INFO-8006: Introduction to artificial intelligence

Project 3 - Bayes Filter

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In this project, we have been asked to implement a Bayes Filter to maintain a belief state about the ghosts locations of the Pacman Game.

1 Introduction

The agent maintains a belief state estimate $P(X_t|e_{1:t})$ and updates it as new evidences e_{t+1} are collected by the sensor. All in all, our code udpates the belief state in such a way that:

$$\begin{aligned} P(X_{t+1}|e_{1:t+1}) &= P(e_{e_{t+1}}|X_{t+1})P(X_t+1|e_{1:t}) && (1)\\ &= \alpha P(e_{e_{t+1}}|X_{t+1})\sum_{x_t} P(X_{t+1}|x_t)P(x_t|e_{1:t}) && (2)\end{aligned}$$

where α is the normalization constant. The normalization can be achieved by using probabilistic notation but can be simply done by summing all the probabilities and devide all the elements of the belief state by this sum.

2 Results

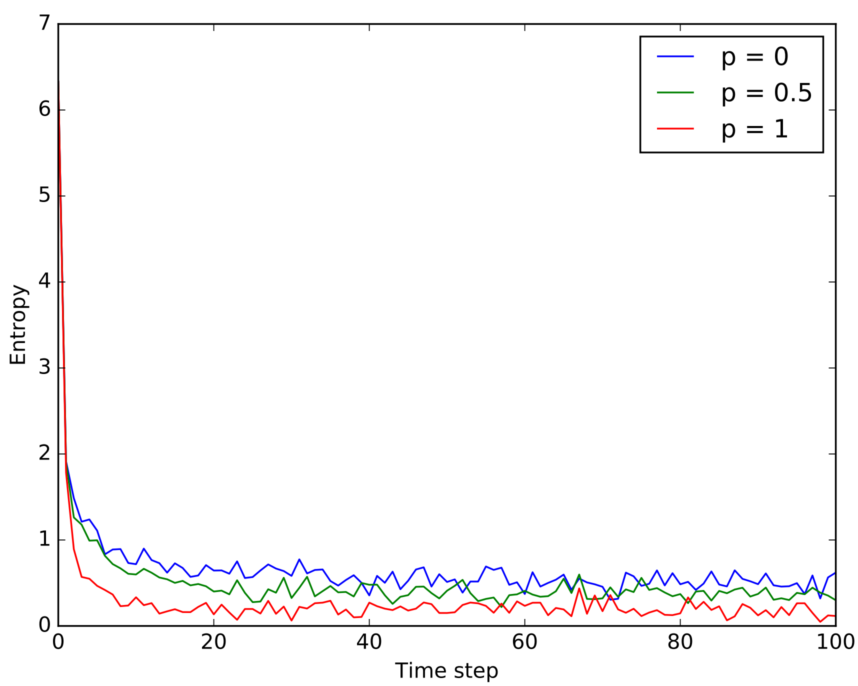

Figure 1: Evolution of the entropy for $w = 1$

3 Convergence discussions

Les gars pour les graphes de l'entropy, a part dire que c'est logique d'avoir une entropie plus petite quand w est petit et p est grand, vous avez fait d'autres analyses ? elle converge plus lentement pour p petit et w

