Signs of Heritage - An Agent-Based Model of the Dynamics of Heritage Categories

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Abstract— **In recent times, heritage has become a key focus of socio-economic concern due to its connections to history, nationalism and especially tourism. It has been highlighted as having major consequences for the sociocultural engagement of local populations. The notion that tourism transforms local heritage through its categorising of local realities has become particularly widespread. However, the specific mechanism through which these transformations occur has remained unformalised in cultural heritage studies. This has lead to a lack of computational approaches to the issue of heritage categorization, which can articulate with other issues of tourism promotion and management. In this paper we conceptualise the cultural dynamics of heritage, such as the changes in categories used to signify heritage, designing and analysing a dedicated computational Agent-Based Model of heritage engagement. In it we seek to explore the role of communicative strategies, as they tie to social groups, as well as the specific topologies of interaction networks. With this, we seek to understand what role mediation, such as that produced by online platforms, can play in producing different levels of consensus between tourists. Results suggest that topology plays the greatest role in generating consensus in the evolution of heritage meaning, with different patterns emerging according to the communicative strategies undertaken. These results have implications for future directions of study of heritage and heritage modelling, placing emphasis on the need to analyse tourist communication contents, as well as being potentially useful for public policy on heritage management.**

***Index Terms*—Agent-Based Modelling; semiotics; heritage; sociology of culture**

I. Heritage Forms and Heritage Meanings

It is an often asserted that cultural heritage is the product of its time, its people and their concerns [1]–[6], and that, owing to that, it is a site of contestation and constant redefinition [4], [7], [8]. It is also accepted that heritage is first and foremost the product of individuals, groups and their social conceptions, and only later institutionalised and legitimised. This means that *elements*, physical entities in the real world such as a church or a door, can be considered heritage to different individuals, through different ways: when we look at a church we can see in it a prime example of National History – the lines it traces, the windows, the light – as much as we can see in it a marker of the Local Community's experiences. In both cases the association can lead us to consider it heritage. These categories of concepts have a cognitive and individual existence as much as a social one, and they tie in together to form conceptual clusters. As such, we can see heritage as being constituted by multiple intersecting categories, and the ontological questions of what heritage *is* amounting in part to the question of which categories are more relevant within a given context.

In all of this lies the idea that it is the continuous re-interpretation by individuals which produces the idea of heritage in a given context, something which is necessarily dynamic [9, p. 2]. Nonetheless, the question of how heritage is transformed – how its meaning changes, or more specifically, how those ways of seeing are changed – is often posed within very specific contexts: as the product and effect of touristic gazes and performances [10,11]; as an attempt to aggrandise national-historical narratives [12,13]; as a product of globalisation [14]; or as the result of specific tensions within and between groups of various social status [8].

Zooming in particularly on heritage tourism, John Urry [11] presented the notion of the "touristic gaze" as a set of expectations that tourists place on local contexts of heritage, and which tend to impose a certain set of categories for interpreting these contexts. In this vein, there is the notion that tourism transforms local heritage through creating a set of categories to interpret the local reality. It implies that tourists generate in local contexts a form of implicit and unwarranted consensus over the categories under which heritage falls. This is relevant for the ambitions of cultural and tourist policy makers to design specific narratives and experiences that anchor the cultural assets available [15]–[17]. Moreover, this also ties with computational and technical ambitions to reason about tourist behaviour, namely factors which affect tourist preferences, in order to optimise their experiences [18], [19].

This paper centres on two baseline questions that relate to this discussion:

i) How can we formally represent the dynamics of heritage as a process of tourism shaping local opinions?

ii) What role do network topologies and group orientations have in generating greater consensus in local contexts of heritage?

The work presented here serves as a first attempt at tackling the issue of how the categories associated with heritage change within a local population over time with the process of successive interpretations and successive actions of tourists, through a dedicated agent-based model. It does so from a social scientific point of view, with the goal of providing a computational tool to reason about these phenomena. It seeks to emphasise the role of communications produced by tourists, and the network arrangements of such tourists, in influencing the consensus over the local meaning of heritage.

Previous research into these issues has mostly focused on issues of class [20], the motivations of cultural tourists [21], as well as the role of local communities [22], [23], in affecting the semiotic context of local heritage sites. Despite the social and group oriented component of tourism (i.e sharing the experience with peers) having been recognised as relevant factors in defining how tourists engage with cultural heritage [5], [10], these aspects remain unexplored in the literature, with some exceptions coming from leisure studies [24] or communication studies [25]. Social networks of tourism and their communicative patterns have largely remained outside the scope of such studies. Moreover, most if not all of these studies have been done from a non-formal or computational perspective, which imposes difficulties in reasoning about large numbers of tourists producing small impacts.

The paper is structured in the following way: we begin, in the next section, by attempting to define a more foundational concept of heritage and interpretation, attempting to piece such a concept out of the broader notion of culture and cultural semiosis, as well as defining the way we chose to model these processes. We then attempt to produce a computational representation of such concepts, through an agent-based model. In the following sections we proceed to analyse the results of the model, exploring several micro-parameters before turning to the role of communication and network topology as essential parts of the dynamics of heritage. Finally, we bring back the discussion of how we can understand heritage dynamics, the limitations of the model and analysis, as well as further lines of research.

II. DEFINING CULTURAL HERITAGE

In order to discuss and computationally formalize something like the dynamics of heritage, we must first have at least an operational definition of what a cultural heritage system may be. We have already stated some basic principles of what heritage must be analytically, which we can briefly summarise:
1) It consists of a set of elements which individuals consider belong in the category of “heritage”;
2) Those elements are taken to belong to certain other conceptual categories, which are associated with being heritage.

As mentioned, an **element** is a physical entity which individuals perceive (cf. Table 1).

To work our way towards a more concrete definition, we can use a baseline example: when an individual says that a given church is heritage, what leads him to make such an assertion?

From principles 1) and 2) we can see that the question of heritage lies in how certain elements are taken in a way to “mean” heritage for a group of individuals. Indeed, similar problems lie at the heart of cultural sociology and its task of conceptualising culture. We can look to the works of Alexander [26], Archer [27], Bourdieu [28] or Geertz [29] to see multiple accounts of how culture develops, is institutionalised and evolves over time, with widely varied perspectives and approaches. Despite their many differences, these authors have in common their admission that culture is at its core a semiotic process, and that in its essence, the question of how something like “Heritage” exists socially is a semiotic one. In this work, we follow in line with Metro-Roland’s [30] application of Charles Sanders Peirce [31] concepts of semiosis.

Concept	Description	Example
Element	A physical entity	An object designated as "a church"
Category	A collection of elements tied together by a perceived similarity	Gothic Architecture
Interpretation	The assignment of an element to a category	The thought "the Church's architecture is gothic"
Prototype	Cognitive structure that defines what is considered most typical of a category	The church arches, which are seen as crucial to it being gothic
Semantic Web	Collection of categories associated to a given category	Medieval History and the Black Plague as categories tied to Gothic Architecture
Action	Interaction with the system based on interpretation	Saying "I enjoyed the gothic architecture at the site, such as the church"

Table 1 - Table of Concepts and Examples

What Peirce called an *objekt*, for our purposes can be considered a **category** – a cognitive structure which collects elements and aspects of those elements based on a perceived similarity, making it a “meaning” of the element. Individuals then make an **interpretation** when they assign an element to a category which, in line with Rosch’s approach [32], [33], is thought to work on the basis of specific **prototypes** – a function that says which elements in a category are more common or more intuitively associated with it (cf. Fig. 1, below). For instance the idea of “Gothic Architecture” may be tied with the Ogival arches, according to a prototype of Gothic Architecture that places arches as a very strong marker of the category. In this we assume that, up to a certain limit, more complex prototypes, in the sense of having more elements previously categorised, lead to higher tendencies to assign elements to that category in the future – the individual becomes disposed to interpret new elements as belonging to that category, in a vein similar to the logic of habituation [34], [35].

