Chapter 1

Analysis

In the first part of this chapter we introduce some some theoretical arguments useful in the analysis. Than we start considering a basic version of the model, trying to understand the basic concepts and ensure that everything work works fine. Than we try to explain what's are the consequences of a specific agent's behavior and ~~finally~~ analyze analyzing some aspect of the ~~complete~~ entire model.

1.0.1 Update Evaluation

Analyzing how ~~person~~ people update their knowledge database, we can find an exponential law.

Let B be the **agent's boldness**, Q the **real quality** of a restaurant and V ~~the **internal valuation** about that restaurant. thought by the agent on his own.~~ the agent's onw evaluation of the restaurant

~~Persons~~ people update V ~~for the next turn~~ step by step with the following recursion rule

$$V(t+1) = V(t) + B(Q - V(t))$$

$$\cancel{V(t+1) - V(t) = B(Q - V(t))}$$

~~we can interpretate that as a discrete derivate~~ by considering an infinitesimal time step dt we can look at this relation ~~such~~ as a partial derivative tha we could integrate

$$\frac{1}{B}\frac{dV}{dt} = Q - V(t)$$

~~Homogeneous solution:~~ In light of this we obtain both an homogeneous solution:

$$\frac{1}{B}\frac{dV}{dt} = -V(t)$$
$$V(t) = V(0)\, e^{-Bt}$$

~~Particular solution~~

And a particular one:

$$V(t) = Q$$

Let's now analyse the model on what concernes the global knowledge related to all agents about restaurant's quality. As mentioned before each restaurant is caracterised by a particular ranking value which outlines its quality. Moreover, the ranking is actually a dual variable: there's the Real ranking Q unknown to customers and the personal thinking, for each person, of restaurant's quality, V; this ranking is, thus, strictly related to the agent's knowledge database.

Thus, the complete solution of this partial differential equation will be the following

~~So~~

$$\boxed{V(t) = V_0 e^{-Bt} + Q}$$

1.0.2 Analyzing the global knowledge

Thus, we ~~Since that, we~~ introduce for, each restaurant, an uncertainty factor … which is defined as the variance of the evaluation of all the people at the specific time step t:

~~We want to test the model observing the global knowledge about the restaurants quality. So we introduce the *uncertainty* factor for a specific restaurant K_{re} as the variance of valuations of all person at time t~~

$$K_{re}(t) = \sum_{per} (\mu(t) - V_{re,per}(t))^2 \quad (1.1)$$

~~The *global uncertainty* about all the world is K, the mean of K_{re} over all restaurants~~

As a natural consequence, the global uncertainty K is simply the mean value of K.. estimated over all restaurants:

$$K(t) = \mathbb{E}[K_{re}(t)] \quad (1.2)$$

1.0.3 Analyzing satisfaction

da fare...
da fare...
da fare...

As mathematically proved before, we can easily verify that every person updates his knowledge database following an exponential law

