# A Free Energy Interpretation of "Small Pig"

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**Abstract**

In this paper, I analyze a story about a pig in a children's book from a free energy perspective. The story is Small Pig, written by Arnold Lobel in 1969, and describes the adventures of a small pig. I also tie the free energy perspective to different concepts of freedom and complementarity. I show how Small Pig's free energy guides his actions as he navigates a difficult time in his life, trading off his various freedoms in a search for stability.

## 1 Introduction and Synopsis

The principle of least action in physics states that any physical object will attempt to move from where it is to where it will be with the smallest expenditure of energy. Otherwise put, the trajectory of least resistance into the future is the one which guides any being to where it is meant to be. This sounds very circular. However, there is evidence that agentic beings like animals use this principle to select the best course of action to take. One can show that this best course of action is defined by how predictable it is. Agents prefer situtations that are predictable, in which they are not surprised. A statement of this principle can be made in which making the future more predictable is equated with minimizing a quantity called *free energy* (Friston, 2010).

Free energy is a description of possibility for doing work - it is a measure of how much a sentient being (broadly defined) can actually "do" in its environment. The free energy landscape of any sentient agent is defined inter-subjectively by how the agent interacts with its environment. It is more than simply a list of possibilities, though, for it characterizes the relative importance of possibilities, either probabilistically, or causally, or both. That is, is describes how likely a certain future configuration is, as a function of the total possibility of the future for the agent, including the agent. This seems circular in the same way that a donkey pulling a cart trying to get a carrot in front of him tied to a stick attached to the cart. Nevertheless, *variational* methods can be used to approximate solutions to this conundrum.

Viewing any agentic system as a free energy optimizer leads to some interesting predictions and conclusions. In this article, I do this for a simple children's story written by Arnold Lobel in 1969 (Lobel, 1969), from the perspective of the main character, Small Pig himself. I end this

section with a synopsis of the story, and then introduce more fully the concept of free energy, and the related concepts of freedom and complementarity. Then, in Section 5, I go through the text and pictures of Small Pig, giving a free energy interpretation.

**Synopsis of Small Pig (Lobel, 1969)**:
Small Pig (Lobel, 1969) is a small pig who lives on a farm. Small Pig has a farmer couple who love him very much. Small Pig has a mud puddle that he greatly enjoys. Small Pig leads a contented, quiet life. One day, the farmer's wife decides to vacuum up Small Pig's mud puddle! Small Pig is very upset and runs away, looking for another mud puddle. He has a variety of encounters along his way, and finds a few different mud puddles and messy places, and even has a traumatic recall event with a junk vacuum cleaner. He ends up stuck in some concrete in the city, where people gawk at him. Finally, the farmer couple rescues Small Pig and he goes back to the farm and his mud puddle is back so he is back to where he started from.[1]

## 2 Free energy

A system with free energy is one in which things can be done to make the world more predictable from some perspective. If such things are done, the free energy is "used" by some part of the system to create (local) order, while the remainder of the system undergoes a usual (in fact, accelerated) increase in disorder, or entropy. While entropy refers to the potential disorder of a system, free energy, in some sense, refers to the opposite, how much potential order is contained in a system. In fact, free energy has been called *negentropy*,[2] defined by Brillouin: *"An isolated system contains* negentropy *if it reveals a possibility for doing mechanical or electrical work"* (Brillouin, 1953, p.1153).

Free energy interpretations of intelligence and agency center on the principle that agents will try to reduce their own free energy. They want their existence to be in a state of predictability, one in which the future is deterministically defined based on the present. However, they are stuck because they do not know what their present state is. Thus, the agents must do a lot of averaging over past, present, and future to come up with strategies for acting in the world.

Free energy interpretations make use of a ternary structure of existence. The *generative process* is the process by which the external world surges into being. The laws of physics and the motion of the moon are part of the generative process. The *generative model* is a reflection of this generative process in the agent's mind: it is the agent's model of the world. The *Markov blanket* is the mediator between these two and describes the relationship between the agent's sensorium and motor controls and the environment. The inside of the agent is conditionally independent of the generative process given the Markov blanket, or the agent's sensorium. Free energy, denoted $G$, describes how well the agent's generative model matches the generative process, mediated by the Markov blanket. See (MacKay, 2003; Friston, 2010) for a complete

[1] not quite - they have a new understanding of each other after this is all over.

[2] A term introduced by Schrödinger (1944) in a popular science text, from which I quote: *"...I should have let the discussion turn on* free energy *instead. It is the more familiar notion in this context. But this highly technical term seemed linguistically too near to* energy *for making the average reader alive to the contrast between the two things."* (Schrödinger, 1944, p.74). In fact, there was some lamentation that the term *entropy* denotes the *unavailability* of energy to do work, it is somehow negatively defined, which is one reason it is so confusing. The word's derivation is from the Greek meaning *transformation*, which would make it a much more suitable word to describe free energy. Nevertheless, one cannot change a century of physics any more now than then.

treatment.

In order to match the generative process, which might include other agents, the generative model needs sufficient accuracy, such that it matches the world as it really is, and sufficient flexibility, so it aligns with a future in which the agent is successful. Consider an agent trying to predict a coin flip in a world where coins have diverse levels of fairness (deviations from the mean of a fair coin). The agent will have some neural representation of the state of the particular coin in question, $\mathbf{x} \in \{\text{heads}, \text{tails}\}$.[3] Suppose it represents the state of this coin as a probability distribution $P(\mathbf{x}|\theta)$ where $\theta$ is the agent's belief (a number from $0 \ldots 1$) that this coin will turn up heads. The agent might learn $\theta$ by observing coin flips. As the number of observed coin flips with this particular coin increases, $\theta$ becomes more and more precise: its value becomes closer and closer to the true fairness of the coin, $\theta^*$. Now suppose this agent runs into different coins, and must be able to estimate how likely it is that any new coin will turn up heads, $\theta'$. It might assume that $\theta' = \theta \approx \theta^*$ for any new coin, and this might be a start, but it would likely be wrong, and may be catastrophic if the agent doesn't learn fast enough. Alternatively, the agent can assume there are many coins, and develop a distribution $P(\boldsymbol{\theta})$ over a set of $\theta$ values, $\boldsymbol{\theta}$, which it can draw from. If it uses the latter method, it will be making predictions of the future based on a set of models distributed according to $P(\boldsymbol{\theta})$. This will necessarily make the predictions less precise, as they must match a *set* of possible futures, not one in particular.

