

CS437: Internet of Things

Lab 5

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Demo video:

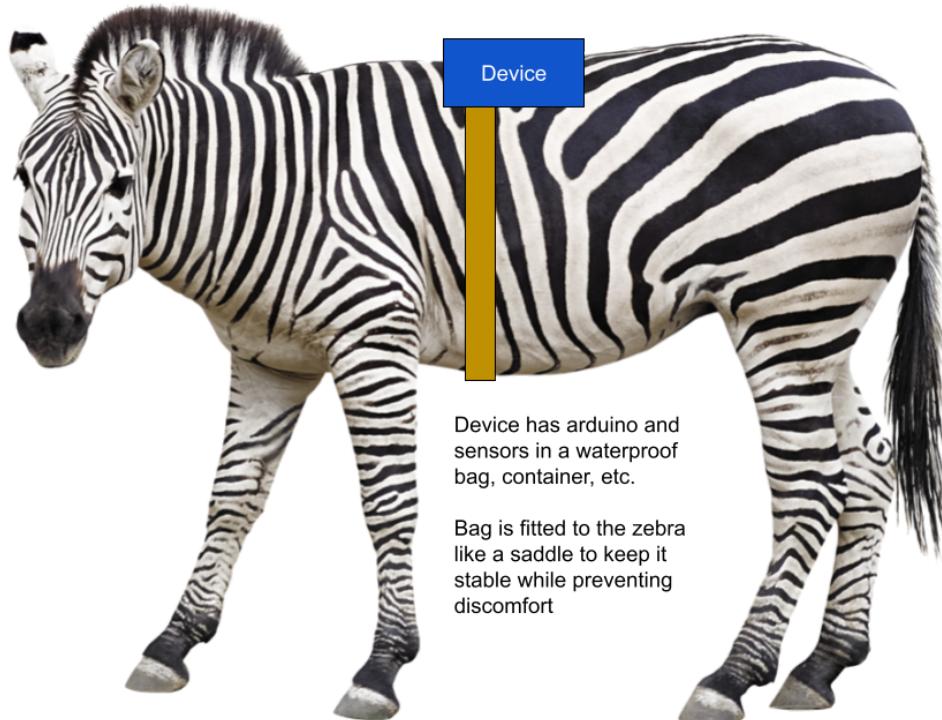
<https://drive.google.com/file/d/1pjMktqtblEpHdbbE7dV2lh0x05euWpMq/view?usp=sharing>

Contributions

Group Member	Contribution
Nishant Sheikh	Device sketch, visualizations, questions, demo video
Molly Yang	Arduino circuits, virtual world, questions, demo video

Step 2a: Device

Sketch



Design Considerations

1. What sensors would you need
 - a. GPS, temperature, vitals, sound
2. How would they be connected
 - a. One arduino board is used for sensor pins to connect to. The GPS sensor has 3.3V, rx, tx, and ground. The sound sensor has 5V, digital input, and ground. The vitals sensor has 5V, SCL, SDA, digital input, and ground. The temperature sensor has 5V, analog input, and ground.
3. What sort of code would you run on there
 - a. The arduino sketch print or write sensors output to serial logs. LED indicators for vitals and sound sensors turn on when readings are available. Digital and analog signals are converted appropriately to readable data.
4. Where would you put the sensors on the animal
 - a. GPS - behind the neck, less likely to get knocked off
 - b. Temp - behind the neck, less likely to get knocked off
 - c. Vitals (pulse oximeter) - on the ear to get direct contact with skin
 - d. Sound - next to the other ear to balance the vitals sensor
5. Physical construction (waterproof? weight? where would you put it on the animal?)

- a. Waterproof - zebras sometimes have to swim through water
 - b. If waterproof, can place on the zebra's back (would probably be better than on the head since may get caught while zebra is eating or interacting with other animals, or may cause weight imbalance)

