

## 1. Semi-annual report

**Göksel Keskin (goksel.keskin@ttk.elte.hu)**

Doctoral School of Physics

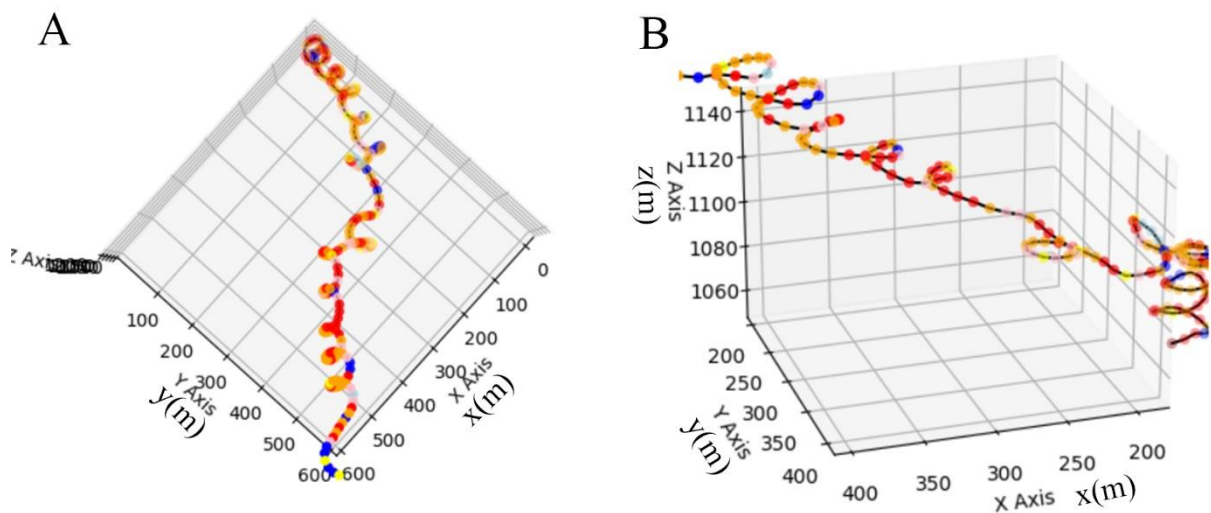
Supervisor: Dr Mate Nagy

### 1. Introduction

In my first semester, according to my research proposal, I collected high-resolution GPS records from different research groups worldwide and my supervisor Dr Mate Nagy's previous studies. I also chose my courses to assist in my research this semester.

### 2. Research

I've been working on GPS records that were collected by different research groups and our sources to compare soaring flight among bird species since the beginning of the autumn semester. High-resolution (range between 10 and 0.3 Hz) GPS recordings contain 8 bird species; Verreaux's eagle (*Aquila verreauxii*), Steppe eagle (*Aquila nipalensis*), Osprey (*Pandion haliaetus*), Black kite (*Milvus migrans*), Eurasian griffon vultures (*Gyps fulvus*), Himalayan Vulture (*G. himalayensis*), Peregrine falcon (*Falco peregrinus*), Lesser kestrel (*Falco naumanni*), White stork (*Ciconia ciconia*), Northern bald ibises (*Geronticus eremita*). The total number of a tagged individual is 98. We have 9.3 million GPS points recorded and in addition to this dataset, approximately 37 hours of raw GPS records. The entire data set originally saved as global coordinates in multiple formats has been converted into local coordinate systems for further analysis in a common framework, and for 2D/3D visualization. The current stage of this work focuses on creating glide polar of the bird species to figure out the minimum sink rate and maximum glide ratio that will be key to calculate thermal circling and cross-country performance.



**Figure 1. A.** The 3D plot of a 200-second-long trajectory shows how a white stork perform during thermal circling when it is aiming for maximizing its flight efficiency to gain height. It can be seen that how the bird follows the tilted thermal that is drifting with the wind. **B.** Moreover, the bird discovers the most efficient region in the thermal as it's seen in the figure. Color-coding of the points indicates the vertical speed. Negative values (downwards motion) are represented as blue and its shades, positive values (areas where gaining height) as red and its shades in the figures.

### 3. Study Activity

Statistical physics of biological systems (FIZ/3/003E)

I attended this class to learn and understand methods of tracking individuals or flocks and creating models to reach quantitative results, that is of the great importance for my research.

Physics of environmental flows (FIZ/3/017E)

Since my project is about taking advantage of air currents to remain flight in unpowered way, I chose this class to learn mechanisms of the air currents.

Ethology (BIO/02/04E)

Understanding animal behaviour plays a key role in my research. Birds perform various flight style such as soaring, gliding, flapping etc. However, species learn and apply this behaviour differently. For this reason, understanding of their behaviour and behavioural effects on the flight is important.