

**Under what conditions can
fiction and non-fiction
coexist?**



Internship Report

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Abstract

In this report, I explore the reasons behind the coexistence of fiction and non-fiction in cultural productions. I argue that cognitive sciences have focused on understanding the psychological reasons for the production and consumption of these works, but there is still a lack of clarity as to why both types coexist. To address this question, I present five specific hypotheses and produce an open-source simulation program in python to test them. The simulation program models a population of consumers and producers, and through varying different parameters, my aim is to find conditions that can explain the coexistence of fictional and non-fictional production. I conclude that certain hypotheses are more likely to explain the coexistence of fiction and non-fiction than others, providing a deeper understanding of the coexistence of these two types of cultural productions and offer a framework for future research in this area.

Table of contents

Acknowledgements	2
Abstract	3
Introduction	4
Hypotheses	5
Method	5
Result 1 – Simulation program	8
Result 2 – Hypothesis evaluations	9
Discussion	13
Bibliography	14
Appendix	15

Introduction

Cultural productions are multiple: films, novels, documentaries, encyclopaedias, cartoons, video games, scientific popularisation programs... Multiple areas of research aim to understand this variability, using various methodologies and theoretical frameworks. In particular, cognitive sciences focus on the psychological determinants for the production and consumption¹ of cultural works (Dubourg & Baumard, 2022b). For instance, recent research in this area has sought to understand why imaginary worlds are so successful in works of fiction (Dubourg & Baumard, 2022a). This question is particularly puzzling, since producers of fiction create a completely unrealistic world that seemingly will bring no useful information to a viewer.

This research has led to the identification of the enigma of fiction (Boyd, 2010): “Why do we consume stories that do not exist or refer to real events?”. It would initially seem more likely that humans should be attracted to consume works that bring the most benefit, which in all cases should be non-fiction as they teach us real and useful information on our world. However, the consumption of works of fiction has skyrocketed over the last century. Previous studies have submitted different hypotheses on the evolution of narrative fiction, notably the idea that it serves as a way of transmitting adaptive knowledge (Coe et al., 2006), a way of regulating emotions (Nettle, 2012), a means of preparing for real world scenarios (Mar and Oatley, 2008), or a way to exploit cognitive mechanisms to entertain (Dubourg & Baumard, 2022b). On the contrary, if fiction is so attractive, then shouldn't it completely replace non-fiction? How is it possible that both fiction and non-fiction co-exist? There is a lack of clarification in the hypotheses to answer this question.

My work during my internship was to attempt to bring elements of answer by identifying theoretical situations in which both fiction and non-fiction can co-exist. Through these situations, the objective was to find conditions which could explain the cohabitation of the fictional and non fictional production in our world. To do this, I built a formal model of a population of producers and consumers where each actor can produce (or respectively consume) fiction and non-fiction. Each actor pays costs and collects benefits in producing or consuming fiction or non-fiction. The model was implemented on python to test a variety of hypotheses.

¹ We use the terms “producers” and “consumers”, as well as “production” and “consumption” in a very broad sense, which does not necessarily imply a willingness and a commercial exchange. The term “producer” includes writers of novels, directors of documentaries, cartoonists of manga, etc. The term “consumer” includes readers of novels, spectators of documentaries, readers of manga, etc.

Hypotheses

Hypothesis 1: Equivalent costs for producers and consumers

Under this hypothesis, the cost of producing and/or consuming fiction is comparable to the cost of producing and/or consuming non-fiction. If fiction is as costly as non-fiction, we might expect that people would consume both.

Hypothesis 2: Trade-off between costs and gains

Under this hypothesis, the cost of consuming fiction is low, as well as its benefits. If non-fiction generates a large gain but with a large cost compared to fiction, we might expect that people would not only consume and produce non-fiction, but also non-fiction.

Hypothesis 3: Balance between fiction and non-fiction

Under this hypothesis, consuming a mixture of both fiction and non-fiction gives an intrinsic gain to the consumer. If a mixture of consumption is beneficial then we might expect people to produce a mixture of fiction and non-fiction.