Step 2c-2d: Arduino Circuits

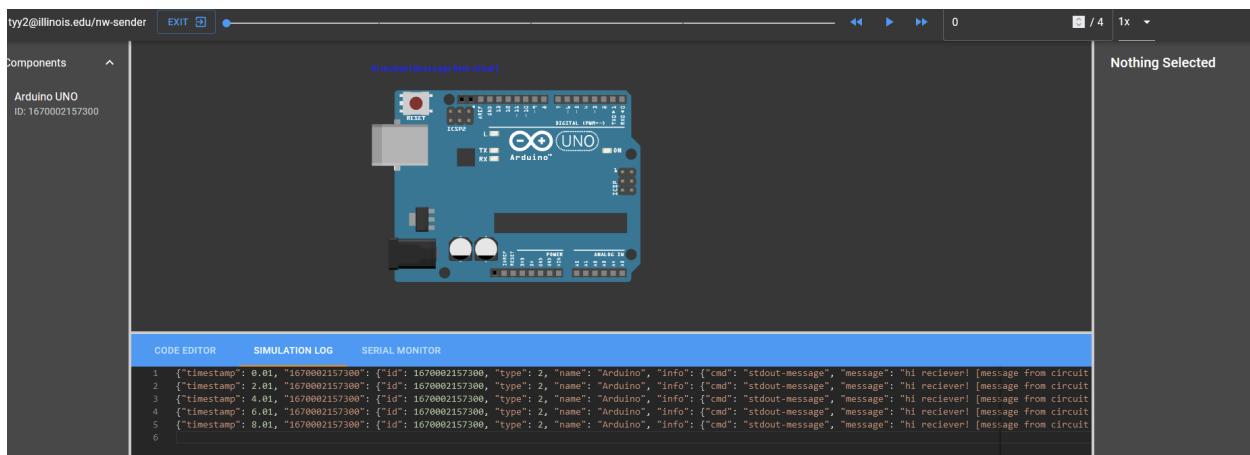
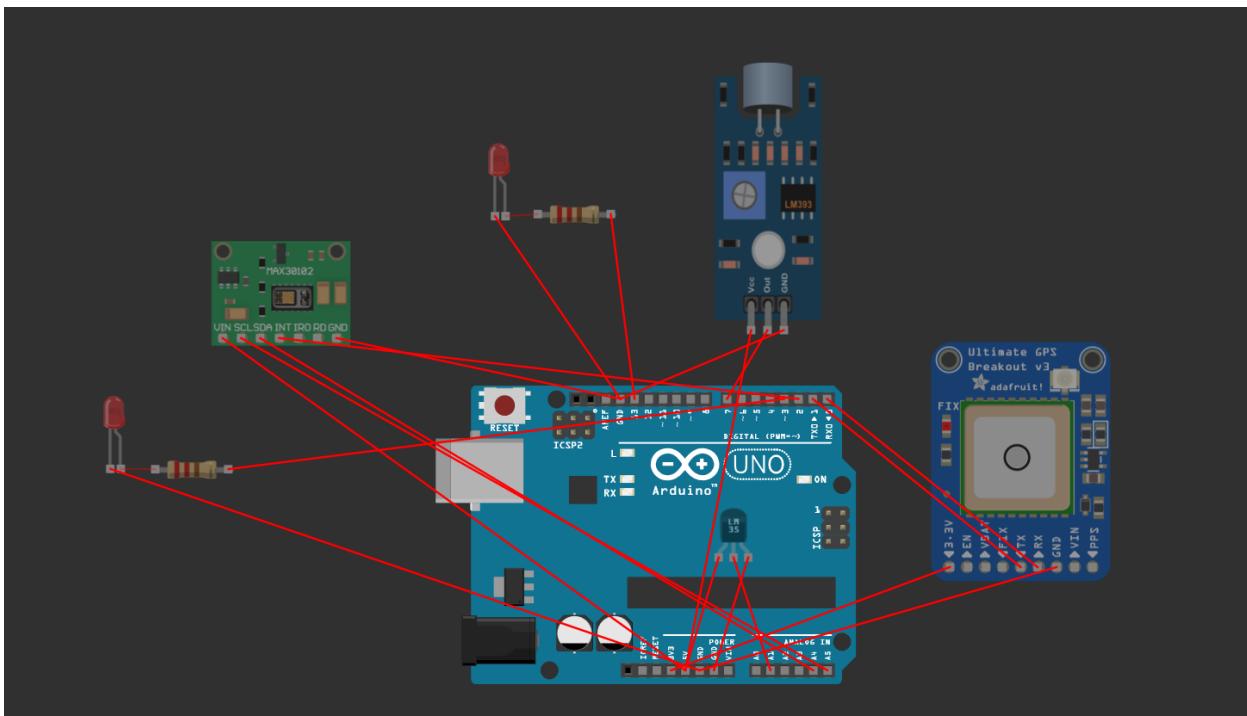


