Social influence and neighbourhood effects in the health care market

Marcello Montefiori and Marina Resta

Social Influence and Neighbourhood Effects in the Health Care Market

Marcello Montefiori[i] - Marina Resta[ii]

Abstract

This work is intended to analyze the market for health care through a computational approach based on unsupervised neural networks. The paper provides a theoretical framework for a computational model that relies on Kohonen's self organizing maps (SOM), arranged into two layers: in the upper layer the competition dynamics of health care providers is modelled, whereas in the lower level patients behaviour is monitored. Interactions take place both vertically between the layers (in a bi–directional way), and horizontally, inside each level, exploiting neighbourhood features of SOM: signals move vertically from hospitals to patients and vice-versa, but they also spread out sideward, from patient to patient, and from hospital to hospital. The result is a new approach addressing the issue of hospital behaviour and demand mechanism modelling, which conjugates a robust theoretical implementation together with an instrument of deep graphical impact.

1. Introduction

The understanding of the health care market is the logical prius to any effective reform or policy. Unfortunately, the market presents a whole series of failures which render intricate its full comprehension.

The main issue concerns the characteristic of the "health service", intended as a good, and the asymmetry of information which characterizes the market. This latter, avoids patients to exactly assess the true quality of the service, even *ex post* i.e. after the service has been experienced 0.

This key point has already been widely discussed in the related literature. Goods subject to the phenomenon introduced in the previous rows are usually referred to as "credence goods", versus the so called "search" and "experience" goods 00: whereas the quality of a search good is known ex ante and the quality of an experience good is known ex post, the quality of a credence good is difficult or expensive to judge even after purchase 00. As result, in order to acquire the conclusive assessment of those goods, a totally new learning/adaptive process needs to be implemented both by patients and providers. Such information asymmetry, in turn, creates a new and uncertain scenario where patients and hospitals reciprocally interact.

The aim of the present paper is to draw a computational approach which is able to take into account all those features as a whole. To such aim, we will introduce a model based on unsupervised neural networks, namely on Kohonen's self-organizing maps (SOMs), arranged into two layers: in the upper layer the competition dynamics of health care providers is modelled, while in the lower level the patients behaviour is monitored. Using topological features of SOMs, interactions are allowed to take place both vertically between the layers (in a bi–directional way), and horizontally, inside each level. In this way, signals move vertically from hospitals to patients and vice-versa, but they also spread out sideward, from patient to patient, and from hospital to hospital.

Within the framework depicted above, the paper is organised as follows: in Section 2 we will provide an insight into the economic model we have taken into account; Section 3 will describe the theoretical background of self-organizing maps, and Section 4 will discuss the results obtained in a case study; finally, Section 5 will conclude.

2. The economic model

We analyze the reciprocities and interactions opposing providers of health care services to patients using such services.

2.1. Main issues concerning the providers of health care services

Health care systems are assumed to provide for internal markets, prospective payment scheme, and competition between public and private hospitals. The basic assumptions are that private and public hospitals compete for patients, and their revenue depends on the number of treatments they provide. Patients may or may not pay for the health services they receive (this is the case, for instance, of a public financed national health system), however they are concerned about the hospital's costs.

The main difference among public type hospitals and private ones is in the scale: public hospitals are generally large-sized, whereas private hospitals are assumed to be small/medium-sized. This is turn affects the number of treatments that the system can offer: large-sized hospitals will be able to treat a larger number of patients and diagnoses than small-sized hospitals.

The previous assumption is consistent to the evidence that in mixed-markets for hospital care, public hospitals are forced to treat, at least in principle, any type of patient (regardless to the cost), and any pathology; furthermore, public hospitals are avoided to implement a too fierce specialization. On the other hand, the private hospitals tend to specialize on those diagnoses/pathologies which can grant higher revenues.

An important issue related to this latter remark concerns the risk that private hospitals can adopt a cream-skimming policy, choosing low cost type patients, i.e., patients with higher ability to recover. In most countries this behaviour is illegal, and punished when detected; however, since illegal behaviour is very difficult and costly to be detected by the government authority, patient selection, when it takes place, is too often a risk-less and rewarding activity to the hospital given such a weak enforcement.

Hospitals can also affect their case mix by means of quality and advertising variables 0. This is possible due to patients' lack of knowledge concerning the true relationships between care and health outcomes that drives them far from rationality: the resulting choice will be biased, and conditioned by indexes of perceived quality rather than by appropriateness and effectiveness of the services delivered by the hospital. Such remarks led us to think to a behaviour scheme for hospitals that we are going to illustrate on following.

