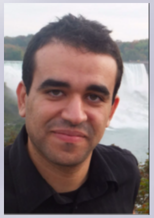
RESCOM 2014

CENTRE NATIONAL DE LA RECHERCHE SCIENTIFIQUE
UMR 5205

Self-Stabilizing Algorithms for graph parameters

Phd student : Brahim NEGGAZI

[1] **Laboratoire d'InfoRmatique en Image et Systèmes d'information**
LIRIS UMR 5205 CNRS/INSA de Lyon/Université Claude Bernard Lyon
43, boulevard du 11 novembre 1918 — F-69622 Villeurbanne Cedex



Associate professor:
Mohammed Haddad

Professor :
Hamamache Kheddouci

Self-stabilization

Self-stabilization was introduced by E. Dijkstra en 1974.

A system is “self-stabilizing” if it can start from any possible configuration and converges to a desired configuration in finite time by itself without any external intervention.

Self-stabilization: advantages & inconvenients

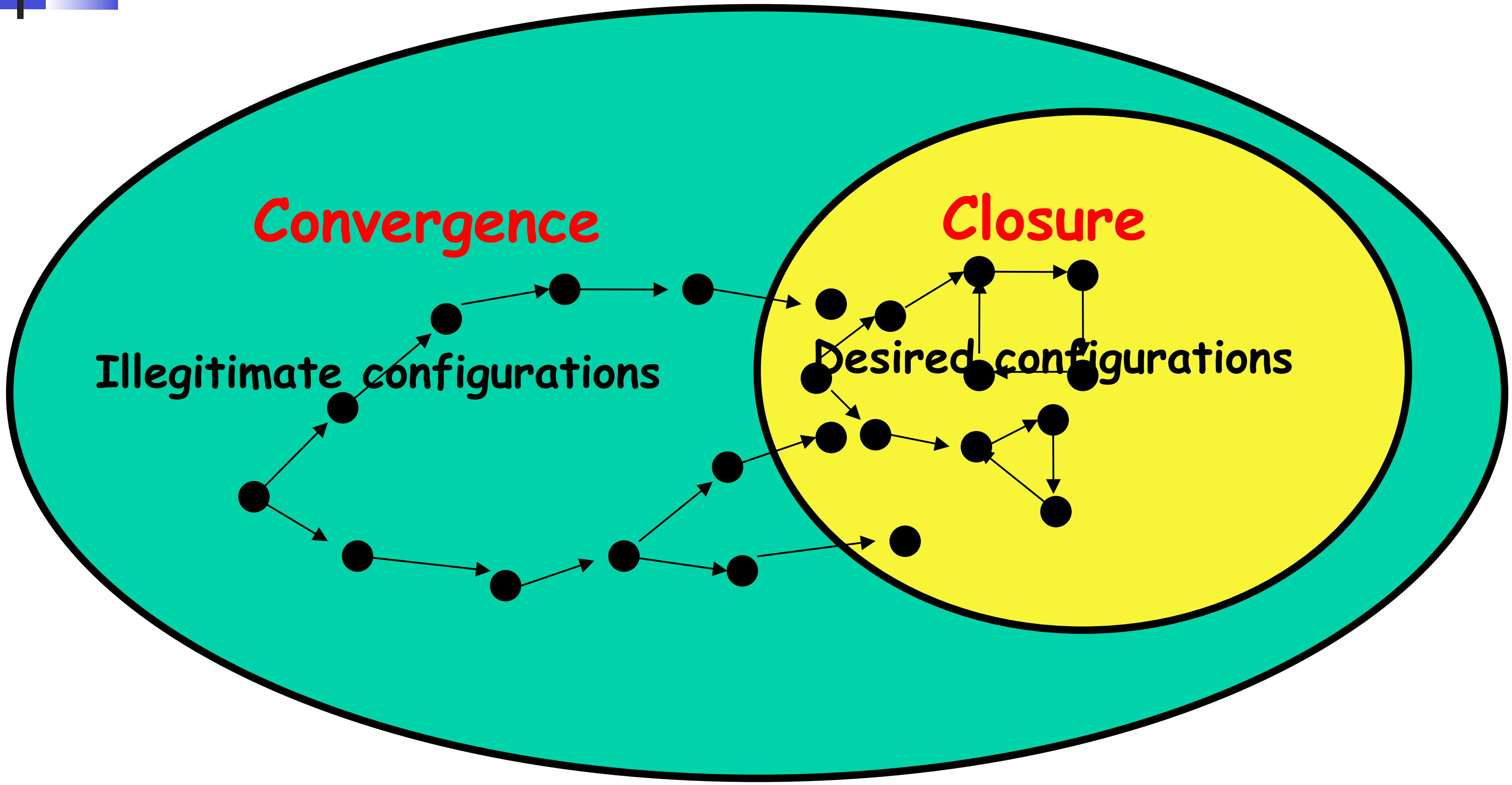
Self-stabilization presents many advantages:

- Self-recovering.
- No initialization.
- Dynamic topology adaptation.