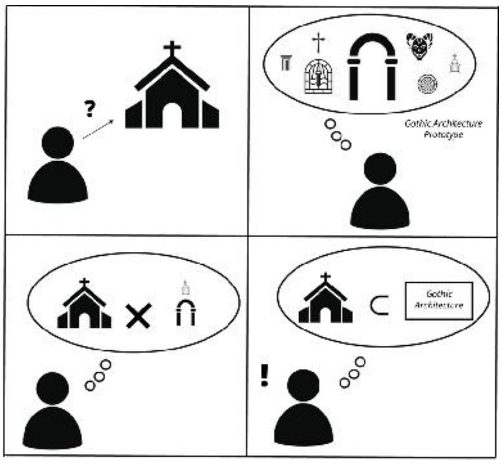

Fig. 1. Representation of the process of interpretation: Agent identifies an element and checks it against the prototype of a given category. If he finds sufficient similarities, he will consider that the element belongs to the category.

It is intuitive to see that these categories will have some properties in their relation to each other. Namely, they can be related through a form of implication, whereby if an element A belongs to "Gothic Architecture", then it will belong to "Heritage" as well. In that sense, rather than interpret something as belonging to the category of "Heritage", individuals would interpret it to belong to "Gothic Architecture", and in turn consider it heritage. The set of such categories tied to Heritage is what we will call the **semantic web** of heritage. It seems unproblematic to assume that not all categories are equally likely to be connected to heritage: some, like National History, may be strongly linked, in that when a person interprets a given monument as belonging to National History, they tie it to Heritage; others, such as "Classical Tilework of the 1960's" may be more circumstantially linked to Heritage.

In this way we assume the relationships outlined in heritage studies, such as the relevance of national identity or community memory for the formation of heritage, to be relationships between these categories and the category of heritage. If individuals have a complex prototype of National History and interpret monuments to be heritage through their belonging to National History, then this could be a case where heritage is tightly linked with nationalistic narratives.

In order for these representations to matter, in the sense that they influence in some way the behaviour of a system, we can turn to a classic symbolic interactionist tenet: Individuals act upon things based on the meaning that they attribute to them [36]. It is through **action** – such as saying to a friend "That church is a good example of Gothic Architecture" – that heritage is transformed, through some degree of effect on other individuals. The system of heritage – in a sense close to critical realism [27] – is what individuals take to belong to that category, and what actions they take on that basis.

Our interest lies in how a group of agents – tourists – transforms the distribution of categories by shaping the semantic web towards the categories most associated with them. Drawing from John Urry's theories, we see tourists as being drivers of transformation through their expectations and through the associated structures which are developed to support touristic activity.

This approach tries to take on an alternative route to most other attempts at formalising cultural dynamics: it assumes a processual, continuously produced nature of culture, closer to the cognitive processes which are present in the social world, and assumes that the categories are borne out of the continuous interpretation of agents. We can contrast this with the classical formal model of Axelrod [37], which saw culture as traits in a population, which whilst metaphorically understandable, does not differentiate between the specific categories which are defined as culture and does not have clear ontological correspondence to the analytical domain at hand [38]. By incorporating the structuralist assumptions that cultural systems such as those of heritage should be represented as emergent from the behaviour of dynamical agents, it seeks to open a vein of work into cultural dynamics, bringing together numerous discussions on the sociology of cultures and groups [28], [39]–[47]. The work also focuses to an extent on questions of consensus which have been the hallmark of the opinion dynamics literature [48]. However, rather than focusing solely on consensus, the key focus here has been on the specific strategies undertaken by agents to communicate, the specific content they focus on, as well as paying greater attention to the social orientation of the agents.

III. Formal and Computational Models

Following on the previous description of heritage systems, we attempt here to formally outline the dynamics of heritage transformation via tourist interpretations by considering: a) the tourists as interpretative agents; b) a network based on a relation of acquaintance or friendship; c) the local contexts, represented by monuments; d) their interpretative process as an evaluation based on their prototypes and the local prototypes found. One aspect which should be put forward is that we assume a distinction between being in a context of interpretation – what we deem in the model as the "Monument Area" (MA), a physical location which brings together multiple elements – and being outside of it, given the focus on tourism. A pseudo-code algorithm can be found in the Appendix.

A. Agent Models

We consider our agents to possess four distinguishing features: a limited lifetime, a set of individual prototypes for a given number of categories tied to heritage, a set of connections they establish with other agents, as well as a certain amount of social influence which depends on the number of connections they have to other agents. Agents change their location only in order to interpret monuments.

Besides the individual prototypes, they have the ability to interact with a general prototype which stands for a general social representation of heritage. This stands for the idea of a Monument Area having a semiotic image, which it projects onto the agents, and which influences them in forming their own prototypes regarding the categories that tie into heritage [10], [30]. As an example, consider a set of internet reviews, which a tourist consults before visiting a monument area, that mention a number of important aspects – the Architecture of the place, which is said to be Neo-Classical, the National History events that took place there, amongst other things. The tourist forms a certain expectation and understanding of the MA, based on these ideas, even before visiting any monuments.

Prototypes are modelled as vector-elements of a vector, $V_n = [x_1, x_2, \ldots, x_n]$, with the size standing for the number of distinct categories. For each agent, its individual prototype is defined as a vector, with each x representing a category:

$$I_{n} = [x_1 \quad x_2 \quad \cdots \quad x_n] \tag{1}$$

The values of each vector element capture how probable it is that the agent will interpret a new monument-element, or monument, as belonging to that category. The sum of all vector-elements adds to 1. We thus assume that the complexity of the prototypes is related to the probability of interpreting elements. This means that a more complex category will have a higher probability of having new elements be interpreted as belonging to it.

Analogously, the general prototype is represented by a vector, called *Global Prototypes* (GP), with each vector element representing how probable it is that in general a tourist will interpret a monument from that MA as belonging to a given category. The initial values of GP are assigned at the beginning of the simulation. Initial values of each agent's IP are generated by taking each value of GP as the mean from a normal distribution and drawing random numbers from it. Considering agents will have a certain amount of heterogeneity in their opinions, a variable H is defined as the standard deviation of the normal distribution from which agents draw their values.

Given we are talking of tourism, we assume that individuals are continuously flowing into the MA to visit it. After they have visited it they maintain an idea of the place – that is, they can be consulted for opinion. We make no assumptions on how their knowledge and representations change outside of the interpretation they make within the MA.

Agents in the model are born according to a given probability and have a limited lifetime (*L*). They travel to the MA for a period of time – they tour, interpreting monuments – then are kept stable for the rest of the simulation, despite their IP values being used by other agents to communicate, as outlined below.

B. Monument Model

"Monuments" – objects which agents will associate with heritage – are assumed to be given and identified by all agents, being located in the MA. Monuments are assumed to be objects with some implicit features which agents are capable of recognising and associating with a given category or other. This is captured through a prototype vector similar to that of the agents', called *Local Prototype* (LP), which refers to the idea of a local tendency to associate these monuments to one category or other. It is thus a variable that represents the opinions of "locals" – agents not explicitly considered in the simulation – who are taken to interpret the monuments with some probability according to their own prior beliefs and according to what they see as the general understanding.

C. Network Topology

For the core part of our model, we assume that tourists move towards the MA, produce a certain interpretation according to their prototype, and move back to their original area, communicating certain categories they related to the area.

We assume that the tourist agents are not entirely isolated: they have a set of connections to other agents, with whom they can communicate and from whom they can obtain knowledge on certain matters. Two possible **topologies** are considered: *Random Network* or *Preferential Attachment* (see [49]) – which we will analyse in the simulations. Agents are assumed to have a **social group** to which they have connections, and which in the model we take to be those agents they are connected to.

