Mapping Memes in the Napoleonic Cadastre: Expanding Frontiers in Memetics

Petitpierre, Rémi

remi.petitpierre@epfl.ch
EPFL, Switzerland

Memetics is an evolutionary analogy, which formulates the concept of meme, an elementary replicator of cultural ideas. A meme can be a tune, a catchphrase, or an architectural detail, for instance (Dawkins 1976). If we take the example of maps, a meme can be expressed in the choice of a certain texture, a colour, or a symbol, to represent the environment.

The validity of meme theory and its pragmatic relevance to the humanities are widely debated (Edmonds 2002; Atran 2001). Complementary mechanisms such as self-organization, and Lamarckian heredity of acquired traits are highlighted in some fields, notably in urbanism and social sciences (Leonard 2016; Moroni et al. 2020). In social sciences, generalized Darwinism also tends to defend the differentiated existence of a meme (replicator) and a pheme (expression, interactor) (Breslin 2011).

Practically, the link between meme and pheme is tough to trace. Replication fidelity also remains an issue; the inability of validating the correspondence between similar visual elements and a meme undermines the conceptual power of the theory. For these reasons and because of methodological gaps, memetics remains often circumscribed to case studies in social networks science or anthropology, where the unit of replication is clearly defined, and the diffusion is traceable (Franz / Nunn 2009; Hewlett / Cavalli-Sforza 1986; Reyes-García et al. 2009; Gomez-Rodriguez et al. 2012; Guadagno et al. 2013).

Here we present a methodology to extend computational memetics to the study of material traces, in particular cartography. We also propose to investigate the limits of replication fidelity, and the relationship between memes and phemes, through a case study on the Napoleonic cadastre. The visual principles of the latter are explicitly formulated in the 'Recueil méthodique' (Hennet 1811). It is therefore an ideal case to study how the same figurative idea is expressed in various contexts.

We work with two corpora. The first contains over 10,000 French and Swiss maps (1600-1950). It is used for the contextual analysis, and feature space optimization. The second consists of 1,576 plates of the Napoleonic or 'renovated' cadastre (1811-1888) depicting fifteen cities and four rural regions, in four countries. It is on this specialized corpus that we investigate the replication fidelity and the relationship between phemes and memes.

First, the digitized maps are filtered and normalized. The geographic layers and the background are segmented using OCRNet (Yuan et al. 2020). The images are then cut into 50×50px tiles, which we call 'mapels'. For each map, a sample of 800 mapels is taken, representing the map's figuration and phemotype.

Candidate graphical features, selected from the literature in map processing, are computed on each mapel. These features describe color distribution, morphology, texture, graphical load, line thickness, and orientation.

The most relevant features among the candidates are selected and assigned a weight using a genetic algorithm. The optimization is based on 11 map series from the first corpus, which form homogeneous figurative and editorial ensembles. The objective is to maximize the geometric distance between these series. In the end, 28 features are retained. Mapels are considered as corresponding to the same pheme if the distance between them in the feature space is below an optimized threshold r.

In a preliminary quantitative analysis based on the frequency of the phemes in corpus 1, by temporal strata, the most consequent change in the whole period covered occurred around 1817. We see a significant and lasting shift in the figurative codes of cartography at that time. In particular, we denote a disruptive evolution regarding the scale. The figuration becomes more and more specialized according to the scale, which results in a divergent use of phemes. These results stress the importance of studying what was perhaps the largest cartographic undertaking of the time: the Napoleonic cadastre (Clergeot 2007).