However, there are of course some disadvantages of self-stabilization which cannot be ignored:

- High complexity.
- No termination detection.

Self-Stabilization properties



Goal of my thesis

Proposing distributed and self-stabilizing algorithms for graph decompositions. These algorithms are very useful for organization and optimization protocols in large scale systems/networks.

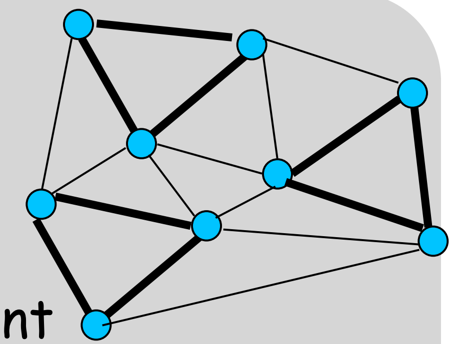
Challenges and originality of the research work

- Focus on the problems of decomposition of graphs subgraphs (triangles, stars, chains, ...)
- Proving convergence of self-stabilizing algorithms,
- Providing distributed algorithms with low complexities.
- Using One-hop knowledge (*i.e.* each node can read only states of its neighbors.

First contribution

Triangle decomposition problem for arbitrary graphs

Decomposition into triangles



Instance

graph $G = (V,E)$ $|V| = 3n$

Question

Can the vertices of G be partitioned into n disjoint Sets $V_1, V_2, \ldots, V_n$ such that each V_i contains exactly 3 vertices forming a triangle in G?

The perfect triangle partitioning problem is one of the classical NP-complete problems

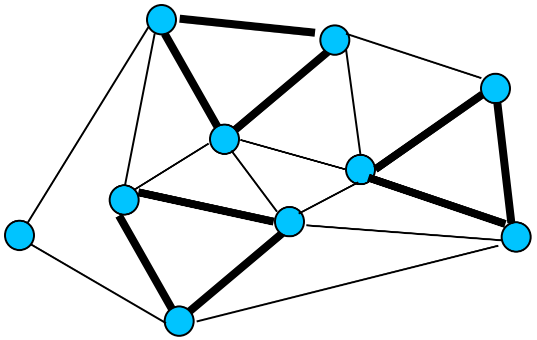
[Garey & Johnson 1979]

Finding the maximum number of node disjoint triangles (k) in graph is NP-Hard. Problem called Node Disjoint Triangle Packing

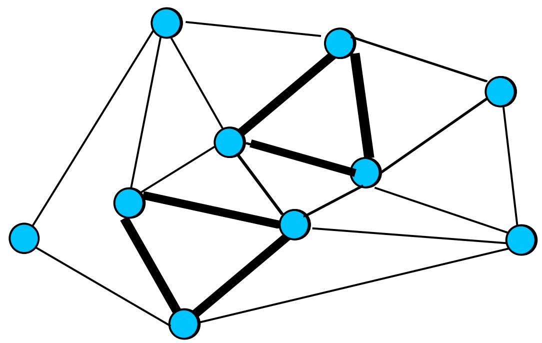
[Albertto & Rizzi 2002]

Maximal decomposition into triangles

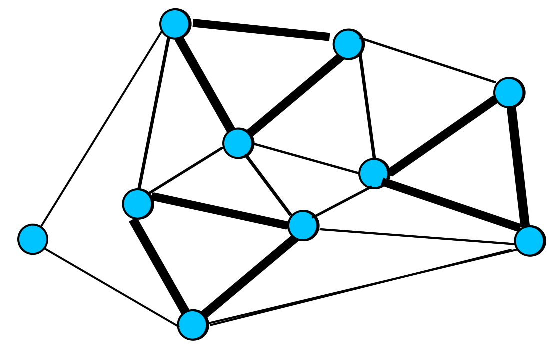
Since perfect partitioning does not always exist for an arbitrary graph, and finding the maximum number of disjoint triangles is hard, we consider **the local maximization** of this decomposition.