Consider the strategies corresponding these assumptions. The first will have a detailed strategy that works very well and can be tuned to new coins, but takes learning. The second has a default strategy that works reasonably well across a wide range of coins. This is highly reminiscent of the story about the hedgehog and the fox (Berlin, 1961). The hedgehog uses a single policy (or model) which works under many conditions (it curls up in a ball), while the fox figures out the entire current situation and works out a method for getting his way. The fox is a precise, fragile agent, and the hedgehog is a coarse, robust agent. A general purpose agent combines these two strategies, and the free energy (the match of generative model to generative process), is a mix of how precise and robust the agent's model is. This agent tries to keep the potential variation in future datasets to a minimum (tries to minimize surprise), so it can avoid being a hedgehog, *while* remaining robust to changes, so it doesn't become too foxy.

The free energy can be computed by simultaneously monitoring and predicting the state, $\mathbf{x}$, and the model itself, $\boldsymbol{\theta}$, using the joint distribution $P(\mathbf{x}, \boldsymbol{\theta}) = \frac{1}{Z} P(\mathbf{x}|\boldsymbol{\theta}) P(\boldsymbol{\theta})$ where $Z$ is the *partition function*, the connective normalization factor that ties $\mathbf{x}$ and $\boldsymbol{\theta}$ together. I am confounding the state $\mathbf{x}$ with the observations made by the agent here $\mathbf{o}$ in order to ease the presentation only. Typically one also needs to integrate over $\mathbf{x}$ leaving only the evidence, $\mathbf{o}$.[4] The partition function is difficult to compute as it involves a sum over all of $\boldsymbol{\theta}$: $Z = \int_{\boldsymbol{\theta}} P(\mathbf{x}, \boldsymbol{\theta})$. The agent wants $Z$ to be as large as possible as this will mean that $P(\mathbf{x}, \boldsymbol{\theta})$ is large, and the world is precisely predicted, but also that the summation is large, so the number of models used is as big as possible, giving maximum flexibility. The *free energy*, $G = -\log Z$, so that $G$ is minimized to maximize $Z$. That is, the *free energy* is lower if the agent trades these strategies off more appropriately for its environment: it will be better able to handle both stasis and change. As more and more of the future is properly expected, being becomes "larger" and occupies more of

[3] I make no assumptions about this representation as a "symbol" or a set of neural weights.

[4] This means the agent computes $Z = \int_o Q(o) do$ where $Q(o)$ is some estimate of $P(o)$. In that sense, I confounded $\mathbf{x}$ and $o$ in Section 2 such that I could define "free energy" as this free energy "landscape" $Q(\mathbf{o})$, making them identical.

the space of an agent's reality, while free energy decreases.

Consider the partition function again:

$$Z = P(\mathbf{x}) = \int_{\boldsymbol{\theta}} P(\mathbf{x}, \boldsymbol{\theta}) = \int_{\boldsymbol{\theta}} P(\mathbf{x}|\boldsymbol{\theta})P(\boldsymbol{\theta})$$

As mentioned above, $\mathbf{x}$ represents the "evidence" (usually denoted $\mathbf{o}$). In order to make $Z$ usable, an agent needs to construct it over the *future*, as these will be its predictions that allow it to not be surprised. However, this presents a problem because the future is not observed, so the free energy cannot be calculated directly. To surmount this problem, the agent may compute $Z$ *in expectation* over the future. Since it should be exactly the future that minimizes free energy, one can see the conundrum. Nevertheless, there are *variational* machine learning methods that can handle this essentially by iterating between estimating $P(\mathbf{o})$ in the future, and computing $Z$ based on those estimates.

When the state, $\mathbf{x}$, also describes *actions*, then the minimization of free energy becomes *active inference*: the model is used to *infer* what action is coming next - essentially, it is used to predict itself. The better it can predict itself, the less surprised it will be. The inferred action, which aims to lower free energy, can do this in three ways which correspond to changing one of the ternary elements of existence discussed at the start of this section. First, by acting in the world, and changing the *generative process*, that world can be made more predictable (e.g. deforestation displaces wild animals away from towns). Second, by acting on itself, and changing its own *generative model*, the unpredictability of the world can be reduced (e.g. learning the patterns of behaviours of the wild animals so as to avoid them). Lastly, by acting on its relationship with the world, and changing its *Markov blanket*, the world can also be made more predictable (e.g. domesticating the wild animals - making them a part of the existing society, rather than excluding them).

The three forms of action correspond to three basic freedoms that any agentic being has. I explore these in the next section.

## 3 Freedoms

From the Greek meaning *"standing out from,"* (Sartre, 1943, p.802) *freedom* means to be able to do something you are not doing (opportunity), become someone you are not (agency), and obtaining something that you don't have (liberty). I see a clear bijective mapping here between these actions that define freedom, and the actions that minimize free energy that were discussed in the last section. While *doing* implies taking advantage of an opportunity and changing the outside world, *being* means being agentic and changing oneself, and *having* means being at liberty to possess something that you don't have and thereby change the interface between yourself and the outside world. I will label these freedoms, borrowing from (Anderson, 2017), as: *positive*, *negative*, and *republican*, freedoms, respectively. Positive freedom means opportunity: agents have the freedom to explore their world. Negative freedom is defined by the agency to choose actions, from whatever choices are given. Republican freedom, also known as *independence* or *liberty*, means people are not subject to anyone's unaccountable will. Restrictions on positive and republican freedoms are elegantly analogized by Sartre as reasons to stay at home either *"because it is raining,"* (Sartre, 1943, p.362) or *"because one has been forbidden to go out,"* (Sartre, 1943, p.362) respectively.

