ZooLogystics

(aka, ***Fauna Fantastico***)

Taes Padhihary*

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Contents

This is a report on the **Offline** conduction of the game.

Update (May & June 2025): We have started an attempt at implementing this online.[1] The details will be updated here: github.com/toyess-37/Technothlon-Trading-Game ☑.

Abstract

Thank you for opening this report. The game aims to introduce participants (it was designed for some very *creative*[2] 11th and 12th graders) to economic ideas of fundamental analysis, auction strategies, and trading and test their performance in the zoo themed trading game. The original game also had participants play in pairs, which encouraged discussion.

This document serves as a report that highlights the challenges and insights that we gained during the development of this project. I proposed to name it *ZooLogystics*, but this proposal was unanimously rejected. Eventually, we had to settle with the name *Fauna Fantastico* for the event. Check out the LinkedIn post here ☑.

We had numerous fruitful discussion sessions throughout August 2024. We were assigned to develop the core logistics and supervise the execution of the trading stage of this game.

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*with friends (the organizing team) Chinmay, Jayant, Ekshith, Vivek, Revanth, Prajith, Prashanth and Dhruv.
[1]Thanks to Claude Sonnet 4 for boilerplate codes, stackoverflow for assisting in debugging the codes, and various YouTube tutorials for introducing the related frameworks to me!
[2]Technothlon ☑ is an exam that attempts to test one's critical thinking and decision-making skills through unfamiliar and challenging logical problems (and tricky marking schemes). The teams supposed to play this game were the top 25 Technothlon-2024 teams!

#1 The Game

> There are various zoos in various biological landscapes of our beautiful planet. Most of them cooperate with each other, boosting tourism. However, there have been *several*[3] instances in history that have led to zoos fighting between them to establish superiority.

In our imagined world, five continents (A, B, C, D, E), each favors a unique type of biodiversity: forest, tundra, ocean, desert, or wetland. In each continent, there are five different zoos, each zoo favoring a specific type of biodiversity (which may not be the same as its respective continent).

So, there are 25 zoos: If you assign forest as 1, tundra as 2, ocean as 3, desert as 4 and wetland as 5, the zoos are $A[1] - A[5], B[1] - B[5], C[1] - C[5], D[1] - D[5], E[1] - E[5]$. In addition, the continent as a whole predominantly favors exactly one of the types of biodiversity (in the event, we let A align with tundra, B with wetland, C with ocean, D with forest, and E with desert).

Description of the players' roles

Each player is the *owner* of a zoo (to be selected by the player) and is given *100 coins*[4] to spend. They have to acquire animals to their zoos, through auction or trading (during sessions). Each animal comes with its own set of perks and traits, which will be explained in greater detail later. In the end, an objective scoring system quantitatively determines the winner.

#2 Animals' Description

The animals are broadly divided into **4 tiers:** Tier 1 to 4.[5] Each team can have:

- at most 2 Tier 1 animals,
- at most 2 Tier 2 animals,
- at most 3 Tier 3 animals and
- any number of Tier 4 animals

Each tier of animals comes with its own set of unique financial strengths. Each animal is assigned a unique ID that encodes both its tier number and its type of biodiversity.

Preference Order

Preference order is the order in which an animal is most likely to be seen by the audience. For example, forest animals are more likely to be seen in ocean biodiversity and least in forest. They are also the most comfortable forest biomes, driving a lower maintenance cost, and a higher one in ocean zoos. Figure 1 displays the preferred order of the animals.

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[3]something like this must have happened somewhere someday; not exactly sure, though.

[4]In the first draft of our plan, we intended to allocate coins based on the performance in `Round 0` of the event. But, we decided to incorporate the variability of the coins as a multiplier that is influenced by the *type* of zoo selected. This also ensured that a player's performance in round 0 wasn't the biggest factor in them winning, it was their understanding of the whole game.

[5]This tier-wise division and the associated perks was inspired by the division of stocks in the market into Low-cap, Mid-cap and High-cap. 4 tiers instead of 3 was just to make it tougher and increase the number of available animals.

Preference order for the various bio-diversities are listed below.