We assume that hospitals are aimed to maximize their objective function whose main variables are:

the number of treatments (*nt*);

the quality delivered. This, in turn, is made up of two components:

the quality for health-related services (*hqs*), i.e. those services that improve the medical quality of the care. The medical quality typically includes aspects like appropriateness, health, nursing, aftercare, etc.

the quality for hotel-related services (*hqns*) which comprises all those services that are not strictly medical, but still improve the patient's stay in hospital. Non-medical quality includes comfort, information, kindness, catering services and so on.

the level of advertising (*hadv*). With this variable we refer to the capability of hospitals to affect patients behaviour providing information about the hospital and its services. In practice, we are modelling a kind of signal by which hospitals try to overcome the asymmetry of information which characterizes the health market.

the general cost (*cgen*) borne by the hospital in order to cover all the variables described in previous rows (a certain amount of treatments *nt*, the health related quality *hqs*, the hotel related quality *hqns*, and the advertising *hadv*).

Note that in our model we assumed the variable *nt* (number of treatments) to have higher values in the case of large-sized public hospitals, and lower values when small-sized private hospitals are considered. The reason may be found in the wider range of treatments provided by public hospitals, whereas private hospitals specialize on a limited (if compared with the public) number of treatments. This, in turn, is due to the fact that private and public competitors pursue different objectives, and they have different attitudes towards the quality mix they offer.

Some remarks are also noteworthy for the variable we have referred to as advertising (*hadv*). Advertising plays a role in the health market in consequence of the asymmetry of information: although it implies a cost to be charged by hospitals, the public promotion is generally cheaper than any kind of intervention on quality, and it is suitable to convey some information (i.e. signals) to patients in order to influence their behaviour (even with false and unreliable facts). Advertising is other than quality but it might inform about it.

2.2. Patients main features

We assume that patients maximize their objective function that depends on the quality of services they receive and on the spatial distance, i.e., on the hospital position with respect to the patient location. Additionally, we consider patients having different attitudes towards quality mix and advertising .

Starting from this point, we have then considered two type of patients: low and high severity type. Our model assumes a different attitude for quality according to the type: high severity patients are more interested in health quality (*hqs*), whereas the low severity patients attach importance to the hotel related services (*hqns*).

Respect to the hospitals side, we have added two additional variables: *CrepH* and *CexpH*.

CrepH express the scores given by patients to hospitals reputation; as such, we have modelled it as a linear combination of the medical quality (*hqs)*, of the non medical quality (*hqns,*), and of the level of advertising (*hadv)*:

$$CrepH = \gamma_1^i hqs + \gamma_2^i hqns + \gamma_3^i hadv$$

where γ_r^i (r =1,…3) is the coefficient associated to each variable, being $\sum_{r=1}^{3}\sum_{i=0}^{1}\gamma_r^i = 1$, and *i* is a binary variable that marks patients in a different way, whether they are of low severity *(i=0)* , or of high severity *(i=1)*. In particular:

$\gamma_1^1 > \gamma_2^1 > \gamma_3^1$;

and:

$\gamma_2^0 > \gamma_1^0 > \gamma_3^0$

The variable *CexpH,* on the other hand, represents the hospital attitude to treat high severity patients. Like in the case of *CrepH*, *CexpH* is a linear combination of variables too, depending on the number of treatments provided by the hospital (*nts*), and on the hospital's health quality (*hqs)*:

$C \exp H = \lambda_1 hqs + \lambda_2 nt$

where λ_s (s=1,2) are the weights associated to each variable, and $\lambda_1 \neq \lambda_2$, $\lambda_1 + \lambda_2 = 1$.

The settings described above are coherent with the assumption of different patients attitudes according to their type.

2.3. Some preliminary conclusions on the examined economic model

As a consequence of the assumptions on patients' behaviour, hospitals will face a demand for each patient severity type which depends on the quality mix and advertising they decide to offer. Taking into account this feature, the hospital will modify its demand, choosing the appropriate quality mix, in a sort of indirect cream skimming.

In the market for health care, because of asymmetric information, patients observe quality (especially the medical quality), with bias. The afore mentioned market failure creates favourable

conditions for an advertising strategy. With reference to credence goods, advertising is an impure signal intended for customers; thus the information provided might be direct, indirect or just false. The advertising scope is to affect patient behaviour even if rational agents should consider it unreliable since its informative content might be biased or false.

According to the patient type, a different weight is given to the different variables: high severity patients will pay more attention to the medical quality with respect to the hotel quality; on the opposite, low severity patients will prefer hotel quality. The advertising role is not directly related to the patient type. In general, advertising represents a cheaper option with respect to quality. If we assume that medical quality is more expensive than hotel quality, then a large investment on medical quality may offset the possibility to invest on hotel quality and advertising. On the other hand, hotel quality and advertising could represent a option to the medical quality.

In our model we assumed that hospitals provide a quality level above that minimum representing malpractice. In other words, we allow for a low investment on quality under the constraint that it has to respect a minimum enforceable level normalised to zero.