To continue that analogy, restriction on negative freedom is a reason to stay home because one is shy. Decreasing negative freedom means removing people's abilities to choose their own actions, but without coercive force. Usually, agents are not capable of *not* doing this. That is, *"From the moment that I exist I establish a factual limit to the other's freedom. I am this limit..."* (Sartre, 1943, p.530) In order to make negative freedom work, social identities or roles can be used to prescribe actions coherent with these identities. If these culturally approved dynamics become institutionalized, they remove negative freedom (agency) of individuals to act in whatever way they choose.

Positive freedom can be minimized by an individual by making his world more organized, like Robinson Crusoe (Defoe, 1719). Republican freedom can be minimized by a dyad, since they can mutually constrain each other. To minimize negative freedom, a dyad is insufficient because it neglects that each member has also a connection to others, and that a third person is necessary. For example, my friend reduces my negative freedom (to behave in an unfriendly way towards him), but it is still possible for my friend and I to have an abusive relationship, so long as no third person can observe us. When observed, I feel the eyes of society on me since the Other is the totality of all others, again restricting my negative freedom. Thus, (lack of) negative freedom requires a relation of transitivity, which completes the reciprocity and individuality that arises from the (lack of) republican and positive freedom, respectively. Strangely, this has a close connection to some basic algebraic principles (Bergman, 2015), as pointed out by Martin (2009). That is, there are three types of algebraic relation, as there are three types of human social networks: those that *"have to do with the relation of an element to itself,"* those that *"...tell us, if we know how two elements relate in one order, how they relate in the reverse order,"* and those that *"...tell us how to use the relation of one element to a second and this second to a third to get a relation between the first and the third."* (Bergman, 2015, p.201-202). I go into more detail about these relationships in (Hoey, 2020).

# 4 Complementarity

Perhaps the most interesting thing about the freedoms (and actions) discussed in the last section is that they are mutually co-dependent and exclusive. That is, the more of one you have, the less of the other(s) you have. Here I derive this ternary complementarity using a Bayesian argument. See (Hoey, 2021) for a derivation using free energy principles applied to a group, and (Hoey, 2022) for a derivation from a Bayesian modeling perspective.

As we have seen, there are three elements in a free energy model: $\mathbf{x}$ and $\boldsymbol{\theta}$ and the connection between them. The first is *denotative*: $\mathbf{x}$ represents actual elements of the world, such as how a coin landed. It is informed by observations of the world $\boldsymbol{O_b}$. The second is *connotative*: is represents a meaning more abstractly, for example the abstract notion of a fair coin. It is informed by emotional signals, $\boldsymbol{E_b}$. The last is *connective* and represents the connection between $\mathbf{x}$ and $\boldsymbol{\theta}$.

As Bayesians, we parameterize these functions with three parameters $\delta$, $\alpha$ and $\gamma$. Let $\psi = \{\delta, \alpha, \gamma\}$ represent the set of all three parameters. The joint distribution over the state of the system *and* of its parameters, $\{\mathbf{x}, \boldsymbol{\theta}\}$, after making observations $\boldsymbol{O_b}$ and $\boldsymbol{E_b}$ is then:

$$
\begin{aligned}
P(\mathbf{x}, \boldsymbol{\theta}|\boldsymbol{O_b}, \boldsymbol{E_b}, \psi) &= \frac{P(\boldsymbol{O_b}|\mathbf{x}, \boldsymbol{\theta}, \boldsymbol{E_b}, \psi) P(\mathbf{x}\boldsymbol{\theta}|\boldsymbol{E_b}, \psi)}{P(\boldsymbol{O_b}|\boldsymbol{E_b}, \psi)} \\
&= \frac{P(\boldsymbol{O_b}|\mathbf{x}, \psi) P(\boldsymbol{E_b}|\mathbf{x}, \theta, \psi) P(\mathbf{x}, \boldsymbol{\theta}|\psi)}{P(\boldsymbol{O_b}\boldsymbol{E_b}|\psi)} \\
&= \frac{P(\boldsymbol{O_b}|\mathbf{x}, \delta) P(\boldsymbol{E_b}|\boldsymbol{\theta}, \alpha) P(\mathbf{x}, \boldsymbol{\theta}|\gamma)}{P(\boldsymbol{O_b}\boldsymbol{E_b}|\psi)} \qquad (1)
\end{aligned}
$$

Note how these trade off against one another, assuming we attempt to keep the posterior, $P(x|\boldsymbol{\theta}, \delta)$ constant, and each parameter is monotonically related to the variance of the distribution it conditions (aka it is the variance of a normal distribution). Suppose $\delta$ is increased, then $P(\boldsymbol{O_b}|\mathbf{x}, \delta)$ will become more dispersed, and so either $P(\boldsymbol{E_b}|\boldsymbol{\theta}, \alpha)$ must become more precise, and $\alpha$ is decreased, or $P(\mathbf{x}, \boldsymbol{\theta}|\gamma)$ must be made more precise ($\gamma$ is decreased). Suppose $\alpha$ is increased, then $P(\boldsymbol{E_b}|\boldsymbol{\theta}\alpha)$ will be more dispersed, so either $P(\boldsymbol{O_b}|\mathbf{x}, \delta)$ must be come more precise, and $\delta$ is decreased, or $P(\mathbf{x}, \boldsymbol{\theta}|\gamma)$ must be made more precise, so $\gamma$ is decreased. Finally, suppose $\gamma$ is increased, then $P(\mathbf{x}, \boldsymbol{\theta}|\gamma)$ is more precise, so one of $P(\boldsymbol{O_b}|\mathbf{x}, \delta)$ or $P(\boldsymbol{E_b}|\boldsymbol{\theta}, \alpha)$ must be made more precise so that it's estimate rises to counter the increase in $Z$. Thus, one of $\delta$ or $\alpha$ must be decreased if $\gamma$ is increased. The following three arguments can be reversed, e.g. if $\delta$ is decreased, then by the same reasoning, then one of $\alpha$ or $\gamma$ must be increased. Therefore, $\alpha$, $\delta$ and $\gamma$ must lie on a simplex, as shown in Figure 1(a). Figure 1(b) shows the same simplex, but in the "inverted" space where $\hat{\psi} = 1/\psi$, and all directions are reversed. $\psi$ and $\hat{\psi}$ are equivalent. I will use this reversed simplex in Section 5.

