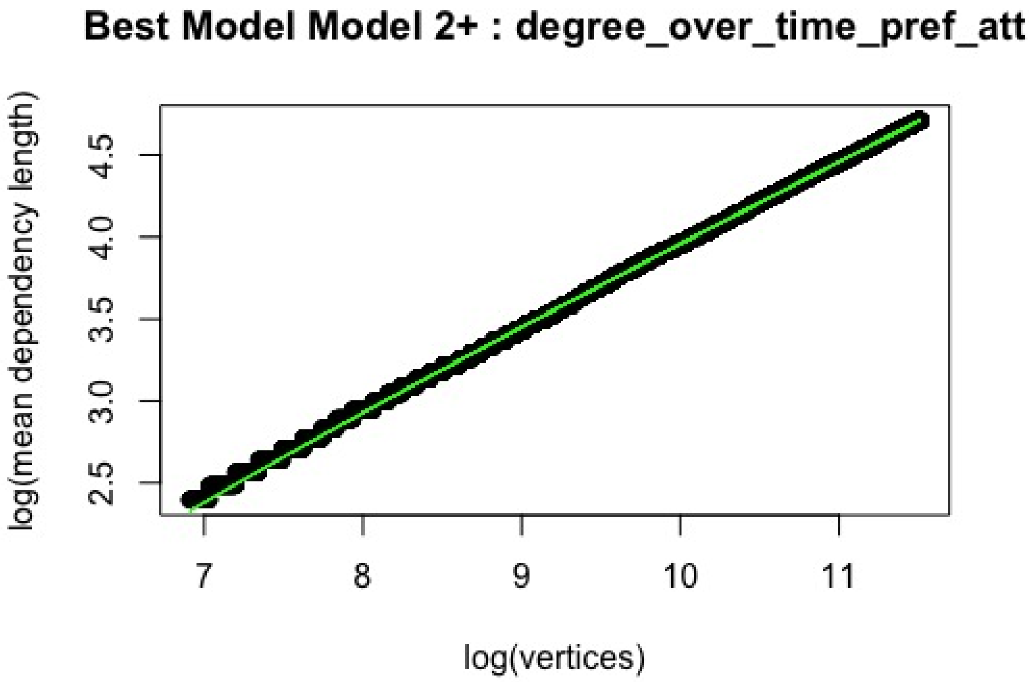

Figure 4: Best Fit Time Growth Degree: Growth + Pref Att

2.2.2 Growth + Random Attachment

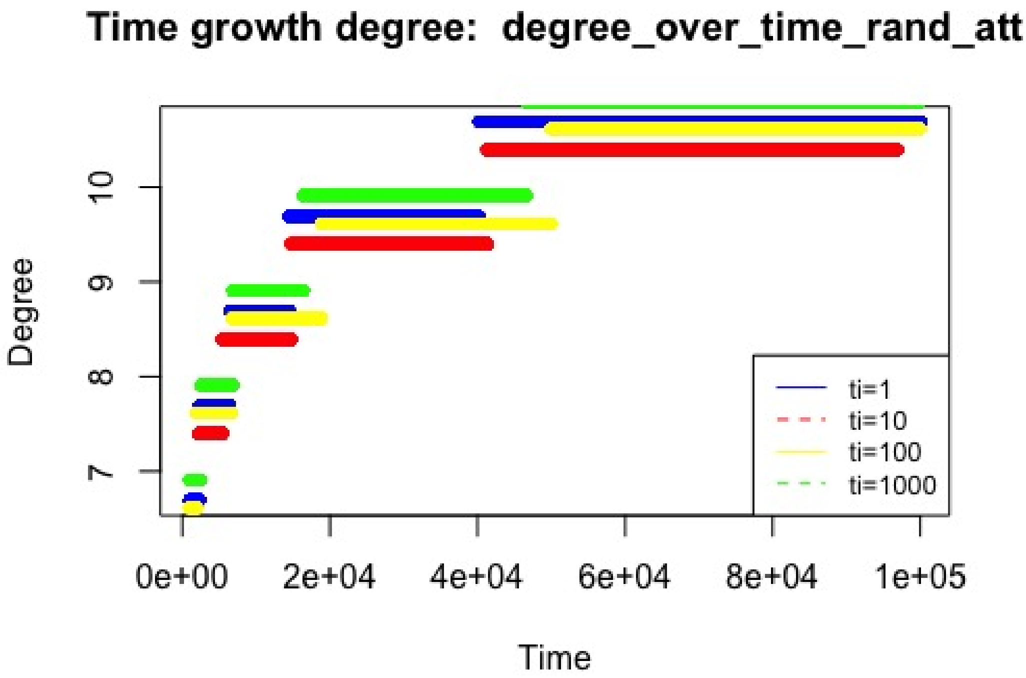

Figure 5: Time Growth Degree: Growth + Random Att

Model	AIC Value
Model 0	529661.14
Model 1	414515.14
Model 2	**40943.69**
Model 3	148894.78
Model 4	60229.36
Model 0+	140375.69
Model 1+	89613.81
Model 2+	45361.77
Model 3+	148896.86
Model 4+	60233.06

