Spatially-dependent growth model for lodgings-services network in urban areas

Juan M Hernández and Christian González

Institute of Tourism and Sustainable Economic Development (TIDES)
Department of Quantitative Methods in Economics
University of Las Palmas de Gran Canaria

September 19, 2017

Introduction

- Tourism development in certain destinations is an example of urban growth in a short time span.
- The industry is considered as a complex system and susceptible to be analyzed using complex network methodology.

Punta Cancún, 1970

- Distance influences on the decision to enjoy certain services
- Our **objective** is to represent the development of a tourist destination. It is based on evolving spatial bipartite network models with distance-depending attachment law [Xulvi-Brunett and Sokolov Phys. Rev. E, 66, 02611870, 2002]

Introduction. Empirical facts

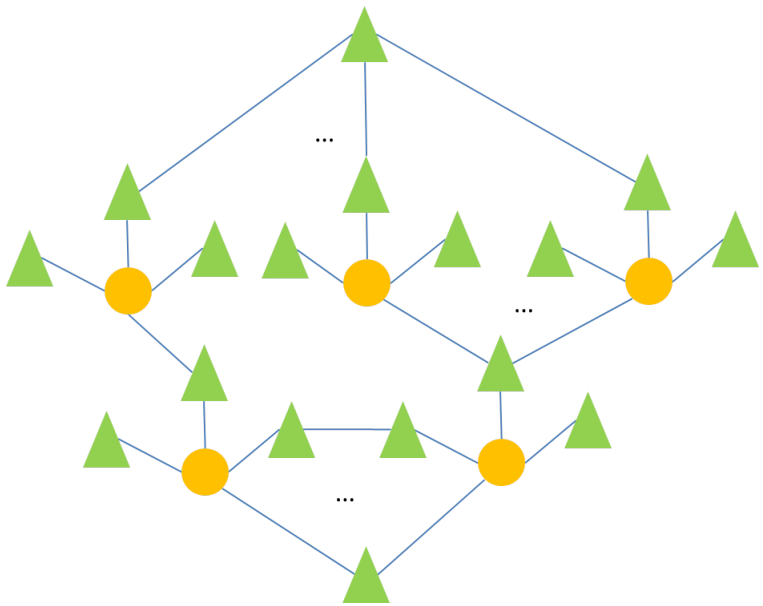
In particular, the model is inspired by the observations of the tourist activity developed in the southern area of the island of Gran Canaria, Spain.

Tourist area of Maspalomas (Gran Canaria)

Tourist area of Maspalomas (Gran Canaria)

The model. Assumptions

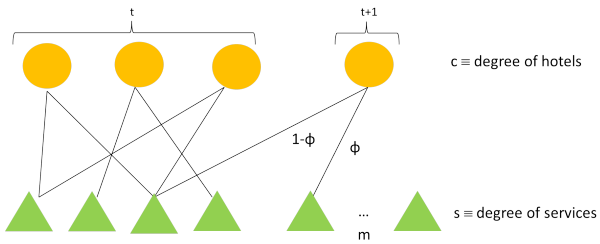
- Assume two categories of nodes, lodgings (H) and services (S).
- A link between a lodging $i \in H$ and service $j \in S$ appears if a representative tourist of lodging i visits service j during his/her staying in the destination.
- Nodes (lodgings and services) are located in a topological space which is represented by a planar network where distance is defined by the length of geodesic paths.



Spatial location of hotels (green triangles) and services (gold circles)

The model. Growing rules

- At any time $t > t_0$, one new lodging and m new services are created in the destination.
- A representative tourist of a new hotel i visit c services, $\phi \in [0, 1]$ of them at random and $1 - \phi$ by preferential attachment, following the rule $\Pi_{i \to j} \sim s_j d_{ij}^{\alpha}$, where $\alpha < 0$, s_j is the service j's degree and d_{ij} is the length of a geodesic path form i to j.



Representation of the growing rule of the supply network of a tourist destination

Empirical data

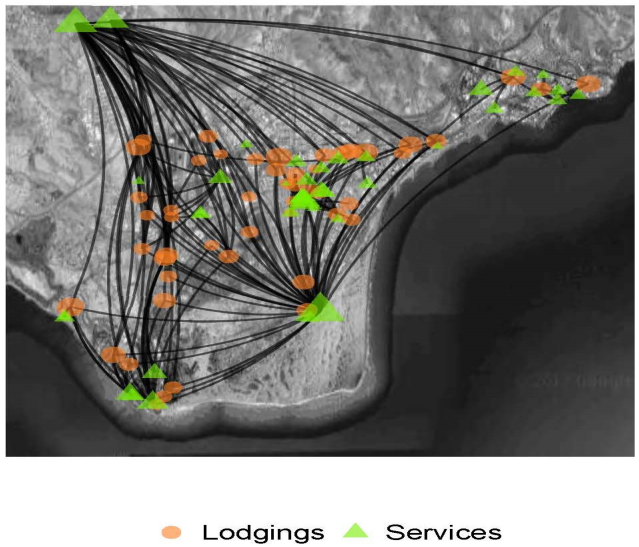
- The model parameters were adjusted to empirical data.
- The data are extracted from the tourist activity developed in Gran Canaria from 2005 to 2016.
- The data was collected from the user opinions published in the web-site trypadvisor.com.
- It includes some relevant biases:
  - Lodgings and services are limited to those published in the web-site.
  - The sample is also limited to those registered users.