This network of tourists is important as we assume that it defines the social influence of the individuals: individuals are taken to be more influential if they have a higher number of connections. Influence should be understood here as a function of the number of connections an agent has, relative to the agent with most connections at that given point in time – the **key node**. Let a_i^+ be one of the agents with the highest number of peers in the network, agent a_i an arbitrary agent, *p* the number of connections each agent has. We define a variable "Power of Influence" (POI) as follows.

$$P \quad (a_i) = \frac{p(a_i)}{p(a_i^+)} \tag{2}$$

With this we intend to represent the social nature of tourism, and the fact that tourists discuss their experiences within their social groups of reference [10]. Random networks are here presented as a 'neutral' alternative to preferential attachment, which appear as predominant, owing both to social stratification of taste [34] and to mediational mechanisms [50] (external travel guide authors, bloggers and others who may be granted greater authority on the subject of travel).

D. Heritage Interpretation

What we are interested in is the process of interpretation that agents make of monuments. For our purposes, a given agent interprets a monument by generating a matrix where each of the vector-elements of their IP is multiplied by each of the vector-elements of the monuments LP. For a given n, defining the vector-elements of *IP* as *x* and the vector-elements of *IP* as *y*, the transition matrix, *Local Prototype Matrix* (LPM) is defined as follows:

$$Ll \quad = \begin{bmatrix} x_1 * y_1 & x_2 * y_1 & \dots & x_i * y_1 \\ x_1 * y_2 & x_2 * y_2 & \dots & x_i * y_2 \\ \vdots & \vdots & \ddots & \vdots \\ x_1 * y_j & x_2 * y_j & \cdots & x_i * y_j \end{bmatrix} \tag{3}$$

After producing the LPM, a die is cast with *i* x *j* faces, each face having probability equal to the corresponding matrix-element. If in the result i=j – that is, both vector-elements are of the same category – the agent changes the monument's LP, setting element y_j higher, according to his power of influence:

$$y_j = y_j + P \tag{4}$$

And changes one of the categories of their own individual prototype according to a knowledge-increment (KI) parameter, randomly defined.

$$x_i = x_i + r \qquad (0, K \ ) \tag{5}$$

If the two categories do not match, both the increments in LP and IP are diminished by a parametrically defined variable called *Uncertainty* (U), a positive number.

$$y_j = y_j + (\frac{P}{U}) \tag{6}$$

$$x_i = x_i + (\frac{r \qquad (0, K \ )}{U}) \tag{7}$$

In this we sought to represent the idea that agents are influenced by the local context, even if their interpretation is ultimately individual, having them "compare" the IP with the LP. This attempts to represent how tourists seek out ways to interpret what they are seeing, both through local guidebooks, institutional information, guides, conversations with locals, etc – all of which shape how they ultimately come to a decision. By interpreting a new element as belonging to a category, the agent will make future interpretations of one of the prototypes of his categories more probable and in turn, through their opinions and what interpretations they make, the agent should influence the local perceptions. If his opinions differ from the local, however, we assume he will be less certain of his interpretation, and that other agents will likewise be less prone to agree with it.

E. Communication

Another aspect that is conceptually relevant is that tourists will, at the end of their trip, speak about what they liked, namely, including statements of their interpretations, something which has become particularly important given the role of social networks and touristic platforms [51]. Based on how much more or much less they thought the MA relates to a certain category, and comparing to the current state of the system, they will communicate a certain category, as an aspect of the trip, to other tourists.

Our assumption is that individuals choose what categories to discuss on the basis of their social group – an idea that further ties with the idea of there existing a *habitus* marked by social positioning as well as habitual experience [28], [34], [52], [53], with several possibilities for their behaviour. Do agents seek to discuss topics about which they are personally more knowledgeable (**Personal Strategy**)? Do they favour categories where their individual prototypes are closer to the group average, thereby seeking to increase their *in-group* belonging, [41], [54], [55] (**Conform Strategy**)? Do they instead focus on categories in which they hold distinct opinions in order to increase their symbolic capital, an extreme form of Bourdieu's ideas (**Distinguish Strateg**y)? Or do they try to balance distinctiveness and group conformity on the basis of their relative social influence within the group, as in the sense of optimal distinctiveness theory [56] (**Tactical Strategy**)?

These behaviours are represented in the model as distinct **strategies** undertaken by the agents. All agents follow the same strategy and it remains the same throughout the simulation. This was chosen to grasp the role of each strategy in isolation and make the problem tractable. After agents leave the MA, they update GP based on their experience, choosing a single vector-element from GP to increment.

Agents first define a vector, Distance (DL), containing for each category the difference of their individual prototype to the global prototype at the current time, weighted by the agent's power of influence:

$$D \quad =< (I\ (a_i) - G \quad) * P \quad > \tag{8}$$

Agents then select which category of GP to communicate about based on one of the following strategies (S_i):

Personal – The agent selects the category which has the highest value in his IP.

Conform – The agent calculates his individual prototypes compared to those of their peers, defined as **Change** (C). Taking a_L as the set of agents connected to agent a_i:

$$C = I\ (a_i) - I\ (\widetilde{\overline{a_L}}) \tag{9}$$

He then selects the category that has the *lowest* corresponding value in C.

Distinguish – The agent selects the category that has the *highest* corresponding value in C.

Tactical – The agent calculates his social influence compared to their peers (R_{POI}):

$$R_P \quad = P \quad (a_i) - P \quad (\widetilde{\overline{a_L}}) \tag{10}$$

If $R_{POI} < 0$, the agent conforms, else distinguish.

Random – The agent selects a category at random.

No Communication – Agents do not update global prototypes.

A single category z_i belonging to GP is selected and updated, adding the corresponding value of DL (dl_i):

$$z_{i+} = z_i + d\ \ _i \tag{11}$$

In all cases where agents update monument and general vectors, the vector must still add to 1, which means that all vector-elements are re-calculated on that basis.

In Table 2 we indicate the role of each parameter and initial values. Initial values are discussed in the next section.

Parameter	Code	Role	Initial values
Size	***N***	Number of categories	3
Power of Influence	***POI***	Social influence of the agent relative to his peers	-
Global Prototypes	***GP***	Set of probabilities of interpreting elements according to each category in general	$\left[\frac{1}{n} \quad \frac{1}{n} \quad \ldots\right]$
Heterogeneity	***H***	Standard deviation for initialising IPs	*(See Section IV.B)*
Local Prototypes	***LP***	Set of probabilities of a monument being interpreted according to each category	Random(0,1) … Random(0,1)
Uncertainty	***U***	Penalty for an interpretation not aligned with LP	8
Communication Strategy	***S***	Criteria for determining which category to communicate about	-
Network Topology	***NT***	Type of network	Random or Preferential Attachment
POI weighting constant	***IS***	Scales the agents' POI in interpretation	4
POI weighting constant	***PS***	Scales the agents' POI in communication	0.25

Table 2 - Parameters of the Heritage Model and initial values. Initial values are discussed in section IV.

IV. Model Analysis

Having produced the previous model, we turn to our second baseline question. By analysing the different outcomes of local prototypes, taken here to represent the local cultural heritage context, we can attempt to reason about the effects of tourist communications and the topology of their networks, drawing some patterns and general trends that emerge out of the model results.

However, in the model, numerous other factors have the potential to influence the process of categorisation: the parameter uncertainty (U), the size of the vector, the initial values of GP and the parameter heterogeneity (H) that sets the standard deviation of the agents' initial opinions.

In order to account for their influence in the model, we sought to first do a sensitivity analysis of the model to their behaviour with two goals in hand: a) to inquire the extent to which the model's output is affected by these parameters; and if the output meets expected patterns b) to set them appropriate values for the analysis of remaining parameters [57].

A. Patterns and Convergence

With the goal of making our model as realistic as possible, we sought to outline some patterns that are both intuitive, broad and well-found in literature [10], [58], [59]. These patterns may serve as a first step in understanding broader transformations in heritage systems. In other words, if the model is good, we should find the following conditions:

1) Non-Stagnation – As long as more processes of interpretation are made the heritage system ought to change in any given iteration.