Furthermore, the patient utility is affected by the cost for the health service required. Even in the case of a patient receiving the treatment free at the point of use, the cost component enters his objective function since he is aware of the fact that the system is tax financed.

3. The computational approach

Computer simulation is nowadays a key technique to model economic dynamics 0.

The current interest on such topic may be variously explained: this work is aligned to the position outlined in 0, who emphasized the importance of looking at the economy as an evolving network. This means that interaction is regarded as a leading aspect of economic systems: individual behaviour arises as a combination of both previous personal experience and partnerships effects.

Those considerations may be applied also to the case under examination, where we take into account both individuals (the patients, and to certain extent, the hospitals), and aggregate entities (group of patients).

With this in mind, plausible simulations of interaction should take into account at least three interrelated levels of issue:

the individual level, driven by personal interest;

the aggregate level, where global behaviour not necessarily emerges as the simple cumulation from the individual stage;

the level of the bi-directional flow, linking individual to aggregate behaviour, and vice-versa, so that the former stage affects the dynamics of the whole, as well as the macro level, in turn, may influence the micro one.

Apart from considerations about its effectiveness, an exhaustive mathematical description would hence require the assumption of a system of partial differential equations, as wide as the number N of individuals in the model. This makes the problem not easy to handle for larger values of N. However, since computers have become widely available, heavy computational methods, previously applied in statistical mechanics and in artificial life simulations have been introduced to model phase transition in economic systems. Moving toward this direction, here we are focusing on a computational technique to model those interplays by means of unsupervised neural networks.

Artificial Neural Networks (ANN since now on), have gained increasing popularity over the past two decades, because of their ability to model input/output (I/O) relationships through plastic linking, which can evolve and adapt over time.

The general formalism is inspired to the nervous system architecture: nodes (i.e. neurons) are modelled as I/O elements, with connections (corresponding to biological synapses, as to say the strength and significance of their activation respect on input patterns) which generally assume values in the open interval (-1,1).

One important characteristic of artificial neural networks is that they are not programmed like classical computers, but they have to be trained. According to the way training is performed, we are able to distinguish supervised and unsupervised neural networks. In supervised neural networks, the

desired output response of neural networks is determined by a set of input targets. The general form of the relationships or mapping between the input and output domains is then established by the training on data, as saying that an external teacher is needed to specify these input/output pairings. On the contrary, unsupervised neural networks assume that training runs without such a teacher, and it takes place through the evaluation of similarity between input patterns presented to the nets and neurons. In practice, unsupervised neural networks make use of the statistical properties of input space to resemble in some way the underlying probability density function of the data. Additionally, unsupervised neural networks make use of the redundancy in input data, in order to produce a more compact representation of the input space itself.

Among the various types of unsupervised neural networks, the most famous (and most used) is represented by Kohonen's Self Organising Maps (SOMs). The Self Organizing Map (SOM) 0 is a projection method based on the principle of space representation through dimension reduction: a finite set of input patterns is represented by means of a smaller number of nodes (neurons), sharing with inputs the same format, and arranged into a mono or bi–dimensional grid; in order to avoid hedges effects, wraparound versions can be also implemented.

When an arbitrary input is presented to a SOM, a competitive procedure starts, during which a winner or leader neuron is chosen in the map, as the best matching node, according to a similarity measure (a metric) previously fixed. A generic step of the procedure may be then summarized as follows: we will refer to the case of a mono-dimensional SOM, but the layout presented can be easily generalized to higher dimensional grids.

If $x(t)=\{x_j(t)\}_{j=1,\ldots,n} \in P^n$ is the input item presented to a map M with q nodes with weights $w_i(t)=\{w_{i,j}(t)\}_{j=1,\ldots,n} \in P^n$, i=1,...,q, then i^*_t will be claimed the winner neuron at step t if and only if:

$$i_t^* = \arg\min_{i \in M} \left(\sum_{i \in M} \sum_{j=1}^{n} |x_j(t) - w_{ij}(t)|^p \right)^{1/p}, \; p \in N \qquad (1)$$

Typical choices for p are p=1 (city block or Manhattan distance), and p=2 (Euclidean distance).