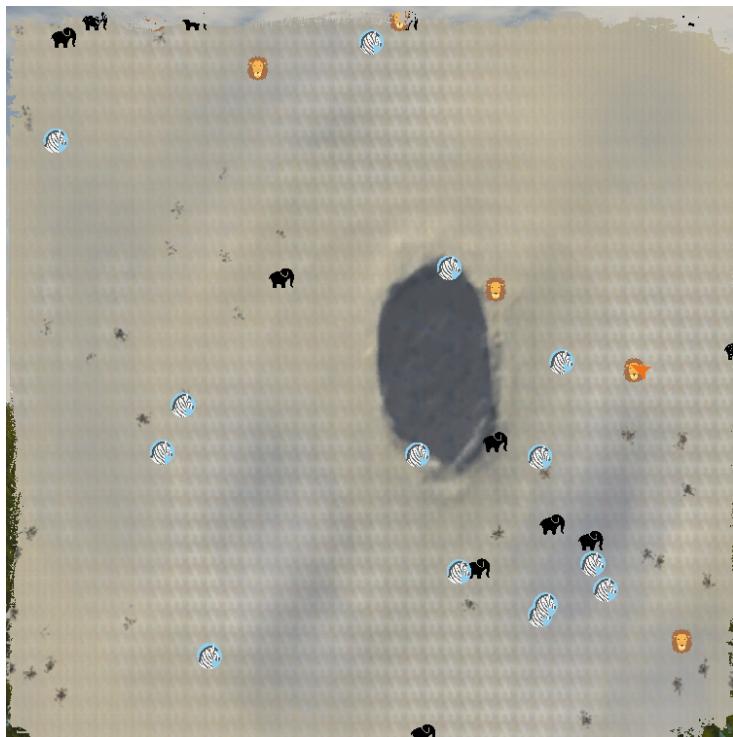
Figure: The network receiver successfully receiving messages sent from the sender

