Boris Galitsky and Mark Levene (2005)

Simulating the Conflict Between Reputation and Profitability for Online Rating Portals

Journal of Artificial Societies and Social Simulation vol. 8, no. 2
<http://jasss.soc.surrey.ac.uk/8/2/6.html>

To cite articles published in the *Journal of Artificial Societies and Social Simulation*, reference the above information and include paragraph numbers if necessary

Received: 01-Dec-2004 Accepted: 19-Feb-2005 Published: 31-Mar-2005

Abstract

We simulate the process of possible interactions between a set of competitive services and a set of portals that provide online rating for these services. We argue that to have a profitable business, these portals are forced to have subscribed services that are rated by the portals. To satisfy the subscribing services, we make the assumption that the portals improve the rating of a given service by one unit per transaction that involves payment. In this study we follow the 'what-if' methodology, analysing strategies that a service may choose from to select the best portal for it to subscribe to, and strategies for a portal to accept the subscription such that its reputation loss, in terms of the integrity of its ratings, is minimised. We observe that the behaviour of the simulated agents in accordance to our model is quite natural from the real-would perspective. One conclusion from the simulations is that under reasonable conditions, if most of the services and rating portals in a given industry do not accept a subscription policy similar to the one indicated above, they will lose, respectively, their ratings and reputations, and, moreover the rating portals will have problems in making a profit. Our prediction is that the modern portal-rating based economy sector will eventually evolve into a subscription process similar to the one we suggest in this study, as an alternative to a business model based purely on advertising.

Keywords:
Simulation of Competition, Subscribing to Rating, Web Portals

Introduction

1.1 Portals providing online rating of services, such as financial services, are becoming more popular nowadays. A rating portal providing comparisons between competitive services, has the potential of becoming a well established web enterprise. For some services the comparison

is performed based on a set of measurable values such as performance and price, for example when the service involves computer hardware. In such an environment, services can make a rational decision whether they wish to advertise on the portal, based on the set of measurable values. However, for some services like banking, brokerage and other financial services, characterised by such parameters as customer support quality, it is impossible to establish an objective set of measurable values. In these cases the rating portals publish their scores for the competing businesses based on their own private estimation strategy. We believe that evolution of the interactions between the agents being rated and rating agents is an important social process which is worth examining through simulation.

1.2 There are two common ways to rate services: (1) assigning to each service a score in a range of values, or (2) ranking the services in order of preference. In this study we simulate the plausible interaction between portals and services using a simplified model, and we analyse possible scenarios of how services can influence the portals' rating system. Our approach is based on a straightforward revenue model for rating portals, where they require the rated services to be paying subscribers in order to obtain a rating. Within this model we follow the dynamics of how the competing services may influence the portals to improve their respective ratings.

1.3 Web-based rating portals are normally assumed to be independent, and they do their upmost to impress on the customers of the services being rated that this is indeed the case. However, the current web economy does not broadly support the revenue model, where rating portals charge their customers, so instead, the companies competing for ratings fund the portals through advertising their products on the portal's website. This model of advertising can be tied in to the rating mechanism, leading to a new form of advertising. In some sense this is similar to the paid placement model of advertising on search engines, where the (sponsored) ranking for a given query is decided by a bidding process for keywords that will be submitted as queries by users to the search engine (Feng et al 2004).

1.4 Over last couple of years, the role of paid placement advertising on web portals has dramatically increased. Within the search engine community such adverts are known as sponsored links, and they are normally charged on a pay-per-click basis. It is natural to expect that the order of paid placement advertising is perceived by users as a form of rating, although, in reality, the rank of a sponsored link for a given search query is determined via a bidding process. It is therefore, possible to explore alternative mechanisms of providing and evolving ratings for sponsored adverts. These mechanisms will be competitive in nature; the competition involves both the services to be advertised and the web portals displaying the adverts

1.5 Here we obtained our dataset of initial (pure) ratings from a selection of search engines' rating of a number of services. (Note that we did not record the ratings of sponsored links.) This provides us with a 'good' starting point for the simulations we carried out. However, prior to being able to speculate about a future possible business model for rating portals, these portals would have to disclose their advertising/rating policy.

Introducing "Rating subscription"

1.6 In this study we suggest a plausible model of advertising based on a process of transferring resources from services to rating portals in the form of a *rating subscription*. In this model services enter into a contract, where they are paying rating portals for a *small increase* of their rating on the portal's list. Portals attempt to carry out this small increase, while not deviating significantly from *pure* rating, which these portals would otherwise assign. In the situation where the subscription rate is the same for all participating services, the rating results would not significantly deviate from pure ones, which are not sponsored by any of the services.

Therefore, we can argue that, in this case, the reputation of the rating portals would not be strongly affected by services who are sponsoring their rating lists. The drawback of this scheme is that the services, which decide not to join into a subscription agreement, will either be forced to withdraw from the rating scheme or to suffer overall low ratings by a community of portals. We will refer to the rating modified in the course of subscription process as to the *forced* rating.

1.7 The methodology of this study is as follows. We analyze the current business model of web portals that provide rating services and hypothesise that they would be willing to be funded by the services rather than by their users (i.e. customers). We then conduct the *what-if* study suggesting a simple model with rational agents for services and portals as possible for a simulation of the subscription model. The resultant behaviour is verified and analysed with respect to the possibility of extracting patterns of rating subscription-based behaviour from real publicly available data. We conclude the paper with a discussion of how the predicted subscription process fits into the current advertising models; also the process itself is considered from the standpoint of conflict resolution in multi-agent systems (Lerman and Shehory 2000, Klusch and Gerber 2002, Galitsky 2005).

1.8 In the literature on decision-making, the what-if methodology uses informal patterns of counterfactual reasoning to analyse the conjecture of an assumption that can be disputed (Thierauf 1982; Turban 1990). In our case the assumption is that rating portals are ready to accept subscriptions from the services being rated, because we envisage no alternative income mechanisms for these portals. The next step is to build the most simple and plausible model of such a subscription procedure using initial conditions taken from the real-world. The behaviour of involved agent (portals and services) is then analyzed with respect to rationality, consistency, plausibility and match with available economic data from a similar domain (compare with Zacharia et al 1999).

Economic model

2.1 Portals are primarily characterised by their reputation. To express this quantitatively, we refer to the difference between the average rating of each service and the individual rating of each service on each portal. The higher the portal's reputation, the more potential customers it has and a higher the number of web surfers who would follow the portal's recommendation to select a particular (top-rated) service. Also, the higher the portal's reputation is, the higher is its appeal for the services to be rated by this portal, and, therefore, the potential revenue stream for the portal is higher. At the same time, when a portal accepts resources from the services it rates, its reputation may drop because its forced rating may become less pure. The dynamics of such a process is the subject of the current study.

2.2 How should the reputation of a portal be defined? Here we suggest a simple model where there is no quantitative measure for objective rating: each portal, while having its own rating system, aims to maximise its revenues on the one hand, and on the other hand aims to deviate as little as possible from the average portal rating. The justification for this is that often the public perceives the average (or typical) rating (or opinion) as the most trustworthy (Myung and Pitt 2003). This is in contrast to a distinctive or radical opinion, which may be too risky to follow.

2.3 Evidently, services' ratings by portals is public information. Therefore, portal reputation may be calculated by an external observer in a similar way to the one we suggest herein. What is not explicitly made clear for an end user is the subscription policy, however, an external observer can speculate about it and capture its features. A portal accepts an offer from the service which has a highest rank by the rest of portals, selecting among all services which offer a subscription payment.

2.4 We selected our model using the average rating as being the most plausible, based on psychological studies of how the public perceive the parameters of relating to the subject of interest (see e.g. Myung and Pitt 2003). We also conducted a limited study of how financial services (mutual funds) are ranked according to search engine keyword-based queries and compared this data with the most popular rating of mutual funds according to morningstar.com. We observed that averaging is the simplest way to perceive the rating data, and that the most popular search engine (google.com) is quite close (however, not the closest) to the rating, averaged over the four search engines (see the selected rating dataset in the "Formal Model" section below).

Selecting a partially rational strategy

2.5 Our model reproduces the real-life conflict between the services and portals: each service is determined to improve its ratings irrespectively of how it affects a portal's reputation, and vice versa, each portal wishes to achieve higher reputation and at the same time to increases its revenues. No evident compromise is possible.

2.6 Rather than attempting to build an optimal strategy for services and portals, we suggest a simple *partially rational* strategy, where the agents only take into account a limited set of (two) parameters:

- Services request a higher ranking from portals with higher reputation.
- Portals select services, which request a change in rating, that would minimise the damage to their reputation.