2) Convergence to Touristic Perceptions – The local prototypes of the monuments should converge to the agents average probability of categorising a given category (mean values of IPs).

The first follows directly from the model – if the model tended towards a fixed state, it could not represent the necessary dynamics. The second draws from the idea that if tourists have an impact in the local prototypes in a MA, then they should over time define what the category probabilities are – something which is based on our assumption that tourists change the local perception. This amounts to asking whether given an initial distribution of LPs in monuments these tend towards the average tourist IPs.

In the following analysis, we use Wilcox's HRel index [60], a standardised version of entropy, as a summary of our vectors for any given run. What the index tells us is how concentrated the probabilities: if all categories have the same probability it achieves **maximum entropy**, and if a single category is likely (a single prototype has probability close to 1) it reaches minimum entropy. For $\boldsymbol{x}$ a random vector, with n random variables assuming discrete values:

$$H(\boldsymbol{x}) = \frac{\sum_{i=0}^{n} p(x_i)*\log_2\frac{1}{p(x_i)}}{\log_2 n} \quad (12)$$

If each vector-element of GP is set to the same value then on average agents should also have a maximum entropy vector. Furthermore, if they are set not to communicate, then GP maintains the original value, which means that, assuming our model of interpretation is good, the average LP should converge to maximum entropy. If instead agents communicate according to the strategies described above, we can use a ratio distance between the entropy of vector LP and the entropy of vector GP, obtaining the distance on a logarithmic scale of the two quantities, and taking them to be convergent if their ratio is approximately equal to 1.

$$C = \frac{H(LP)}{H(G)} \quad (13)$$

Our initial tests indicated that the parameter heterogeneity (H) of the agents plays a distinct role in each of the strategies in terms of the convergence and general behaviour of the model. Seeking to isolate these effects, we chose an initial setup where agents were as similar as possible in their behaviour: heterogeneity (H) was set close to zero, agents were made to adopt the "No Communication" strategy, the initial values of each GP category were set for the same value and the topology was defined as "Random" to avoid uncontrolled network effects. Size, uncertainty and initial values of GP were analysed through a parameter sweep. An additional parameter discovered in the process, a constant that scales the power of influence, was also analysed. Sensitivity was defined here as a relatively high change in the convergence of the HRel LP to GP between consecutive levels of parameters.

Our dataset for the whole study included one experiment, comprising of 10 runs per each parameter level, over 20k individual time steps. Standardised entropy (Hrel) was used as a reporting variable, and averages were taken of the 10 runs. The values of each parameter were set to the values in Table 2 and discovered in the following preliminary analysis except where noted. CL was analysed using only final values, with averages taken of the CL values.

The main results of this analysis were the following:

Size: 8 possible values of n were tested, from 1 to 8. The size of the vector does not seem to impact the convergence or stagnation of the model.

IS (weighing constant of POI): An analysis of 20 levels was made, noting no substantial differences from 0.5 to 8 except in the times of convergence. At sufficiently small levels (<0.5), however, the dynamics of consensus changed substantially, with the LP not converging to the GP in 20k ticks, and having a much slower ascent.

Uncertainty: Uncertainty was analysed using 10 levels – from 0 to 20. Uncertainty could be expected to decrease the consensus over LP: it restricts the effect of interpretations that are contrary to the local prototypes (LP), and thus promote the initial values of LP over those of the tourists. This was however not seen on a relevant level, with the model being relatively insensitive to changes in agents' general uncertainty.

After establishing that the model was not sensitive to these parameters and to their interactions, we opted to fix the values of the size of the vector, the multiplicative constant and uncertainty, according to Table 2. In the interest of maintaining the observed patterns, and to make sure that the calibrated values could be used outside of the constraints originally assumed, we sought to assess how these aspects affect convergence and dynamics:

Different strategies and topologies: To verify that convergence was not restricted to a "No Communication" scenario, we attempted to assess whether these calibrations made the model converge in other strategies. The results are outlined in Table 3. Noting the ratios did not significantly differ from those above, we proceeded the analysis with these parameter values.

A similar effect to that described above was also noted in terms of the communication algorithm – the updates to the global prototype – with the scale of POI influencing how fast the dynamics played out. Here, the values of the scaling constant control the slower oscillation and dynamics of the categories in GP and LP. A total of 10 levels were analysed, from 0.1 to 1.45. Since too much oscillation could lead to issues in the analysis, a baseline level of 0.25 was chosen.

Strategy	Topology	Average ratio of entropies (CL)
Random	Random	0,987
	Preferential Attachment	0,996
Personal	Random	0.999
	Preferential Attachment	0.967
Conform	Random	1,073
	Preferential Attachment	1,001
Distinguish	Random	0,844
	Preferential Attachment	0,998
Tactical	Random	0,928
	Preferential Attachment	0,997
No Communication	Random	1,000
	Preferential Attachment	1,000

Table 3 - Convergence Levels of LP to GP according to communicative strategy and topology after 20k ticks.

Initial values of GP: We sought to analyse how varying the initial values of GP away from maximum entropy affected the model's convergence. We used the parameters previously defined, detailed above (see Table 2). The model converges most consistently when the initial values of GP are closer to each other, as shown in Fig. 2. Considering this higher level of convergence, and in order to have fewer factors interfering in convergence, initial values were set to 1/n.

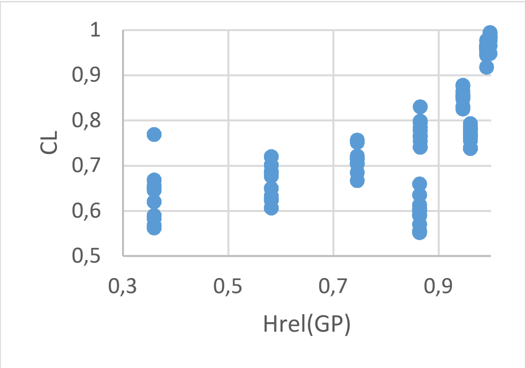

Fig. 2 Dispersion plot of runs of multiple setups, with varying levels of Hrel(GP) and corresponding spread of ratio of entropies CL.

B. *Influence of Heterogeneity on Diversity of Opinions*

Having calibrated the former parameters, we sought to understand the behaviour of the model in terms of communication strategies, network topologies and agent heterogeneity. We used Hrel as a summary of the dispersion of opinions in the local context – that is, analysing changes to the dispersion of ideas in LP according to these factors. The analysis was carried out with a 6x2x5 design, running six levels of *H* for each topology for each strategy, analysing the average of 10 runs. Levels of Heterogeneity were varied between 0 and 0.1, with increments of 0.02. The maximum bound chosen was low for two reasons: to analyse the effects of heterogeneity and the sensitivity of the model to its variation, as well as due to tests revealing no critical points or changes in behaviour owed to higher levels.

It would make intuitive sense that increasing initial heterogeneity of agents' opinions would lead to a general increase in the diversity of opinions, which would result in a higher Hrel. Our analysis seems to lend support to this idea, though the underlying reasons for why heterogeneity generates lower consensus are not the same in each strategy (cf. Figure 3).

Right away one can note the difference between PA and RN networks, with the former achieving much less consensus, and generally staying near maximum entropy, whereas the latter exhibits different degrees of approximation. This is due to the structure of the network and of the mechanisms of change: if fewer individuals have relevance in the network, then the change induced by a random agent is on average much less relevant than in a RN network, leading to a greater conservation of the "status quo". In that sense, all strategies except Tactical maintain the same trajectory in RN and PA networks, although with very distinct levels of variation and values of Hrel. This seems to suggest that greater centralisation of opinions does not necessarily lead to greater consensus overall if influence is not evenly distributed – and that higher heterogeneity seems to further this trend. We highlight the following results.

"Conform" strategy: Within this strategy we found the tendency for low levels of heterogeneity to result in lower levels of entropy. In RN two clusters seemed to appear. Within PA networks, most levels appear very close, with a smaller variation in entropy.

