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Summary Report

Behavioral Classification of Oystercatchers by Integrating Spatial Features of Movement

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Aim and Scope

The overall idea of doing this STSM was to investigate the potential of applying movement analysis methods for behavior classification of bird migration data. The data used relate to GPS trajectories of three Oystercatchers (and also relevant accelerometer data) and the main aim was to apply a segmentation method originally developed by Dodge et al. (2009) in order to explore spatial features of bird movement data. The outputs of the segmentation process are subsections of trajectories with homogeneous movement characteristics, which could be used afterwards for characterizing meaningful behavioral states. It should be noted that the STSM was a concurrent research with Rudolf Netzel from the University of Stuttgart, to see the potential combination of developed methods from my side with the visualization and classification processes developed by Rudolf. In the following, a brief summary of the STSM can be found.

Summary

On the first day, we had a meeting with Emiel van Loon and Rudolf Netzel to discuss what we had done in preparation of the two STSMs. I had already applied the segmentation algorithm and explained how it works and what inputs I needed from Emiel. We decided to apply the segmentation on raw 3-dimensional accelerometer data. The reason to do so was that the GPS observations were not finely-grained enough to distinguish between micro-behaviors like foraging, walking etc., whereas using high-resolution accelerometer data could be much more useful in order to do so. The overall idea of using the segmentation is to develop new input features for the classification which are capable of distinguishing between different classes in the feature space. So, the results from the segmentation would be added to the input feature vector to show how helpful they could be in improving the classification performance. For tuning threshold parameters of the segmentation, some statistical approaches for function optimization where introduced (e.g. Levenberg-Marquardt algorithm, steepest descent, etc.), which could be considered in the future as an interactive way of optimizing the segmentation parameters based on the observed behavior tagged manually. The dataset used was planned to be the same as the one used in Shamoun-Baranes et al. (2012).

The dataset was then resampled in order to include the sub-trajectories with the length of less than 60 seconds. The segmentation was applied afterward on 3-axis acceleration data and the results were discussed with Emiel. Seemingly, there had been a misunderstanding of the acceleration data. I had understood that the time interval between two acceleration observations is 3 seconds. Instead, the 3 seconds interval is the overall time period in which all of the 60 acceleration fixes were captured. So, the raw acceleration data couldn't represent a sequence of points in which the segmentation could be sensibly applied. Consequently, we decided to apply the segmentation on extracted movement parameters (e.g. speed, acceleration, turning angle and sinuosity) derived from the GPS observations. The segmentation labels for four movement parameters were assigned to each observation point and I tried to see if adding these features to the ones already used in the paper could improve the classification accuracy. The obtained results showed the potential of the segmentation methods applied, especially for distinguishing foraging and non-foraging behavioral classes. A potential output for the next steps would be to explore the segmentation classes in relation to food density. In other words, the relationships between segmentation classes and different behaviors annotated by the expert would be investigated.

In the final meeting at the end of the week with the host institution's staff – represented by Willem Bouten, Adriaan Dokter and Emiel van Loon – and I agreed on the general usability of the segmentation method for the different dataset collected by the host university on a variety of birds. For a large portion of the data set, only GPS data is available and therefore it was decided to apply the segmentation only on the

GPS data. Also, since the main objective is to distinguish between micro-behaviors (e.g. foraging and non-foraging), the main issue is the availability of finely-grained GPS data, which was achieved at the end and a new dataset with temporal resolution of 6 seconds was received to apply the segmentation. The outputs of the segmentation could be then validated through the data from other sensors (e.g. accelerometer or annotated tracks) in order to apply them in cases where only location data is available.

Results and Future Work

The main outcome of this STSM is firstly the demonstration of the applicability of the proposed segmentation method and secondly, for the purpose of getting better insights through segmentation, the importance of higher resolution data if the goal is to distinguish between micro-scale behaviors. The main objective of the STSM was almost fulfilled, namely to see if integrating spatial features (through segmentation) could help in improving the behavioral classification of bird data. Comparing and combining alternative methods between me and Rudolf Netzel was also found to be helpful for the domain experts at the host university in better understanding of behavioral mechanisms of bird movement. Both STSM recipients will continue working on the new dataset: I will extract features based on the segmentation and import them into classification flow, while Rudolf will work on the evaluation of different classification methods in an interactive visualization process.

Finally, I would like to thank MOVE for giving me this opportunity to collaborate with other researchers to work on real-world application problems. As described in the STSM application, there's a firm commitment of all involved in this joint project that the outputs should be published in a journal paper. So, the potential target journal and an outline of the content were also discussed and the writing process will start soon after preparation and evaluation of results from the different partners involved in the two STSMs.

References

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Shamoun-Baranes J, Bom R, van Loon EE, Ens BJ, Oosterbeek K, et al. (2012) From Sensor Data to Animal Behaviour: An Oystercatcher Example. *PLoS ONE* 7(5): e37997.