Forest

Preference Order
1. Wetland
2. Desert
3. Ocean
4. Tundra
5. Forest

Tundra

Preference Order
1. Forest
2. Wetland
3. Desert
4. Ocean
5. Tundra

Ocean

Preference Order
1. Tundra
2. Forest
3. Wetland
4. Desert
5. Ocean

Desert

Preference Order
1. Ocean
2. Tundra
3. Forest
4. Wetland
5. Desert

Wetland

Preference Order
1. Desert
2. Ocean
3. Tundra
4. Forest
5. Wetland

Figure 1. Preference Order of Animals (e.g. forest animal will be highly valuable in a wetland zoo and so on)

Every animal comes with **auction base price**, **audience income** and **maintenance cost**. These prices depend upon the tier of animal and the preference order of biome (orders are listed in Figure 1). Auction base price depends only on the tier of the animal. However, the audience income and maintenance cost are determined by the animal's native biodiversity and the zoo in which it is kept.

There are special perks associated with some types of animals as well. These perks will be used during the Trading round to give you a chance at attaining maximum profit.

Tier-wise Animal Analysis

This section of the project went through various revisions. Highlights of the four tiers (quantified in Figure 2):

- **Tier 1.** Offer the highest earnings but come with a steep maintenance cost. Keeping them in a different biome increases overall zoo revenue, but maintenance costs rise too. If a Tier 1 animal becomes *unhealthy*, it can severely hurt a zoo's economy.

- **Tier 2.** Owning both Tier 1 and Tier 2 animals outside their native biome grants extra profits. They provide decent earnings without the extreme upkeep of Tier 1. Unhealthy animals still affect revenue, but not as harshly as Tier 1.

- **Tier 3.** Affordable and have minimal maintenance expenses. Low on maintenance.

- **Tier 4.** Safest investment, with stable income and no risk of financial loss. Best used as supplementary income rather than a primary revenue source.

The details about the continents, zoos, animals and valuations can be found here ⧉.

Tier 1 Animals

Auction Base Price: 30 coins

- **Audience Income (earning):**
  Pref. 1 ~ 30 coins
  Pref. 2 ~ 26 coins
  Pref. 3 ~ 24 coins
  Pref. 4 ~ 22 coins
  Pref. 5 ~ 20 coins

- **Maintenance Cost (expenditure):**
  Pref. 1 ~ 12 coins
  Pref. 2 ~ 10 coins
  Pref. 3 ~ 09 coins
  Pref. 4 ~ 07 coins
  Pref. 5 ~ 06 coins

In case when the animal is unhealthy,

- Maintenance cost to retain the animal in Pref. 5 (native) biome becomes **2x** (i.e. 12 coins)

- Maintenance cost to retain the animal becomes **4x** for Pref. 1 (48 coins), 2 (40 coins), 3 (36 coins), 4 (28 coins)

- Audience income becomes **0.75x** everywhere

Perks:

- If you can retain a tier 1 animal in biome **other than its native biome** then the audience incomes (earnings) of **ALL** your animals become **1.4x.**

- If you retain a tier 1 animal in **its native biome** then, the audience incomes of ALL your animals become **1.2x.**

Tier 2 Animals

Auction Base Price: 20 coins

- **Audience Income (earning):**
  Pref. 1 ~ 20 coins
  Pref. 2 ~ 19 coins
  Pref. 3 ~ 18 coins
  Pref. 4 ~ 17 coins
  Pref. 5 ~ 16 coins

- **Maintenance Cost (expenditure):**
  Pref. 1 ~ 08 coins
  Pref. 2 ~ 06 coins
  Pref. 3 ~ 05 coins
  Pref. 4 ~ 04 coins
  Pref. 5 ~ 03 coins

In case when the animal is unhealthy,

- Maintenance cost to retain the animal becomes **2x** (irrespective of region)

- Audience income becomes **0.8x** everywhere

Perks:

- If you have **Tier 1** and **Tier 2** animals of the same biome (other than their native, i.e. Pref. 5, biome), you will get an additional profit of **10%** on the audience income generated by **ALL** your Tier 1 and Tier 2 animals. If the zoo is of the same biodiversity as native biome of the animals then you will get **5%** of the audience income generated as above.