What this appears to indicate is that higher variability in group opinions, when in-group maintenance is the strategy for which individuals go for, makes group consensus harder. Such a result falls very much in line with the general approach outlined by social identity theory [41], [54], as well as with the general framework of opinion dynamics models that take group belonging as relevant [61]–[63]. However, perhaps surprisingly, the convergence of all levels below 8 to the same general values of Hrel seems to propose that there might be thresholds of heterogeneity that distinguish between different levels of consensus.

"Distinguish" strategy: the model maintains high levels of entropy in all levels of H, with the exception of H=0. Higher heterogeneity seems to increase in-group differences and makes it difficult for group consensus to emerge when individuals choose to distinguish each other, as presumably they will have more widely different ideas of what it is that can set them apart – however, as we will see below, its impact is rather to "slow down" the formation of consensus.

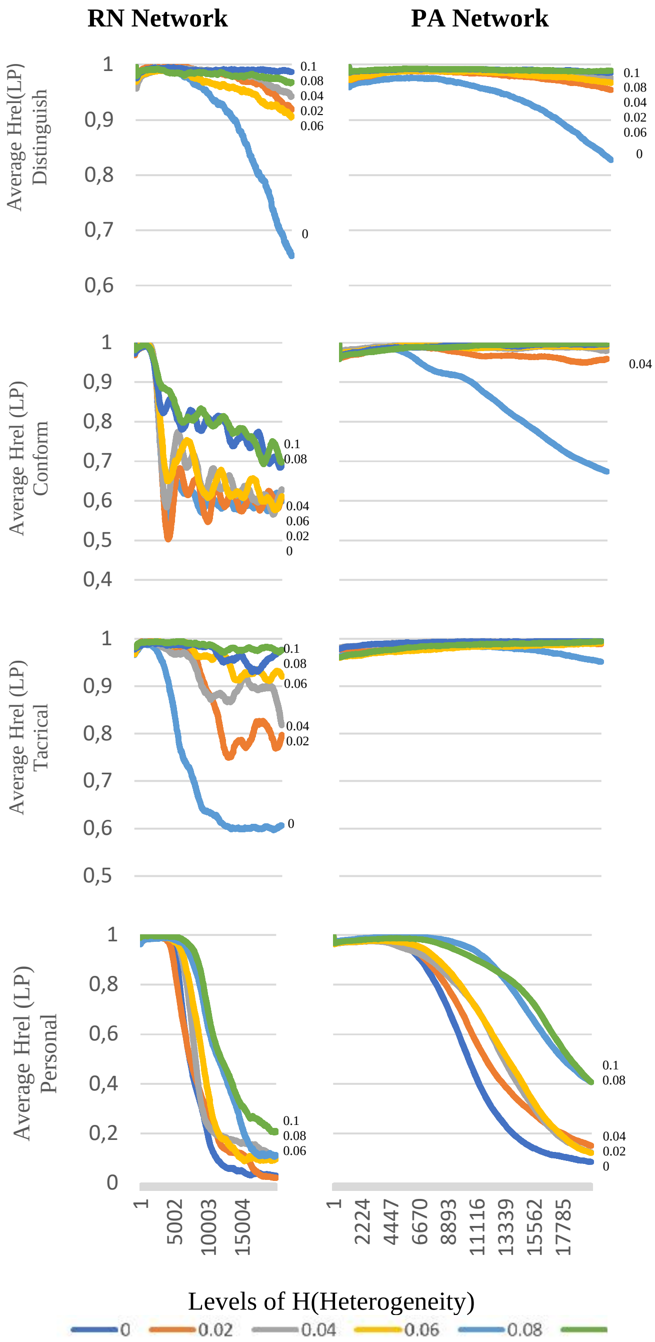

Fig. 3 Simulations of Heritage meaning. Levels of HRel (average of LP) varied over Heterogeneity (H), Distinguish, Conform, Tactical, Personal and two topologies.

"Tactical" strategy: The strategy has many similarities with Distinguish in a PA topology, having a marked trend towards maximum entropy and away from consensus, with heterogeneity increasing the speed of ascent. The RN network configuration in turn bears semblance to the RN "Conform", albeit with less pronounced curves, whereas preferential attachment leads to an increase in entropy towards maximum entropy. Such a result is in fact somewhat surprising: if we recall, the "Tactical" strategy has agents using "Conform" if more than average the peers in the network had lower influence than the calling agent, and Distinguish, if more than average had less. This could make us expect that the dynamics of conformity should dominate; however, since there are multiple key nodes – i.e, individuals with a high level of social influence – in the network, what results is that the dynamics are closer to distinction. If we interpret this, it would indicate that in highly stratified systems, individuals with high connections would seek to mostly distinguish themselves from others as a means to become better recognised, whilst lower status individuals would seek to emulate them – which also goes in line with the theory and empirical findings of cultural sociology mentioned above.

"Personal" strategy: the tendency here is for a "tipping point" pattern to emerge, up until which entropy remains near maximum, only to begin decreasing until it reaches near minimum entropy. Heterogeneity (H) seems in this sense to mediate the time at which the descent begins and its steepness.

In general, we conclude that heterogeneity in the model leads to lower levels of consensus throughout, with the highest levels being set apart from the rest by a threshold. In short, more heterogenous tourist populations lead in general to less consensus on the meaning of local monuments over time. This which could have potential implications for thinking about categories and their relationship with tourism: for instance, take the goal of having a certain form of consensus in the local cultural narratives and categories, in turn based on local populations and interactions between tourists and such populations – such as in creative tourism endeavours [64], [65]. In this context, our conclusions would point that having a wide array of opinions from very different types of tourists – i.e cultural tourists, food and wine, family travellers, etc – could lead to lower consensus, and make the efforts of creative tourism fruitless.

C. Strategies and Topology

From the previous discussion we can already see that the topology and communication strategies undertaken by tourists have a greater effect in shifting the heritage system than does heterogeneity. Here we will look at this in greater depth. Our analysis is mostly descriptive and exploratory, and seeks to outline the kinds of behaviour emerging from each communicative strategy. This allows us to reason about what kind of heritage dynamics could emerge in empirical contexts that generally satisfy the conditions imposed by these parameters. In turn it allows us to evaluate the more important features that one should pay attention in empirical analysis, in order to verify the model [57].

In Fig. 4, we present the results focused on the baseline of H=0.4. This was chosen to allow for comparison between the different strategies, as at this level all strategies and topologies appeared to have a typical behaviour as regards the consensus, in terms of their dynamics