Hypothesis 4: Asymmetrical gains for producers and consumers

Under this hypothesis, consuming fiction might yield a high gain, whilst producing fiction might yield a very low gain. If there is such a difference between the gains of producers and consumers concerning fiction, then we might expect people to not only consume or produce fiction.

Hypothesis 5: Diminishing returns

Under this hypothesis, consuming too much of one thing leads to diminishing returns in gain. If consuming too much fiction or non-fiction leads to smaller additional gains, then we might expect a mixture of fiction and non-fiction to exist.

Method

The first step was designing a model in which producers and consumers of works of fiction and non-fiction would interact in different conditions (see Figure 1). Each actor has his own strategy, based on gains and costs. The model is a series of interactions between a population of consumers and producers, where after each generation a new strategy is developed based on the best outcomes of the previous one.

We defined both the producers and consumers which both behave differently:

- A producer produces a certain amount of works of fiction or non-fiction. He has a cost for each work produced, and a gain for each work that is consumed by a consumer. The higher the payoff, the higher the probability that his strategy gets repeated by future producers.
- A consumer consumes a certain amount of works of fiction or non-fiction. Each type of work has a cost and a benefit for the consumer. After the first generation, the payoff of consumers is tallied, and the next generation's probabilities of consuming fiction or non-fiction is based on the highest payoff of consumers of the previous generation.

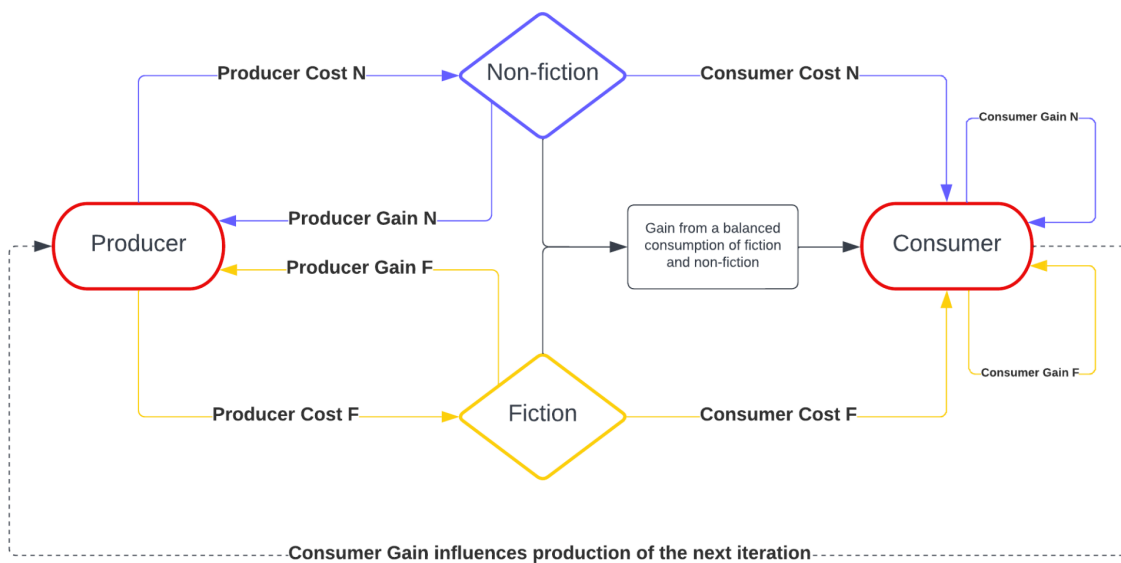


Figure 1 - Diagram of the model

The model iterates over several generations (see Figure 2). Eventually when the model has run enough times, it reaches an equilibrium where each new generation will produce a similar proportion of fiction and non-fiction than the last. This equilibrium depends on the values of the parameters of the model (see Table 1). This state is what we are interested in and therefore we can extract these results in a graph. .