Tier 3 Animals   Tier 4 Animals

Auction Base Price: 7 coins   Auction Base Price: 3 coins

- **Audience Income (earning):**
  Pref. 1 ~ 7 coins
  Pref. 2 ~ 6 coins
  Pref. 3 ~ 5 coins
  Pref. 4 ~ 4 coins
  Pref. 5 ~ 3 coins

- **Maintenance Cost (expenditure):**
  Pref. 1 ~ 3 coins
  Pref. 2 ~ 2.5 coins
  Pref. 3 ~ 2 coins
  Pref. 4 ~ 1.5 coins
  Pref. 5 ~ 1 coin

- **Audience Income (earning):**
  Pref. 1 ~ 5 coins
  Pref. 2 ~ 4 coins
  Pref. 3 ~ 3 coins
  Pref. 4 ~ 2 coins
  Pref. 5 ~ 1 coin

- **Maintenance Cost (expenditure):**
  Pref. 1 ~ 1 coin
  Pref. 2 ~ 1 coin
  Pref. 3 ~ 1 coin
  Pref. 4 ~ 1 coin
  Pref. 5 ~ 1 coin

Tier 3 and Tier 4 animals are unaffected by diseases

Figure 2. Tier-wise details and perks associated with the animals.

#3 Game Proceedings

The game continues in several stages:

- **Stage 0** (Optional)**.** Used to determine the ranking of the 25 players by a quick 5 problem speed-Math test. They are then allowed to choose their zoos in order of their ranking.

- **Stage 1.** This is an auction round, with *usual*[6] auction rules.

- **Stage 2.** This round involved four stages of trading.

Stage 1: Auction

The auction proceeds in 9 stages as described in Figure 3. One condition is that at least 4 animals need to be bought, else a penalty of 5 coins will be imposed on the player. The other key rule is that the **sum of the total biddings of each player in an auction round should not exceed the available money.**[7]
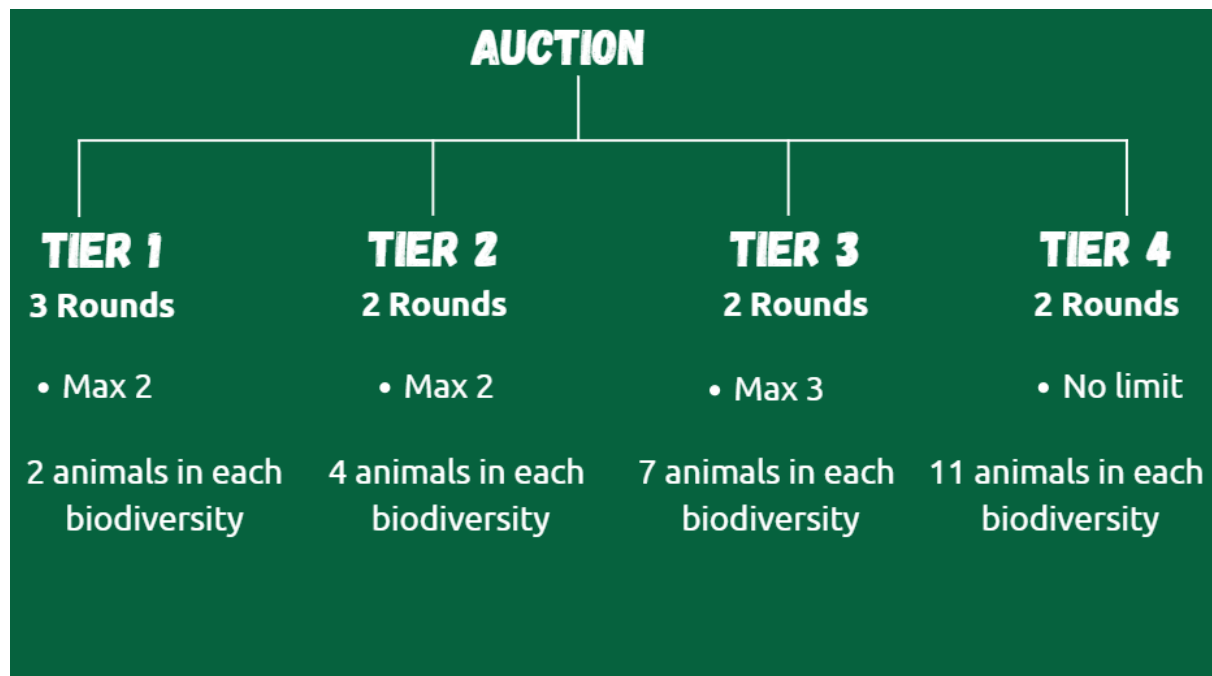

Figure 3. Auction: $3 + 2 + 2 + 2 = 9$ rounds

We conducted each stage of the auction with the help of Google Forms. The thing that we didn't think of initially:

> If someone submits a bid for an animal in Round 1 of auction, can they take it back and submit a lower bid in Round 2? For example, should the bids {90, 10, 25} be allowed in a 3-round auction for the same animal?