Once the leader has been identified according to Eq.(1), the correction of nodes in the map takes place; if $Neighb_{i*}(t)$ is the set of neurons in the map belonging to the *neighbourhood* of i* (in a topological sense), then:

$w_i(t+1) = w_i (t)+h_{i*,i}(t)[x(t)- w_i(t)]$ \qquad\qquad (2)

Here $h_{i*,i}(t)(.)$ is an interaction function, governing the way the nodes adjust respect to the winning neuron on the grid. Typical shapes for $h_{i*,i}(t)(.)$ include the constant function:

$$h_{i*,i}(t) = \begin{cases} \alpha, i = i * \vee i \in Neighb_{i*}(t) \\ 0, \text{ otherwise} \end{cases}$$

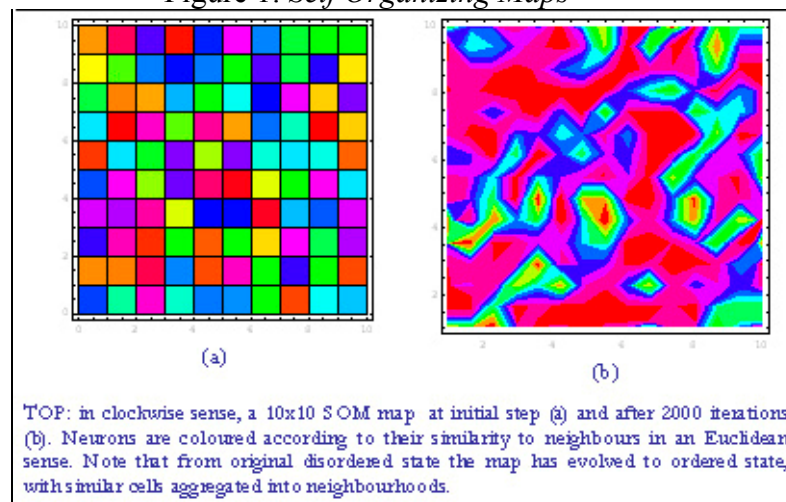with $\alpha \in (0,1)$, and the Gaussian function:

$$\boldsymbol{h_{i*,i}(t)} = \exp\left\{ -\frac{\sum_{r=1}^{n} |w_{i,r}(t) - w_{i*,r}(t)|^2}{2} \right\}$$

After iterating such procedure over a number of epochs, the map should tend to a steady organized state, and neighbouring neurons should represent similar inputs.

Note that performing the steps described by Eqns. (1) and (2) implies that inside the map an organization process takes place, and through it the preservation (i.e. organization through similarities) of input topology features. Figure 1 shows this concept in a more intuitive fashion.

Figure 1: *Self Organizing Maps*

TOP: in clockwise sense, a 10x10 SOM map at initial step (a) and after 2000 iterations (b). Neurons are coloured according to their similarity to neighbours in an Euclidean sense. Note that from original disordered state the map has evolved to ordered state, with similar cells aggregated into neighbourhoods.

Once the training process is concluded, SOMs can be used to visualize into the mono or bi-dimensional manifold the multidimensional input: different colours represent nodes (neurons) with different features, while similar colour shades represent nodes or group of nodes (clusters) that are a projection of input sharing the same features.

These aspects make SOMs a quite promising instrument to model human behaviour and interactions into an economic system, because they make possible to represent complex dynamics, and to visualize them, even when we are dealing with multidimensional input, through the projection of data into mono or bi-dimensional neural manifolds. Additionally, whereas the SOM represents the bi-dimensional projection of a multidimensional input space, the original map may be split into as many sub-maps as the number of components of the input space itself. This enable us to view at the overall results, as well as at the influence on such result of the single components.

Starting from this point, in the examined case we have focused on the following issues:

- the patient behaviour and its adaptive process;

- the hospital behaviour and its responses to external input;

- the feed-back among the agents (patients and hospitals) of the market.

We have therefore used the SOM algorithm to develop a more complex bi-layered model: in the upper layer SOM hospitals are organized and interact, while in the second layer SOM, interactions among patients are observed. This approach should be suitable to help to understand different behaviours and outcomes of the two observed populations.

The goal of the SOM procedure in both layers is to identify and select emerging behaviours, according to the significance of clusters and to the proximity of nodes of the maps.

4. Case study

We consider a two layer SOM model, the upper layer is a nrH x ncH map, representing hospitals behaviour, while the lower layer which is a nrP x ncP map, is aimed to describe the behaviour of patients.

From a technical point of view, the map representing hospitals is a 10x10 self-organizing map whose nodes are 5-dimensional arrays; those, in turn, are made up by components that express the variables outlined in section 2.1, affecting hospitals behaviour. An overall number of 200 input patterns (i.e. hospitals) have been used to train the map. Such inputs have been built in order to represent various types of hospitals, diversified according to the number of offered treatments, advertising costs, and services (health and non-health related) quality.

Figures 2-7 show the initial organization of the hospitals input space, both as a whole and by components. In each figure, various colour refer to different variable values: in particular, shading blue tones represent lowest values: moving from them to different shades of yellow and red we will also move towards higher values.