The denominator in Equation 1 is the partition function, $Z$, which as we have seen, is the (inverse of the) *free energy*, $G = e^{-\log Z}$. All parameters contribute to this free energy, and it gives an overall scaling factor to the simplex: its distance from the origin, as shown in Figure 1 with a green arrow. In fact, the free energy is a scalar field in this space, with its derivative being a vector field perpendicular to, and pointing at the simplex. Any free energy minimizer thus can follow this derivative to the simplex. I show in Section 5 how Small Pig does this during his ordeal.

Let us now connect up this simplex with the three freedoms, and then we will be ready to tackle Small Pig. The denotative component, $\mathbf{x}$, is individual: it is a description of the world *as it is* from an agent's perspective. Thus, $\delta$ corresponds to how precisely predictable the actual future is in the world. Decreasing $\delta$ thus corresponds to *doing* something in the world, to opportunity, and to a restriction of positive freedom. Increasing $\delta$ corresponds to *undoing* something in the world. The connective parameter $\gamma$ is a description of how pairs of individuals should act together. Thus, $\gamma$ corresponds to to how much of the present, the world *as it is*, is being used to update the agent's connotative component, it's modeling space. A smaller $\gamma$ means connnotative meanings must be more precisely tied to actual reality. This means more of the world is under the agent's control: it *has* more things, and its republican freedom is restricted. Increasing $\gamma$ means *giving up* things. Finally, the connotative component $\alpha$ is a description of how individuals are tied across wider groups. In Affect Control Theory, this is the EPA space. Thus $\alpha$ corresponds to how precisely predictable the society is. For any new individual, can we get along? Decreasing $\alpha$ corresponds to *being* something in the world, to agency, and to a restriction of negative freedom. Increasing $\alpha$ means *vanishing*.

The partition function and free energy give the overall scale of the parameters. In a variational optimization of free energy, this corresponds to how much the observations are used to modify

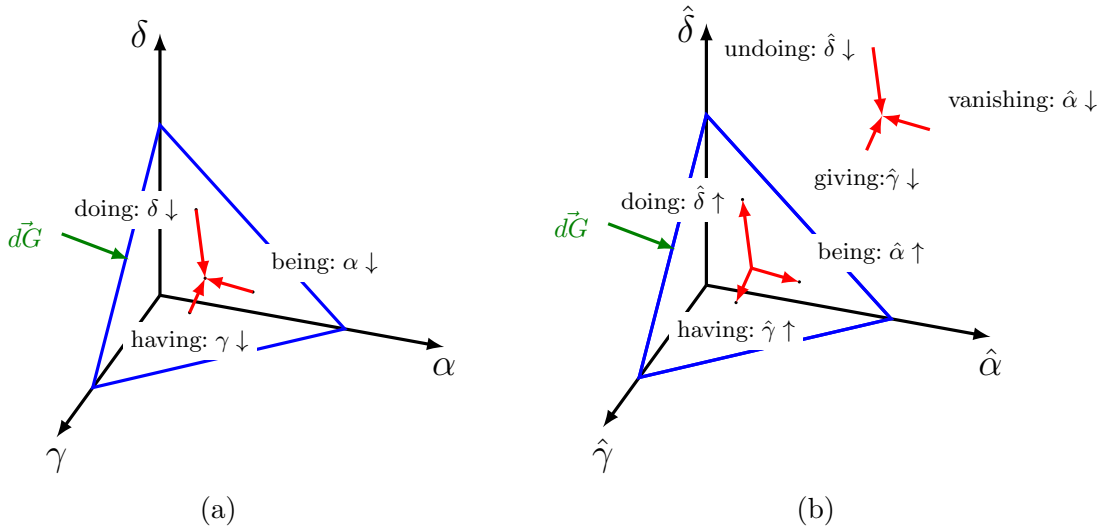



Figure 1: (a) Simplex showing three changes applied to three points by the three actions: *doing*, so $\delta \downarrow$ and $\alpha \uparrow, \gamma \uparrow$; *being* so $\alpha \downarrow$ and $\delta \uparrow, \gamma \uparrow$; and *having* so $\gamma \downarrow$ and $\alpha \uparrow, \delta \uparrow$. (b) Simplex in the inverse space where $\hat{\psi} = 1/\psi = \{1/\alpha, 1/\gamma, 1/\delta\}$, and all directions are reversed. Also shown offset from the simplex are the inverse actions of *undoing*, *vanishing*, and *giving*. The green arrow represents $d\vec{G}$, the derivative of the free energy, shown drawn in the (a) $\alpha = 0$, and (b) $\hat{\alpha} = 0$ plane (see text).

the variational approximation at each step. If the approximation changes quickly in response to external events, then $Z$ is smaller, and the free energy $G$ is larger. Conversely, the approximation changes more slowly, and $Z$ is larger, and $G$ is smaller.

