An Explanation for Specified Starvation (& Pain Learning)

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Abstract

In this paper, we try the describe the specified hunger then provide an idea for learning algorithms in ML.

1 Introduction

Probably you have experienced a starvation situation in which you seek only a specific kind of food. For example, after not eating fat and oil for a long time, you feel a staving for fat which is not resolved by eating sweet things, or after not eating specific vitamins, one can feel starving for eating bizarre things like fish eyes! Starvation generally is not a unified concept and has specified kinds and receptors in the body. It can be considered a special case of pain, which we discuss in more detail.

2 Possible Description for Starvings

Here I describe the starving with my current understanding. When an important metabolite is scarce in the body (let's call it m), cells (some of them) will produce some metabolites less or more than the usual peaceful situations (let's call them $markers(m)$). Those marker metabolites (their existence or absence) will be dispersed (*e.g.* through the blood) and behave as signaling molecules to stimulate some other mechanisms in specific sites. Probably the most important site for starvation is the stomach, and $markers(m)$ will stimulate one of the following cells (I don't know which at the moment):

- Specific Nociceptors (to express this starvation like a pain)
- Secreting epithelial cells to secret a distinct composition of stomach secretions.

In each case, the stomach would not be in rest a neuron (or more) is sending impulses at a high rate. This is exactly like what happens during *slow pain*, and corresponding nociceptors spike at a high rate and make us feel upset, tense, distressed, and unease. The process of getting rid of this distress plays

an important role in learning, *Pain Learning*! Releasing from the constant spiking of the neuron gives us a good feeling, and it is desirable probably by the secretion of Dopamine or Serotonin (I don't know the underlying mechanism at the moment).

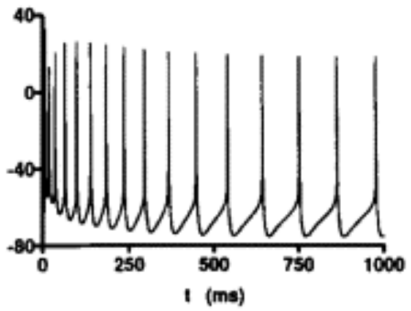
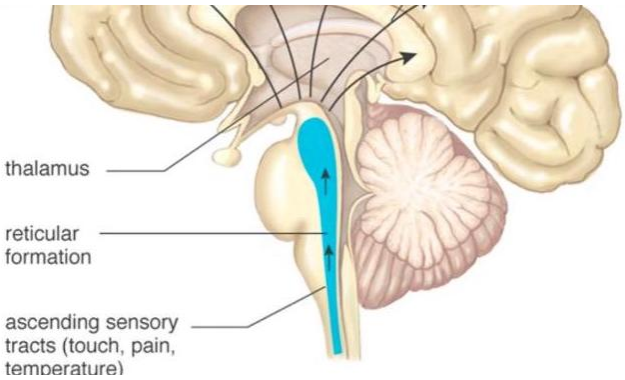


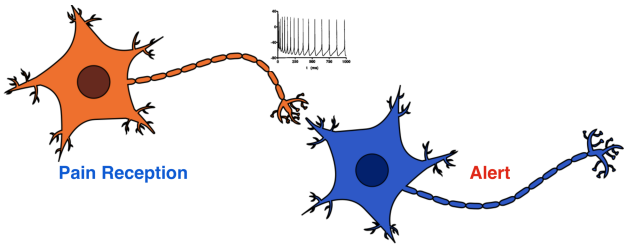
Figure 1: Nociceptor spiking at a high rate = distress!

3 Alert Mechanism

As I know, the *Reticular Formation* is responsible for alerting the brain of the pain and concentrating most of the processes on this distress. This concentration



is important and makes the reward of eliminating that pain bigger than before. The command of the nervous system will be "shut the pain!" after this pain magnification (like starvation). In a more biological sentence, it will be "shut the neuron's stimulation!". However, this command is not explicit and is expressed implicitly by assigning a great reward or peace to the freedom, by the secretion of Dopamine or Serotonin chemicals after slowing the neuron's stimulation.



4 Solution for Tranquility

Remember the starvation from a specific metabolite like fat. What do we do after this great feeling of hunger? We think of fatty foods and seek them. Following steps are happening in our minds during this process:

1. Recalling foods, as what is saved consequently after this pain
2. Thinking about foods or looking at them
3. Dreaming about eating those foods and recognizing that fatty foods stimulate our saliva production and a good feeling in our stomach (the nociceptor's stimulation decreases when thinking about fatty foods, and it is concurrent with Dopamine or Serotonin secretion as discussed)
4. Seeking the real fatty food to keep feeling that tranquility (as the result of the inhibition of the neurons).

Step 3 emphasizes that thinking of a pain-killer kills the pain for a period. It is a regular pattern during counterfactuals, dreaming, thinking to the end of a bad season, etc., and it is not restricted to thinking about the desired food. Step 4 implies that the dreaming is not long-lasting. A real pain-killer or food shuts the stimulation of our neurons, and the problem will be finished after that. Yet, a dream does not end the problem, and it is only a temporary pacifier. Unless the pain is not killed, the need for a pacifier is not ceased, and we should seek real food. This is the process happening in the *Imitation Learning*, in which we try to mimic physically a behavior that we have thought about. It is tricky to understand the neuron we try to shut in this case. When we think of movement and skeletal muscles, corresponding somatic neurons will begin to spike, and they won't be shut unless we perform that action physically, which is the neuron of interest.

5 Pain Learning

To connect our explanation to the computer science learning literature, we introduce the concept of *Pain Learning*. Consider the set of all nociceptors in our body as $\mathcal{P} = \{P_1, P_2, \ldots, P_k\}$, which can be considered as all possible pains

that we face. Consider $r_{P_i}(t)$ as the spiking rate of the nociceptor P_i at time t. This is a feature of the environment and is not directly manipulatable unless we act on the environment (such as entering food into our body, bandaging a scar, warming a frozen organ, etc.). The attention mechanism (in the reticular formation) defines the most important pain at the moment by $i(t) = argmax\{r_{P_i}(t)\}$. Our memory recalls some solutions (like foods), $\mathcal{S} = \{s_1, s_2, \ldots, s_n\}$, and their learnt values as $V_t(s_j)$s. Skipping the dreaming details, we choose a solution to seek and a sequence of actions to catch it like $a_1, a_2, \ldots, a_l$. During following those actions, we receive rewards which are the amount of decreasing of that pain:

$$reward(s_j\,; P_{i(t)}) = r_{P_{i(t)}} - r'_{s_j}$$

in which r' is the spiking rate of the stimulated neuron after following the solution s_j. Simultaneously, our memory of values ($V(.)$) is updated based on these rewards.

It is obvious that *Reinforcement Learning* is a special case of *Pain Learning* ($RL \subset PL$) when $\mathcal{P}$ is a single pain, and we have a single world with universal rewards.