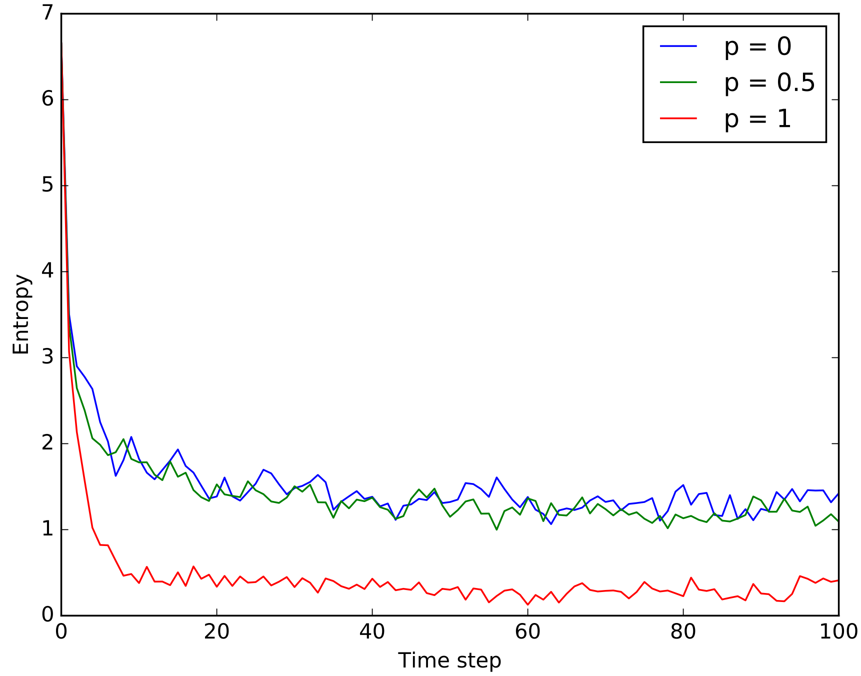

Figure 2: Evolution of the entropy for $w = 3$

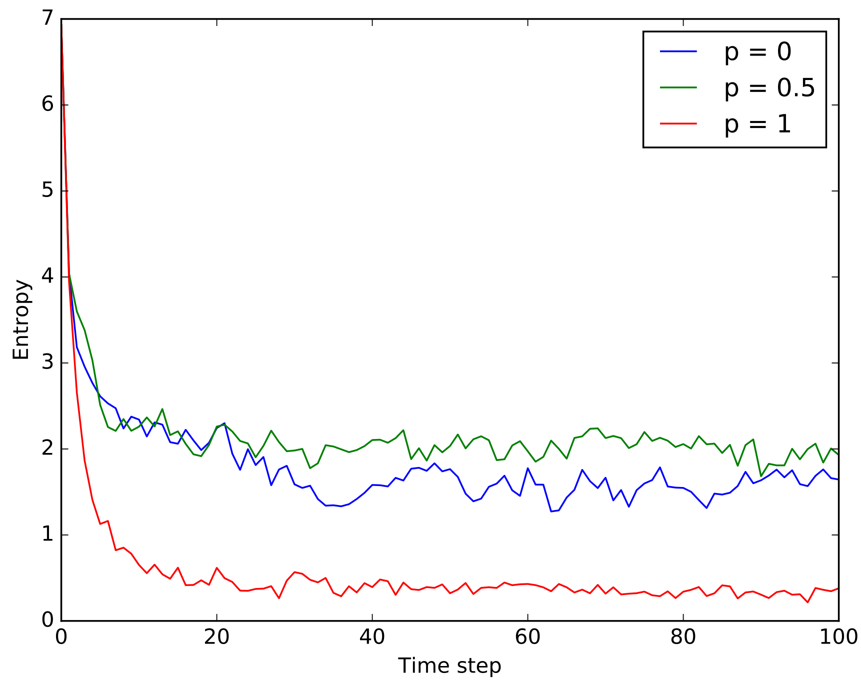

Figure 3: Evolution of the entropy for $w = 5$

grand aussi

In general, we can observe that the number of time step has the same effect in every situation : at the beginning of the game, the convergence has a rather high value, which is normal since our belief state is an uniform distribution over the whole area covered by the radar of Pacman. This belief state will gradually be enhanced, leading to the decreasing convergence we can observe in our graphs. We can see this decrease happens pretty fast, which makes sense since the belief state will be change greatly during the first steps, due to the transition from an uninformed belief state to an informed one. The convergence then stabilize itself around values that can vary between 0 and 2.

3.a Influence of p

The entropy is lower the bigger p is. This is logical since. We can also see that the convergence is slower to stabilize for a smaller p.

3.b Influence of w

The size of the area covered by the radar is quadratically related to w. It is rather obvious that a bigger radar area leads to a worse accuracy, since probabilities will be splited over a larger area. Therefore it is not surprising to see that the convergence is lower for a smaller w, and bigger for a larger w. Also, we can notice that the convergence stabilize itself faster for a smaller w. This is also easily explained : a smaller radar area makes it easier to converge since the probabilities are less spread.

4 Possible improvements

In this version of the code there is one thing that could definitely be improved : we do consider tiles beyond walls "reachable". This means that if we have a position on which Pacman could be on the belief state, and that this position is next to a wall, there is a possibility that the next belief state attributes a non null probability to the tile right across the wall. This tile is however completely out of range, wherever could Pacman be on the radar. Deleting this possibility would be a nice improvement.