Parameter	Baseline value	Meaning	Hypotheses
N	100	Number of consumers and producers	N/A
T	1000	Number of iterations	N/A
m	0.01	Mutation rate	N/A

p	3	Number of purchases each consumer makes per round	N/A
s	0.9	One generation's influence on the next	N/A
$C_{i,j}$	0.5	Cost of producing or consuming fiction or non-fiction (four separate parameters)	Hypothesis 1, 2
$B_{i,j}$	0.5	Gain of consuming or producing fiction or non-fiction (four separate parameters)	Hypothesis 2, 4
L	0	Gain of consuming a balance of fiction and non-fiction	Hypothesis 3
S	0	Saturation of gain	Hypothesis 5

Table 1 – Parameters of the model. *Baseline values* indicate the parameters of the model of reference. *Hypotheses* indicate the hypotheses that are linked to the parameters.

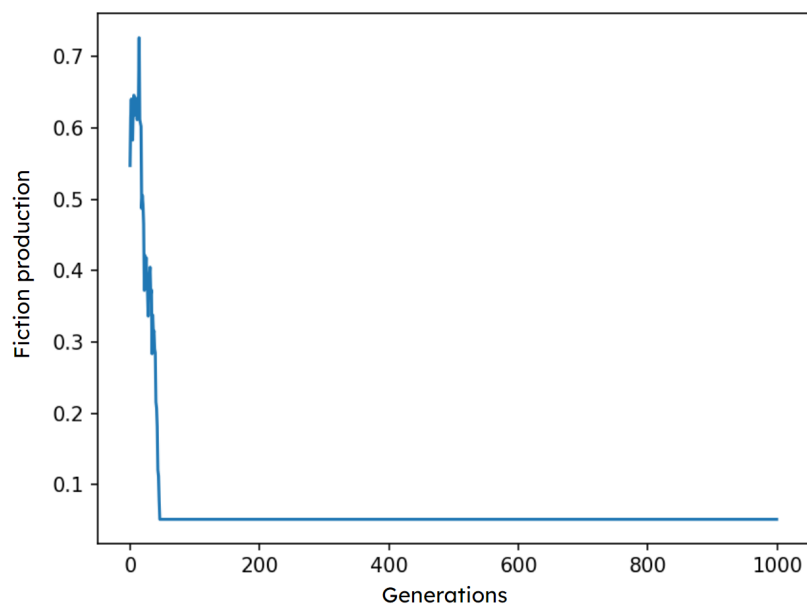


Figure 2 – Evolution of the average probability of producing fiction when non-fiction is free for consumers.

To properly test the hypotheses, we need to represent the effect of the variation of two parameters at once in the form of a heatmap where we can clearly see the impacts that both parameters have on the final equilibrium.

Result 1 – Simulation program

A first outcome of this project is an open source simulation program ([link: https://github.com/AerialBomber/ConsumerProducerModel.git](https://github.com/AerialBomber/ConsumerProducerModel.git)). The objective was to create a framework that others (including members of the hosting team) could use to test different hypotheses to the ones we had chosen to study. For those reasons python was our choice as it is one of the most popular programming languages, especially in modelling.

Figure 3 describes the framework for the code, which gives a broad understanding of the way it functions. One of the main difficulties encountered whilst making the model was the overwhelming presence of lists of data needing to be stored, updated, and linked amongst each other. The code was modified slightly in order to generate the heatmaps by adding an additional loop around this entire framework.