## 5 Analysis

I now present the analysis of Small Pig through a free energy minimization lens. I go through each major component of the story. I can roughly sketch out that Small Pig starts in the center of the simplex: a balanced, contented, aligned life. He then suffers multiple imbalances which throw him off the simplex, to which he attempts to return each time. He does this by following thre free energy gradient, and imputing from that the optimal behavior for himself, which is to "run away" in all cases but the last. In all cases, his self is shifted by exogenous events and his freedoms are restricted. In all cases up to his arrival in the City (Section 5.6), he frees himself from these chains by fleeing the situation. However, after getting stuck in the cement in the city, Small Pig is not able to independently recover from his loss of freedoms, and he must be rescued and brought back to equilibrium by the farmer couple.

To start, he suffers a decrease in positive freedom (an increase in $\hat{\delta}$) when is mud puddle is removed. In the swamp, he suffers a decrease in republican freedom (an increase in $\hat{\gamma}$). In the junkyard, it is his negative freedom that is reduced (and $\hat{\alpha}$ increases). Finally, he nullifies his own positive freedom by getting stuck, his negative freedom is again removed by the crowd, and finally, his republican freedom is constrained as he is "coerced" (forced with jackhammers) by the firemen to get out of the cement. Thus, we could draw the entire trajectory as shown in Figure 2,

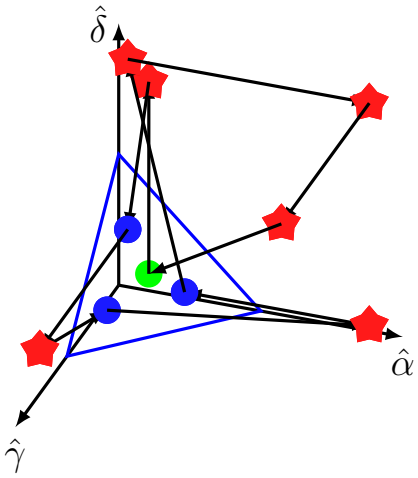



Figure 2: Simplex showing Small Pig's overall trajectory, with ● showing his initial state. The ⋆ show the situations where Small Pig is off the simplex, in a high free energy state, and the ● show the situations where Small Pig has reduced his free energy and returned to the simplex.

with the red stars denoting higher free energy states caused by the decreases in freedom, and the circles denoting the relaxed position after Small Pig moves on. Small Pig returns to the middle after the disruption, with the green circle being the start and end positions.

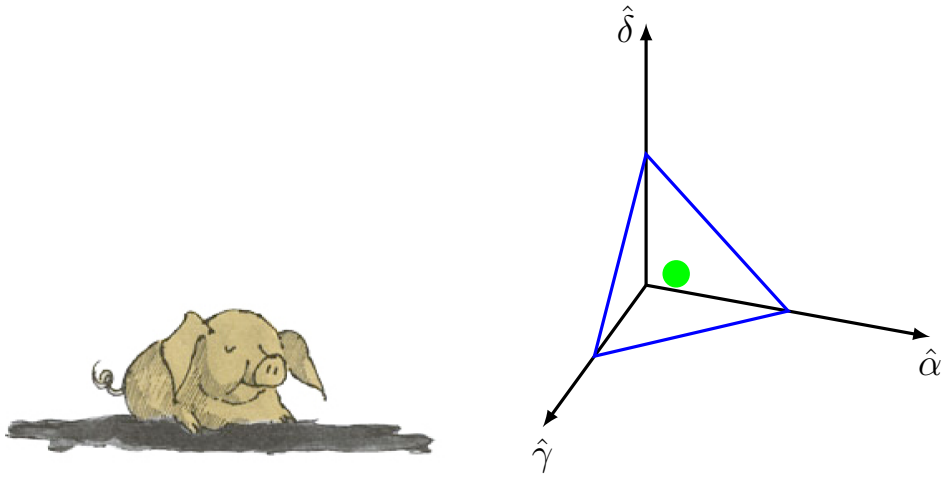
### 5.1 Pages 5-15: Initial Conditions

In the initial state (start of the book), Small Pig is happily living in his mud puddle on the farm. Small Pig's econiche is very simple: he easts, he runs, and he sleeps. He presumably does one more thing but we won't mention that. The thing that Small Pig likes best, however, is to "sit down and sink down into good, soft mud." (Lobel, 1969, p.7). Finally, he is well accepted by his little society consisting of himself and the farmer couple.[5] Judging by the expressions on Small Pig's face, see Figure 3(a), as he does these activities, he is at a low free energy state - he is very well aligned with his econiche. I have placed him at the center of the simplex in Figure 3(b) but there is an arbitrary scaling factor, so we take this as the starting point.

### 5.2 Pages 16-19: Catastrophe!

The farmer's wife decides to clean the pigpen and wash Small Pig. This is a major shock for Small Pig as his expectations (of mud) are suddenly violated by the unexpected arrival of the vacuum cleaner. Small Pig's free energy rises substantially and he is very surprised by this happening, see Figure 4(a). Small Pig's positive freedom has dropped substantially: his opportunity to do the thing he loves best is suddenly gone. Thus, he finds himself thrown off the simplex away from the origin along the $\delta$ axis, see Figure 4(b). He must now find a way to reduce his free energy.

[5]There is also a horse, cow and some chickens, but these play no role in the story and are sequestered in their own places on the farm.




(a) (b)

Figure 3: (a) Small Pig sinking in mud. (b) Simplex showing ● where Small Pig is in the initial state with a green circle.

### 5.3 Page 20-21: Anger and Departure

His identity of "pig" is shifted to one of "neat and tidy pig," and Small Pig reacts to this identity shift with anger (see Figure 4(c)). He expresses this shift in how he thinks he should feel and how he does feel by eating his bow and scowling. He thus increases his positive freedom by *undoing* (his bow, symbolically). The objective of his expression is that the farmer sees it and attempts to restore the mud. However, the farmer does not do this, and so Small Pig is motivated to shift his environment to return to the simplex, which he accomplishes by running away (vanishing, the opposite of being, increasing his negative freedoms). Small Pig has now increased his negative and positive freedoms, as he can once again be who and do what he wants, as shown in Figure 4(d).