One way of verifying this approach is by changing the partially rational strategy into a random one, and showing that the performance in terms of revenue and rating/reputation significantly decreases (Section 4).

2.7 This strategy is called partially rational because all involved agents implement a limited strategy and are not capable of applying introspection. Services do not take the strategies played by all other services into account. More specifically, if services were fully rational in the usual (economic) sense, one would expect them to anticipate (or try to anticipate) the behaviour of other services and then to incorporate the effect of other services' strategies into their own strategy. For instance, one service could anticipate that it is competing with another service, which has a higher chance of being accepted than itself. In that case, a refined strategy would be to choose another portal which may not exhibit the best "reputation/ranking" compromise, but with whom the service has a higher chance of being accepted. While more difficult to implement, such strategy may be more 'rational' than the suggested strategy.

2.8 To provide realistic initial conditions for our simulation, we have chosen fifteen mutual funds as services and four well-known keyword search portals, which provide ratings for these services by ordering them within search results page. We believe such a setting is most closely related to our model. In terms of the initial conditions, this is because the ratings of respective websites are objectively ranked, or otherwise ranked as with paid advertisement. The ranking order changes in time due to modifications in the rating algorithms effected by keyword search portals, on one hand, and website infrastructure development for the services, on the other hand. Therefore, the evolution of services' rating by keyword search portals are partially caused by changes in advertisement efforts of services (by means of websites). In our model, we will simulate the efforts of website improvement as a subscription process having a direct influence on rating portals. We suggest the reader to consult (Tennenholtz 1999) for social issues regarding agents' rationality.

2.9 We have chosen a relatively small number of agents so that we can track their behaviour and observe the results. We have also verified the model with a larger set of participating agents and although the convergence time is longer, we recorded similar phenomenology as revealed

by the smaller data set.

2.10 We have simulated all phases of the subscription process, including the initial phase, when the services initiate the subscription process to modify their initial (pure) rating, and the terminal phase, when the services run out of resources, and stop being selected by portals, or see no further benefit in participating in the process. We believe that simulating the full cycle of the subscription process rather than just recording the resulting stationary process, provides us with sufficient phenomenology to identify similar processes in the real business world.

2.11 Modern markets for information tend to be dominated by "gatekeepers" (portals in our case) who charge fees from services and their consumers who transmit and acquire information. For traditional gatekeepers, such as newspapers and magazines, these fees are simply advertising and customer subscription fees (Bhargava and Feng 2001, Bhargava and Feng 2002). In case of Internet, in most scenarios, there is no contribution from the consumer side at all.

Advertisement models

2.12 With regard to related models in the economic literature, it is worth mentioning (Baye and Morgan 2001) who deal with price-rankable products within an equilibrium model. Thier work addresses the economic impact of portals, where both consumers and service providers are being charged by portals. The portal fees come from services that advertise prices on their websites, and from consumers who access ratings (list of advertised prices).

2.13 Portals' profits are maximized in an equilibrium, with the conditions where (a) the product market exhibits price dispersion, (b) access fees are sufficiently low so that all consumers subscribe; (c) advertising fees are partially affordable for services, and (d) advertised prices are below unadvertised prices. In addition, a large numbers of models have been used to assist in decision making in advertising. Econometric and other market models, as well as decision calculus models such as ADBUDG, have been used in the determination of advertising budgets (Little 1970). Media selection and scheduling models have included linear and nonlinear programming-type models, such as MEDIAC (Lodish 1966), and decision calculus models. Few models, such as ADMOD (Aaker 1977), have been designed to deal simultaneously with resources and media allocation decisions, where what we model in this study is a partial case of the latter. Our model can be considered as being complementary to the advertising model of Vidale and Wolfe (1957). It is an econometric model that represents the rate of change of sales as a function of the rate of advertising spending. The tagged effect of advertising is incorporated using a sales decay term. (The model allows the effect of advertising to have different increase versus decay rates).

A formal model

3.1 We use a matrix *M* to express ratings (initially pure and then forced), where *M(s,p)* denotes the rating of service *s* by portal *p*. Ratings of services are represented by integers from 1 to *ns*, where the ratings are presented in ascending order from the highest rated service (1) to the lowest one (*ns*). Each column of *M* contains integers 1,...,*ns* in a certain order such that each integer occurs only once, i.e. a portal cannot assign the same rating to two services.

3.2 The average rating for a service, *s*, over the set of portals, is given by:

$$r_{avg}(s) = \sum_{p} \frac{M(s,p)}{\#p} \qquad (1)$$

where *#p* denotes the number of portals. Indeed, services intend to achieve better rating from portals with higher reputation, so the weighed *M(s,p)* comes into play (Section 4).

3.3 The reputation for a portal is calculated as the reciprocal of the deviation of the rating it gives to each service from the average rating of the service, and is given by

$$reput(p) = \frac{1}{\sum_{s} | M(s,p) - r_{avg}(s) |} \qquad (2)$$

3.4 Portal reputations are greater than zero: the higher *reput(p)* the better the reputation is (i.e. the closer the totality of the given portal is to the average). If we assume that for a given portal its rating of every service is identical to the average rating, then the reputation of a portal approaches infinity. When selecting which portal to subscribe to, a service chooses the portal with the highest reputation while taking into account its possible increase in rating so that its rating will be as close to the highest rating (i.e. 1) as possible. More specifically, service, *s*, makes a subscription offer to portal, *p*, in such a way that

$$\frac{reput(p)}{M(s,p)} \qquad (3)$$

is maximized.

3.5 Out of the totality of services which make a subscription offer to a given portal, the portal selects the one which would decrease its reputation the least. More specifically, portal *p* chooses to accept the subscription from the service *s* that minimizes

$$| M(s,p) - r_{avg}(s) | \qquad (4)$$

.

3.6 When portal, *p*, accepts the subscription offer from service, *s*, then *s* transfers *m* resource units to *p*, and *p* increases the ranking of *s* by one. So, if *s* was ranked at position *n* and *s'* was ranked at position *n*-1, their rankings are swapped. In the special case when *s* was already ranked at position 1, the portal does not accept the offer from *s*.

3.7 For example, the top scenario shown in Figure 1 is beneficial for a rating portal because after the rating for the subscribed service is increased, this services rating will get closer to the average rating over all portals, and therefore its reputation increases as a result of the transaction. Conversely, for the scenario shown on the bottom of Figure 1, the increase in rating desired by this service will cause the portal's reputation to decrease, since its rating of the service moves further away from the average rating for this service.

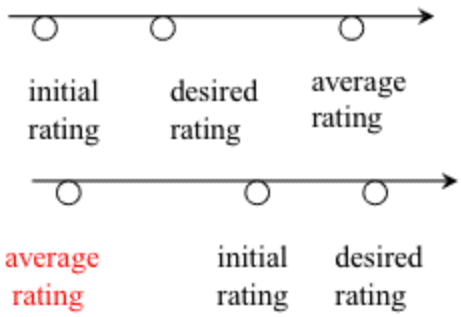

Figure 1. Two scenarios showing how portals' ratings change

3.8 The algorithmic steps of the simulation are depicted at Figure 2. Two modules where the selection strategies are implemented are highlighted.

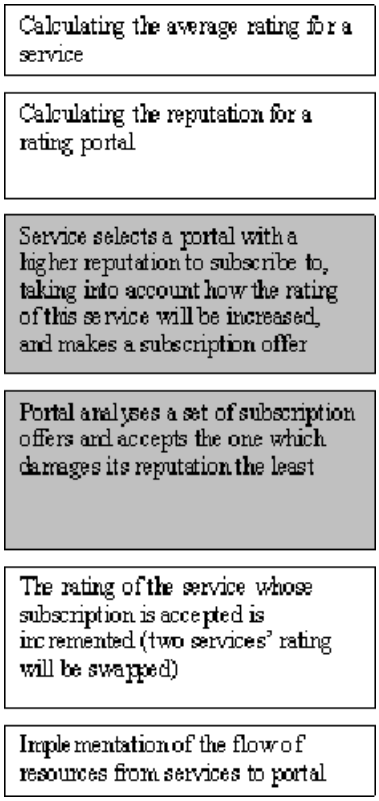

Figure 2. The modules of the interaction process

The simulation that produced the results described in the next section was implemented in Matlab and is available from the first author on request.

Simulation runs

Forming the simulation dataset

4.1 We first present the dataset that we used to track the dynamics of the interaction between services and portals, capturing the behaviour patterns of the involved agents and judging their rationality. The purpose of this dataset is to verify the consistency of our model with respect to the rationality of the portal selection strategy of services and the offer acceptance strategy of

portals.