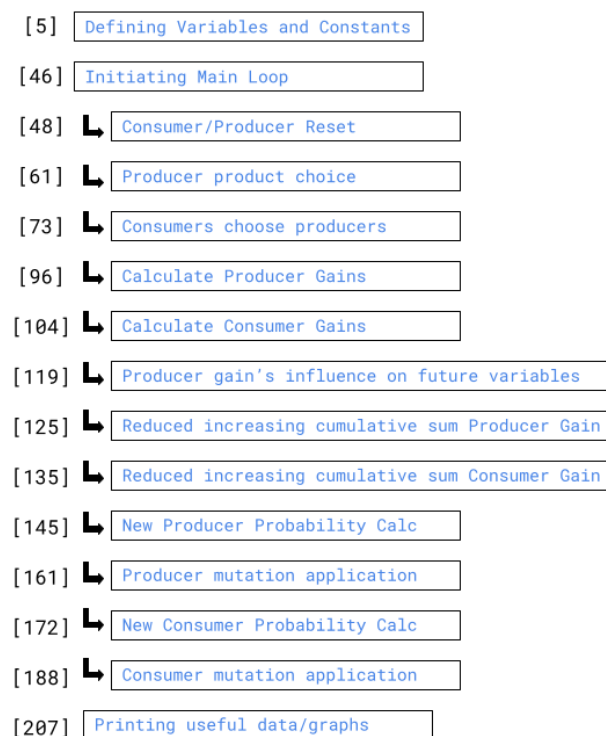


Figure 3 – Diagram of the logic of the simulation program

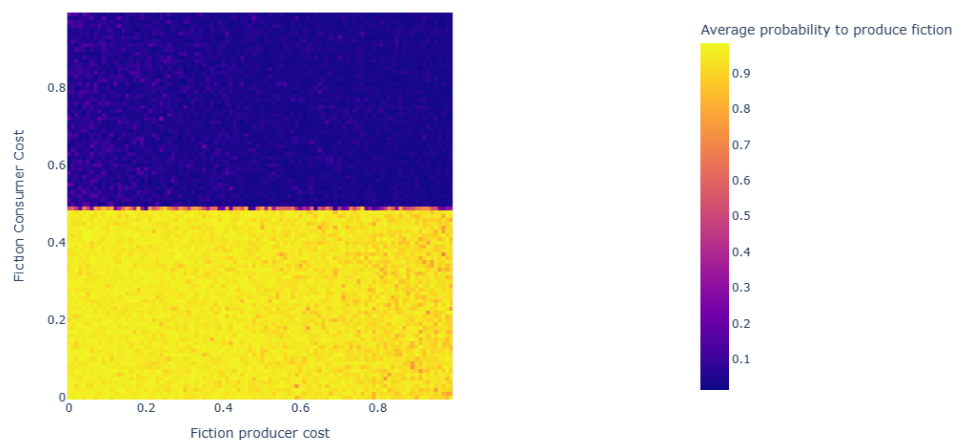
Result 2 – Hypothesis evaluations

The final code produces a 100 by 100 heatmap with a population of 100 individuals, and 100 generations would take about 30 minutes. Such a model takes time to run. Although there are no real limitations on the size of our initial parameters, it was clear from the start we would need to choose a reasonable population size (to limit the time needed to reach a state of equilibrium), as well as an acceptable heatmap. A 1000 by 1000 heat map could be expected to take 100 times longer, which on the computers accessible to me was unrealistic.

In each of the experiments we have a population of 100 consumers, each consuming 3 cultural works over 100 generations. Each consumer and producer has a standard cost and benefit of 0.5. To test the different hypotheses we varied these different parameters by making them change from 0 to 1 with increments of 0.01. Additionally, the mutation value was set 0.01 meaning it could change the probabilities of copying a certain value by + or - 1%.

Hypothesis 1: Equivalent costs for producers and consumers

Effects of Producer cost and Consumer cost on the production of fiction

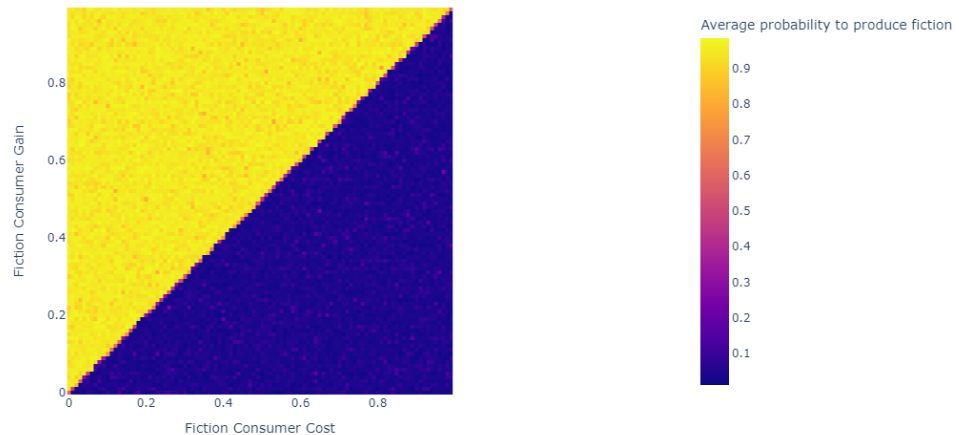


To study this hypothesis, simulations vary the cost of producing fiction for producers with the cost of consuming fiction for consumers. We can see on the graph that the area above 0.5 consumer cost is blue (almost guaranteed production of non-fiction), whilst the area below is yellow (almost guaranteed production of fiction). Additionally there is a small line of cohabitation between fiction and non-fiction precisely at the 0.5 consumer cost value, separating the blue and yellow areas. This means that coexistence can happen when the cost of consuming fiction is precisely equal to the cost of consuming non-fiction (as explained earlier, the unvaried values are set at 0.5).