Based on semantic segmentation and phemes extraction, we study the figuration of the Napoleonic cadastre (Fig. 1). Speaking of replication fidelity, no cadastre in corpus 2 seems to strictly follow the rules of the Recueil méthodique. Based on the geometric distance between series (Fig. 2), the Antwerp cadastre appears to be the most central phemotype we have; it also shows the highest figurative consistency. However, even this cadastre does not comply with all the instructions from the Recueil, e.g. reinforced line in the shadow (Fig. 3). The centrality of this cadastre echoes Antwerp's centrality in the european economy. Its dynamic printing industry could also have favored the diffusion of ideas. In general, the phemotypic centrality of Belgian-Dutch cadastres is higher than that of French cadastres, although the impetus was originally French. Urban cadastres seem also more central than rural ones, which is fully consistent with the theories on the diffusion of innovations. As for the temporal diffusion of the Napoleonic cadastral memes, the figurative consistency tends to decrease gradually, between 1811 and 1888 (Fig. 4). This could be interpreted as a gradual decrease in replication fidelity.
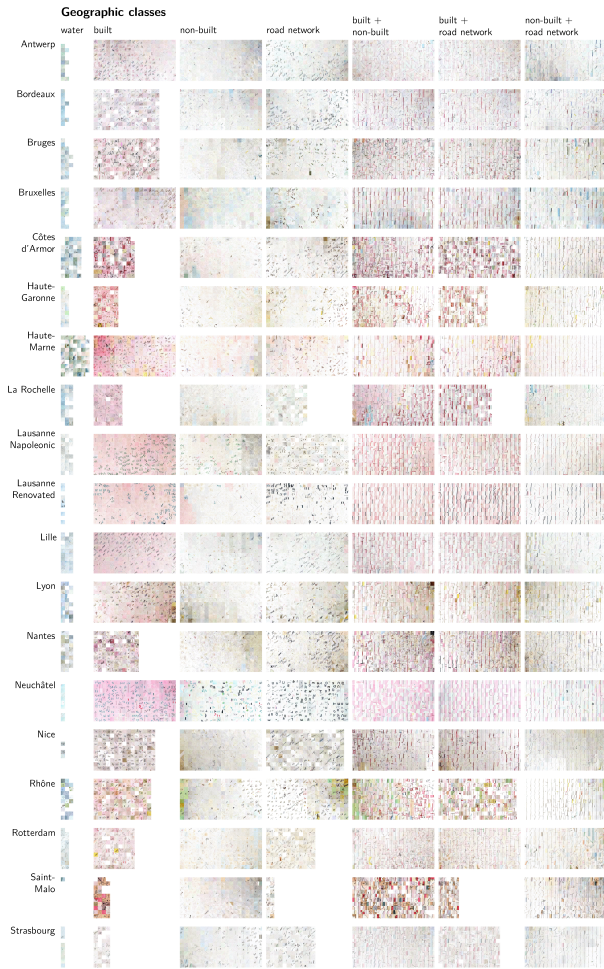
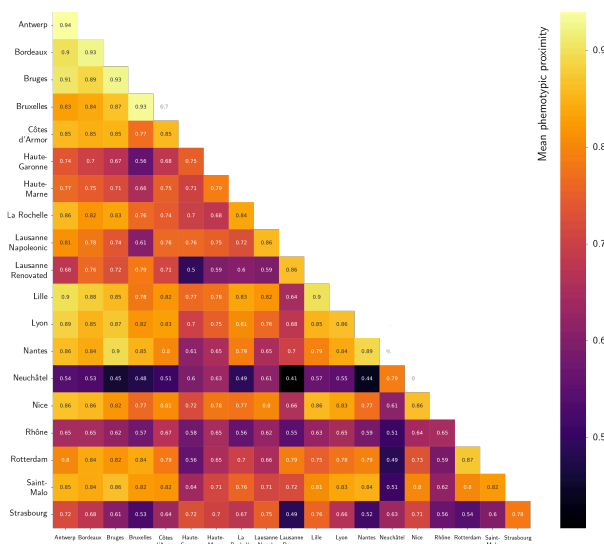Figure 1. Most common phemes, per cadastre and geographic classes.