4.2 We formed the initial dataset of pure ratings from a selected set of fifteen mutual funds, rated by a set of four portals as a 4 by 15 matrix, where each column, representing a portal, contains numbers from 1 to 15 (without repetitions) denoting the ratings of the services by the portal.

4.3 For our simulations, we select four keyword-search companies as portals (Google, Altavista, Lycos and Hotbot) and obtained the pure ratings of the fifteen mutual funds as services abbreviated as ici, brill, vanguard, ameristock, mfs, bmo, rbcfund, ariel, oakmark, janus, portfolio21, scotia, prudential, ci, calvert. Our choice of mutual funds as potential subscribers to rating services is because their ratings are very important for investment decisions. Also, it is very hard for a non-experienced investor to estimate a rating of mutual fund even having invested in it.

4.4 To obtain the initial rating, we observed the order in which each of the above mutual funds appeared in the list of items delivered in response to query "mutual fund". Only the occurrences (sequence) of the above funds were extracted from the search query results in each of the above search engines. For model validation we have extracted the above search results during 6 consecutive months, starting from April 2004. The dataset for initial conditions was collected on 12 April 2004.

4.5 To visualize the dynamics of the interactions, we plot the two following types of curves:

1. Distributions of ratings/reputations and resources of services and portals; and
2. The evolution of these parameters over time.

Simulating distributions of rating, reputation and resources

4.6 The first type of curve is useful to illustrate how services and portals are different at a specific point in time, and the second type to illustrate the changes of ratings/reputations and resources for each agent over a period of time.

4.7 In addition to the initial ratings, the following simulation parameters were used:

1. Initial resources set at 1000 units.
2. Subscription fee (per transaction) set at a flat rate of 50 units.

Portals do not need initial resources in this model because they can only acquire them. At this point we assume that all services have the same initial resources; when they run out of resources they cannot subscribe for rating any more and become dormant. In our further simulations we will show the trends for randomized initial conditions.

4.8 For the sake of uniformity of our simulation the services pay the same (50 units) for increasing their ratings. It is the same amount to change a rating from 13 to 12 as it is from 2 to 1; rating increases always start with the lowest number (which is the number of services being rated).

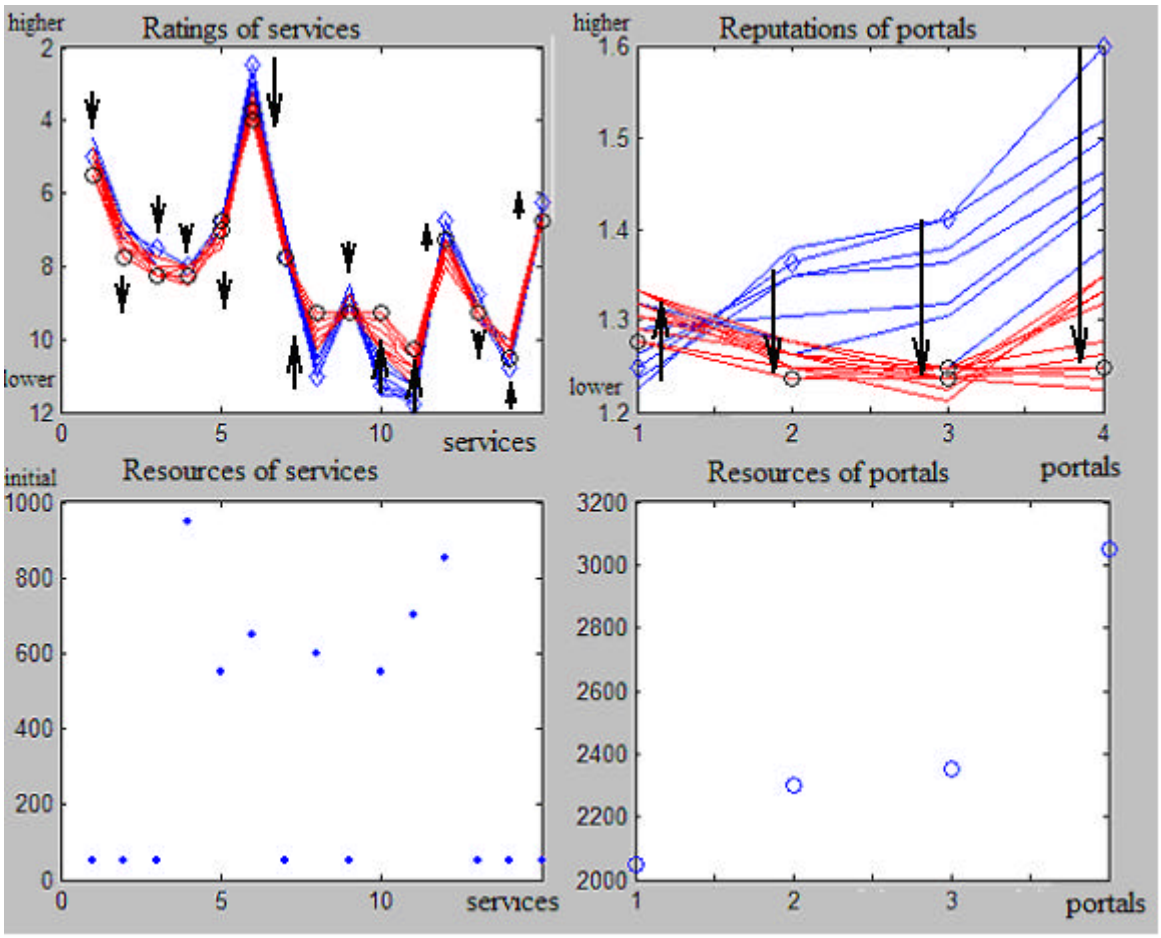

Figure 3. Distributions of average (forced) ratings, reputations and resources. Both partially rational strategies of service subscription offers and portals acceptance are used. Arrows on the top charts show the overall change in average rating/reputation (from zero to 60th simulation step, to match with Figure 4)

In Figure 3, on the charts for distributions of ratings/reputations shown in the upper half of the figure, diamonds denote the initial ratings and circles denote the final ones. On the charts for resources shown in the lower half of the figure, dots and circles denote the respective values for services (left) and for portals (right).

4.9 We observe that about a half of services have run out of resources, all of which have been transferred over time to the portals (see the dots on the bottom of the resources of services chart). Remarkably, these services (except for #15) did not improve their ratings.

4.10 Those services which dramatically improved their ratings still have some resources left, which they can use to further improve their rating on portals. We observe on the chart that only those services whose average rating is below 11 have actually improved their pure rating.

4.11 Therefore, one may suppose that only the lowest rated services will have an interest in paying a subscription fee to the portals (assuming that a pure rating is possible). However, this is far from the truth: the other services need to keep trying to move the ratings in the direction which favours them, otherwise, their forced rating will significantly deteriorate relative to their initial pure rating. What our simulations show is that the group of services with an initial higher ratings run out of resources earlier than the group with an initial lower rating. This happens, since the first group has to compensate for the actions of the second group.

Dynamics of subscription process

Naturally, the sum of the average ratings of the services is constant irrespectively of individual ratings. However, this is not the case for portals, whose reputations get worse in the course of subscription process.