Figure 2: *hospitals overall density*	Figure 3: *variable hqs*	Figure 4: *variable hqns*
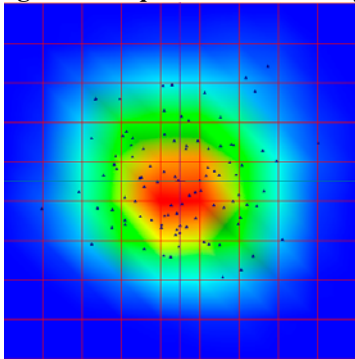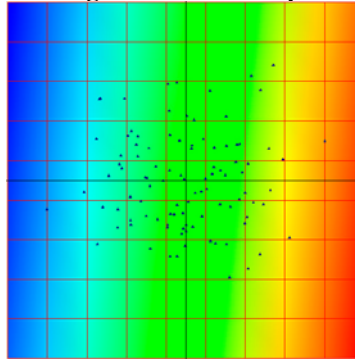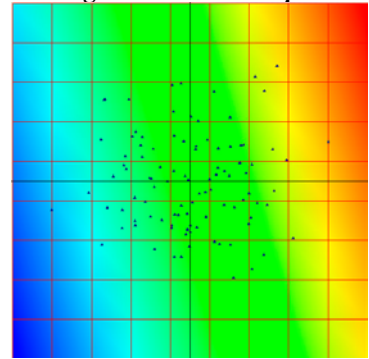
| Figure 5: *variable hadv*	Figure 6: *variable hcgen*	Figure 7: *variable hnt*
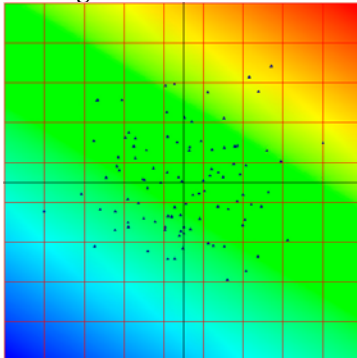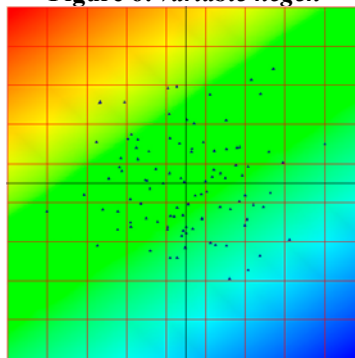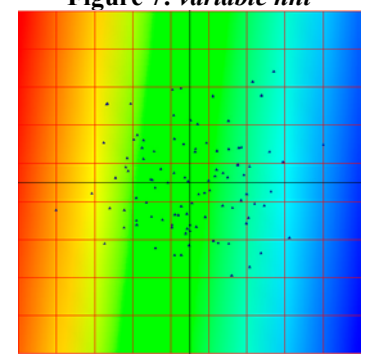
Figures 8-15, on the other hand, represent the initial organization of the patients input space. In this case, we have taken into account the evidence that generally a greater number of patients share a reduced number of hospitals offering cares and services. To such aim, the lower layer SOM has been built wider than in the case of hospitals: here we have managed a 25x25 map with 7-dimensional nodes, for an overall number of 2000 input patterns (patients). The greater number of

components (7 instead of 5) is simply due to the greater number of variables affecting patients behaviour: as said in section 2.2, in addition to the variables significant for hospitals, we have also introduced two variables called *CrepH* and *CexpH* to express the scores given by patients to hospitals reputation (C*rep*H), and the perceived hospital attitude to treat high severity patients (*CexpH).*
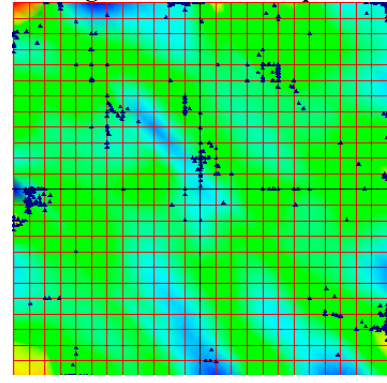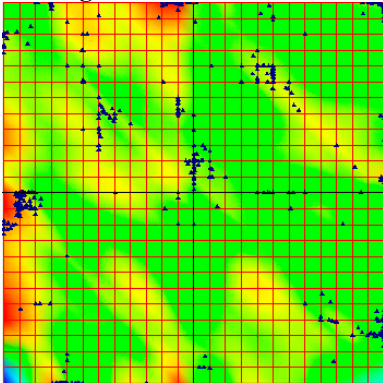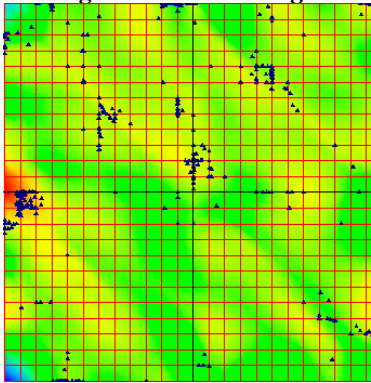
Figure 8: *patients overall density*
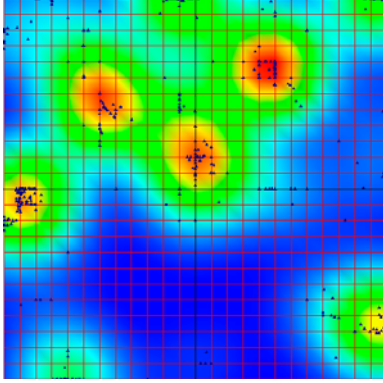
Figure 9: *variable Cqs*
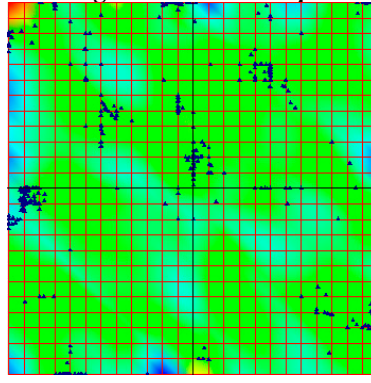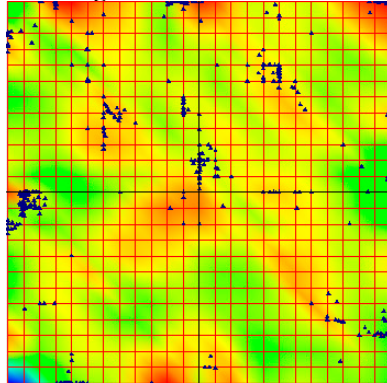