We decided to *allow* it during the event (because of the lack of instant fixes of 'not allowing' it). The contestants actually liked it, as was conveyed to us during feedback.[8]

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[6]Our limited technical expertise actually enabled us to learn many new things in this

[7]This was the part that took a lot of our time, slightly more than what was expected. We had no interface to automate it and had to manually sort our responses and update data after each round.

[8]We personally didn't quite like it, though: The main purpose of multiple rounds for each animal was to inflate the prices of the animals so that the available purse of each player takes a hit. But this move makes the 'Tier 1' auction a virtual 2-round auction only. It also enables some *smarter* players to trick others.

Stage 2: Trading

There will be **4** trading rounds with 5 groups of 5 teams in each round, governed by the following rules (everytime):

1. One can trade with any one in respective group.

2. One can trade any number of animals with anyone in the same group in one trading round, **but** any given combination of two teams can trade only once.

3. If you fail to reach an agreeable exchange, you can also trade the animals for money.

4. There needs to be at least 4 animals in the zoo at the end of every trading round, else the zoo will be penalized.

A different situation was given in each trading round:

- **Trading Round 1.** Half of the Tier 1 and Tier 2 animals become unhealthy.

- **Trading Round 2.** The other half of the Tier 1 and 2 animals become unhealthy.

- **Trading Round 3.** Each zoo comes with a unique multiplier to scale up the total score in the end. Details in Figure 4.[9]

- **Trading Round 4.** No conditions. Target is to achieve maximum profit.

Figure 4. Multipliers for the zoos

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[9]This multiplier favors the biome which is of the same type as its parent continent as discussed in section 1.

#4 Scoring Formula

This was a tricky part.

Considering the above tier-wise distribution of animals, simply considering the money with the zoos cannot be used as the only important factor in determining the result. A counterbalance was necessary to offset the income advantages of the top-tier animals.

Furthermore, the effect of monetary differences should be reduced. For example, 50 coins and 60 coins should not be considered much different, when factoring in the *variety* of animals present in the zoo.

Hence, if A is the amount they have with them at the end of all rounds, then our function will operate on $|\log_2(A)|$ instead of on A from now on. If $A < 0$, then their net score becomes 0.

To incorporate the variety of animals, we simply focus on the *number of different biomes* successfully established in the zoo.[10] Let $n(\leq 5)$ denote this number.

> $n = 1$ by default, the chosen biome of your zoo. If you have at least 2 animals in a single biome, then you have successfully established one more biome. This makes $n = 2$. The pattern continues, allowing for a maximum of $n = 5$.

Now, we want both $\log_2(A)$ and n to have a considerable effect. So, we will take some function of n as the exponent. So, the official scoring format was decided to be

$$|\log_2(A)|^{(n-0.5)}$$

#5 Key Challenges

The most recurring challenge discussed in several meetings was: timely completion of the game. This was mainly due to the lack of an automated auction interface for smooth conduction of the various operations. We were unable to address it back then and unfortunately it still remains the most significant challenge.

The next challenge is enhancing its scalability. It was sufficient to design the game for 25 teams back then. But, now We keep pondering about the various improvements we can implement and whether the game can be scaled up significantly or not.

The game mechanics were highly intricate and conveying them clearly without ambiguity was a tedious job. Thanks to the participants and our outstanding volunteers, we managed to do it pretty well.

Ensuring fairness while creating opportunities to make this game engaging was a very challenging, yet motivating task.

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[10]We avoided a deep breakdown of the tier of animals because it'd over-complicate the already confusing scoring algorithm. The goal was to ensure that the participants could make quick decisions while keeping this algorithm in mind at all times. So, just the biome diversity is considered without further complications.