This case is very unlikely. For this hypothesis to explain the cohabitation of fiction and non-fiction in the real world, we would need fiction and non-fiction to be extremely similar. As a result we reject hypothesis 1.

Hypothesis 2: Trade-off between costs and gains

Effects of Consumer cost and Consumer gain on the production of fiction

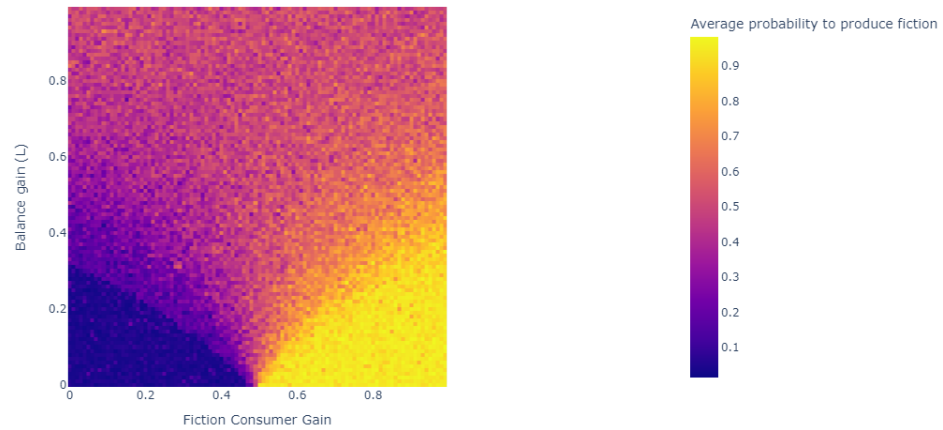


To study this hypothesis, simulations vary the cost of consuming fiction with the gain of consuming fiction. The graph is split diagonally, with the bottom right triangle showing an almost total production of non-fiction at the equilibrium, and the top left triangle an almost total production of fiction. Similarly to hypothesis 1, the separation between the two triangles is marked by cohabitation between fiction and non-fiction. This graph shows that the cohabitation under normal circumstances only exists when the difference between the cost and gain of consuming fiction is equal to the difference between the cost and gain of consuming non-fiction.

This hypothesis is slightly more realistic because it suggests that both works don't need to be identical, and only need to output the same final payoff. However, this remains unlikely to happen in the real world (the area of cohabitation is too small),. For this reason this hypothesis we reject hypothesis 2.