Figure 10: *variable Cqns*

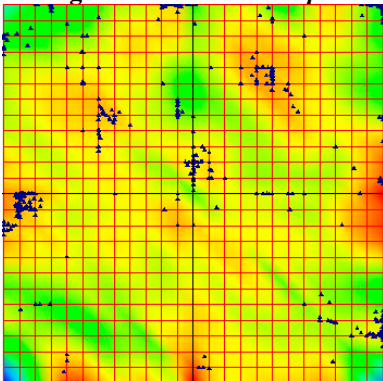**Figure 11:** *variable Cadv*

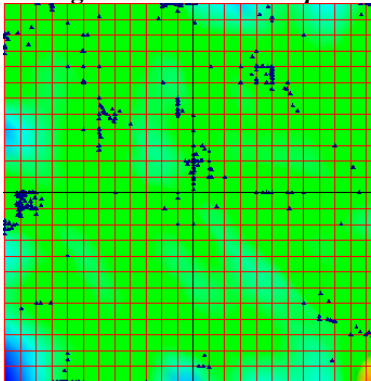**Figure 12:** *variable Cgen*

Figure 13: *variable Cnt*

Figure 14: *variable CexpH*

Figure 15: *variable CrepH*

Note that hospitals and patients initialization is at random and independent one from each other. With respect to patients, Figures 8-13 refer to the same variables than in the case of hospitals, while Figures 14 and 15 represent the density for CrepH and CexpH components, respectively.

As previously said, patients and hospitals lie in two different layers, but when the learning/adaptive process takes place then interactions move horizontally and vertically. In the

upper level, where hospitals are located, there is a dynamic competition for patients that rules out according to Eqns (1) and (2). Hospitals react to other hospitals behaviour and strategy. In particular, a sort of specialization might take place in those components that grant higher revenue to the hospital.

In the lower level map, information moves sideward from patient to patient, once again according to Eqns (1) and (2), and patient's expectation is affected by other patients experience and judgement. Additionally, information and signals move upwards from patients to hospitals: the supply side adjusts its components in order to meet the demand requirements: information moves also downwards from hospitals to patients; as a consequence of the asymmetry of information, patients experience a learning process about the hospitals' quality and behaviour.

Such vertical interaction is managed at each time t (from lower to upper layer) according to the following rule:

$$w_{r,s}^H(t+1) = \max\left[w_{r,s}^H(t), w_{r,s}^H(t) + \frac{1}{crnk - Nc - 1} \times \left(1 - \frac{rnk}{nr}\right) \times f^H\left(CrepH_{w_{r,s}^H(t)}, C\exp H_{w_{r,s}^H(t)}\right) \right] \quad (3)$$

with r=1,…,nrH; s=1,…, ncH. Going deepest in the detail of the formula, $w_{r,s}^H$ is a generic array in the upper map, while *crnk* is the cluster ranking in the lower map, Nc expresses the number of clusters in the lower map, *rnk* the cluster ranking in the upper map, *nr* is the average number of elements for each cluster, and, finally, $f^H\left(CrepH_{w_{r,s}^H(t)}, C\exp H_{w_{r,s}^H(t)}\right)$ measures the influence on each hospital operated by CrepH and CexpH:

$$f^H\left(CrepH_{w_{r,s}^H(t)}, C\exp H_{w_{r,s}^H(t)}\right) = \frac{1}{nrP \times ncP} \frac{\sum_{v=1}^{nrP}\sum_{z=1}^{ncP} CrepH_{w_{v,z}^P(t)} + C\exp H_{w_{v,z}^P(t)}}{\sum_{k=1}^{5} w_{r,s}^H(t)}$$