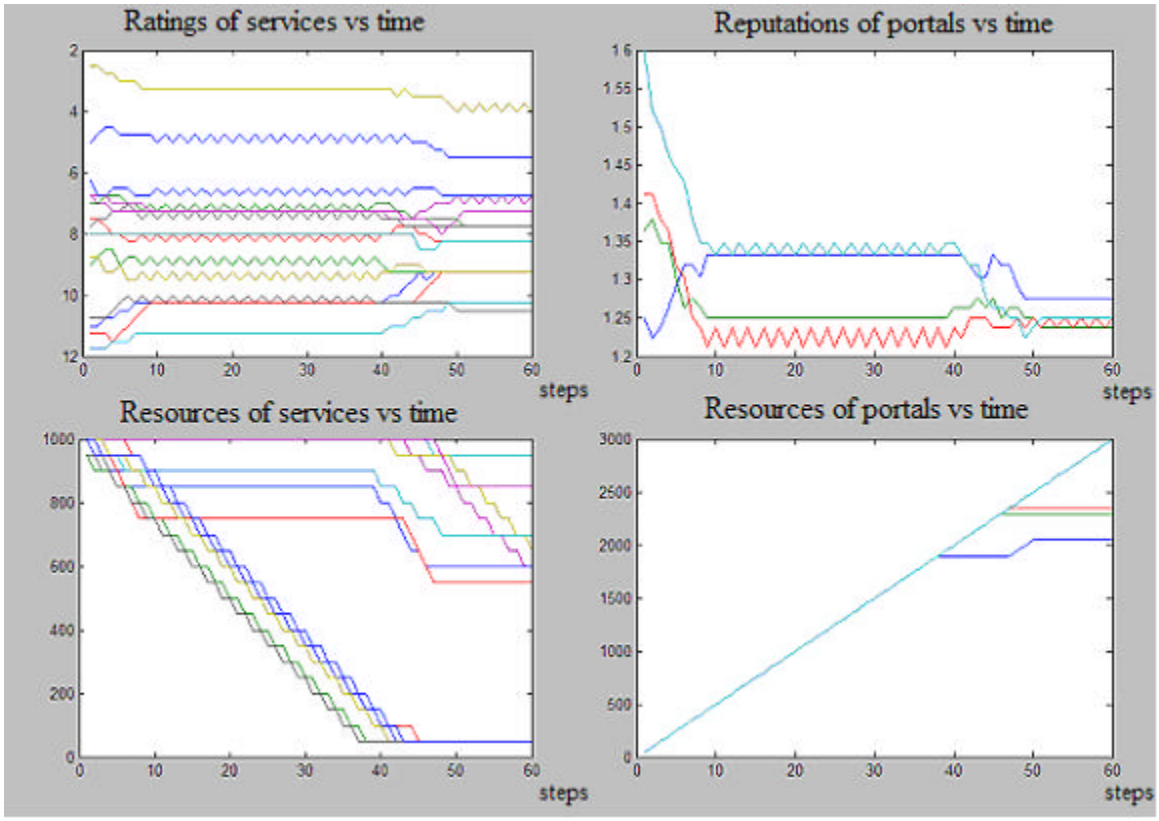

Figure 4. The evolution of ratings/reputations and resources of services and portals over time.

It takes first 10 steps to establish an equilibrium of ratings between the services, and an equilibrium of reputations between the portals (see Figure 4). Once the equilibrium is achieved, an oscillation pattern appears, which is caused by pairs of financial services that have their ratings swapped between position *i* and position *i*-1. As a result, the reputations of the portals are interchanged in a similar way, leading to an oscillating pattern between portals as well. The amplitude of oscillations for services is a quarter of unit (one out of four changes to the reputations of portals contributes to this amplitude). On the other hand, for the portals we observe oscillations with amplitudes which are higher than a single unit.

4.12 There is the critical point, at steps 38-45, when the interaction between the agents changes, at the time when eight of the services run out of resources. After that, the offers of the remaining services are always accepted, and the portal reputations are subject to further deterioration, as well as the ratings of these eight services that ran out of resources. However, the ratings of those services which have not run out of resources during these steps increase during steps 45-60. After that time, there is a smaller number of services capable of paying a subscription fee; 3 out of 4 of the portals are not offered a subscription and therefore do not increase their resources after this critical point. The competition for the subscription offers by services to be accepted by portals is still strong: all services wish to subscribe to the same portal, and the portal they all desire to subscribe to can only accept the subscription from a single service according to the rules of the game.

4.13 We outline the five zones we have detected within the evolution charts of interacting services and portals:

1. The *equilibrium establishing zone*;

2. The *oscillation zone*;
3. The *resources disappearance zone*;
4. The *limited resources equilibrium establishing zone*; and
5. The *stationary zone*.

As is visible in the evolution charts (Figure 3), in accordance to what we have revealed in the distribution charts (Figure 4), only the lowest-rated services benefit from the process (the bottom part of top-left chart in Figure 3). The evolution charts show that the rating of the lowest-rated services increases during both the second (oscillation) and the fourth (limited resources equilibrium establishing) zones. There is no service that would significantly benefit from the process, since no service has improved its average rating by more than 2 units.

4.14 In introducing the model of the subscription process, the assumptions we are making are as general as possible. These assumptions were the result of observations regarding the sequence of characteristic zones in the evolution curves of ratings and resources of the involved agents. We therefore conjecture that an arbitrary subscription process that is connected with rating-providing businesses would have a similar set of zones. Concerning the last zone, our conjecture is backed up by the assumption that this process eventually ends because the services would not want to spend any further resources.

4.15 Since the rating, reputation and resources data for business agents is available, it is possible, in principle, to apply the respective feature extraction mechanism to identify the simulated process and its current zone.

Introducing "independent" portals

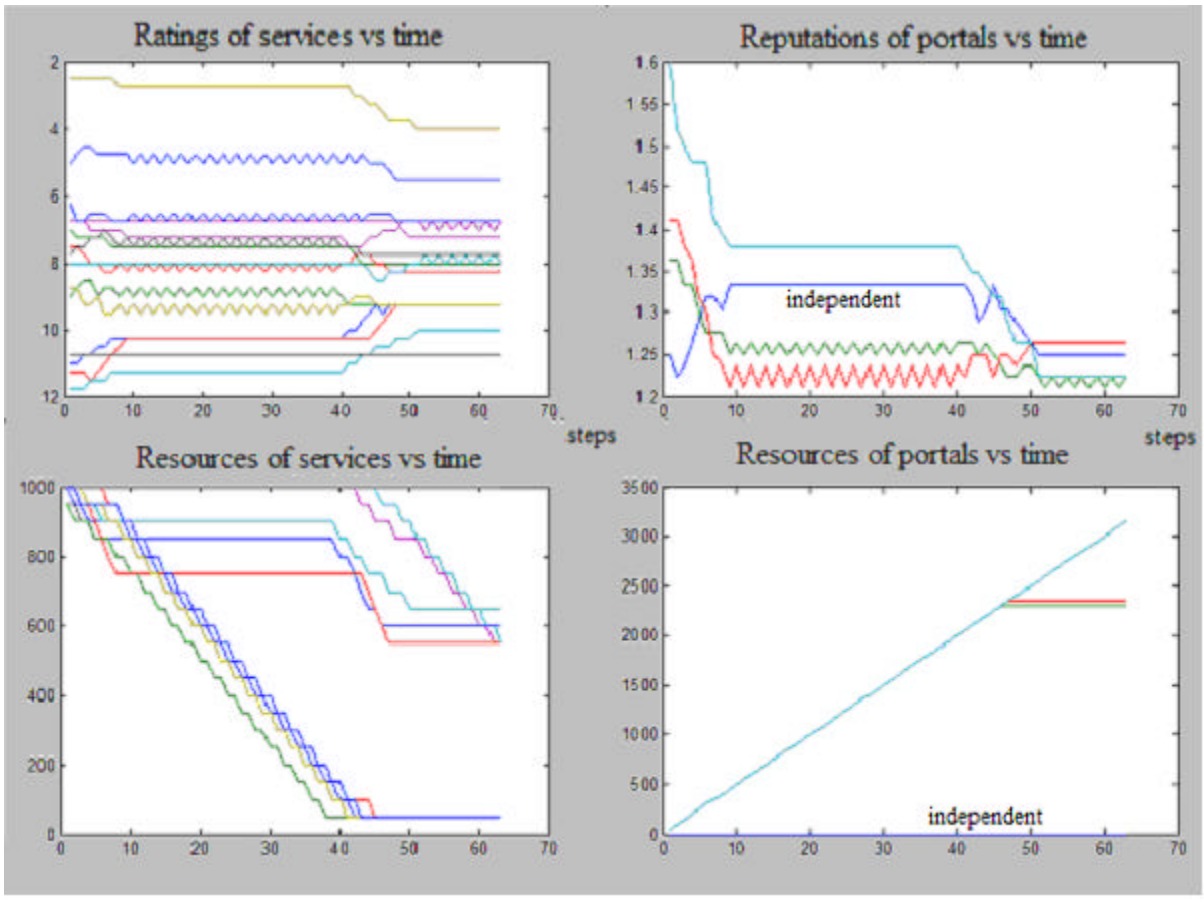

Figure 5. The evolution of ratings/reputations and resources of services and portals over time, where one portal with a low initial reputation is independent (i.e. it does not accept service subscription)

4.16 When a given portal does not accept subscription fees, its rating in the evolution curve in an environment where other portals accepts subscription fees is quite similar to the situation above, where every portal accepts subscription fees (Figure 5). The resource curve for this portal is a horizontal line on the bottom of the chart; the three remaining resources curves go together until step 48 when two of the portals stop gaining any further resources.

