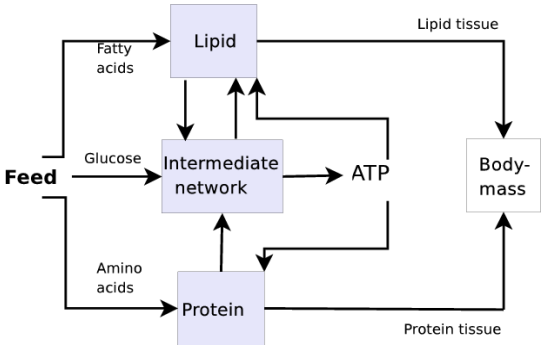
Systems Projects, related to biology 2014

1. Simulation and numerical optimization of a dynamic model of growth (System biology: applied modeling)

A novel model that predicts the growth of fish, given the feed type and environmental conditions, has been developed during 2003-2009. The model traces the nutrients, proteins and fat, through the metabolic processes of the body, and basically it is a set of ordinary differential equations. It was implemented in Matlab code, using a constant time step, first order Euler integration method to solve the differential equations.

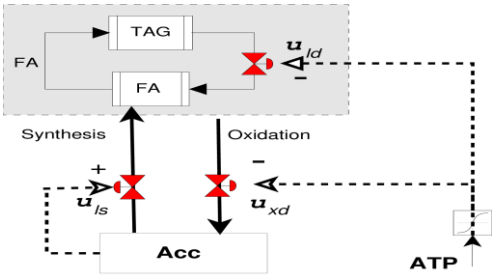


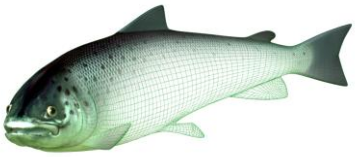
However, this method for solving the differential equations is very inefficient, and a more practical implementation is needed.

The main goal of this project is to optimize the integration method of the model, using a combination between a constant time-step and Matlab's ODE time variable solvers (ode45, ode15s). The project is interesting since it attempts to give a practical, industrial, applied solution to a theoretical model. If the program (the implementation of the model) could be optimized and made efficient, it will have a great value to the aquaculture field, both in study fish development and design more healthy fish feed.

The candidate will gain many useful skills, that are very important in the research and development in industry, such as how to make model solvers more efficient, how to simulate and solve models using ordinary differential equations, a very important aspect of any applied modeling.

Main Supervisor: Assoc. Professor Nadav S. Bar





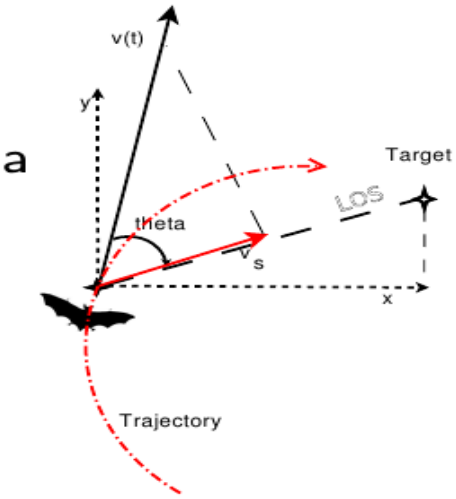
2. Modeling and simulations of bat flight and sonar in 3-dimensions (Systems biology: Neuroscience).

It was found in 2010 (Science Magazine, Yovel et al. 2010) that Egyptian fruit bats apply a sonar measurement strategy that is similar to the strategy used by certain GPS. One of the explanations was that the bat tries to reduce the sonar measurement noise during its flight to the target (which can be fruit or insect).

In our lab (in cooperation with Univ. of Maryland, Weizmann Institute of Science, and the U.S. defence), we developed a dynamic model that estimates the x-y trajectories of the bat's flight as it converges to its target, and explored the strategies it applies to reduce the noise that is reflected from the surroundings (trees, leaves, and other objects around the target). We found that the bat's brain

processes the sonar information and filter the noise in a very interesting manner, stems from the fact that the bats has to apply a specific flight control system due to its non-linear flight maneuvers (the bat flies using turbulences, not the common aerodynamics applied by birds).

The main goal of the project is to extend the model (implemented in matlab) to the z- axis as well. It involves modeling of the flight dynamics and the control system, extending it from 2- dimensions to 3-D.



The bat flight, control and filtering is a state space model, implemented and simulated in matlab, and estimated using 145 real time experiments. The project can be later integrated in Master thesis, studying the sonar effect and the flight convergence strategies.

Main Supervisor: Associate Professor Nadav S. Bar

Co-supervisor: Prof. Lars Imsland, Departemnt Engineering Cybernetics

3. Modeling and simulation of path -finding and tracking, applied to ants

Most of the ants navigate their way in a path, from the nest (home) to the target (food) and back, by sensing the pheromones that create the path, using two antennas (sonsors). However, the manner they are doing so is still unknown. We have gathered data, using manipulation of the trail width and the strength of the pheromones, which indicate that the ants do not walk where the smell is strongest, but walk more to the side of the trail. We believe that the ants use a special form of simple optimization to sense its location, and process it inside its simple brain to calculate its direction and distance from the center of the trail.

The student who will choose this work will join the intenational group of researchers, and his/her part will be to model and simulate the path-finding algorithm that we believe the ants use. The modeling will be in matlab, and will include very simple optimization strategies. Successful completion of the project/ diplom will result in a publication in a high impact international journal.

Sounds interesting? More details? Contact Nadi.bar@ntnu.no.