

Títol	Hodge decomposition to understand how the spatial layout of cities affects citizens mobility
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Motivació, descripció dels objectius i els mètodes del Treball Final de Màster

Vector fields are the convenient mathematical objects in physics to describe the motion of particles in a fluid, the direction and magnitude of a force, or the flow of a fluid. Several attempts [1,2,3,4] have been conducted to introduce this concept to study human mobility, most of them in the continuous domain [1,2,4]. This may become sufficiently detailed at interurban scales or when studying commuting patterns. However, in the intra-urban layout most of the normative mobility happens upon networks: sidewalk networks for pedestrians [5], road networks [6], or public transport networks [7], or a combination of them. In this case, one needs to rely on Hodge theory [8], the equivalent of Helmholtz decomposition on the discrete graph domain, which is barely explored [3] in the complex networks field.

The main objective of this master thesis is to understand pedestrian and vehicle mobility within cities, through Hodge decomposition of the vector field defined by citizen mobility. In particular, the different components of the vector field may help to understand how the spatial layout of the city affects citizen mobility: does it facilitate social interaction of dwellers? Is it relevant for road congestion? Or, else, it helps to naturally define traffic islands?

In the master thesis, we define two main and a secondary objective:

- Define mobility (vector) fields in terms of graph non-biased random walks and study their patterns via Hodge theory.
- Construct road and pedestrian networks for several big cities and apply the Hodge decomposition.
- Relate the different components of the vector field: gradient, curl, and harmonic to urban features.

Bibliography

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¹Si el director no pertany a un Departament amb docència en el màster, caldrà assignar un tutor del TFM designat per la Comissió Coordinadora del màster.

Tasques a desenvolupar		Cronograma (setmanes)																			
Tasca	Breu descripció i hores estimades ²	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20
T01	Cerca bibliogràfica (75 h)	X	X	X								X	X								
T02	Discussió dels objectius (25h)		X	X	X																
T03	Resolució del problema (150h)				X	X	X	X	X	X	X	X	X								
T04	Anàlisi de resultats i retroalimentació (100h)											X	X	X	X	X	X				
T05	Redacció de la memòria (75h)															X	X	X	X	X	
T06	Preparació de la defensa (25h)																			X	X
T07																					
T08																					
T09																					
T10																					

Observacions i altra informació addicional

Signatura (el director del TFM)

Javier Borge-Holthoefer

Signatura (el tutor del TFM, si s'escau²)

²Modifiquen la taula per tal que s'ajusti a l'estudi o projecte. El total de la dedicació al TFM per part de l'alumne no ha de superar les 450 hores.

³Si el director pertany a un Departament amb docència en el màster, aquest actuarà com a tutor.