# A mathematical model for butterfly wing patterns

Colours and shapes patterns on butterflies wings are often mesmerising and interesting. The research on how such patterns from has been going on for several years: Many experiments have been conducted on butterflies at pupal stage, and the application of mathematical techniques to biology has favoured the sprouting of several possible models to explain these patterns. In this project, we will consider models based on two main mechanism: at a time $T_0$ some cells of the wing release an impulse of morphogen substance, which diffuses across the wing surface; the local concentration $S$ of the morphogen then triggers a gene activation which gives rise to the colourful patterns and geometries observed in nature.

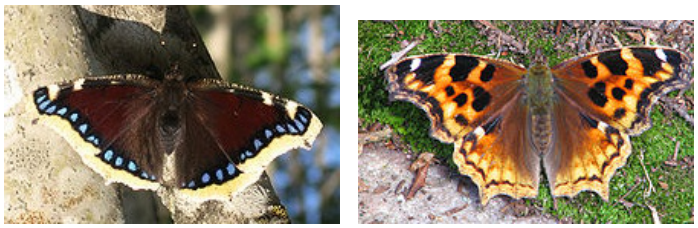

Figure 1: Images of butterflies taken from Wikipedia.

## Task

In this project you will study section 15.2 from [1] and write the numerical code based on finite differences to solve the mathematical models described therein which are based on the two-pahses, time dependent diffusion and activation process described above. You will test how the geometry and size of the wing affects the formation of the pattern, and compare the numerical results to experimental observations.

## Workload and prerequisites

Previous knowledge of the content of the course *TMA4212 Numerical solution of differential equations by difference methods* is encouraged, although not absolutely necessary. If you are unfamiliar with such methods you can pick up the basis by self-reading. The workload is expected to be about 60 hours.

## Supervision

The supervision will be carried out by Mats Ehrnström (Professor) and Filippo Remonato (PhD Student).

## References

[1] J.D. Murray. *Mathematical Biology.* Springer, 1993.