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**MSc Basic Module**
**Title: Understanding Faster Deterministic Fully-Dynamic Graph Connectivity**

There is a lot of research work proposing theoretical algorithms and sophisticated data structures to answer connectivity query for undirected fully-dynamic graphs in order to achieve the best complexity. The goal of this basic module is to study a recent publication by Wulff-Nilsen [1] that improves the state-of-the-art for both updates (edge insertions and deletions) and querying, leading to a better understanding of the data structures and algorithms proposed in [1]. Ideally, this would reach a level that would then allow us to implement the (full) algorithm.

**Tasks:**

- **Task 1: Literature Review**
  - Study the paper [1] and relevant literature.
  - Study the cluster forest in section 3.1.
  - Show complete examples of insertions in section 3.2 and deletions in section 3.3 using the cluster forest.
- **Task 2: Understand data structure**
  - Local trees. Show complete examples to demonstrate and maintain a local tree in section 3.4.
  - Bitmaps. Show a complete example of maintaining bitamps in section 3.7.
  - Searching for edges. Show a complete example of searching for edges using local trees in section 3.5.
- **[Optional] Task 3: Understand improved data structure**
  - Maintaining lazy local trees. Show a complete example of merging lazy local trees

in section 4.2.

- Show complete examples of adding and removing a child in section 4.3 and section 4.4.

- **Task 4: Write a brief report**
  - Summarize all the findings in a short report of about eight to ten pages.

**References**

[1] C. Wulff-Nilsen. Faster deterministic fully-dynamic graph connectivity. In *Proceedings of the Twenty-Fourth Annual ACM-SIAM Symposium on Discrete Algorithms*, SODA '13, page 1757–1769, USA, 2013. Society for Industrial and Applied Mathematics.

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