4.17 The resultant reputation of a portal is even lower when no subscription can be accepted, because the pure ratings it publishes will have a greater deviation from the average value. The latter is mostly affected by the portals that can accept subscriptions. The reputation dynamics closely follow the case when this portal can accept a subscription (see Figure 4). Therefore, the overall subscription process is only weakly affected by a minority of portals which cannot accept subscription. The reputation of an independent portal which does not accept subscription drops because this portal becomes "less than average", representing a true rating for services. Overall we observe the phenomenon that if the majority of portals accept subscriptions, their rating becomes "more average" and their reputation grows in comparison with an independent portal.

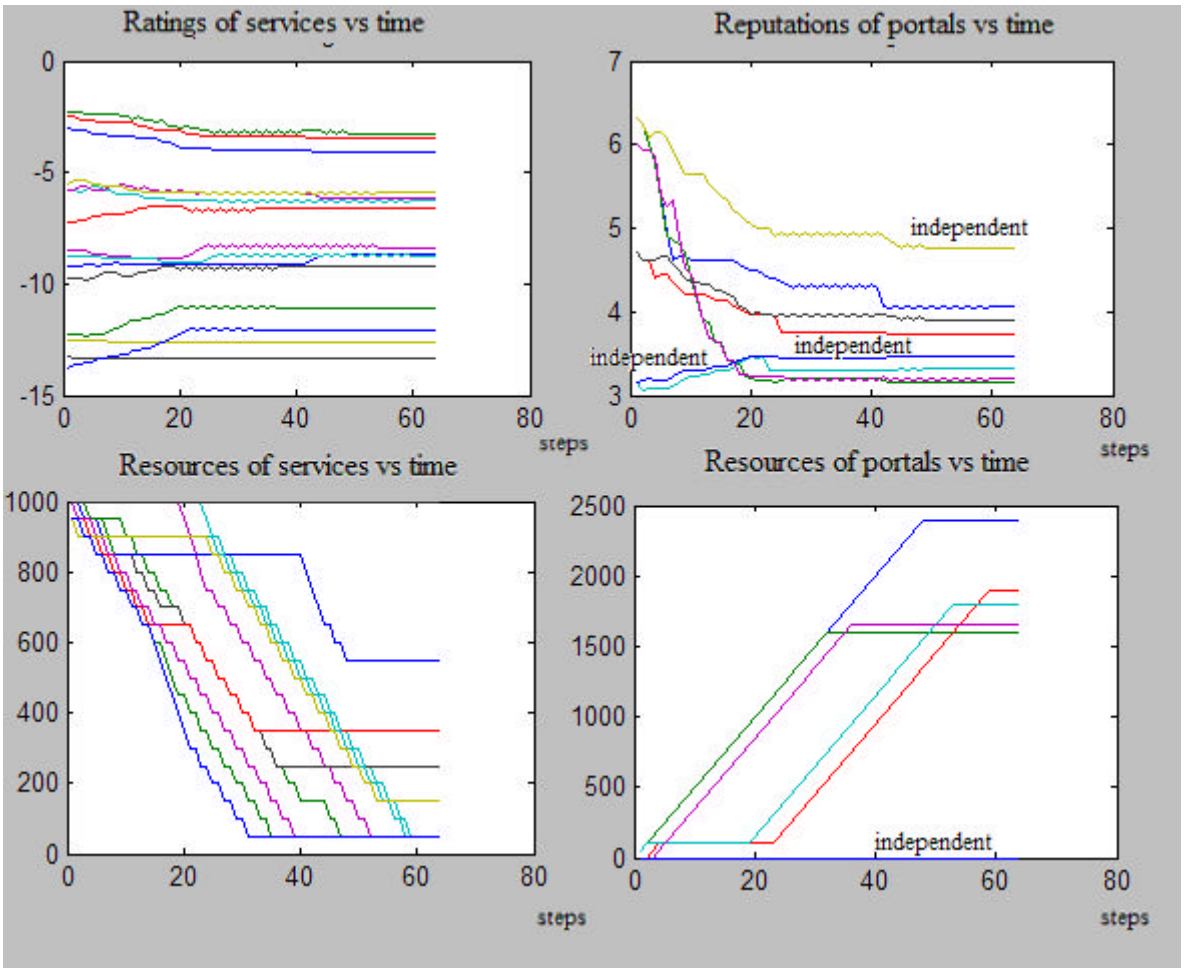

Figure 5a. The evolution of ratings/reputations and resources of services and portals over time, where three portals out of eight with a low, medium and high initial reputation are independent

A similar situation is depicted at Figure 5a. The portals with initially low reputation gain are the independent ones. This would not be the case if they accepted subscriptions.

4.18 We observed that if a majority of portals select to accept subscription, the rest of portals which decide to stay independent would sacrifice their reputation (and, obviously, resources). At the

same time, if a minority of portals choose to accept subscriptions, they would gain revenue but loose their reputation In our simulation settings we do not obtain a quantitative estimate of the ratio between these two groups of portals.

Introducing services unwilling to subscribe

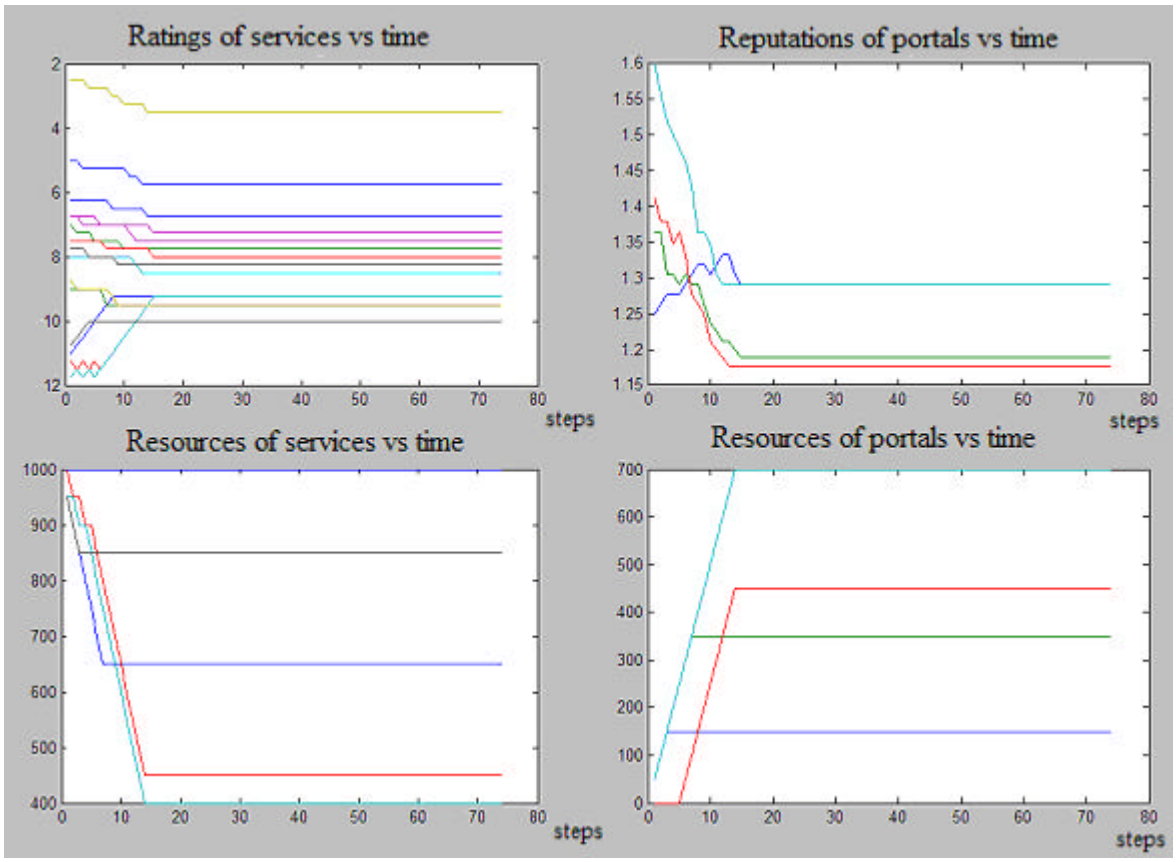

Figure 6. The evolution curves where only the four lowest-rated services subscribe

4.19 When only the lowest-rated sites choose to offer subscription fees to portals to increase their ratings, the process immediately converges to the fifth zone (stationary) without passing through the intermediate zones (see Figure 6). In this case portal reputations significantly drop, as well as the ratings of all the services which decided to avoid the subscription. The case when some service withdrew from the subscription process is quite different from that of portals: there is a dramatic change in the process for the former, whereas the latter case does not significantly change. The competition between the services is not strong enough to lead to an oscillation.