From the practical standpoint Eq.(3) means that hospitals are not only influenced by the competition among themselves, but also by the evolving ranking that patients make about hospitals, and by the influence expressed in such process by hospitals reputation and hospitals ability to treat high severity patients. In a similar way, downward interaction is managed according to the:

$$w_r^P(t+1) = \max\left[w_r^P(t), w_r^P(t) + \left(1 - \frac{rnk}{nr}\right) \times f^P\left(CrepH_{w_{r,s}^P(t)}, C\exp H_{w_{r,s}^P(t)}\right) \right] \quad (4)$$

Other in the case of (3), here $f^P\left(CrepH_{w_{r,s}^P(t)}, C\exp H_{w_{r,s}^P(t)}\right)$ represent the conditioning expressed by hospitals on patients , and it is given by:

$$f^P\left(CrepH_{w^P_{r,s}(t)}, C\exp H_{w^P_{r,s}(t)}\right) = \frac{1}{nrP \times ncP} \cdot \frac{\sum\limits_{v=1}^{nrP}\sum\limits_{z=1}^{ncP} CrepH_{w^P_{v,z}(t)} + C\exp H_{w^P_{v,z}(t)}}{\sum\limits_{k=1}^{7} w^P_{r,s}(t)}$$

Simulations have been then run, moving from the random initialization of the two layers up to arrive to a steady state. Figures 16-23 represent the more interesting maps components of such final organization for both the upper and lower layer map.
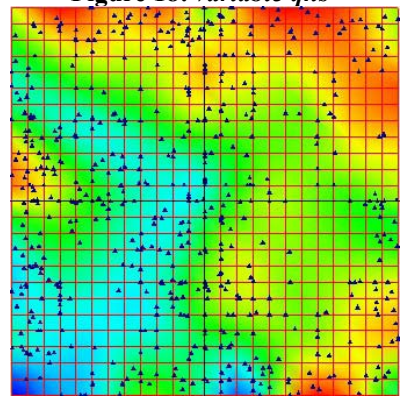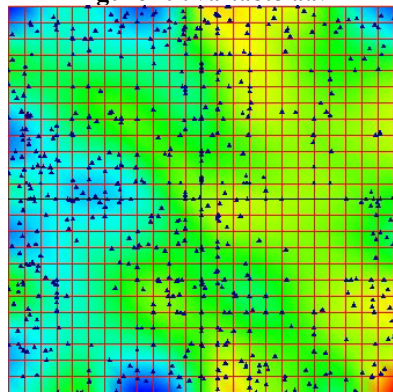
Figure 16: *overall density*
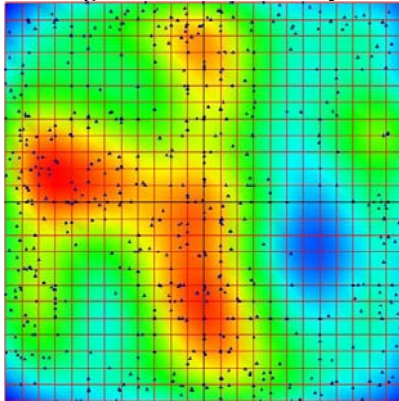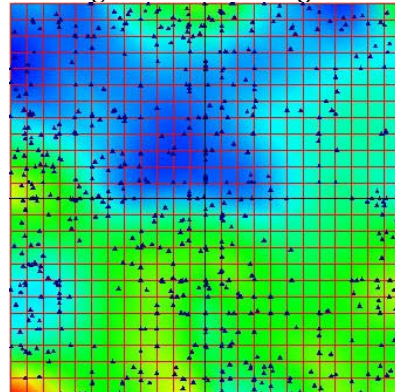

Figure 17: *variable qs*
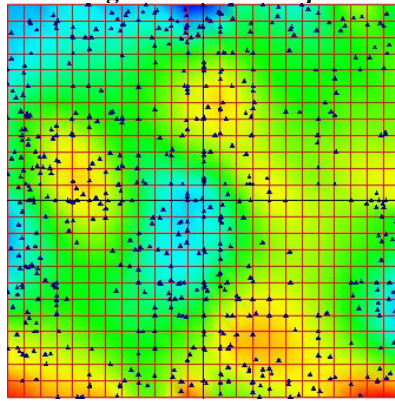
Figure 18: *variable qns*