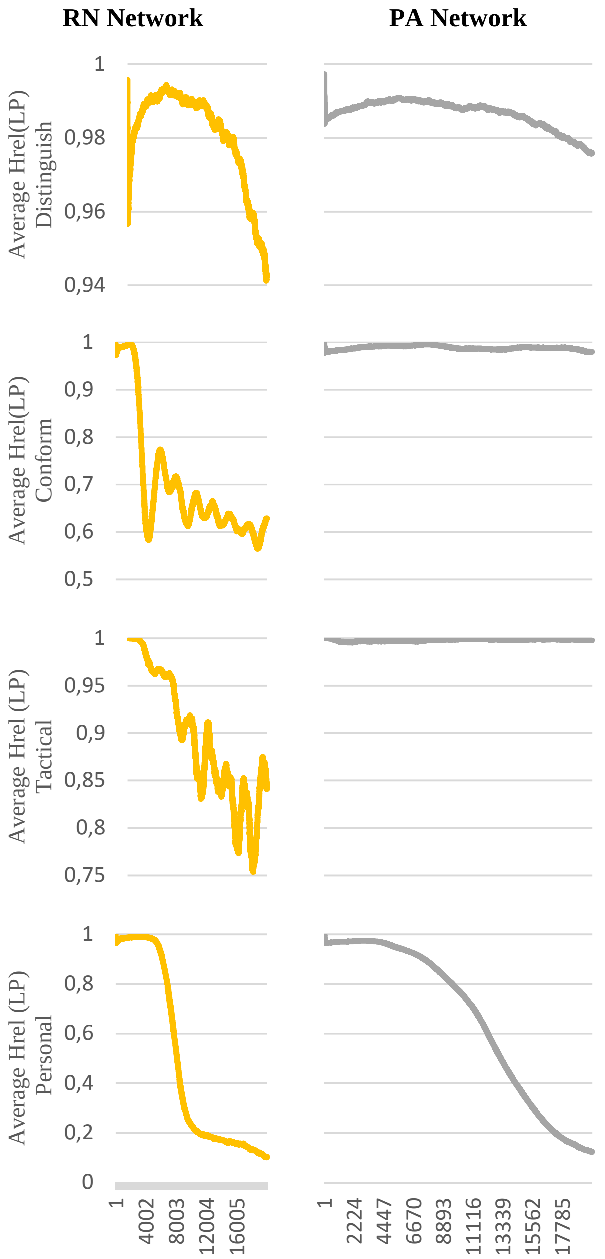

Fig. 4 Simulations of Heritage meaning. Levels of average HRel(LP) varied over Distinguish, Conform, Tactical, Personal and two topologies.

We begin with the "Personal" strategy. Its behaviour, marked by a sharp increase in consensus/decrease in entropy, can be counter-intuitive at first: if individuals are each choosing what they are better at, why should it lead to overall consensus? However, we can note that they select the categories they are more knowledgeable of *in relation* to other agents, in a temporal framework: when tourists focus on the categories they know more, they lead to future tourists also having more knowledge of that category, leading to a positive feedback loop which ultimately leads to near absolute consensus over the most relevant and complex category.

A similar trend towards consensus can be found in the "conform" strategy, although the dynamics are widely different. Conformity here is understood as the tendency to favour in-group belonging, in line with the ideas of social identity theory [41], [54]. Used as a strategy by the agents in the model, it leads to cyclic oscillation between higher and lower levels of Hrel, in both topological structures (although in PA this is hardly visible from the image), with substantially different effects on the formation of a consensus on what determines heritage. Our analysis revealed that this behaviour emerges again due to a generational effect akin to a cycle:

1) At first, the first generation finds a certain category, and increases it in the GP;
2) New agents of the same generation are pulled to agree with these actors (who are already outside the MA), and thus a virtuous cycle of growth for the category begins;
3) As new generations appear these ones have even closer levels to the first generation than the previous ones;
4) Eventually, as the main category grows larger at a fast rate, the gap between new generations and old ones becomes larger, and agents start to have closer levels in other categories;
5) A new category begins its growth, and leads the first one to decrease.

If we interpret all of this, it seems to indicate that consensus is mostly formed in network structures where agents have in-*group* tendencies which are also horizontal in terms of power. Further than that it also indicates that in these structures there are tendencies for "hypes" to appear due to new generations – something which is a consistent result of cultural sociology, such as subcultures of punk or fashion trends [66]–[68], wherein individuals tend to adapt their behaviour to be consistent with the in-group.

Quite the opposite could be expected in "Distinguish", since it implies that individuals should try to be as different from the in-group as possible. Indeed, consensus is much harder to form with this strategy, and entropy stays roughly the same over time in local terms: when each tourist pulls in their own direction, uncertainty and disagreement on interpretation remain high over time. Nonetheless, on a macro-scale the tendency is for some categories to become dominant, which seems to indicate that despite the small oscillations, distinction does lead to some categories becoming more relevant. What this implies is that when individuals attempt to distinguish themselves from each other, a form of consensus slowly takes place, due to the existence of multiple actors and the need for distinction from many of them, in line with the Bourdeusian ideas on field negotiations – such as in the successive attempts at being "the most avant-garde" seen in art fields leading to the formation of movements [69], and similar tendencies for distinction seen in touristic settings [5], [70].

As expected, the Tactical strategy appears as a mix of the former two, with a sharp distinction between the RN and PA topologies: RN has a structure similar to Conform, and PA is closer to Distinguish, albeit not drawing the same downwards trajectory. We can then ask: if we have a heritage system where tourists' social groups play a role in influencing what tourists communicate, with individuals gauging the relevance of what they share based on their group and attempting to adapt it based on their peers experience – as can be the case of cultural tourism practices online [71], [72] – what role will the specific forms of touristic networks have in generating consensus?

V. Discussion

The results of the model indicate that the dynamics of the semantic web of heritage are tightly connected both to how communication of preferred categories is selected – its orientation in terms of groups – as well as to the way the networks of individuals are constructed.

The model revealed that group-conforming opinions do not lead to stable consensus, but rather generate an intergenerational loop where "the most important category" keeps switching between one of two options undertaken by agents in different times. Whilst this behaviour can approximately be seen in many other social psychological and sociological contexts, its appearance in the context of categorisation of heritage and in the context of tourism is surprising and seems worthy to be considered for further analysis in the dynamics of heritage. This can include empirical work in contexts with few categories. Likewise, we noted that distinction leads to certain categories becoming more relevant despite there being a constant struggle between agents. In tactical strategies – where the category discussed depends on the relative power of influence of the tourists – we find a middle ground between distinction and conformity.

We noted that network topology seems to play the greatest role in making certain strategies result in substantial differences for the null model of no communication. The implications of this is that networks which are driven by very centralised sources of information, with few agents being seen as having more power or authority on a given matter, can lead to a much greater variation and less consensus, and make local contexts less prone to a common narrative. This is an important clue and, with empirical confirmation, could point to strategies hinged on cultural experts promoting local contexts being less effective than currently understood [50, p. 139].

These results were also shown to depend to an extent on the heterogeneity of the agents' opinions – how much they differ – which in cases such as conformity to group opinion shows threshold effects – i.e. convergence to certain levels of variability only after a certain value of heterogeneity is reached. This seems to support the idea that certain forms of tourism, hinged on the idea of consensus and cohesion in local contexts, should target fewer types of audience to preserve the consistency of their narratives.

VI. Conclusions

In this paper we sought to analyse the question of consensus over cultural meaning in local contexts that receive tourists, producing an agent-based model of the phenomena. This process is relevant as it ties to efforts to create local narratives, rooting identities and framing cultural goods in a common light, something which can be transformed by the touristic gaze that is cast on the context. Towards that end, we argued that the process can be understood as the relationship between tourists interpreting monuments according to specific categories, and transmitting those interpretations to other tourists. We argued in particular that the networks established by agents in this process, and the communicative processes they undertake, should be understood as a key part of this process.

Our analysis of this model showed that both topology and directionality play a major part in shaping the evolution of the cultural context in this sense. In particular, we noted that preferential attachment networks, in comparison to randomly formed networks, create greater differences in the interpretations, with the consequence that cultural systems hinged on expert opinions could have the counter-intuitive effect of leading to less consensus. It remains to be analysed if this is due to the creation of 'local' clusters of interpretations within the preferential attachment networks, or to other mechanisms which might explain it. Moreover, in both cases in-group orientation tends to showcase greater consensus, which lends grounds to the idea that in touristic contexts where social groups are homophilic, consensus is easier to achieve. These results raise the hypothesis that the success of cultural narrative promotion may be related to more diffuse (i.e, less driven by small numbers of individuals) and socially conforming groups of tourists. This raises important questions in tourism and local heritage studies, as well as to public policy developed in these areas, which can be analysed empirically in these areas. As noted, it can also have consequences in the design of online platforms and recommendation systems, as well as other computational approaches, by postulating the importance of such relational features.

The assumptions we made lead to the results bearing some shortcomings which we hope to address in future work:

- Why should we expect all individuals within a group to behave using the same strategy?
- Do tourists all have the same levels of uncertainty in their appreciations?
- Does the transmission of categories work only through reference to a global prototype? What role is there for parental or peer socialisation?
- How do the prototypes evolve outside of the specific context in which they are generated – how do agents change their opinion as part of a general consensus?