FIRST SIMULATION: ONE RESTAURANT

*SOTTOLINEARE CHE IL RANK DEL RISTORANTE E' FISSO A 2.5 MENTRE IL THINKING INIZIALE DEI PERSON E' CASUALE

1.1 ~~First Tests~~

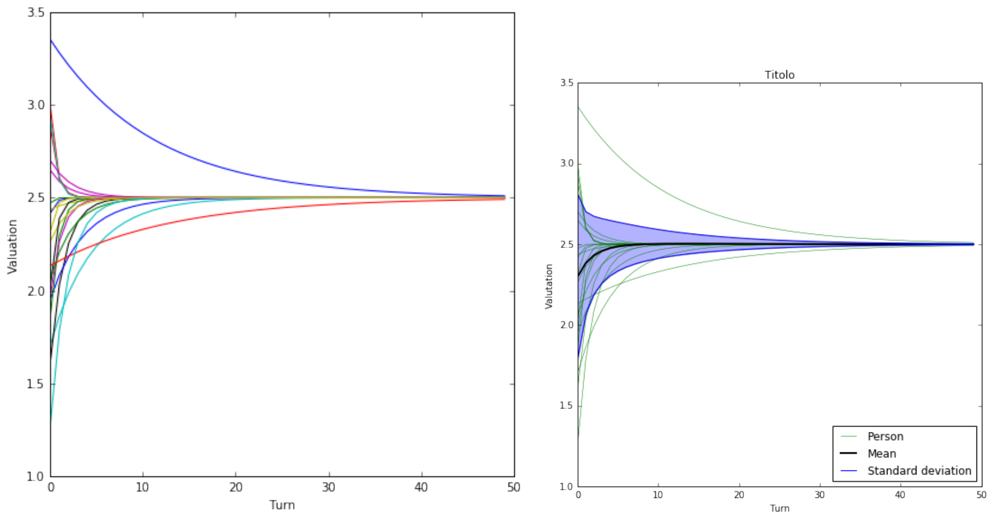
in order to study how people update their thinking of each restaurant

~~In order to test the valuation updating~~ we start with a very simple situation: 1 restaurant, 20 persons and no friends.* ~~As predict every person update the knowledge database about a restaurant, in exponential way~~. Notice that different persons with different boldness coefficient, converge at the true restaurant quality with different velocities.
Computing the average valuation and the standard deviation over time lead us to compute even ~~We can also compute~~ the K_{re} coefficient.
GRAFICOOOO!!!!

As we see in plot 1.1(?), the Kre coefficient after a sufficient number of turns

~~It's important to see that K_{re}~~ converge to 0, this means that at $t \to \infty$~~,~~ all ~~persons~~ people will know the real quality of the restaurant.

It is important to outline that different people, with different boldness coefficient, will converge to the true restaurant quality in different ways. As we could expect people who are more obstinated (higher boldness) will be slower in converging to the true value of the restaurant; people more open-minded, instead, will be more incline in updating their knowledge database faster.



Personal thinking of a person

Figure 1.1: Each color represents the ~~internal valuation for an agent~~. ~~Simulation with: 1 restaurant, 20 persons, no friends and restaurant is big enough for all persons.~~ For the simulation we set 1 restaurant, 20 persons and no friends; the restaurant capacity should be set high enough to host all people.

1.2 ~~With multiple restaurants~~

SECOND SIMULATION: MANY RESTAURANTS

Now we set up a test with different restaurants. So it's important the rule used by person to choose where to eat.

In this second section we set up simulations by considering a more realistic situation with many restaurants. Since people now have to choose where to go among many places becomes important the way how they take this choice.

Randomly choose

People ~~Person~~ select randomly the place where to eat. In this case, ~~Here~~ the process of updateing the ~~valuation~~ thinking is a bit different, ~~in fact~~ Actually a person goes ~~in~~ to different restaurants and updates the ~~valuation~~ knowledge database only for that place; ~~so focusing on~~ thus, since a person focuses only on… a single restaurant we see that the curve is not an exponential but an exponential with some constant zones. The process on discovering the real valuation is obviously slower than before,.

Person that choose the best

All person try to eat at the best restaurant they believe. We see that selecting a restaurant, some person never updating their valuation about it. This happen because persons start with a random valuation about places and if they think that a specific one is disgusting they never go there. This seem