Hypothesis 3: Balance between fiction and non-fiction

Effects of L and Consumer gain on the production of fiction

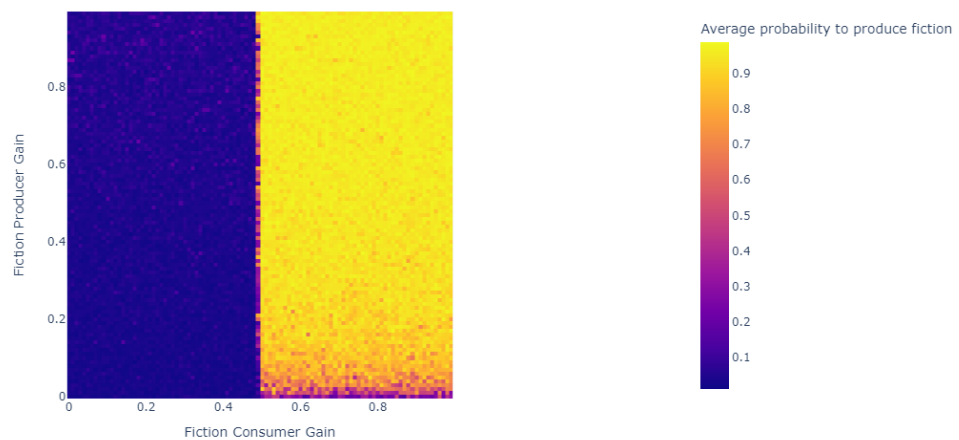


To study this hypothesis, simulations vary the gain of consuming fiction and the importance of consuming both fiction and non-fiction. This was done by introducing the parameter L (see table 2). As L gets closer to 1, it becomes increasingly important to consume both works. This graph is marked by a small triangular area of blue in the bottom left, and a mirrored area of yellow on the right. The rest of the graph is filled with a cohabitation of both fiction and non-fiction. The large amount of red shows a promising lead to verify our hypothesis. It seems that with an increased importance of a balanced consumption that, despite lower gains, fiction remains interesting, and with higher gains so does non-fiction.

The only limit to this hypothesis is the lack of real world application. Indeed it is not particularly clear why a balanced consumption should lead to higher gains. The hypothesis is therefore verified, however we believe we should not concentrate on it to answer the question of cohabitation between fiction and non-fiction. That said, it would remain interesting to keep this in mind for further testing, possibly in a real world scenario.

Hypothesis 4: Asymmetrical gains for producers and consumers

Effects of Producer Gain and Consumer gain on the production of fiction

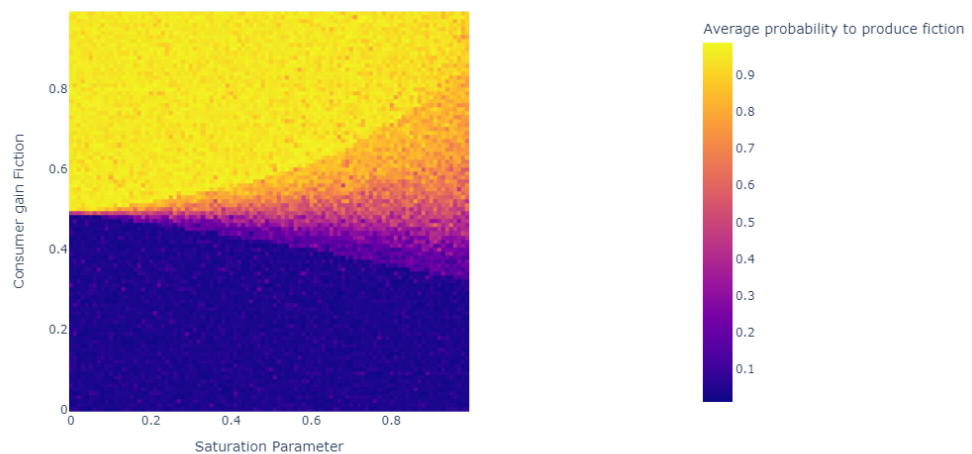


To study this hypothesis, simulations vary the gain a consumer has when consuming fiction with the gain from the producer. We see a vertical separation with the left side almost only producing non-fiction, and the right side almost only producing fiction. However, there is also some cohabitation down the middle of this line, and also on the bottom right rectangle. The presence of this cohabitation suggests that if the gain for consuming fiction is high enough, but the gain for producing fiction is very low, then we might be able to see a balanced production of fiction and non-fiction.

Those conditions are very restrictive so they are unlikely to occur in real life. Additionally, the gain for producing fiction has to be particularly low (very close to 0), which once again seems unrealistic. For this reason, although some cohabitation can exist, is it unlikely that this hypothesis can be validated.

Hypothesis 5: Diminishing returns

Effects of Saturation and Consumer gain on the production of fiction



To study this hypothesis, simulations vary the gain obtained by consuming fiction with a saturation parameter introduced within the model. The idea is that the higher the value of the saturation

parameter, the more consuming too much of one thing decreases our consumer's gain. On the graph we can see the top is very yellow (high likelihood of producing fiction), whilst the top is mostly blue (high likelihood of producing non-fiction). However, the cohabitation area gets progressively higher as saturation increases.