Eliminating cycles from services subscription

4.20 In this section we will simulate the behaviour of service agents with augmented rationality. In the course of the subscription process, the following kind of cycle is frequent:

> At a current step, one service, #1, swaps its rank with another service, #2, being rated by a portal.
>
> At the next step, #2 selects this portal and swaps its rank with that of #1.
>
> At the next step, #1 selects the same portal and swaps rank with #2 **again**.

At the next step, #2 ...

As a result, both services #1 and #2 quickly run out of resources without gaining much rating, because they directly compete only with each other. A more rational strategy for a service would be to avoid getting into a cycle by choosing the second best portal with respect to its reputation and obtain the rating of service #1 at this portal. Such increased rationality will be beneficial for #2 but not other services, and will not allow portals to have an "easy ride" with respect to collecting resources and not giving up reputations in the above cycle scenario.

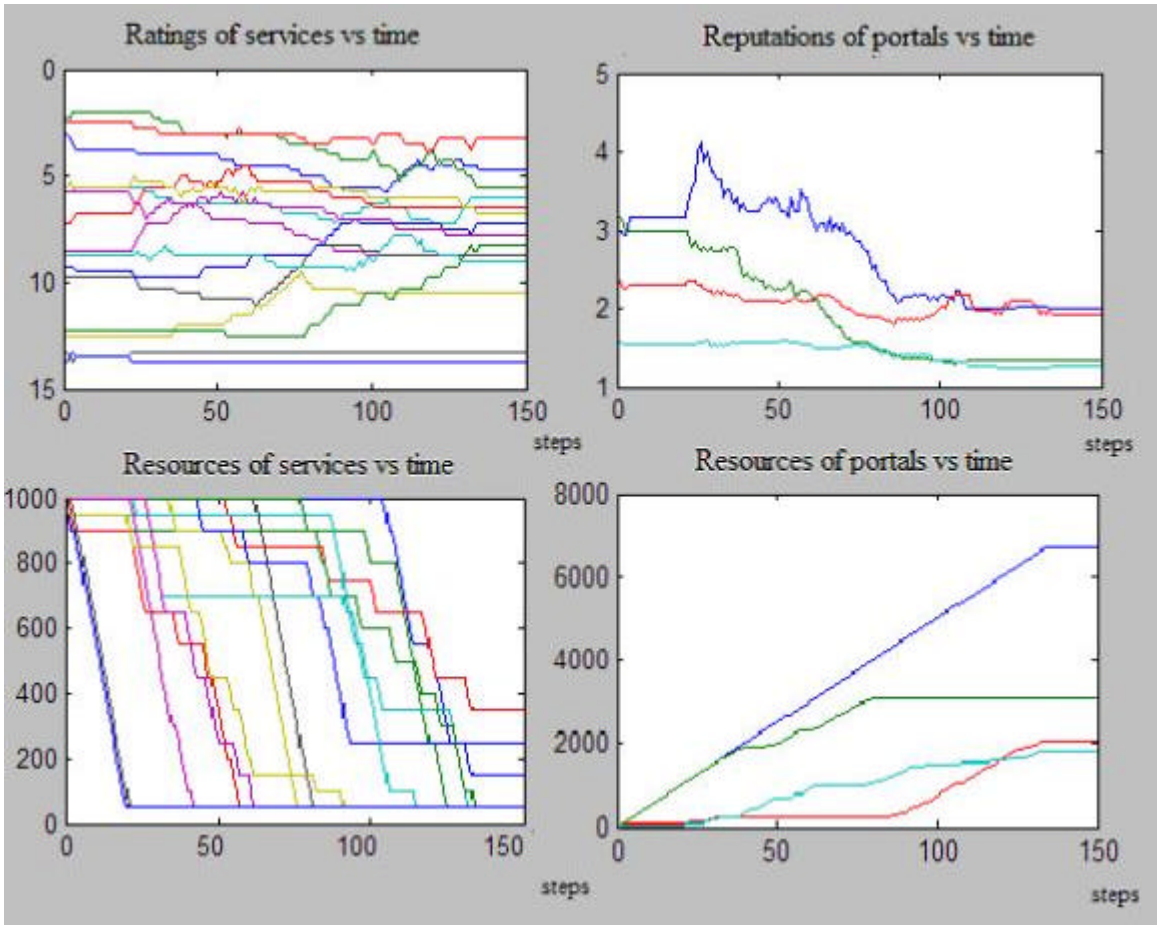

Figure 7. The evolution charts where services avoid cycles (longer run, 150 steps)

4.21 The curves at Figure 7 do not demonstrate the "oscillation" behaviour (compared with Figure 4). The overall behaviour is more complex, and it is hard to distinguish zones because services continuously run out of resources. The simulation requires more steps since the resources are spent in a more rational way.

Services and portals with random strategy

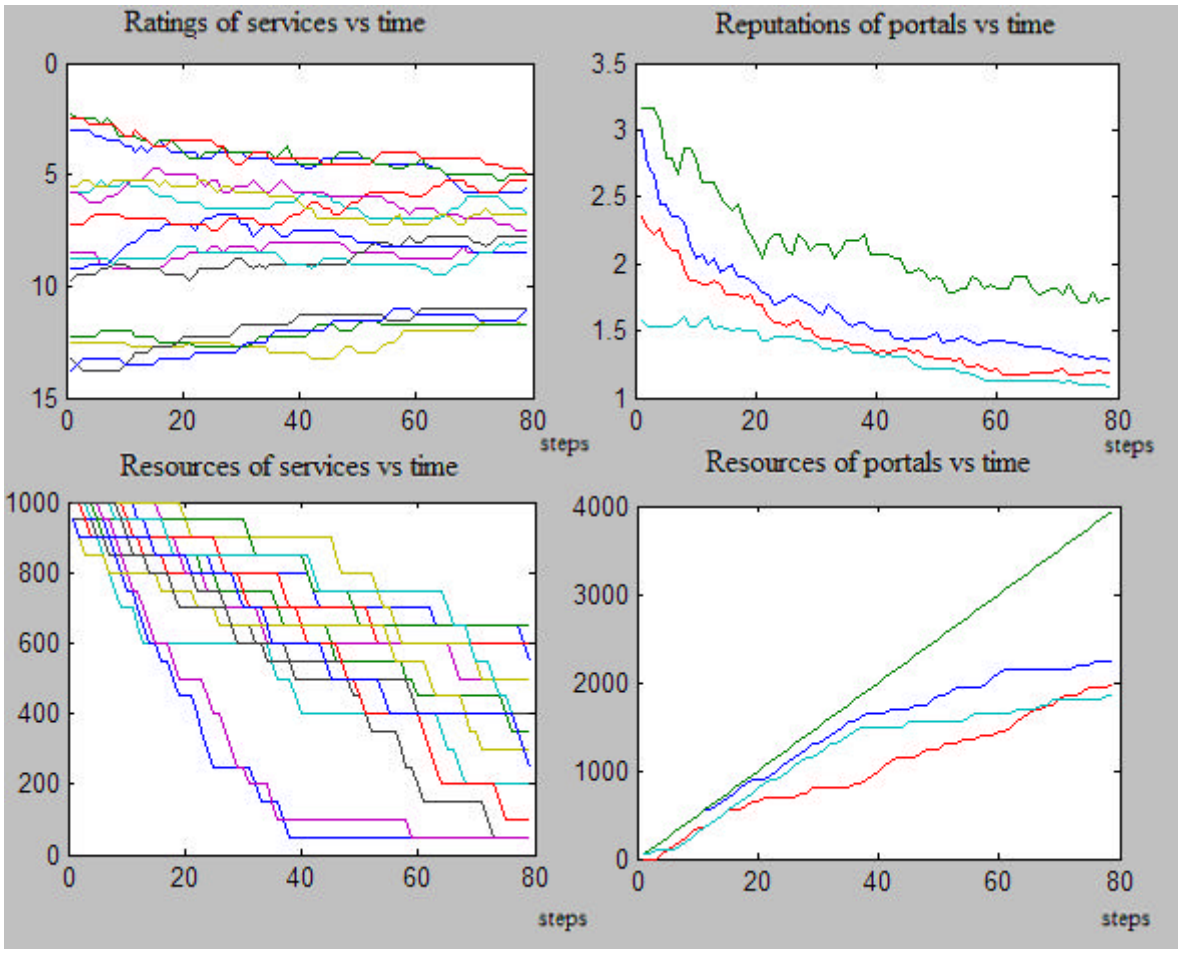

Figure 8. Evolution charts where portals accept subscription randomly

4.22 In this section we simulate a less rational behaviour of portals and services, where the services are ignorant about their rating and/or portals are ignorant about their reputation. To parameterise the ratings of services, taking into account how they are rated by portals with higher and lower reputations, we use the weighted rating calculated as

$$r_{avg\_weight}(s) = \sum_{p} \frac{M(s,p)\, reput(p)}{\# p} \qquad (5)$$

As we presented in the "Economic model" section above, a rational strategy for a service is to maximize the above expression and also subscribe for portals which gives it higher ratings. Moreover, as we mentioned in the previous section, avoiding cycles usually helps to decrease inefficient spending of resources competing with the same service. Hence random strategy prevents services from achieving the above.