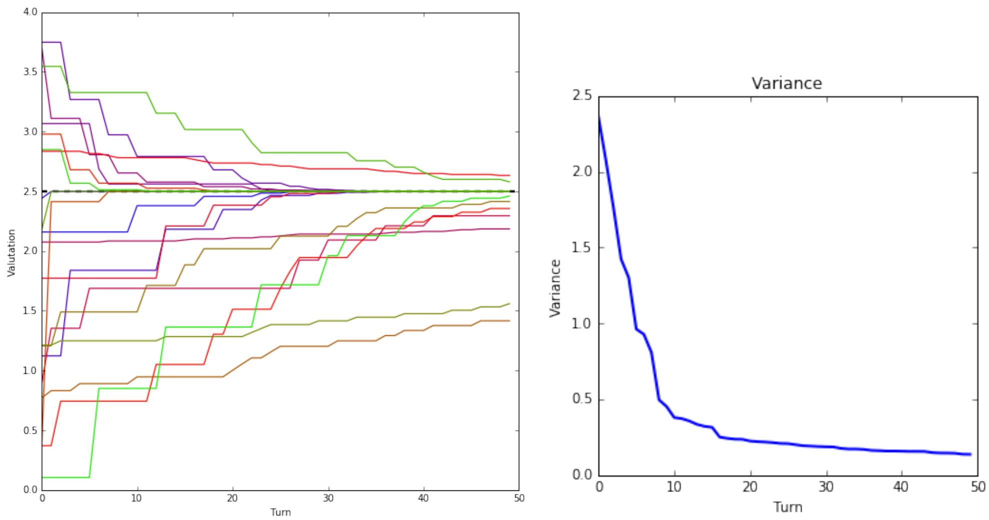


Figure 1.2: Simulation with: 4 restaurant, 20 persons, no friend, 50 turns, random choose.

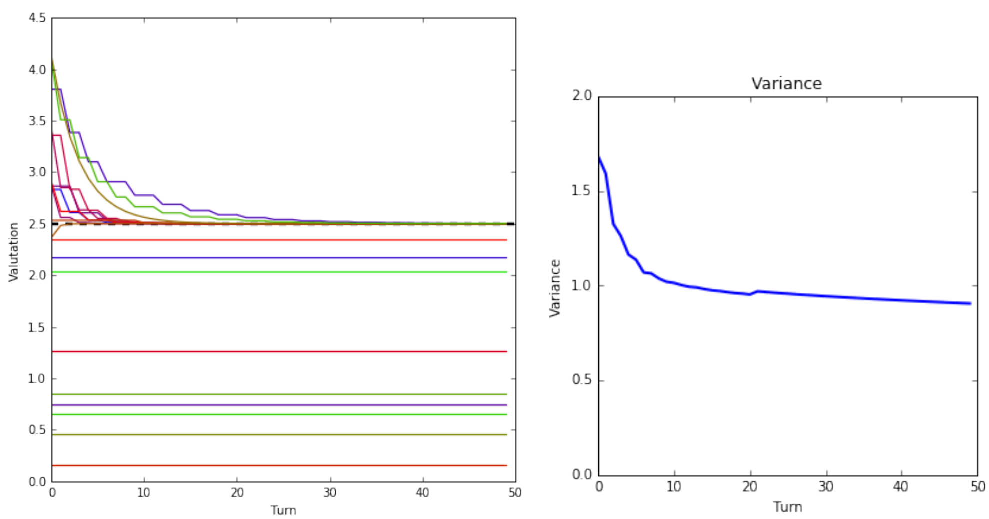


Figure 1.3: Simulation with: restaurant, persons, no friend, turns, best thinking choosing.

natural if the restaurant is really a bad one, but can happen that a restaurant with a good valuation is never discovered by persons.
We can see that K_{re} not converge to zero.

OSS: Notice that this issue can also be resolved later with introduction of communication between persons.

1.3 Complete Behavior

Previous behavior are too simple to model the real world, we want that persons choose the best they think, but also explore the world. So we a more complex behavior in which 50% of time person use *random choose* and 50% *best choose*. Observing the K_re we are sure that people explore the world

