0.2 Simplification (Abstraction)

To solve our zebra hunting problem presented in 0.1, I have introduced several fundamental tools in mathematicians' toolbox: type, number, adding and counting. By correctly using these tools and memorising the procedure of calculation, one can easily calculate the number of zebras to facilitate decision making.

However, I suppose our readers will never experience lives of lions at African grassland. The goal of this series is also never a cookbook for African lions (and for civilised human beings). *Solving this problem* is almost at all time less important than *how* to solve this problem and other problems. In the previous section, we have used two higher level tools before introducing the mathematical tools — **simplification**[1] and **precision in language**. I will mostly explain simplification in this section and language in the following section.

Recall our zebra hunting problem — you act as a lion and here comes a group of zebras. The decision of whether or not to hunt is nothing equivalent to counting the number of zebras: it can be much more complex by considering the attributes of the zebras (age, size, health), the attributes of you as a lion (hunger scale, energy, health) and the environmental conditions (weather, light, temperature); or it can be much easier by taking binary consistent action (always hunt or always retreat). Particularly for this problem, we can list down some of the potential decision making processes based on different levels of simplification (note that the list can never be exclusive). The order follows a hierarchical manner as a layered cake, from the simplest to the complex (a top-down approach).

1. Layer 0: Always hunt or always retreat.
2. Layer 1: Count the number of zebras, hunt when number is 1 or 2, retreat when number is greater than 2.
3. Layer 2: Count the number of zebras, and evaluate the age of the zebras, hunt when number is 1 or 2. If number is 3, and the ages of all zebras have not reached maturity, hunt; otherwise retreat. If number is greater than 3, retreat.
4. Layer 3: Count the number of zebras, evaluate the age of the zebras and hunger level of yourself. If you are starving, hunt when number of zebra is 1 or 2. If number is 3, and the ages of all zebras have not reached maturity, hunt; otherwise retreat. If number is greater than 3, retreat. If you are not starving, hunt when the number of zebra is 1, retreat when number is greater than 1.
5. Layer 4: Count the number of zebras, evaluate the age of the zebras, hunger level of yourself, and historical hunting experience with zebras. If your previous experience of hunting zebras

never fails and you are starving, hunt when number of zebra is 1 or 2. If number is 3, and the ages of all zebras have not reached maturity, hunt; otherwise retreat. If number is greater than 3, retreat. If you failed always at hunting zebras more than 1 and you are starving, hunt when the number of zebra is 1, retreat when number is greater than 1. If you failed always at hunting zebras more than 1 and you are not starving, retreat.

6. And many more...

From the short list above which is far from exclusive and involves a lot simplifications even at each layer, we may observe that 1) from layer 2 onwards, the presentation becomes more and more puzzling and verbose; 2) repeated (or partially repeated) presentations appears in multiple layers; 3) the directions of information flow and the conditions of choices are unclear; 4) both the object is hard to describe and the decision is hard to formulate with only numbers and binary conditions (can be considered as number 1 and 0).

It turns out to be that even a daily decision of an animal is intrinsically difficult and complex [2]. To deal with the complexity, the first and the most important tool we have developed is **simplification** (abstraction).

Simplification is to tear off, to reduce, to detach, or to hide the complexity of problems and focuses on the essential parts in the particular context. This is a minimalism approach not for fad or restriction but for easy, simple and understandable [3]. The tool of simplification is not exclusive to computer science, but a scientific method that has gained great success in Physics from the day of Aristotle till now [4] and widely used in personal problem solving and decision making. If the complexity is irrelevant to the context, we discard it; if it is indispensable, we hide and reuse it, just like we do not need to know how the air-conditioner work to use the air-conditioner [5]. The idea under simplification as the first and foremost tool of scientific method represents the humbleness of human species to take fumble steps to understand the infinite mystery of the universe. And the journey is still long.

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1. The more generally used terminology is **abstraction**. Here I deliberately use simplification instead of abstraction is because the term "abstraction" appears to be feared for, especially at the very beginning (e.g., abstract algebra is usually more difficult than algebra). But abstraction indeed means simplification in this sense — to simplify the complexity (abstract out the complexity) and focus on the simple and understandable essence.↩

2. It appears to be easy (we have not observed any single lion think 2 hours before hunting) because for animals, most of the complexities have been abstracted out and inherited genetically. This topic may be discussed further in a later stage.↩

3. All tools have valid physical or philosophical foundations, and with its usages. The preferences of one over another is actually practical. We invent math and use it widely not because math sucks, but because it is simple and easy. So does computer, computer science, and many more. ↩

4. Allan Back, Aristotle's Theory of Abstraction, Volume 73, 2014, Springer.↩

5. This potentially lead to another useful tool(concept) named modularity in computer science.↩