4.23 As to the portals, random selection of subscription offers (which does not target minimizing a drop in reputation) leads to situations where portals get less resources for the same drop of reputation (compare with Figures 4 and 5 a above). In case of irrational behaviour reputations drop monotonously to lower values than under the partially rational behaviour we build for portals in this study. Under both random and rational behaviour the reputation of each portal approaches its asymptotic value. All such values are below the initial reputation of the lowest portal for the former.

4.24 When portals are irrational, there is no strong deviation in services' behaviour from the case when portals are rational, except that the services lose resources at a slower pace. In real life,

the degree of rationality may vary but we believe that the suggested strategy for services and portals is simple, plausible and brings in a dramatic improvement in results of the subscription process.

4.25 When services are irrational, they choose arbitrary portals to subscribe to. As a result the irrational services spend more resources for the same gain in rating or the same support of their rating level than rational services.

4.26 There are also a number of common features regarding the behaviour of services and portals which do not change under a random subscription strategy.

Varying initial conditions

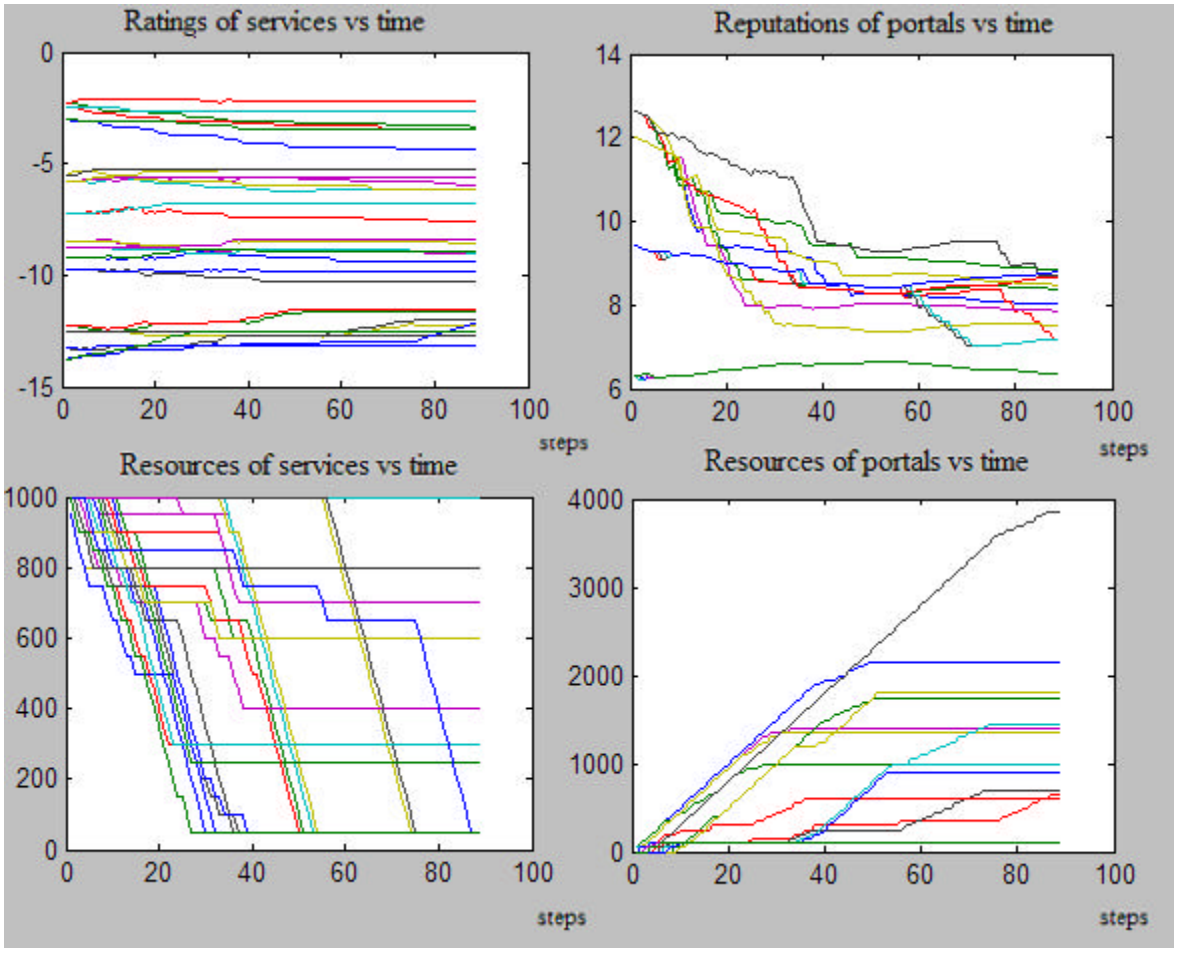

Figure 9. The simulation run with 16 portals and 30 services showing the behaviour similar to the one produced by a smaller number of agents

4.27 We have verified that similar behaviour of services and portals occurs under a wide spectrum of initial conditions, having their strategies fixed. Moreover, under both partially rational and irrational strategies the process of averaging of ratings takes place (compare Figure 6,7,8). Ratings of services tend to converge.

4.28 Under a higher number of services (30) and portals (16) we also observe similar behaviour (Figure 9). Moreover, an increase in the number of services and portals does not lead to a noticeable change in agents' behaviour, except that the rating curves are smoother and reputation curves are more volatile than when the number of agents is lower.

4.29 Varying the subscription cost between services and between portals, and deviating initial

distribution of resources from uniform does not result in additional behavioural observations, and therefore the results support the stability of simulation model with respect to above parameters. Also, the extreme cases with all agents having equal initial ratings, and totally independent initial ratings by different portals have been verified not to deviate from the common pattern. Moreover, in cases of symmetric or asymmetric initial distributions of ratings and resources, the ratings converge and resources decrease at the same speed, but the delays of the decrease in resources is indeed dependent on the respective symmetry or asymmetry.

Results

5.1 In this study we have simulated the process of the interaction between the services which desire a higher rating on portals, whose revenue model is based on a subscription fee where the flow of resources is from services to portals. We called this process the "subscription process".

5.2 We enumerate the common features of the behaviour of services and portals demonstrated under a wide variety of simulation settings, including their strategies and initial conditions:

- Participating in the subscription process, initially highly rated services run out of resources and their ratings drop, while low rated services both increase their rank and keep their resources. Overall ratings of services converge to a narrower range than initial.
- When each agent participates in the subscription process, the reputation of independent portals, which do not accept subscriptions, drops. Also, the ratings of the highly-rated services, which choose not to subscribe to portals in order to compensate for subscriptions of other services, drop in the course of the process.
- When just a small portion of lowest-rated services offer subscriptions to portals, it nevertheless strongly decreases the reputation of portals accepting these subscriptions and the ratings of other services.

Therefore, it seems that when a low proportion of interacting agents participate in the subscription process, it has a negative effect on the ratings of others, and thereby encourages these other services to compensate for their lost rating by joining the process. At the same time, it is quite unprofitable with respect to both ratings and resources to stop subscribing to portals. For services, it would be profitable to stop subscribing synchronously, knowing that other services would cooperate and also stop subscribing. This is, however, impossible because the services do not have knowledge about each other in terms of participation in the subscription process.

5.3 We observe that both for services and portals, it is not a "winner takes all" situation: services which were initially rated as "best", drop their rating in the process of subscription. If the best rated services do not participate in subscription, their ratings fall even further. Therefore, special initiatives or proper timing of participation does not play a major role in the subscription process. Our prediction based on the current model is that eventually all or a majority of players in a market sector would have to join the subscription process, but one cannot expect major winners or losers. Instead, the subscription process is the machinery which brings the participants into an equilibrium state, providing a revenue stream for portals.

5.4 The paper suggests that portals should be following other portals very closely to observe and forecast their advertisement policy. Failing to do so would lead to loss of reputation even if a given portal tries to rate services as objectively as possible.