### 5.4 Pages 22-27: The Swamp

Small Pig finds some mud and sinks into it, thinking he has resolved his free energy issue. His free energy drops again, although probably not very far as he has no social support here. Sure enough, along comes an aggressive dragonfly, frog, turtle, and finally, a snake. These are all coercive elements, indicating a decrease in Small Pig's republican freedom. The snake says "you are taking up space that belongs to us." (Lobel, 1969, p.26). There is now social conflict and private property - the mud puddle is not "his," it is the snakes'. In a state of low replublican freedom, private property is enforced, and usually "owned" by the authoritarian leader, who can evict anyone by force at any time. Small Pig encounters the concept of "having" now which comes along with threats and aggression. His republican freedom is severely reduced, his positive and negative freedoms remain high as he can leave. His free energy is very high, and Small Pig's terrified expressions to not assuage the swamp owners, and Small Pig runs away again, giving up the swamp and increasing his republican freedom. Figure 5 shows Small Pig's situation after this event, and his relaxed position again on the simplex after running away.

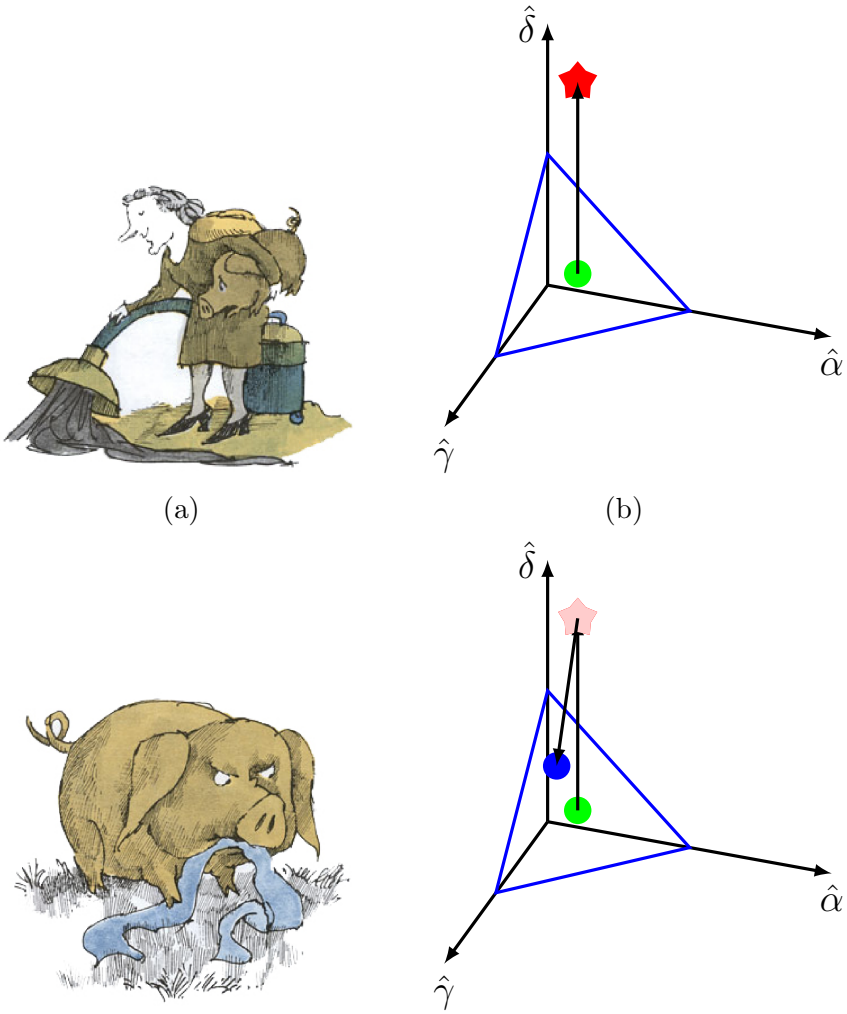



Figure 4: (a) Small Pig freaking out as his puddle is vaccuumed up, and (b) simplex showing a $\star$ denoting where Small Pig is after this traumatic event, and his displacement vector to get there from the initial state. (c) Small Pig getting angry and (d) simplex showing the relaxed situation $\bullet$ after Small Pig runs away for the first time (see Section 5.3).

