

# A probabilistic model to simulate urbanization

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## Introduction

Rybski et al. (2013) model the city growth in a region. The paper introduces a simple probabilistic model where urban areas in a given region expand over time based on distances from other urban areas - closer distance means higher probability for cities to emerge. The state of the system at a given point of time depends on: (a) an exponential parameter  $\gamma$ , which controls strength with which the probability (of new urban regions emerging) decays with distance and (b) the current iteration, as shown below in Fig. 1. The paper analyzes the spatial distribution of the cities as well as the relationships between the parameters and the properties of the region. We will use Cluster Size Distribution (only section III.A in the paper) to find various relationships and would not explore Fractality and Percolation Transition.

## Research Question

What is the relationship between the spatial distribution of the clusters of urban growth in a region and the parameters and properties of the region? Our sub-objectives to achieve this goal are:

- Write a program in Python using PCRaster which shows the growth of a city (initially a single point) based on parameters such as exponential decay ( $\gamma$ ), size of the study area ( $N \times N$ ), iteration ( $i$ ) and occupation probability ( $p$ ). We will be able to reproduce Fig. 1 from the paper after this.
- Find the relationships between Probability Density vs. Cluster Size (with iteration number in labels). We will be able to reproduce Fig. 2 (a) from the paper after we write the code for this sub-objective.

## Conceptual Model

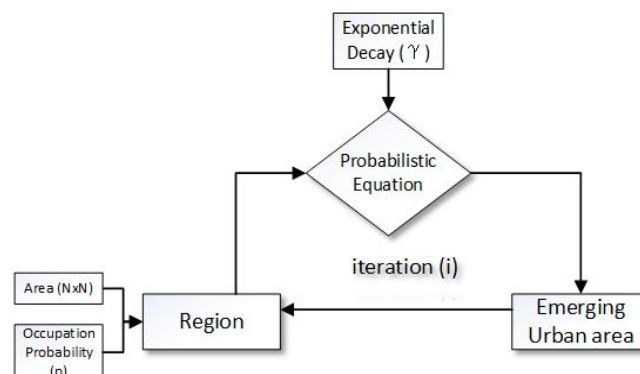


Fig. 1: The region under study is updated with each iteration by applying a probabilistic equation with a few factors & parameters

## Task Division

- Assessing the need for external Python libraries for implementing some parts (clustering algorithm) - Monica
- Implementing the model - Primit, Raphael & Zhendong
- Coding to re-generate the plots from Fig. 1 and Fig. 2 (a) of the paper - Primit, Raphael & Zhendong
- Understanding the results and presenting it - Monica, Primit, Raphael & Zhendong

## Planning

We are using [a GitHub repository](#) for working collaboratively on this project.

From the 15<sup>th</sup> to 22<sup>nd</sup> of January we are writing the code to implement the model. In the following week we are planning on finishing the coding part to reproduce figure 1 and figure 2 (a) of the paper (till the 28<sup>th</sup> of January). In the following four days, we are going to set up the presentation.

## References

Rybski, D., Ros, A.G.C. and Kropp, J.P., 2013. Distance-weighted city growth. Physical Review E, 87(4), p.042114.