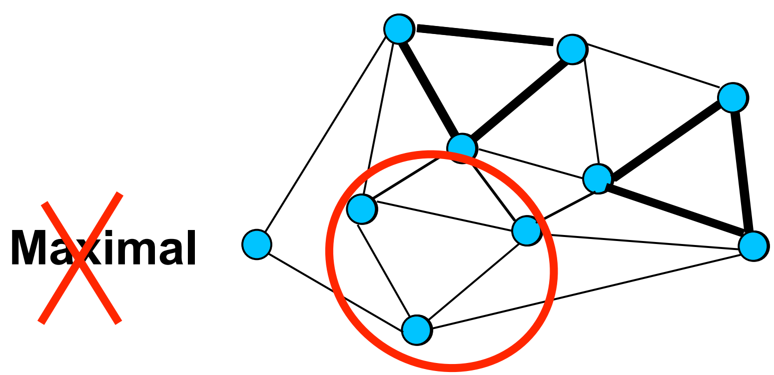
Maximal decomposition into triangles



(a) **Maximal**



(b) **Maximal**



(c)

Results

First step:

We propose a first distributed and **self-stabilizing algorithm** for maximal graph decomposition into disjoint triangles .

The complexity of the first algorithm is **$O(n^4)$** where n is the number of nodes in the graph (More details can be found in the published paper: Self-stabilizing Algorithm for Maximal Graph Partitioning into Triangles. 14th International Symposium on Stabilization, Safety, and Security of Distributed Systems, 2012, Toronto, Canada).

Second step:

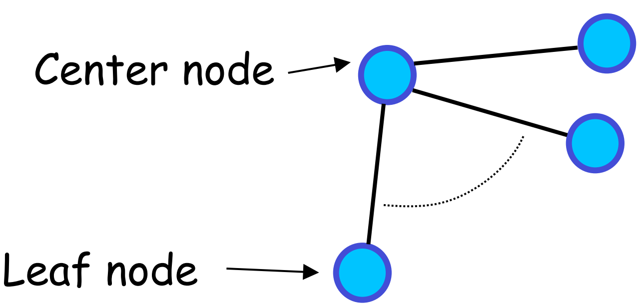
A second algorithm is proposed that stabilizes within O(m) where m is the number of edges in graph (Submited).

Second contribution

P-Star decomposition problem
of arbitrary graphs

p-Star decomposition problem

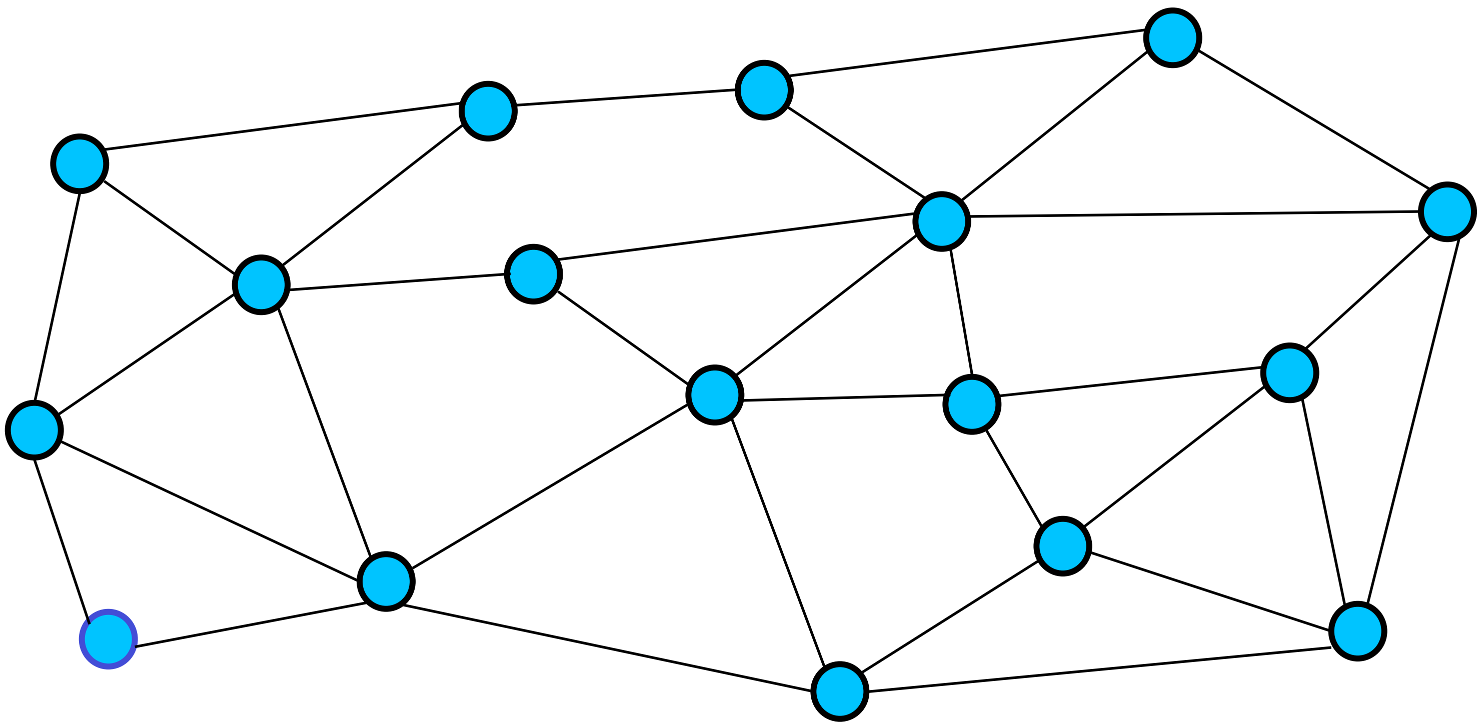
A p-star has one center node and p leaves where $p \geq 1$.