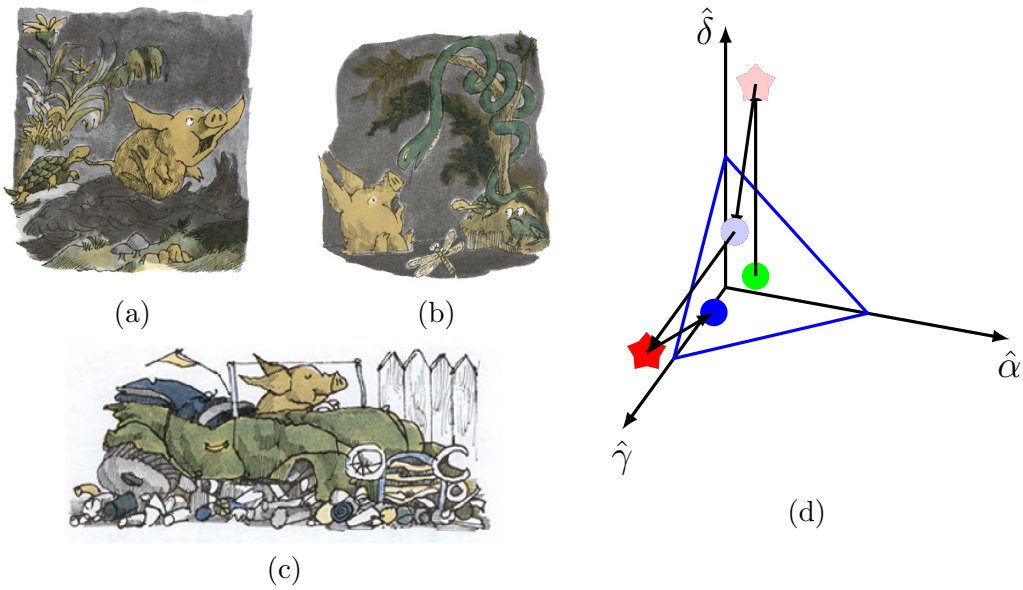


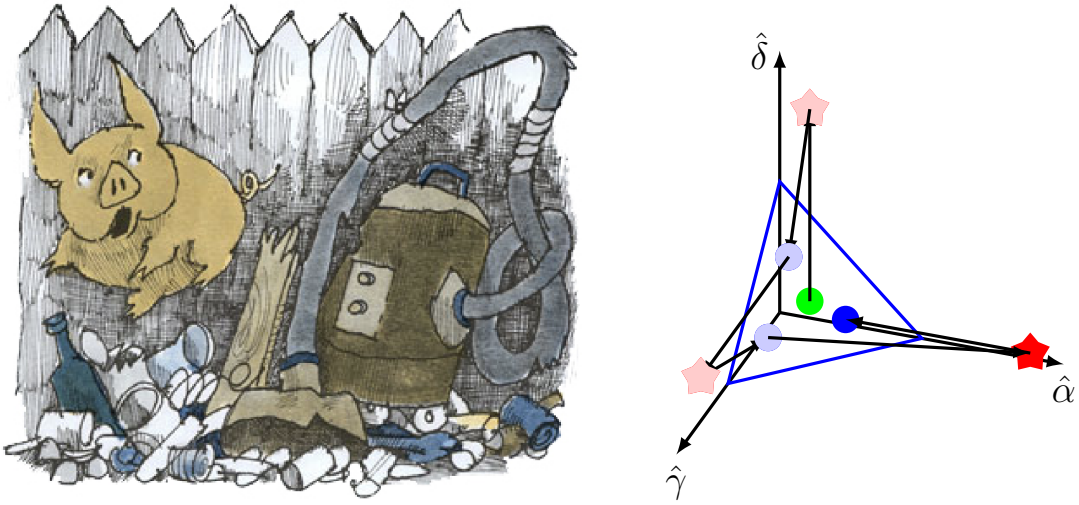

Figure 5: (a) Small Pig is assaulted by a turtle, and (b) is told to get out of here by the snake; (c) Small Pig the car driver (see Section 5.5)- lots of freedom; (d) Simplex showing a ⋆ where Small Pig is when he is evicted, and his displacement vector to get there from the last state. Also shown is the relaxed state ● Small Pig enters by running away and finding the junkyard (see next section).

### 5.5 p.28-33: The Junkyard

Small Pig finds a dirty place: a junkyard. He is now really branching out because he has re-invented himself as a junk-yard pig who likes to drive cars and lie on couches (see Figure 5(b)). Small Pig is exploring his positive and negative freedom, as he is at liberty to do so. Unfortunately, this does not last long as he encounters a vacuum cleaner (non-functioning, but Small Pig does not know this - see Figure 6(a)). The vacuum cleaner is a symbol of cleanliness, while the junkyard is a place of disorder. Small Pig is no longer a pig in a junk-yard: the looming possibility that he is a neat and tidy pig has challenged has challenged that newfound identity. His negative freedom is severely reduced, while his other freedoms stay the same. Small pig has no one to express anything to, so he runs away again, and by vanishing, recovers his negative freedom, see Figure 6(b).

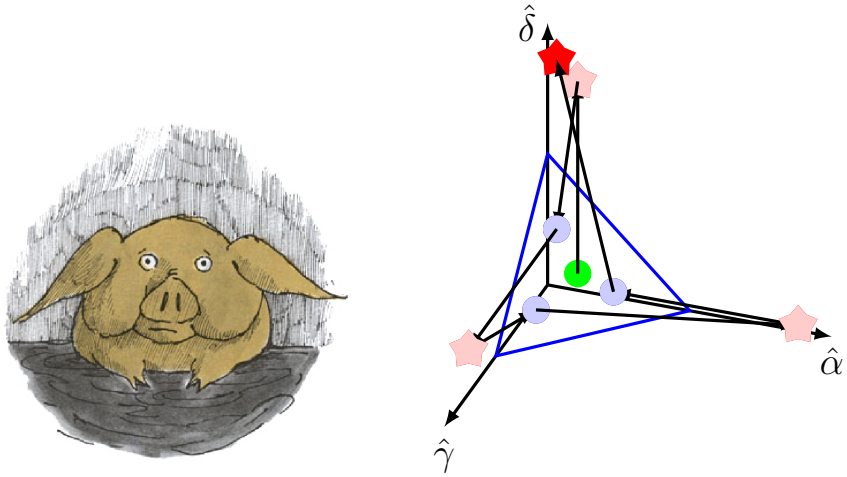
### 5.6 Pages 34-39: The City

Small Pig arrives in a big dirty city and finds some mud to sink down into (see Figure 7. Unfortunately, this mud is drying concrete and Small Pig is stuck! His positive freedoms are reduced even further: he cannot even move. He has full negative and republican freedom though, as he can choose to be who he wants to be and certaintly he is not subject to coercion as he cannot move. Small Pig is not able to independtly recover from this free energy rise because he is stuck in cement!