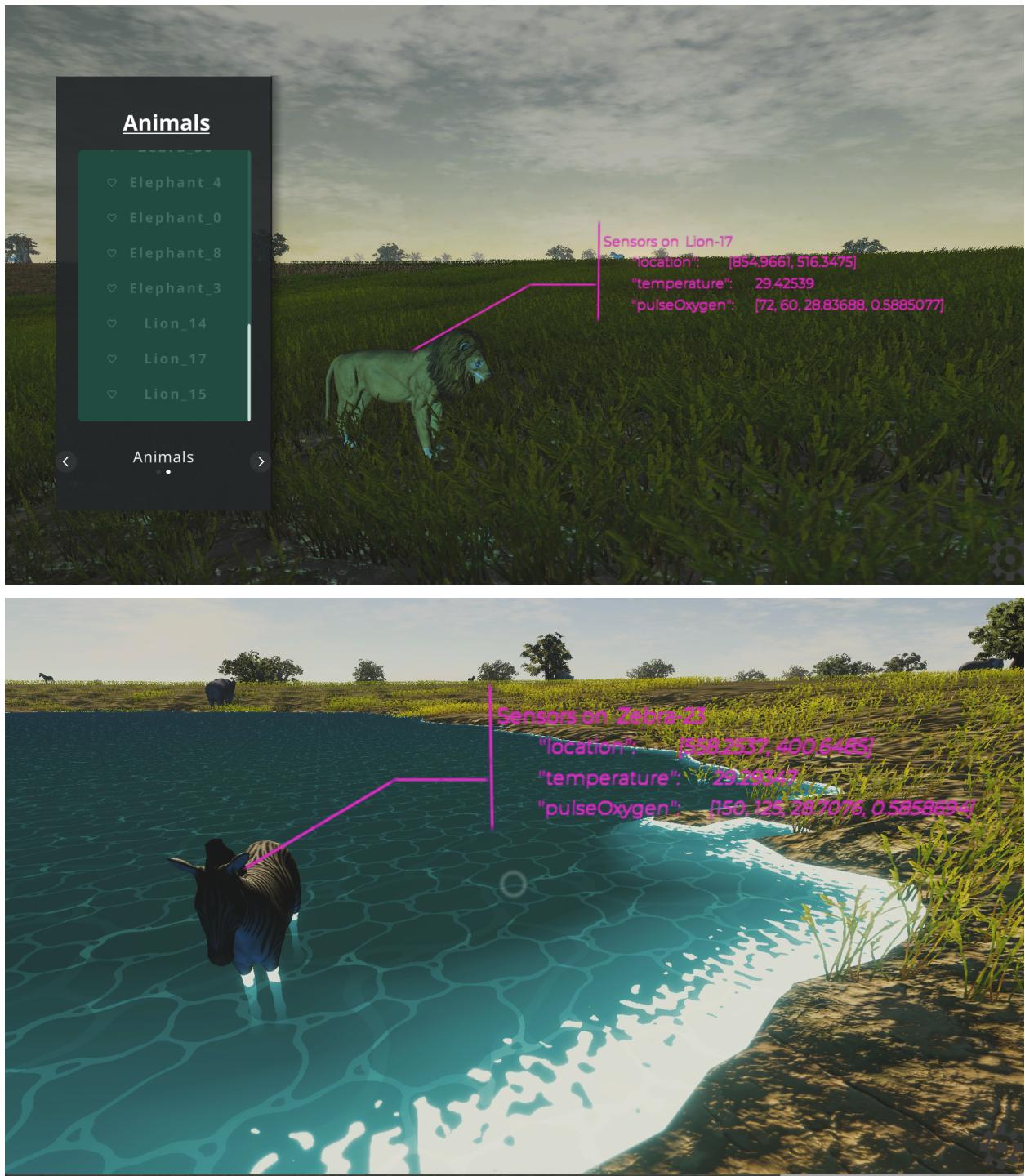
Step 3: Virtual World

Screenshots of virtual world (step 3)

How many animals and which species you deployed your IoT devices on, and why?

11 zebras, 3 elephants, and 4 lions are carrying our IoT devices. We have many sensors on zebras since they are the main subjects we want to study. The elephants and lions were selected from the map to represent their overall ratio. In addition, we hoped that by tagging lions and elephants, we could learn about how the zebras behaved during interactions with these animals.





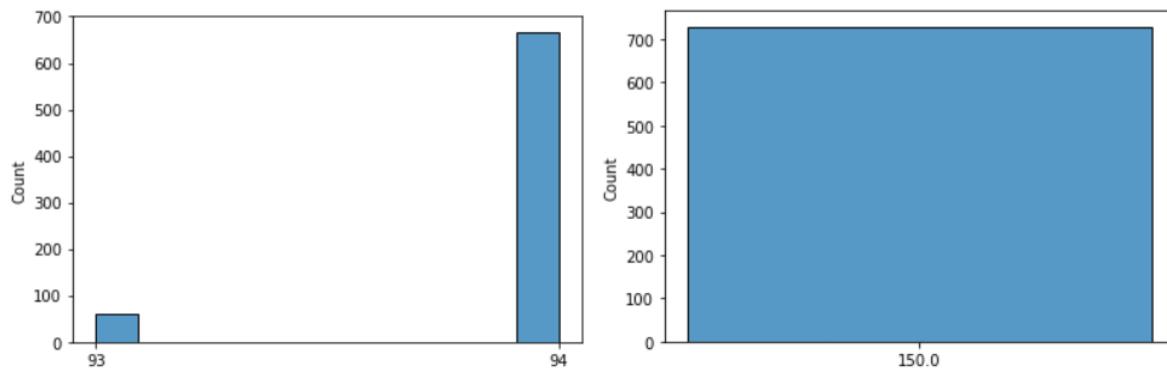
Figures: Screenshots of putting sensors on the animals in the simulation