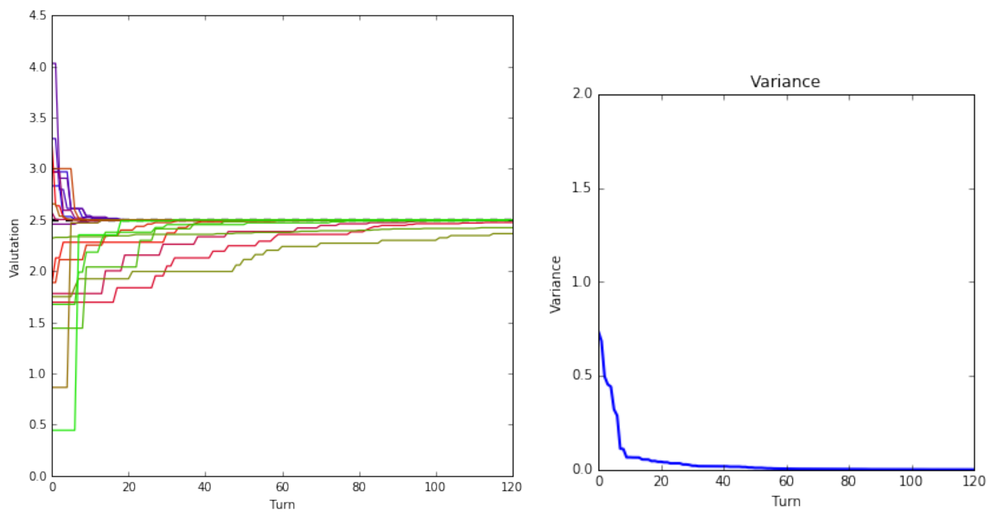


Figure 1.4: Particular situation for a fixed restaurant. Simulation with: 4 restaurant, 20 persons, no friend, 300 turns, fifty-fifty.

although occasionally they choose the best.

OSS: notice that in the graph Valuation vs. Turn under the quality of restaurant the convergence il slower than above

1.4 Complete Model

For all the following experiment we use a model in which persons can **comunicate** each other and use 50% of time random choose behavior and 50% of time the best choose.

This model introduce stochastic elements, not only in the random choose, but also due to the fact that person can find full restaurants.
So we have to do multiple experiments that represent only a single realization of the process (model).

1.4.1 Difference between number of friends

We want to analyze how $K(t)$ varied by varying the number of person's friends. We set up four different experiments with 0,1,3 and 5 friends, for each we consider 5 different realizations.

Start considering the case with 20 persons 4 restaurants and no friends. We plot $K(t)$ for all the 15 realizations. than we compute the mean and

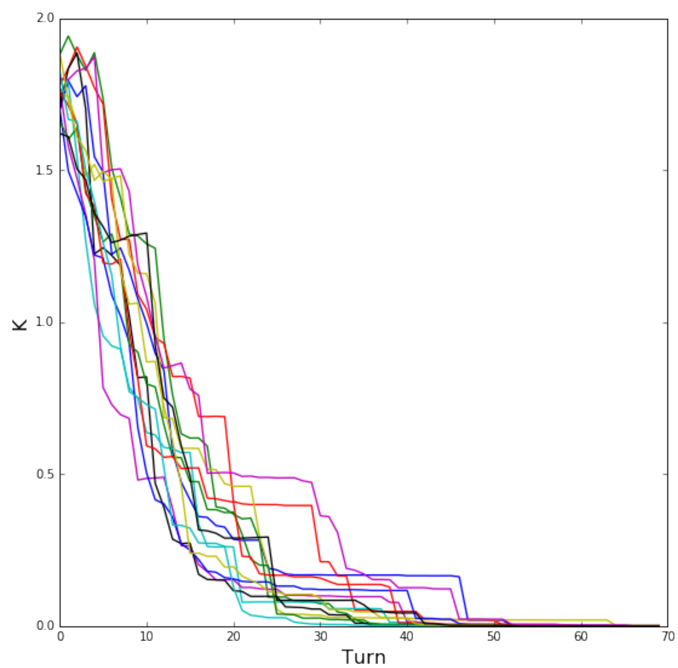


Figure 1.5:

the variance of $K(t)$ and try to approximate it with an exponential. The approximation is good as confirmed with a chi-sqared test. $\chi^2 = 43.4$ with $DF = 47$ The exponential fit:

$$K\left(t\right) = ae^{-bt+c}$$

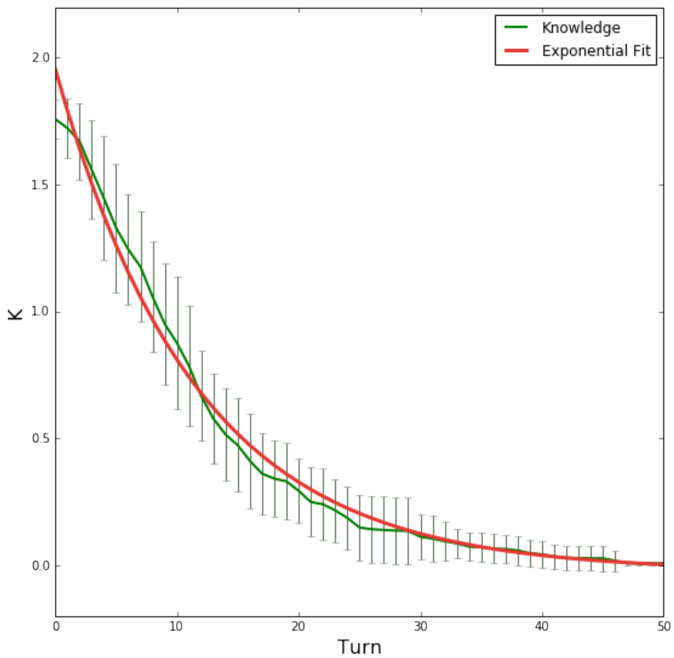


Figure 1.6:

with

$$a = 1.97$$
$$b = 0.086$$
$$c = -0.02$$

We can consider exponential time constantnt $\tau = \frac{1}{b} = 11.5$ that measures the number of turns needed to reduce K by 63%, so we can think approximately that in $5\tau = 57$ turns uncertainty is 0.

Than we reproduce the same experiment with friends and find: As we expect model with higher number of friends have K that go to zero faster then other, in fact persons inform each other about the quality of restaurants and in less time they discover the real rating. In particular

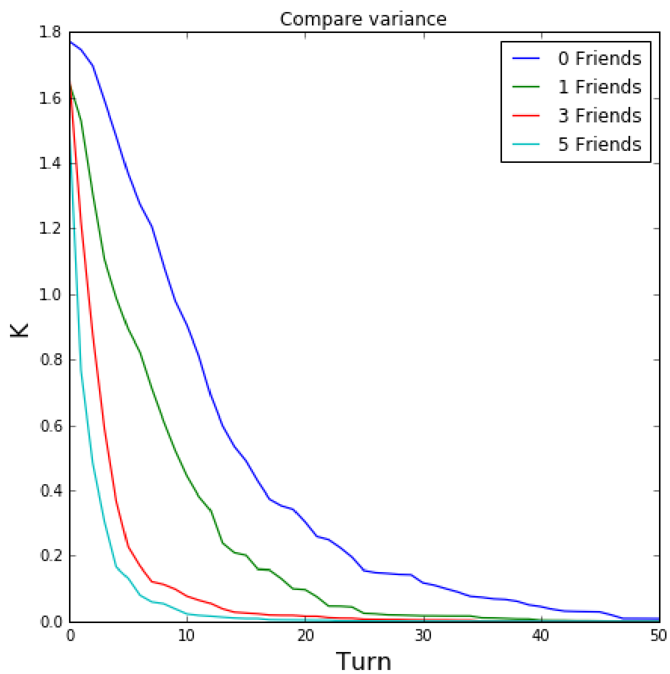


Figure 1.7:

Table 1.1:

n friends	b coefficent	τ	n turn to zero
0	- 0.086	11.5	58
1	- 0.134	7.4	37
3	- 0.359	2.7	14
5	- 0.560	1.8	9