A **p-star decomposition** subdivides a graph into **p-stars**

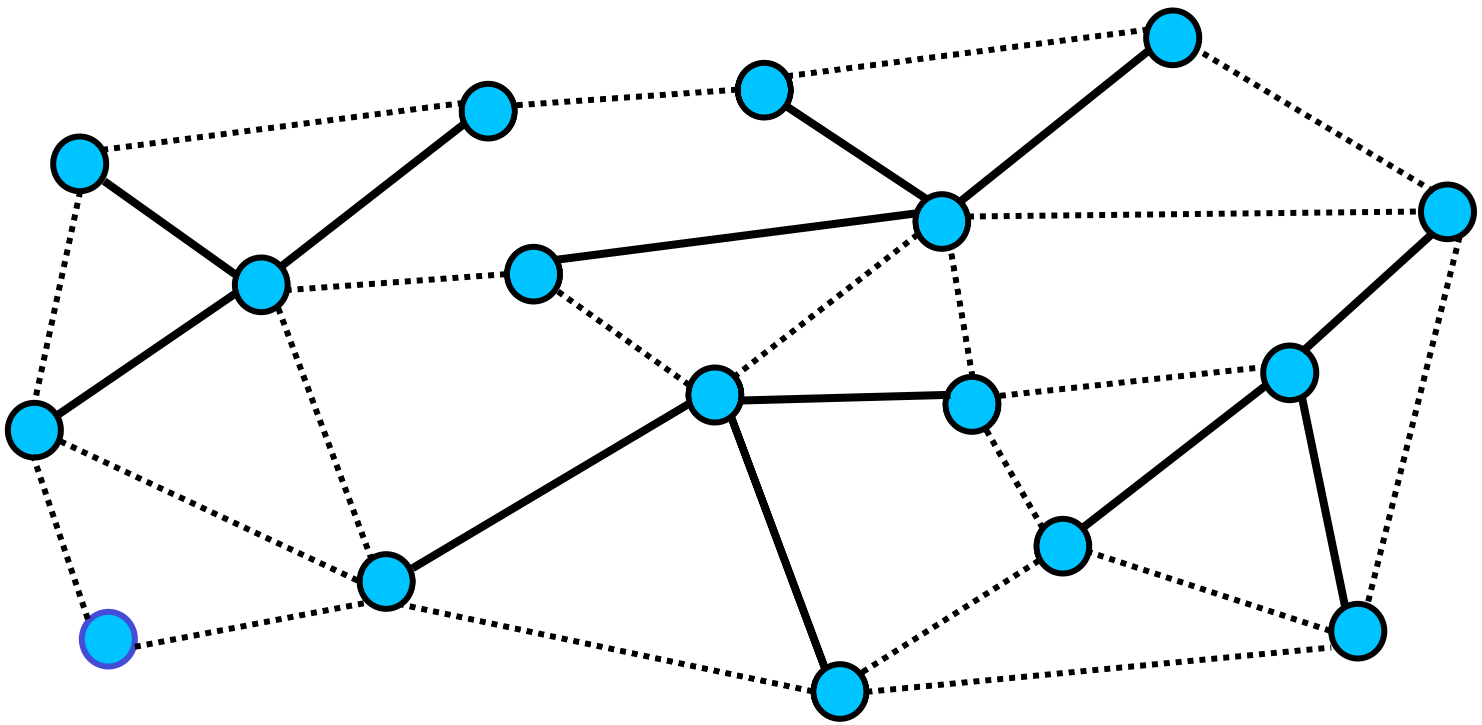
Variant of generalized matchings and general graph factor problems that were proved to be NP-Complete [D. Kirkpatrick et al. in STOC 78] , Journ. Comp. 83]