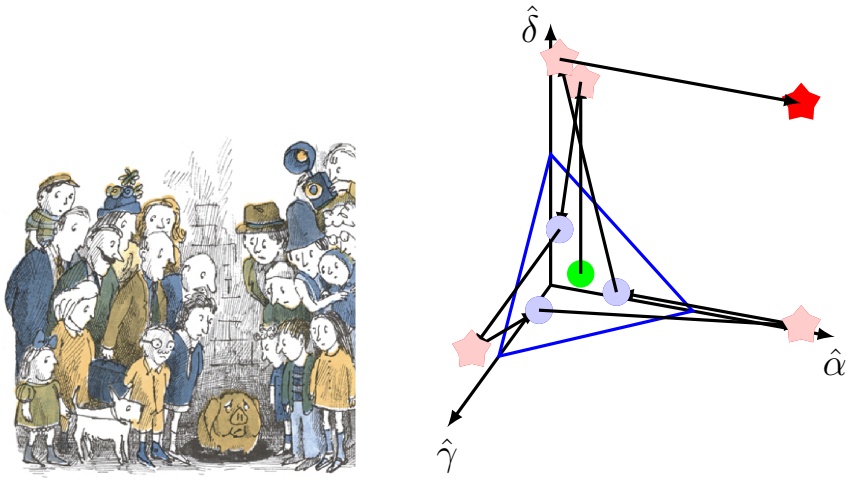

(a) (b)

Figure 6: (a) Small Pig sees the vaccum cleaner in the Junkyard. (b) Simplex showing a ⋆ denoting where Small Pig is after this traumatic event, and his displacement vector to get there from the last state, and the relaxed state ● he gets to after running away.




(a) (b)

Figure 7: (a) Small Pig stuck in cement. (b) Simplex showing a ⋆ denoting where Small Pig is after this traumatic event, and his displacement vector to get there from the last state.




(a) (b)

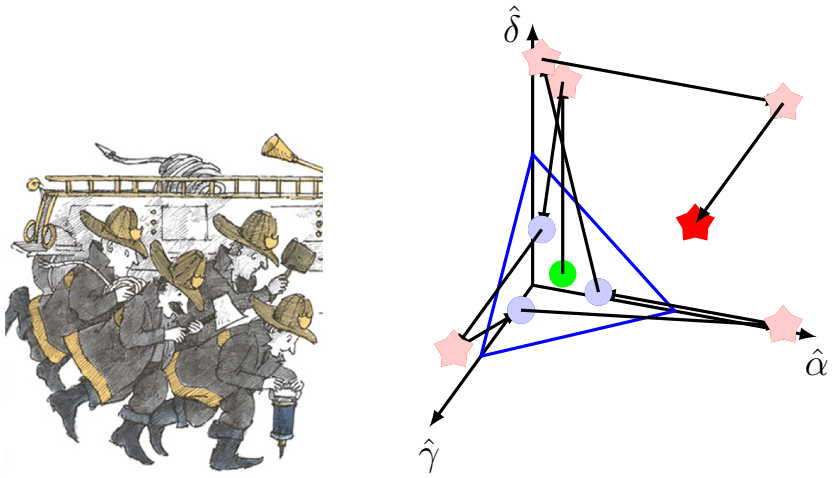
Figure 8: (a) Small Pig being gawked at. (b) Simplex showing where Small Pig is after this traumatic event with $\star$, and his displacement vector to get there from the last state.

### 5.7 Pages 40-45: The Crowd

Small Pig's negative freedom does not last however, as a crowd of people gather (see Figure 8(a)). Their curious, perplexed, somewhat pitying expressions signal to Small Pig that he is *not* being who he is supposed to be (pigs should not be in sidewalks...). Small Pig's negative freedom is drastically reduced as he is pigeonholed by the crowd into an identity of "helpless, childlike, perhaps a bit stupid, animal." Small Pig has still not recovered from his loss of positive freedom in the last section, and his loss of negative freedom now compounds with that positive freedom loss. Poor small pig expresses emotions of shame and despair (see Figure 8(a)) in an attempt to sway the crowd into helping him, but this does not appear to work.

### 5.8 Pages 46-55: The Rescue

Luckily, Small Pig's farmer couple happen to drive by and they call the fire department, who arrive with jackhammers and other implements of destruction (see Figure 9). The firemen forcibly drill into the cement around Small Pig, restricting his republican freedom briefly. Strangely, although Small Pig is being freed, his freedom (to be encased in cement) is being restricted, much like the age-old question of whether one can enslave oneself as the ultimate signal of freedom (Nozick, 1974). This again compounds with his loss of positive and negative freedoms, and Small Pig is in the worst shape he has been in since his ordeal started. The firemen are able to free Small Pig! His positive freedoms again rise up, and his negative freedoms do as well. He returns to essentially the same place he started from, although he still does not know if his mud puddle will be back, so his negative and positive freedoms are still restricted somewhat in his mind.




(a) (b)

Figure 9: (a) Coercive firemen arriving with instruments of destruction. (b) Simplex showing where Small Pig is after this traumatic event with ⋆, and his displacement vector to get there from the last state.

### 5.9 Pages 56-63: Mud Sweet Mud

As they near the farm, it starts to rain, and Small Pig, upon returning to his pigpen, finds it once again filled with good, soft mud. He is returned to his original position, perhaps with some additional knowledge about the world.

## 6 Discussion and Conclusion

Small Pig is a free energy optimizer. His trajectory is a simple example of the intersubjective dynamics of an agent with a dynamic and social environment. It presents a view of the past that recalls a Hegelian dialectic in which the society determines its own course as a reaction to, and based upon, the way it is determining its own course. In this essay I have shown how the simple, yet believable, trajectory of an agent through a series of events can be interpreted as a free energy landscape of possibility intimately tied with ambiguity and uncertainty, and navigated by Small Pig using a combination of having, doing and being, and of giving, undoing and vanishing.

My future efforts are aimed at applying the same type of analysis to other stories. In particular, Campbell (1949)'s Hero, which also maps to many stories, may be interpretable in the same fashion. Small Pig does not quite go through everything the Hero with a Thousand Faces does, meaning that analysis will be more complex. For example, Small Pig never encounters an "ally." I have also done a free energy interpretation of Sartre's "Being and Nothingness" (Hoey, 2024), but this is more of philosophical study of mind than a good story.

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