The hypothesis seems validated and it makes sense in a real world context. Consuming too much non-fiction, for example, will likely cause it to become redundant, and the gain obtained for consuming it will become less and less as time goes on. As a result it might be worth switching our consumption to the alternative where our gain may be higher now.

Discussion

Our objective was to create a model of consumer-producer interactions in order to show the conditions needed for the cohabitation of fiction and non-fiction. We achieved this by developing a python model that allowed us to test a series of hypotheses as well as allow further development on the model.

We formulated 5 hypotheses, out of which three offered possibilities of cohabitation outside the bounds of considering an identical cost-benefit ratio for fiction and non-fiction. Out of those, we deemed that the cohabitation shown by hypothesis 4 was minimal and under circumstances that are unlikely to exist in the real world. Additionally, hypothesis 3 showed large areas of cohabitation, however arguing that a mix of fiction and non-fiction should increase our gains when consuming either does not have a clear interpretation in the world.

The diminishing return hypothesis suggests that as you consume more of one type of work your benefit increase becomes lower and lower. As a result eventually it makes more sense to begin consuming the other type. This shows the possibility of cohabitation in the long term of both fiction and non-fiction. This also makes sense in a real world context: think about reading a history book, you might read three or four and find them interesting, but after your tenth they may start to get repetitive and the amount of new content you are learning becomes less and less.

From this we have identified a possible explanation behind the coexistence of fiction and non-fiction in the world, however many more possible hypotheses can be made. Notably, studying further impacts of saturation with other parameters such as costs or the importance of consuming a balance of work, could provide interesting results. That said, one of the most important steps that still need to be taken in order to validate the findings in this report is collecting and analysing real world data. Running laboratory experiments would provide concrete tests that the diminishing return hypothesis is valid.

Bibliography

Boyd, B. (2010). *On the origin of stories: Evolution, cognition, and fiction*. Harvard University Press.

Coe, K., Aiken, N. E., & Palmer, C. T. (2006, March). Once upon a time: Ancestors and the evolutionary significance of stories. In *Anthropological forum* (Vol. 16, No. 1, pp. 21-40). Routledge.

Dubourg, E., & Baumard, N. (2022a). Why imaginary worlds? The psychological foundations and cultural evolution of fictions with imaginary worlds. *Behavioral and Brain Sciences*, 45, e276.

Dubourg, E., & Baumard, N. (2022b). Why and How Did Narrative Fictions Evolve? Fictions as Entertainment Technologies. *Frontiers in Psychology*, 277.

Mar, R. A., & Oatley, K. (2008). The function of fiction is the abstraction and simulation of social experience. *Perspectives on psychological science*, 3(3), 173-192.

Nettle, D., & Bateson, M. (2012). The evolutionary origins of mood and its disorders. *Current Biology*, 22(17), R712-R721.

Powell, M., Olsen, K. N., & Thompson, W. F. (2022). Morbid curiosity for music containing violent themes. *Personality and Individual Differences*, 197, 111797.

Appendix

Transcribing Questionnaire data:

During my internship, I also helped Valentin Thouzeau transcribe questionnaires on excel. They had been handed out at the Hellfest festival, where unfortunately cellular connection was limited due to the large number of people in the same area, and therefore digital questionnaires were unusable. The aim of the project is to understand if the causes underlying the consumption of certain music genres are the same as those on the consumption of fiction.

Use of AI in my project:

Two AI systems were used whilst carrying out my internship and writing my report:

- **Chat GPT** was extremely useful to summarise long passages of articles I did not necessarily have the time to read fully. Additionally, it was extremely useful in providing more creative ways to structure some of the paragraphs of my report. It was also used to produce the first version of the abstract of my report. It is important to note that it was only used as a tool. It never replaced any physical writing, and it was not used as a verified source.
- **Midjourney** was used to generate the cover page image of my report. It is an AI that was trained on images and their descriptions. When given a “prompt” it is able to create a selection of “art” pieces, from which I chose my favourite. I asked the AI to draw “*an imaginary world at night looking at the stars, beautiful planets, vibrant colours, peaceful, cinematic, realistic, 4k*”. The objective behind this was to have a beautiful cover page of a completely fictional world.