In order for these questions to be properly settled a more micro-foundational model would need to be developed. This could perhaps be done by considering monument elements explicitly, making no assumptions as to what elements counted as "monuments", and allowing the creation and disappearance of categories over time. In developing such a model, the model developed here can serve as a guideline. Such a model could likewise be used for the analysis of specific trends in local contexts of heritage – although the present efforts can still hold some indicative value for the same purposes. The present results seem to us to hold value in understanding systems of heritage, with particular emphasis on the role of networks for the analysis of cultural sociology, as well as its implications for computational approaches to heritage studies, in complexifying the concepts of agents and of their interactions in recommendation systems or online platforms. They also point the possibility of developing more models of cultural-semiotic dynamics outside of the specific model of heritage.

Appendix – Algorithm

Main

A. Generate Global Prototype vector of size n, GP=<k_1,k_2,...,k_n>;

B. Generate N_a agents. For each agent, generate agent's Individual Prototype vector of size n, according to a normal distribution centred on each element of GP, with standard deviation given by heterogeneity H:

IP=<x_1,x_2,...,x_n>, with x_i=N(k_i, H).

C. Generate social network of agents (random or preferential attachment). Let one of the agents with most peers be called “top peer”. Let each agent’s power-of-influence (POI) be the ratio of their number of neighbours and the number of neighbours of the top peer:

$$P \quad (a_i) = \frac{p(a_i)}{p(a_i^+)}$$

D. Generate N_m monuments. For each monument, generate monument’s Local Prototype vector of size n;

LP=<y_1,y_2,...,y_n>

E. While not stop-condition:

E1. Move to the monuments area (MA) an agent who has not recorded being in at least one of the monuments. Agents stay in the area for T time, with

T=U(MinTimeInArea,MaxTimeInArea).

E2. For each agent:

if agent is in the MA for time < T,

then randomly select an unvisited monument and execute LPE

else execute GPU and exit the area

E3. Agents in the simulation for t > Max-Time-in-Simulation exit the simulation

E4. Generate N_{new} times agents, each one with probability New-Agent-Probability

LPE (Local Prototype Exchanger) for agent a and monument m:

a. Calculate heritage joint probability matrix LPM = IP*LP

b. Cast a die with nxn faces, each one with probability $x_i y_j$ in LPM:

if i==j (that is, interpreted category of agent and socially interpreted category of monument are the same)

then y_i=y_j * power-of-influence, x_i=x_i * knowledge-increment, with knowledge-increment=U(0,MaxKnowledgeIncrement)

else y_i = y_j * (power-of-influence / uncertainty), x_i = x_i * (knowledge-increment / uncertainty)

GPU (Global Prototype Updater) for agent a_i:

a. Let the difference DL = |(IP – GP) * POI(a_i)|

b. Let the difference of IP between the agent and the average IP of his neighbors (a_L):

$$C = I \ (a_i) - I \ (\widetilde{a_L})$$

c. Let the difference in power influence between the agent and its neighbors:

$$R_P \quad = P \quad (a_i) - P \quad (\widetilde{a_L})$$

d. Choose a category i according to one of the following behaviours:

random: select a random category
personal: select the category with the highest value in the agent’s IP
conform: select the category with the lowest value in C
distinct: select the category with the highest value in C
tactical: if R_{POI} > 0 diverge else conform

e. Modify the category i in GP, GP[i] = GP[i]+DL[i]

References

[1] F. Tilden, *Interpreting our Heritage*. Chapel Hill: University of North Carolina Press, 1977.

[2] D. Uzzell, “Interpreting our heritage: A theoretical interpretation,” in *Contemporary Issues in Heritage and Environmental Interpretation*, 2006.

[3] L. Mydland and W. Grahn, “Identifying heritage values in local communities,” *Int. J. Herit. Stud.*, vol. 18, no. 6, pp. 564–587, Nov. 2012.

[4] D. C. Harvey, “Heritage Pasts and Heritage Presents: temporality, meaning and the scope of heritage studies,” *Int. J. Herit. Stud.*, vol. 7, no. 4, pp. 319–338, Jan. 2001.

[5] E. Waterton and S. Watson, *The Semiotics of Heritage Tourism*. Bristol: Channel View Publications, 2014.

[6] A. Bourdin, “Sur quoi fonder les politiques du patrimoine urbain ? Professionnels et citoyens face aux témoins du passé,” *Les Ann. la Rech. urbaine*, vol. 72, no. 1, pp. 6–13, 1996.

[7] T. Winter, “Heritage and Nationalism: An Unbreachable Couple?,” in *The Palgrave Handbook of Contemporary Heritage Research*, London: Palgrave Macmillan UK, 2015, pp. 331–345.

[8] E. Waterton and L. Smith, “The recognition and misrecognition of community heritage,” *Int. J. Herit. Stud.*, vol. 16, no. 1–2, pp. 4–15, Jan. 2010.

[9] E. Waterton and S. Watson, *The Palgrave Handbook of Contemporary Heritage Research*. New York: Palgrave MacMillan, 2015.

[10] D. MacCannell, *The Tourist: A New Theory of the Leisure Class*. London: University of California Press, 1999.

[11] J. Urry, *The Tourist Gaze. 2nd Edition*. London: Sage Publications, 2002.

[12] R. Hewison, *The Heritage Industry: Britain in a Climate of Decline*. London: Methuen, 1987.

[13] D. Lowenthal, *The Past is a Foreign Country*. Cambridge: Cambridge University Press, 1985.

[14] R. Harrison, “Heritage and Globalization,” in *The Palgrave Handbook of Contemporary Heritage Research*, E. Waterton and S. Watson, Eds. New York: Palgrave MacMillan, 2015, pp. 297–312.

[15] M. K. Smith, *Issues in Cultural Tourism Studies*. London: Routledge, 2003.