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PulseOximeter", "info": {"current": null, "voltage": 15.0}, {"pin": 0}}, {"timestamp": 45.531, "id": 1670000547603, "type": 31, "name": "MAX30102"}, {"PulseOximeter", "info": {"current": null, "voltage": 0.0}, {"pin": 6}}, {"timestamp": 45.531, "id": 1670000675797, "type": 10, "name": "Resistor"}, {"info": {"current": 0.0, "voltage": 0.0}}, {"timestamp": 45.531, "id": 1670000758628, "type": 4, "name": "LED"}, {"info": {"current": 0.0, "voltage": 0.0, "brightness": 10.0, "state": "off"}}, {"timestamp": 45.628, "id": 1669951328646, "type": 2, "name": "Arduino"}, {"info": {"cmd": "stdout-message", "message": "[494.7493, 241.8015]n"}}, {"timestamp": 45.628, "id": 1669951328646, "type": 2, "name": "Arduino"}, {"info": {"cmd": "stdout-message", "message": "Oxygen percentage: 93; Heart rate: 168.75\n"}}, {"timestamp": 45.628, "id": 1669951328646, "type": 2, "name": "Arduino"}, {"info": {"cmd": "stdout-message", "message": "this is oxygen percentage: 93, this is heart rate: 168.75"}}, {"timestamp": 45.628, "id": 1669952625003, "type": 27, "name": "GPS"}, {"info": {"current": null, "voltage": 3.3}, {"pin": 0}}, {"timestamp": 45.628, "id": 1669952625003, "type": 27, "name": "GPS"}, {"info": {"current": null, "voltage": 3.3}, {"pin": 0}}
```

Figure: Values received from pulse oximeter

Step 4: Zebras

Is the Zebra population healthy? Make a thoughtful case one way or another.



Figures: Distribution of the zebra oxygen percentage (left) and heart rate (right)

(Note: the heart rate graph has only 1 bar - all measurements were 150 BPM. That image has been edited to remove extraneous graph ticks, which made it confusing as to whether there was just one bar or several bars with the same height.)