Table 8: AIC Selection: Growth + Random Attachment over Time Degree

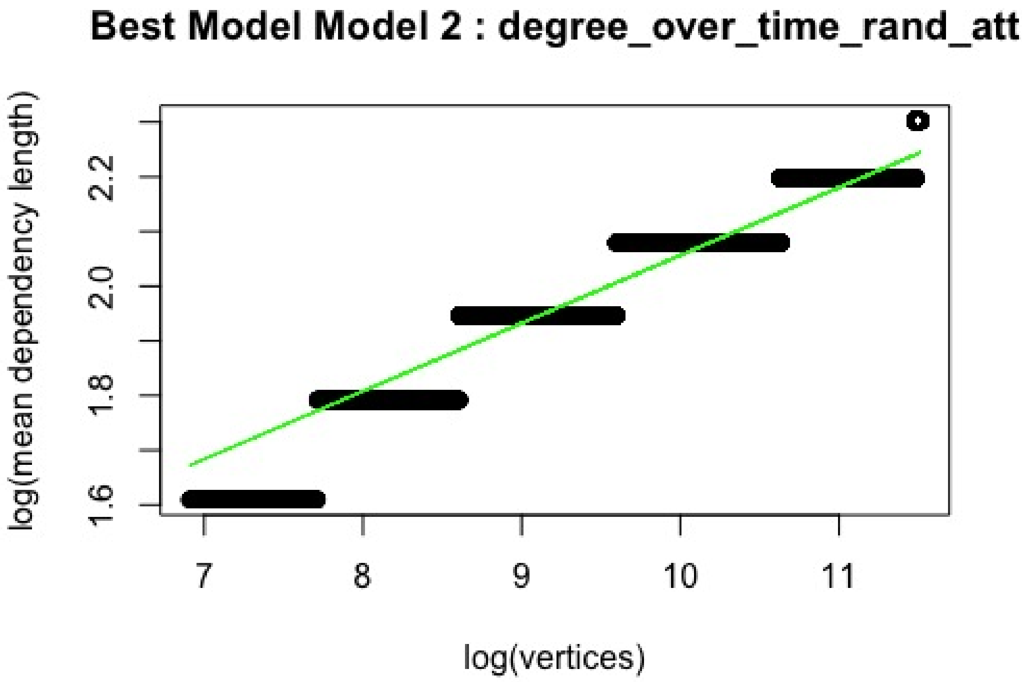

Figure 6: Best Fit Time Growth Degree: Growth + Random Att

3 Discussion and Methods

3.1 Methods

As we have pointed out in the introduction we have use **C++** code for generating the different kinds of Growth in the Barabasi-Albert model. This can be found in the source code file `code/main.cpp`.

Regarding *R* scripts we have the following scripts:

- `code/FromHomework2.R`: Which is the same script we have used on the Homework 2 for Fitting model analysis but we have change Zeta in order to fix $\Gamma = 3$
- `code/Task1.R`: We have developed here the analysis and plotting of the first task about analysis of Degree Distribution
- `code/Task2.R`: We have developed here the analysis and plotting of the first task about analysis of Time Growth Degree

3.1.1 Parameters Selection

Regarding the selection of parameters we have selected $m_0 = 1$, $n_0 = 2$, $t_{max} = 100.000$. This selection is based on the fact that we have tried different kind of alternatives, but the only one which has given the best fit in 2.1 is this set of parameters.

Other option that we have tested are:

- $m_0 = 2$, $n_0 = 3$, $t_{max} = 100.000$
- $m_0 = 3$, $n_0 = 5$, $t_{max} = 100.000$
- $m_0 = 5$, $n_0 = 3$, $t_{max} = 100.000$

3.2 Discussions

3.2.1 Degree Distribution Analysis

Regarding the Degree Distribution analysis we can appreciate that for G Pref Attachment we have checked that the best model that fits is the Zeta Distribution as it is expected according to its Akaike value and the plot obtained here 3 and here 2.

4 Conclusions

As we have appreciated in the 3.2 .....