[16] A. P. Russo and G. Richards, *Reinventing the local in tourism:*

producing, consuming and negotiating place. Bristol: Channel View Publications, 2016.
[17] R. Govers, F. M. Go, and K. Kumar, "Promoting tourism destination image," *J. Travel Res.*, vol. 46, pp. 15–23, 2007.
[18] I. Christensen, S. Schiaffino, and M. Armentano, "Social group recommendation in the tourism domain," *J. Intell. Inf. Syst.*, vol. 47, no. 2, pp. 209–231, 2016.
[19] F. Barile, A. Caso, and S. Rossi, "Group recommendation for smart applications: A multi-agent view of the problem," in *CEUR Workshop Proceedings*, 2014, vol. 1260.
[20] C. M. Hall and J. Rath, "Tourism, Migration and Place Advantage in the global Cultural economy," in *Tourism, Ethnic Diversity and the City*, J. Rath, Ed. New York: Routledge, 2007, pp. 1–24.
[21] A. M. Munar and J. K. S. Jacobsen, "Motivations for sharing tourism experiences through social media," *Tour. Manag.*, vol. 43, pp. 46–54, 2014.
[22] E. Crooke, "The politics of community heritage: motivations, authority and control," *Int. J. Herit. Stud.*, vol. 16, no. 1–2, pp. 16–29, Jan. 2010.
[23] T. Mordue, "Tourism, performance and social exclusion in 'Olde York,'" *Ann. Tour. Res.*, vol. 32, no. 1, pp. 179–198, 2005.
[24] S. Wearing and B. Deane, "Seeking Self: Leisure and Tourism on Common Ground," *World Leis. J.*, vol. 45, no. 1, pp. 4–12, 2003.
[25] M. Månsson, "Mediatized tourism," *Ann. Tour. Res.*, vol. 38, no. 4, pp. 1634–1652, 2011.
[26] J. C. Alexander and P. Smith, "The Strong Program: Origins, achievements, prospects.," in *Handbook of Cultural Sociology*, J. Hall, L. Grindstaff, and M.-C. Lo, Eds. London & New York: Routledge, 2010.
[27] M. Archer, *Realist social theory: the morphogenetic approach*. New York: Cambridge University Press, 1995.
[28] P. Bourdieu, *Distinction: A Social Critique of the Judgement of Taste*. Cambridge, M.A.: Harvard University Press, 1984.
[29] C. Geertz, *The Interpretation of Cultures: Selected Essays*. New York: Basic Books, 1973.
[30] M. Metro-Roland, *Tourists, Signs and the City: The Semiotics of Culture in an Urban Landscape*. Surrey: Ashgate, 2011.
[31] C. S. Peirce, *The Collected Papers*, vol. 1–6. Cambridge, M.A.: Harvard University Press, 1958.
[32] E. Rosch and B. B. Lloyd, Eds., *Cognition and Categorization*. New York, London, Toronto, Sydney: John Wiley & Sons, 1978.
[33] H. Cohen and C. Lefebvre, *Handbook of Categorization in Cognitive Science*. Amsterdam: Elsevier, 2005.
[34] B. Dicks, "The Habitus of Heritage: a Discussion of Bourdieu's Ideas for Visitor Studies in Heritage and Museums," *Museum Soc.*, vol. 14, no. 1, pp. 52–64, 2017.
[35] M. Merleau-Ponty, *Phenomenology of Perception*. London & New York: Routledge, 2012.
[36] H. Blumer, *Symbolic Interactionism: Perspective and Method*. New Jersey: University of California Press, 1969.
[37] R. Axelrod, "The dissemination of culture: A model with local convergence and global polarization," *J. Conflict Resolut.*, vol. 41, no. 2, pp. 203–226, 1997.
[38] N. Gilbert, *Agent-based models*. Los Angeles, London, New Delhi, Singapore: Sage Publications, 2008.
[39] N. Ogata, "Formal Ontology of 'Cultures' and 'Ethnic Groups' Based on Type Theory and Functional Programming," in *Intercultural Collaboration: First International Workshop IWIC 2007*, I. Toru and others, Eds. Kyoto: Springer, 2007.
[40] A. Morris, W. Ross, H. Hosseini, and M. Ulieru, "Modelling Culture with Complex, Multi-dimensional, Multi-agent Systems," in *Perspectives on Culture and Agent-based Simulations: Integrating Cultures*, V. Dignum and F. Dignum, Eds. Cham: Springer International Publishing, 2014, pp. 13–30.
[41] H. Tajfel, *Human Groups and Social Categories*. Cambridge, M.A.: Cambridge University Press, 1981.
[42] P. Hedström and P. Bearman, *The Oxford Handbook of Analytical Sociology*. Oxford: Oxford University Press, 2009.
[43] D. Hebdige, *Subculture - The Meaning of Style*. London: Routledge, 1979.
[44] H. S. Becker, "Art world and social types," *Am. Behav. Sci.*, vol. 19, no. 6, pp. 703–718, 1976.
[45] P. DiMaggio, "Culture and Cognition," *Annu. Rev. Sociol.*, vol. 23, pp. 263–287, 1997.
[46] P. DiMaggio, "Classification in Art," *Am. Sociol. Rev.*, vol. 52, no. 4, pp. 440–455, 1987.
[47] B. Lickel, D. L. Hamilton, and S. J. Sherman, "Elements of a Lay Theory of Groups: Types of Groups, Relational Styles, and the Perception of Group Entitativity," *Personal. Soc. Psychol. Rev.*, vol. 5, no. 2, pp. 129–140, May 2001.
[48] C. Castellano, S. Fortunato, and V. Loreto, "Statistical physics of social dynamics," Oct. 2007.
[49] A.-L. Barabási and R. Albert, "Emergence of Scaling in Random Networks," *Science (80-.).*, vol. 286, no. 5439, pp. 509–512, 1999.
[50] H. Du Cros and B. McKercher, *Cultural Tourism.*, 2nd ed. New York: Routledge, 2015.
[51] A. M. Munar and C.-S. Ooi, "What Social Media Tell us About the Heritage Experience," Copenhagen, 2012.
[52] P. Bourdieu, "Forms of Capital," in *Handbook of Theory and Research for Sociology of Education*, New York: Greenwood, 1986, pp. 241–258.
[53] P. Bourdieu, *The Field of Cultural Production: Essays on Art and Literature*. Columbia: Columbia University Press, 1984.
[54] J. C. Turner, "Social Categorization and Self-Concept: A Social Cognitive Theory of Group Behavior," in *Advances in Group Process: Theory and Research*, E. J. Lawler, Ed. Greenwich: JAI press, 1985, pp. 77–121.
[55] J. C. Turner, M. A. Hogg, P. J. Oakes, S. D. Reicher, and M. S. Wetherell, *Rediscovering the social group: A self-categorization theory*. Cambridge, M.A.: Basil Blackwell, 1987.
[56] G. J. Leonardelli, C. L. Pickett, and M. B. Brewer, "Optimal Distinctiveness Theory," *Adv. Exp. Soc. Psychol.*, vol. 43, pp. 63–113, 2010.
[57] N. David, N. Fachada, and A. C. Rosa, "Verifying and Validating Simulations," in *Simulating Social Complexity*, Springer, 2017, pp. 173–204.
[58] T. Parsons, *The System of Modern Societies*. New Jersey: Prentice-Hall, 1971.
[59] Y. Kashima, "How can you capture cultural dynamics?," *Front. Psychol.*, vol. 5, Sep. 2014.
[60] A. R. Wilcox, "Indices of Qualitative Variation and Political Measurement," *West. Polit. Q.*, vol. 26, no. 2, p. 325, Jun. 1973.
[61] C. Castellano, S. Fortunato, and V. Loreto, "Statistical physics of social dynamics," *Rev. Mod. Phys.*, vol. 81, no. 2, pp. 591–646, 2009.
[62] G. Weisbuch, G. Deffuant, F. Amblard, and J. P. Nadal, "Interacting Agents and Continuous Opinions Dynamics," Nov. 2001.
[63] Y. Dong, M. Zhan, G. Kou, Z. Ding, and H. Liang, "A survey on the fusion process in opinion dynamics," *Inf. Fusion*, vol. 43, pp. 57–65, Sep. 2018.
[64] G. Richards and L. Marques, "Exploring Creative Tourism: Editors Introduction," *J. Tour. Consum. Pract.*, vol. 4, no. 2, 2012.
[65] N. Duxbury, S. Silva, and T. V. de Castro, "Creative tourism development in small cities and rural areas in Portugal: Insights from start-up activities," in *Creating and Managing Experiences in Cultural Tourism.*, Singapore: World Scientific Publishing.
[66] P. Guerra, *A instável leveza do rock*. Porto: Edições Afrontamento, 2013.
[67] P. Hodkinson and W. Deicke, *Youth Cultures: Scenes, Subcultures and Tribes*. New York: Routledge, 2007.
[68] N. L. Fischer, "Forever Vintage: How Changes in the Fashion Industry Helped Vintage Style Become a 40-Year Trend," *Am. Sociol. Assoc. Annu. Meet.*, vol. 8, no. 2012, pp. 17–20, 2012.
[69] P. Bourdieu, "Le champ literáire. Préambles critiques et principes de méthode," *in Lendemains.*, vol. 36, 1984.
[70] R. Shepherd, "Commodification, Culture and Tourism," *Tour. Stud.*, vol. 2, no. 2, pp. 183–201, 2002.
[71] Z. Xiang and U. Gretzel, "Role of social media in online travel information search," *Tour. Manag.*, vol. 31, no. 2, pp. 179–188, Apr. 2010.
[72] A. Kavoura and A. Stavrianea, "Following and Belonging to an Online Travel Community in Social Media, its Shared Characteristics and Gender Differences," *Procedia - Soc. Behav. Sci.*, vol. 175, pp. 515–521, 2015.