The general zebra population is healthy based on the data from the pulse oximeter. The heart rate and blood oxygen percentage of zebras are consistently in the normal range. No unusual signs or dead zebras were observed. Most zebras seem to be traveling in herds, and lonely zebras were able to make friends.

Do the Zebras have enough room to move around in?

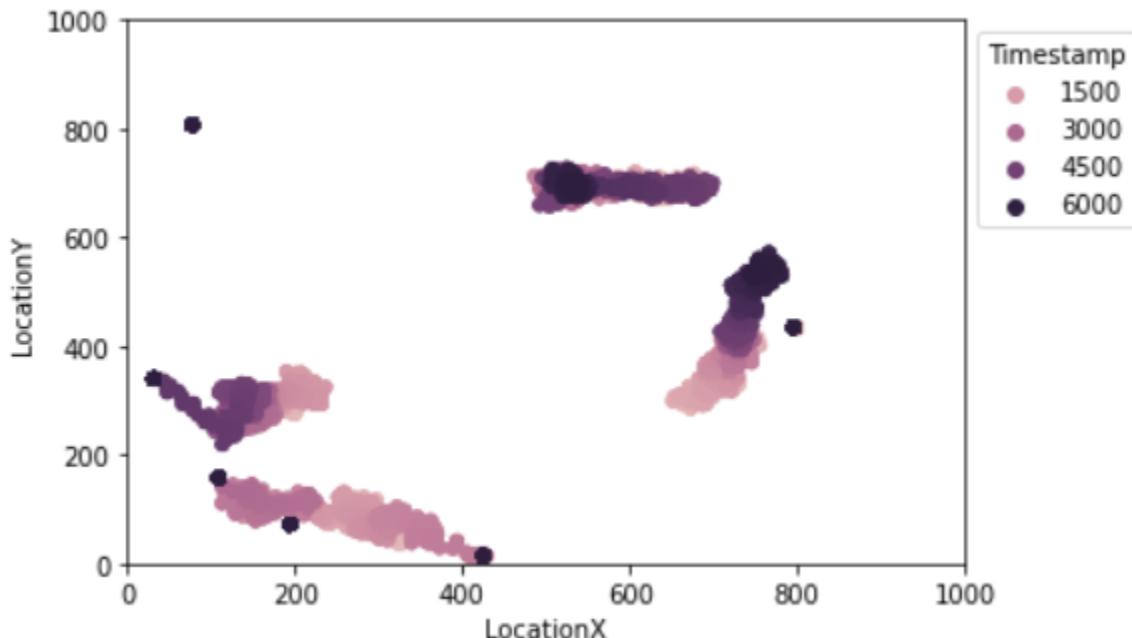
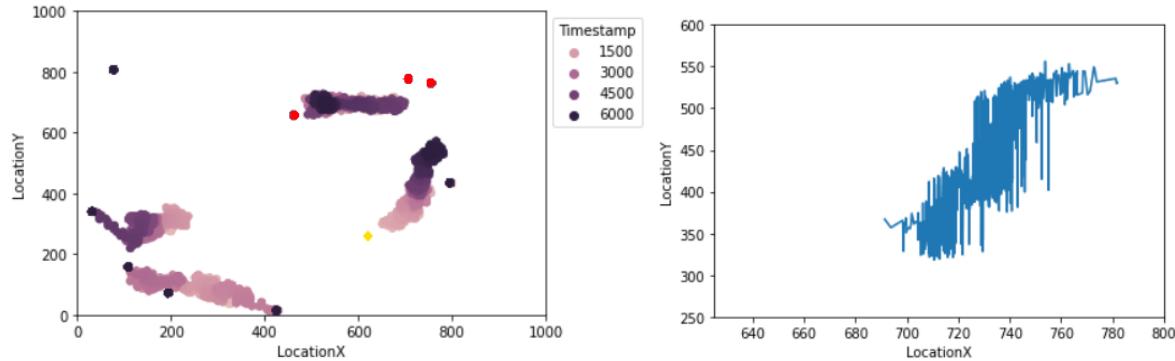


Figure: Visualization of zebra travel over time

Yes, the zebras were able to move around freely. The zebras are usually > 10 meters away from each other. In case of the need to run away from predators or poachers, the zebras have plenty of space to escape.

It doesn't seem like the zebras are running into any "walls" near the edges of the map either.

Do you see any signs of poachers? If so, where are they?



Figures:

*Assumed poacher location on the map [poacher is the yellow diamond, lions are red dots] (left)
Zebra going from normal walk → zigzag → normal walk, near assumed poacher location (right)*

From the background information we were given, the zebras run away from threats in a zigzag manner. We observed an instance where the zebra seemed to be roaming around relaxingly, but started a series of zigzag runs over 100 m distance in X direction and finally relaxed. There were no lions observed in this area.

Plot a CDF of the zebras' movement speed. What do you observe?

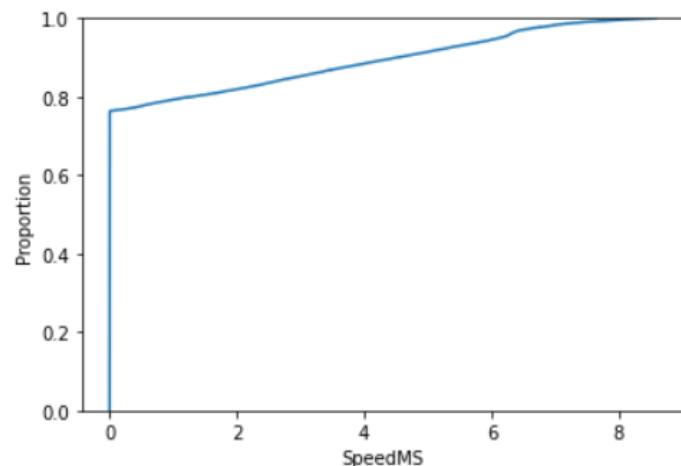


Figure: CDF of the zebras' speed (meters per second)