Table 1. Basic statistics. $H \equiv$ Logings; $S \equiv$ Services; $L \equiv$ Links; $< c > \equiv$ Mean degree of lodgings; $< s > \equiv$ Mean degree of services; $\rho \equiv$ Density; $\bar{d} \equiv$ Average shortest path length; $C \equiv$ Clustering coefficient in one-mode projection.

H	S	L	$< c >$	$< s >$	ρ	$\bar{d}$	C
182	1,496	13,359	73.4	8.9	$9.5\ 10^{-3}$	3.28	0.55

Simulations and comparison with real data

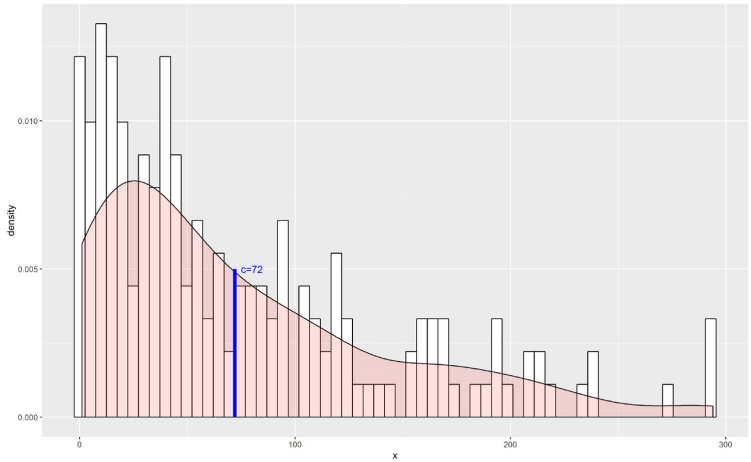
- Initially, we assume the existence of two extreme services in the network.
- The initial lodgings are linked to the extreme services.
- The hotels and the closest new services appear at every time step.



Representation of the lodging-services network in Maspalomas, Spain. The link lodging-service indicates that at least 15 opinions of the service was made by tourists hosted in the lodging. Node's degree is represented by the ball size.

Simulations and comparison with real data

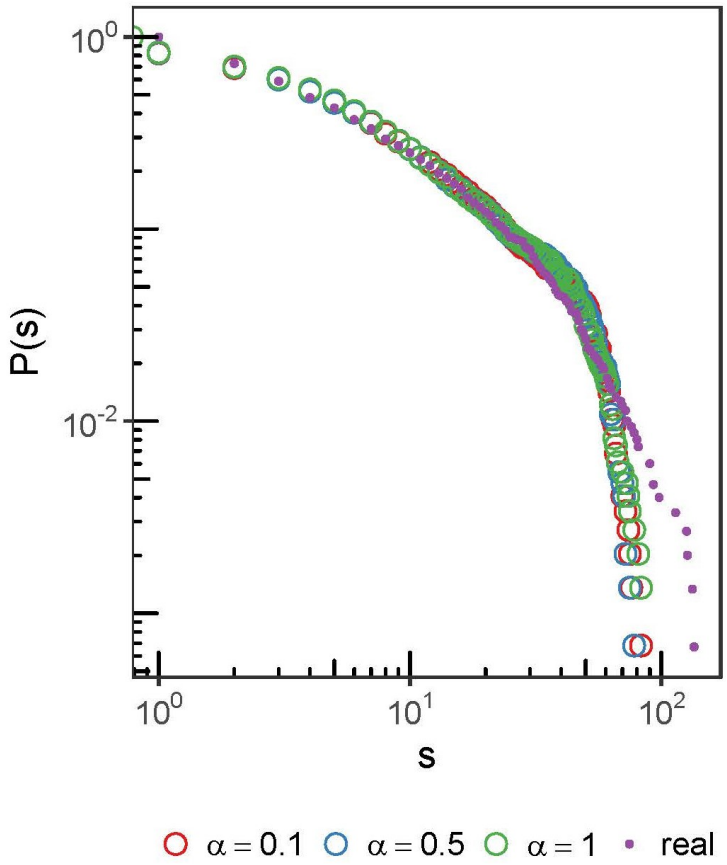
- The clustering coefficient and average shortest path length are similar.
- The degree distribution of hotels failed by assumption



Lodgings degree distribution in the empirical sample of Maspalomas (Gran Canaria). The lodging's degree in the model is $c = 73$.

Simulations and comparison with real data

- The degree distribution of services agree in the long term, but not for empirical size.



Comparison among the services degree distribution (s): Empirical (red points), simulated (circles).

Conclusions

- We have built an evolving bipartite network model that represents the supply network formed by the tourist visits to services, having into account the spatial restrictions of service location.
- The model fits relatively well the real data for a specific selection of parameters.
- Limitations and extensions:
  - Other economic characteristics from the supply-side (promotion, quality of the service) or demand-side (visitor's preferences) are not included.
  - Aging and links rewiring are not included either.

Thank you!