Discussion and Related Work

6.1 We have presented the process of competitive services *officially* subscribing to a rating

mechanism on portals. In reality, this process may not have such a formal arrangement and occur in way where different participating agents lack information about the subscription arrangements of others. We have obtained the sequence of zones in our simulation process: transition from the initial zone to the final zone is expected to be associated with some *legalisation* process, when explicit rules of subscription offer/acceptance are formed and every agent becomes knowledgeable of these rules. The services subscription model should become transparent to the customers, and we suppose that some legislation will control the practice of this process and enforce the disclosure of its details. Currently, the Federal Trade Commission in the USA recommends search engines having paid-placement advertising results to clearly separate these from results obtained from the search engine ranking algorithm (Federal Trade Commission 2004).

6.2 We expect the portals will find ways to legalize the practice of subscription. Since the technology and business development moves ahead of the respective legislation, we believe portals will try to be appealing to both services (advertisers) and end users. In a more realistic model, we assume that portals will have a more accurate way to reflect the true rating.

Economic issues

6.3 We also think that the applicability of the above simulations goes beyond the online media. When the practice of subscription to the online rating services becomes generally accepted without clear alternatives, TV and paper media may wish to follow it.

6.4 Acceptability of the concept of monetary value associated with rating is not as striking as may seem to the reader initially. Consulting various media, the majority of people have got used to the idea that all the information is biased and therefore needs some re-digestion to be trustworthy. We believe that a rating portal, which prefers to stay independent, would not impress the audience as being so because the ratings of such a portal may significantly deviate from those of other portals involved in the subscription process.

6.5 The other possibility that needs to be mentioned is that the subscription process may become illegal or highly discouraged. In this case the process of subscription laid out in this study may be perceived by the reader as a process of *corruption*. Since our simulations suggest the criteria to extract the behavioural patterns from the rating data that is publicly available, in this case, we may be able to reveal corruption that is specific to rating portals.

6.6 Nowadays, after Google's IPO, the business model of paid placement and sponsored advertising has become very popular, and the majority of search engines have designated areas for displaying advertisement slots on their search results web pages. The number of advertisement placements is expected to grow even faster, and their order (from top to bottom) may be interpreted by users as a rating by a respective search portal. This is due to the fact that it is hard for end users to access the pricing policy for paid placements at keyword search portals (Sherman 2004).

6.7 Relevant data available for our analysis is the evolution of ratings of services from a particular sector (finance), obtained as an ordered list of links to services' websites. Sponsored links could be a better data source here, but as of the end of 2004 there is no sufficiently extensive dataset available for our analysis. We collected the ratings of 15 services from 4 portals mentioned in the introduction in May 2004 and then twice in July and November. The data collected in May is used as initial conditions of our simulation, and two consecutive ratings are used to match the phenomena of rating convergence. Although a systematic pattern in the evolution of ratings cannot be extracted from such limited dataset, there is an explicit reduction of the range of ratings for the selected mutual funds. We can at least state that this observation does not defeat our simulations results. Further analysis of the evolution of the

rating of paid placements is required to reveal the role of the subscription process.

6.8 In this study we assumed that it is hard for the users of the services to estimate the pure rating. In particular, it is the case for the selected dataset of the mutual funds. As a further study we plan to bring the user agent in the loop, taking into account the deviation of the portals' rating from the pure rating; reputation of portals will then be redefined accordingly. The subscription resources of services will then be added proportionally to the overall rating perceived by users. It may happen in these settings that the winner-takes-all situation occurs. We also plan to build a multi-agent web infrastructure for automated agents for portals, services and users.

6.9 This work follows along the lines of the study of an economy of web links, where the potential monetary values of web links has been explored, and a link exchange process has been simulated (Galitsky and Levene 2004). Clearly, assuming that the majority of links are established as a result of such an exchange is unrealistic, however, it sheds some light on how web links might be established in a future economy should the process of link exchange become prevalent. Analogously, in the current study, we overstate the role of the interaction between a service and a rating portal in order to judge how the former may affect the latter in the course of a competition for a better rating.

6.10 The results of our simulation study can be considered as creation of a novel advertising model that is suitable for online portals. Subscription process is a way of increasing demand by bringing the product to the attention of consumers. Advertising can be either informative or persuasive. The effectiveness of advertising can be measured by the elasticity of demand, which measures the percentage increase in demand divided by the percentage increase in advertising spending. In terms of advertisement, rating can be considered as a persuasive advertising means (compare with Section 2).

Conclusions

7.1 In this study we suggested a possible process of how the natural intentions of services to spend their resources to gain a better rating may be formulated, and the formulation of the intentions of portals to, possibly, sacrifice their reputation in order to gain resources from services, may compliment each other. We observed that the collective intentions of the above agents (Galitsky 2002) find a matching strategy, not necessarily compatible with the individual intentions of participating agents, some of which may deviate from the majority of agents. In particular, initially highly rated services do not intend to enlist to the subscription process, but they have to accept the rules of the game once the other services have enrolled.

7.2 Since it is possible to observe real-world rating data and its evolution, one can extract the patterns of the subscription process, including the stationary zones and the transition zones. Such behaviour as oscillations in ratings , for example, will indicate that there is a strong competition between services for a particular portal. Such patterns can be revealed , for example, by analysing search engine ranking resulting from keyword queries.

7.3 Returning to the real-life problems, we cannot reject the possibility that the rating portals would form their business model in accordance to what we suggest in this paper. The question remains, if not the suggested business model, what else should the rating portals do nowadays to have a stable revenue stream?

References

AAKER DA(1997), ADMOD: An Advertising Decision Model, *Journal of Marketing Research* v.12, 37-45.

BAYE, MR and Morgan J (2001) Information Gatekeepers on the Internet and the Competitiveness of Homogeneous Product Markets, *American Economic Review*, 91(3), pp. 454-474)

BHARGAVA, H. K., and J. Feng (2001): Paid Placement Strategies for Information Gatekeepers, *Workshop on Information Technology and Systems*.

BHARGAVA, H. K., and J. Feng (2002): Preferential Placement in Internet Search Engines, *Eleventh World Wide Web Conference.*

FEDERAL TRADE COMMISSION (2004) Dot Com Disclosures, http://www.ftc.gov/bcp/conline/pubs/buspubs/dotcom

FENG, J., Bhargava, H.K. and Pennock, D. (2004) Implementing Paid Placement in Web Search Engines: Computational Evaluation of Alternative Mechanisms, working paper. http://www.cba.ufl.edu/dis/research/04list.asp

GALITSKY B (2002) Designing the personalized agent for the virtual mental world, *AAAI FSS-2002 Symposium on Personalized agents*. Cape Cod MA (AAAI Tech report FS-02-05), pp.21-29.

GALITSKY B. and Levene M. (2004) Web link economy *First Monday* N7 v1 (Jan).

GALITSKY B. (2005) Simulating the mental attitudes of virtual community members. *Encyclopedia of Virtual Societies.* Idea Publishing Group.

KLUSCH M and Gerber A (2002) Dynamic coalition formation among rational agents. *IEEE Intelligent Systems*, 17(3):42-47.

LERMAN K and Shehory O (2000) Coalition Formation for Large-Scale Electronic Markets *Proceedings of the International Conference on Multi-Agent Systems.*

LITTLE J D C (1970) Models and Managers: The Concept of a Decision Calculus, *Management Science* v. 16, B466-B485.

LODISH L M (1966) A Media Selection Model and Its Optimization by Dynamic Programming, *Industrial Management Review*, VIII, pp. 15-24, with John D.C. Little, Fall 1966

MYUNG J and Pitt M. A. (2003) Model Comparison Methods. In L. Brand and M. L. Johnson (eds.), *Numerical Computer Methods, Part D* (A volume of *Methods in Enzymology*).

SHERMAN, C. (2004) Rating Search Engine Disclosure Practices. http://searchenginewatch.com/searchday/article.php/3439401

THIERAUF R. J. (1982) *Decision Support Systems for Effective Planning and Control - A case Study Approach*, Prentice Hall, Englewood Cliffs, New Jersey.

TURBAN E. (1990) *Decision Support and Expert Systems*, MPC, New York.

TENNENHOLTZ, M. (1999) On social constraints for rational agents, *Computational Intelligence*, Vol. 15, 1999.

VIDALE ML and Wolfe HB (1957) An Operations Research Study of Sales Response to Advertising, *Operations Research*, 5, 370-381.

ZACHARIA G, Moukas A, Guttman R and P. Maes P (1999) An agent system for comparative shopping at the point of sale. *European Conference on Multimedia & E-Commerce*, Bordeaux, France.

Return to Contents of this issue