Figure 2. Matrix of mean geometric, or phemotypic, proximity between cadastres.
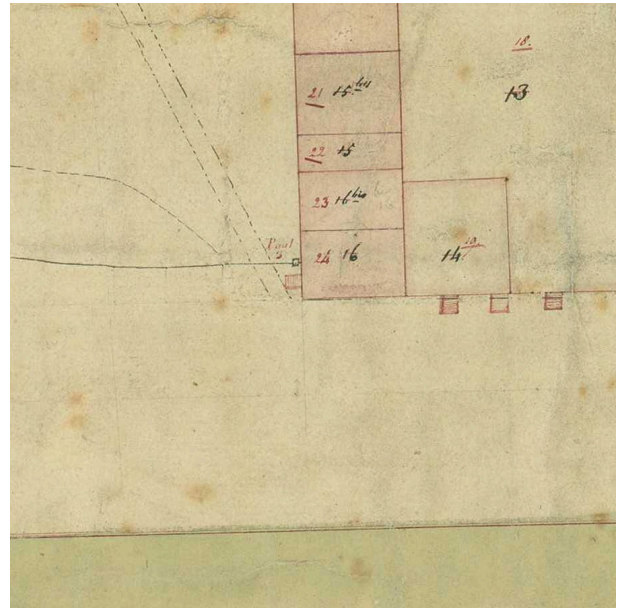

Figure 3. Excerpt from the digitized Napoleonic cadastre of Antwerp (1823).
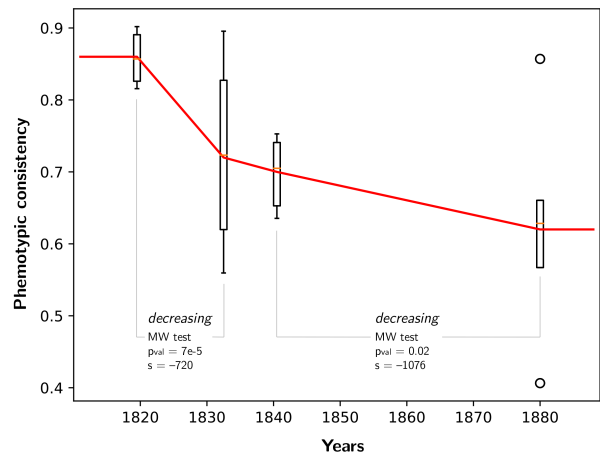

Figure 4. Mean consistency of cadastral phemotypes, by temporal stratum.

On the relation between memes and phemes, we show that it is possible to classify and distinguish the Napoleonic plates, against corpus 1, based on only 552 phemes (Fig. 5), i.e. less than 1% of the observed phemes. At test time, a recall of 87% and 93% precision is achieved with a simple classifier. In comparison, chapters 1.X and 2.IV of the Recueil state 94 basic figurative principles (memes). Phemes are both non-specific and more numerous than memes. There is simply no function such as Me = f(Ph). However, our results show some co-occurrences.

In conclusion, memetics is not only practical, but could even be a prolific, approach for studying material traces, and the semiotics of cartography. We propose a novel methodology, digital memetics, to concretely trace the spatial and temporal diffusion of ideas over the long term.
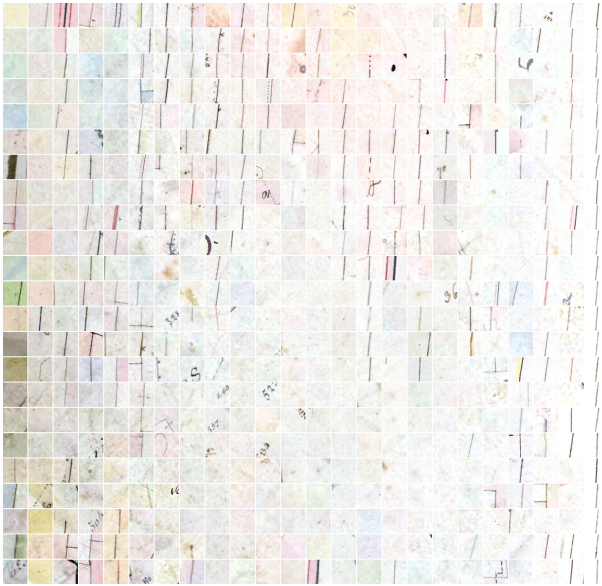
Figure 5. Characteristic phemes, used for the classification of the Napoleonic cadastres.

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