Figure 19: *variable adv*

Figure 20: *variable cgen*
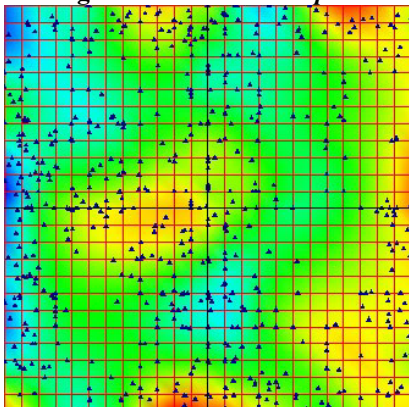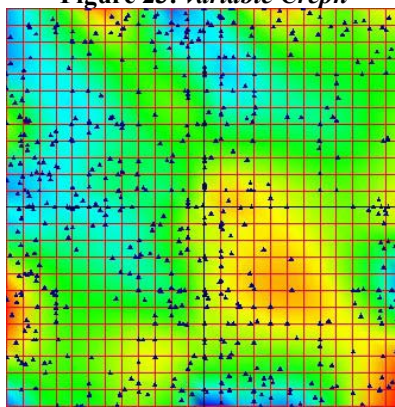

Figure 21: *variable nt*
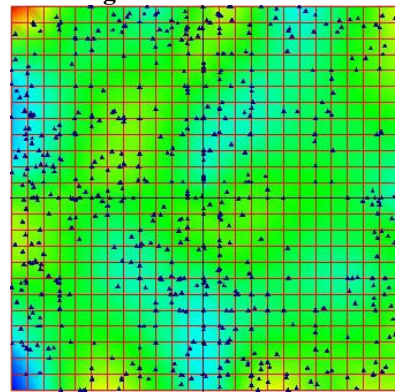
Figure 22: *variable CexpH*

Figure 23: *variable Creph*

From the simulation we observe that hospitals uniformly set a homogeneous optimal size. Figure 21 which refers to the number of treatment *nt* suggests that hospitals should tend to reach a middle size (the green colour is as far from the red, which represents large size, as from the blue,

which represents the small size), i.e. they reach better financial results (that means lower costs) when they are able to provide a number of treatments on average respect to the extrema of the fully specialized hospital (which provides only a single treatment) and of the generic hospitals that furnishes the whole variety of treatments.

Additionally, looking at Figures 18, 19 and 20, it is easy to note that higher values for *qns* and *adv* are associated to lower general costs *cgen*. This information is quite interesting, especially if we think that it comes out from a process which is completely data driven (instead that model driven). As consequence of the adaptation that takes place according to Eqns. (1), (2), and (3), hospitals seem to sustain costs that influence only the quality of health-related treatments: the higher they are, the higher the effects on hospitals reputation, even without changing anything in the quality of non-health service. In practice, our results suggest that some mystifying actions on the effective level of the quality of services are possible to the extent of the imitation component which is inside the neighbourhood structure of the map.

5.Conclusions

In this study we have suggested a computational approach to model the functioning of the health care market which is suitable to provide insights concerning the interactions among hospitals and patients. The hospitals and patients behaviour has been modelled by a learning/adaptive process which takes jointly into account all the components of interest for both hospitals and patients.

In our study we have modelled both the role of patients in influencing the hospital decisions and strategies and the behaviour of hospitals by means of unsupervised neural networks belonging to the class of self organizing maps (SOMs). In particular, we managed a model where two SOMs are arranged into two layers, one representing hospitals, and one representing patients. In such depicted settings, where hospitals compete among themselves, and take into account and react to external signals expressed by a feedback with the patients layer.

We have described hospitals varying in size. The small-sized hospitals do not provide a full range of services and specialize on those treatments they prefer. The specialization would probably take into account two aspects: the most rewarding diagnosis and the patient type. Low cost type patient might be selected by a suitable quality mix, assuming a different attitude towards medical quality, hotel related quality, number of treatments and advertising of low cost/severity patients with respect to the high ones.

Moving to the simulation results, it comes out that our model incorporates not only the positive elements of a demand driven mechanism, but also negative ones. In particular, we refer to the risk that the market structure may induce hospitals to curb the medical quality level (avoiding the case of malpractice) with a consequent social loss.

In our opinion, our model fits to provide insights to analyse the implications for health quality, hotel related quality, cost and advertising of the proposed market structure and to understand the welfare implications of the different scenarios.

The introduction of a new policy should evaluate the ability and the potential to save and improve quality in the market. Any government policy intended to provide incentives to competition would seek first to identify the quality variable and its outcome level when competition among providers is implemented in the market of interest. Thus the second step would consist on determining (by simulation) the best market structure so as to advance quality and generate appropriate mix among quality, advertising and efficiency.

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