p-Star Decomposition of General Graphs



Graph G = (V,E)
p=3

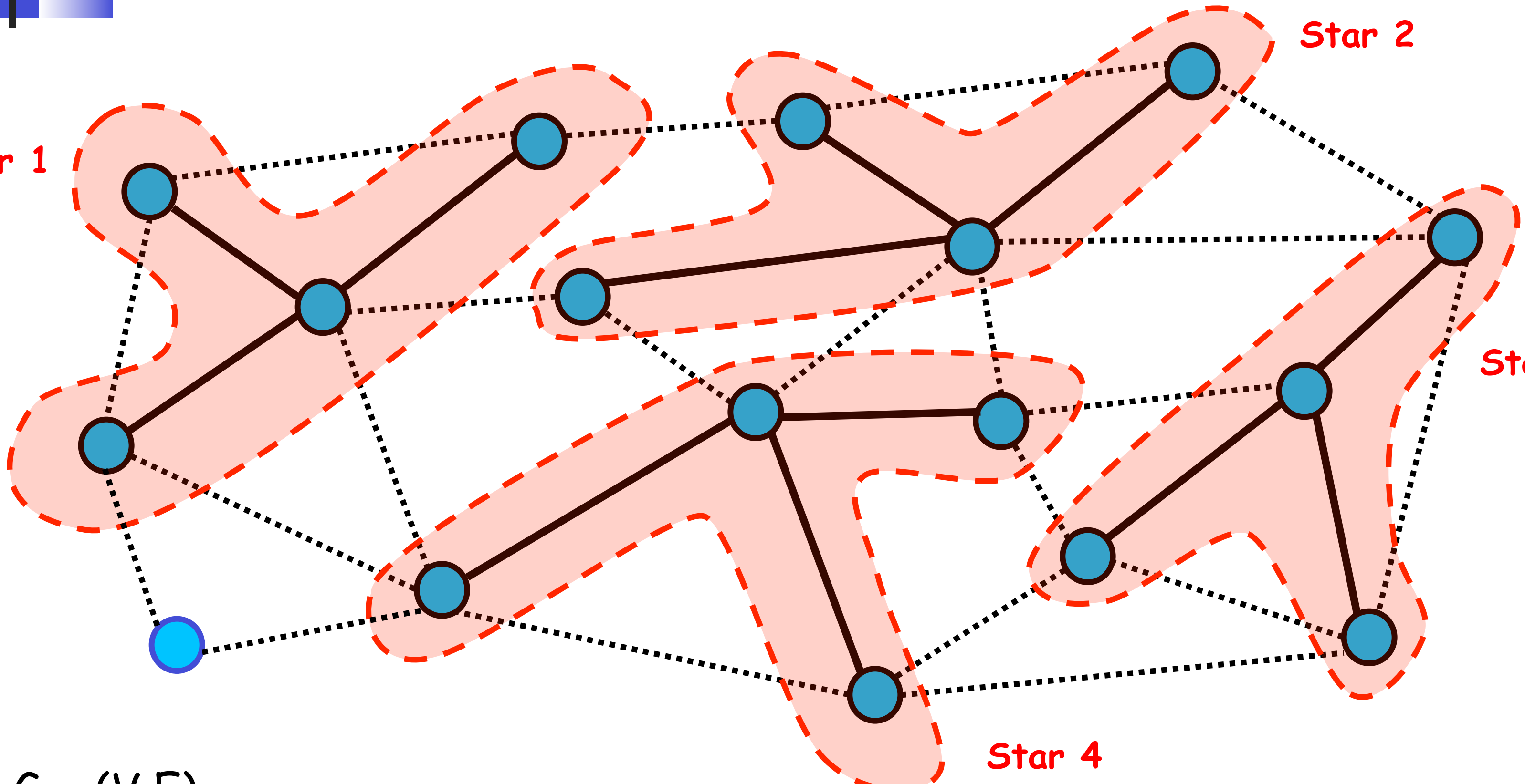
p-Star Decomposition of General Graphs



Graph $G = (V,E)$

$p=3$

p-Star Decomposition of General Graphs



Graph G = (V,E)
$p=3$

Maximal *p*-star Decomposition

Results

We propose the first distributed and **self-stabilizing algorithm** for decomposing a graph into p-stars.

The algorithm operates under a **Distributed Scheduler** and stabilizes within O(n) rounds (More details can be found in the published paper: Self-stabilizing Algorithm for Maximal p-star decomposition of arbitrary graph. 15th International Symposium on Stabilization, Safety, and Security of Distributed Systems 2013, Osaka, Japan)

Thank you for your attention