The zebras appeared to remain stationary for the majority of our observation period. Occasionally, the zebras would move from place to place at a slow speed, and there were one or two instances at which a zebra would travel quickly (around 8 m/s) for a short period of time. It could be that most of the zebras are not in danger and conserving their energy. Another possibility could be sampling error due to it being easier to mount sensors on zebras that are stationary versus the ones that like to roam around.

Do Zebras make friends? Do you see pairs that tend to stay together?

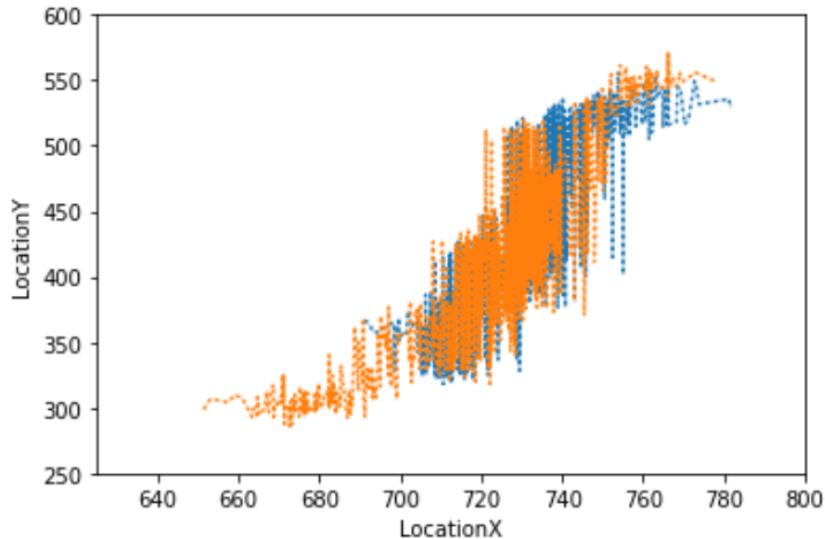


Figure: two zebras (marked orange and blue) joining up - potentially also performing a zig-zag avoidance maneuver.

We observed a pair of zebras that were initially 16 m away from each other that seemed to notice each other at one point in time, and started walking closer to each other and walking in the same pattern.

What locations do Zebras tend to congregate at? Why do they tend to go there?

No particular pattern was observed of big groups of zebras congregating. We observed some zebras near the water or in the grasslands. Perhaps the grasslands provide them a source of food, and the zebras in the water need to drink and cool down.

Are there any locations Zebras tend to avoid?

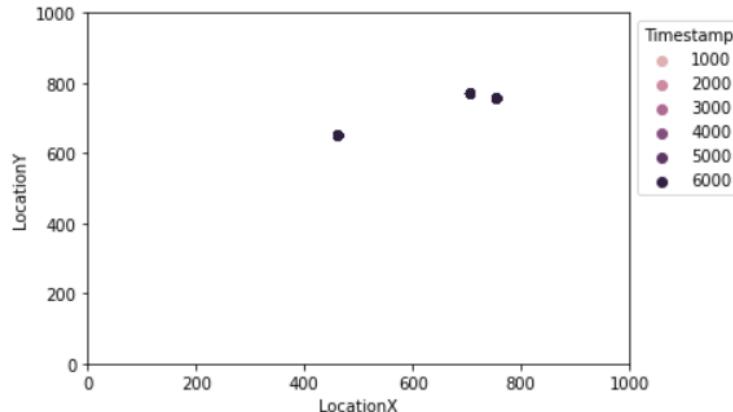


Figure: Lion locations. The lions appeared to stay still during the entire observation period.
When lions are present, the zebras would avoid them. We observed a zebra having to go back and forth between two points - one was close to a lion, and the other we assumed to be a poacher.

Additional Question: How are zebras and elephants getting along?

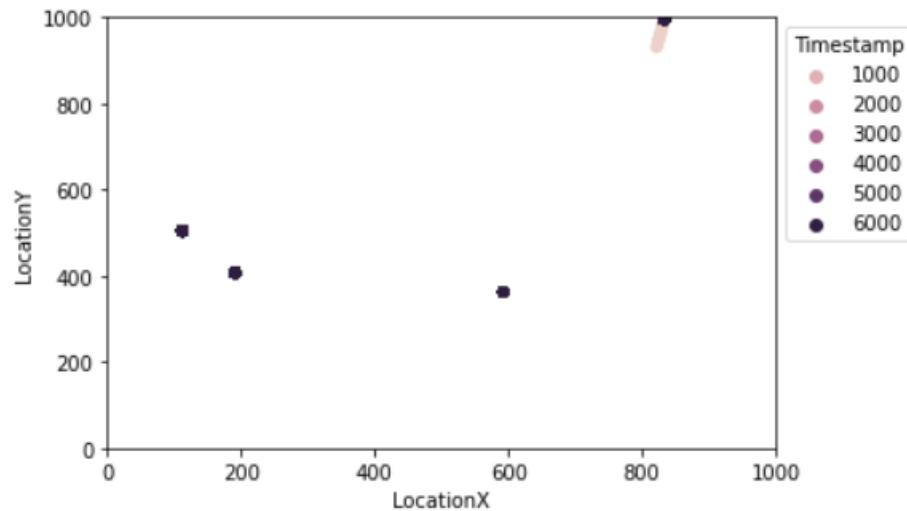


Figure: elephant locations over time

Zebras and elephants tend to show up at similar areas in relatively close proximity (compared to zebras and lions). This could be explained by the fact that zebras and elephants have different diets and do not often compete for resources.