D4D Challenge
Commuting Dynamics 4 Change

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Abstract

Our idea is to use the geolocation data from the antennas processing the mobile phones calls in order to know which sub-prefectures the customers have been getting around. The main goal of our project is developing spatio-temporal models to detect commuting patterns for the different sub-prefectures, including some other factors related to the region and/or time: wealth, development, infrastructure, investment, grants...

By means of GIS technology, we will be able to apply our generated models to the gathered data and to analyze their correlations over the Côte d'Ivoire surface, working with geographical layers: landcover, roads map, railways lines, water sources... Consequently, the reached conclusions from our study will be properly visualized, allowing a better explanation of the facts. With a bigger amount of data gathered for a longer period, more interesting and accurate trends could be discovered, allowing us to calculate associated coefficients.

Our analysis models will provide coherent data to support a correct urban design and will mean a monitoring tool for development, specially related to population dynamics. In the near future, some other measures could be included. For instance, hospitals and police stations locations, their calls rate... Thus, we could know its real use, being able to improve their service to the citizens: dangerous areas, crowded hospitals...

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1 Introduction

Our aim and final goal in this project is to detect spatio-temporal patterns in order to obtain an usefull knowledge to manage better the country resources. As example, if we can predict the intensity of traffic segemented by road, day of the week and hour, could be suggested anothers secondary roads or invest into improve the most used ones.
In this paper is proposed a space-temporal model in order to achieve this goal. A space model because user interactions or dynamics with geolocate antennas are analized and treated, and a temporal model because several time windows are used to group this user dynamics. Later, the mix of this two variables (space and temporal) are consumed and visualized by a Geographic Information System.

The aim comes to the Commuting concept and could be defined as follow: *Commuting* is regular travel between one's place of residence and place of work or full-time study (Wikipedia, 2012), but sometimes its refers to *any regular or often repeated traveling between locations when not work related.* Our first commuting approach is defined like: "Mobility patterns through infering dynamic users movements grouped by temporal windows".
A dynamic user is defined like an user that change his antenna position into the studied temporal window (i.e.: each temporal window group the whole user communication into one specific hour). Between this temporal windows static users habe been removed, i.e.: users that does not change its antennas positions into the temporal range. The justification to remove this users comes to focus our study in users that are moving into this temporal windows and perform micro-displacements.

2 Mathematical model

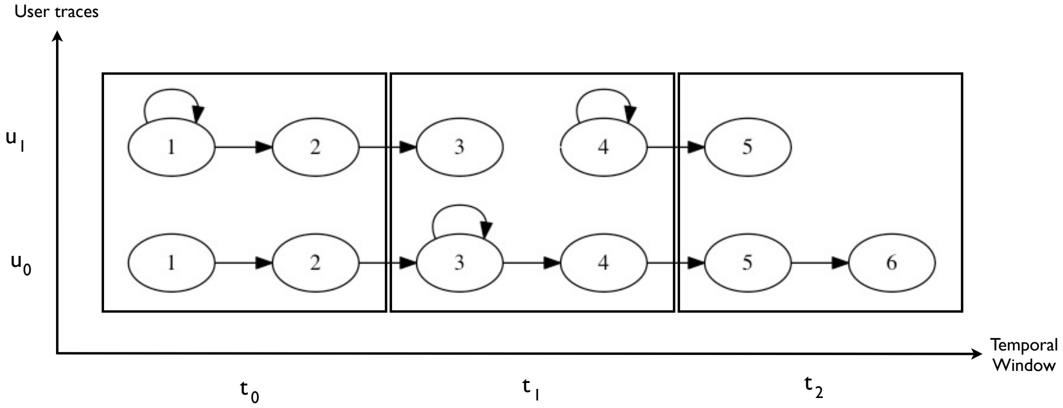

Figure 1: Dynamic and static user patterns

The above figure shows two users u_0, u_1 repesented on the vertical axe, grouped by three time windows t_o, t_1, t_2. A time window is defined as t_n where $n \in \{0, .., 24\}$. Each t_n group the comunnications traces of the whole set of users in a 60 minutes range.
More formally, an user trace is defined as follows:

$$\vec{T}_{ut} = (p_0, p_1, ..., p_n)$$

where, $p_n \in \mathbb{R}^2$, $n \geq 2$, t is a temporal window range and , u the unique user id.
For instance, $\vec{T}_{00} = (p_1, p_2)$, $\vec{T}_{10} = (p_1, p_1, p_2)$ and so on.

Also, two functions are defined in order to meassure the distance (Cook, 2012), given a set of points in spherical coordinates (i.e.: user$_{ut}$):

$$D(p_0, p_1) = \text{acos}(\sin(\phi(p_0^0)) * \sin(\phi(p_1^0)) * \cos(\theta(p_0^1) - \theta(p_1^1)) + \cos(\phi(p_0^0)) * \cos(\phi(p_1^0)))$$

where:

$$\phi(x) = (90 - x) * \frac{\pi}{180}$$

$$\theta(x) = x * \frac{\pi}{180}$$

therefore the function realated with distance as defined as follow:

$$U(u, t) = 6373 * \sum_{i=0}^{n-1} D(\vec{T}_{ut}^{\,i}, \vec{T}_{ut}^{\,i+1})$$

The second function is related with the number of antenna connections into a trace, the key point is to count only the dinamic transitions, i.e.: remove the self edges over a given trace as follows:

$$\text{S}(p_0, p_1) = \begin{cases} 0 & \text{if } D(p_0, p_1) = 0 \\ 1 & \text{if } D(p_0, p_1) > 0 \end{cases}$$

therefore, the function is defined as follows:

$$N(u, t) = \sum_{i=0}^{n-1} S(\vec{T}_{ut}^{\,i}, \vec{T}_{ut}^{\,i+1})$$

Results

bla bla

Model and Data challenges

to show the last dimension of aour model (the geographical one).
finish to link to whole research work.

Final Conclusions

Several algorithms has been implemented and tested. We observe that we can identify main parameters like ρ in order to enhance exploration or enhance exploitation. Also, several approachs have been studied in a real problem trough a labeled graph map.
We provide our source code[1] in order to allow researchs and students check our results and experiment with this algorithms.

[1] https://github.com/yarox/alos

References

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