Color-Coded Dispersion in Mobile Robot Networks

Himani
202221003@daiict.ac.in

Dhirubhai Ambani Institute of Information and Communication Technology (DA-IICT), Gandhinagar

February 12, 2024

Contents

Introduction

Dispersion

- **What is Dispersion?**
  Input: Graph G with n nodes and $k \leq n$ robots.
  Output: Each node containing at most one robot.

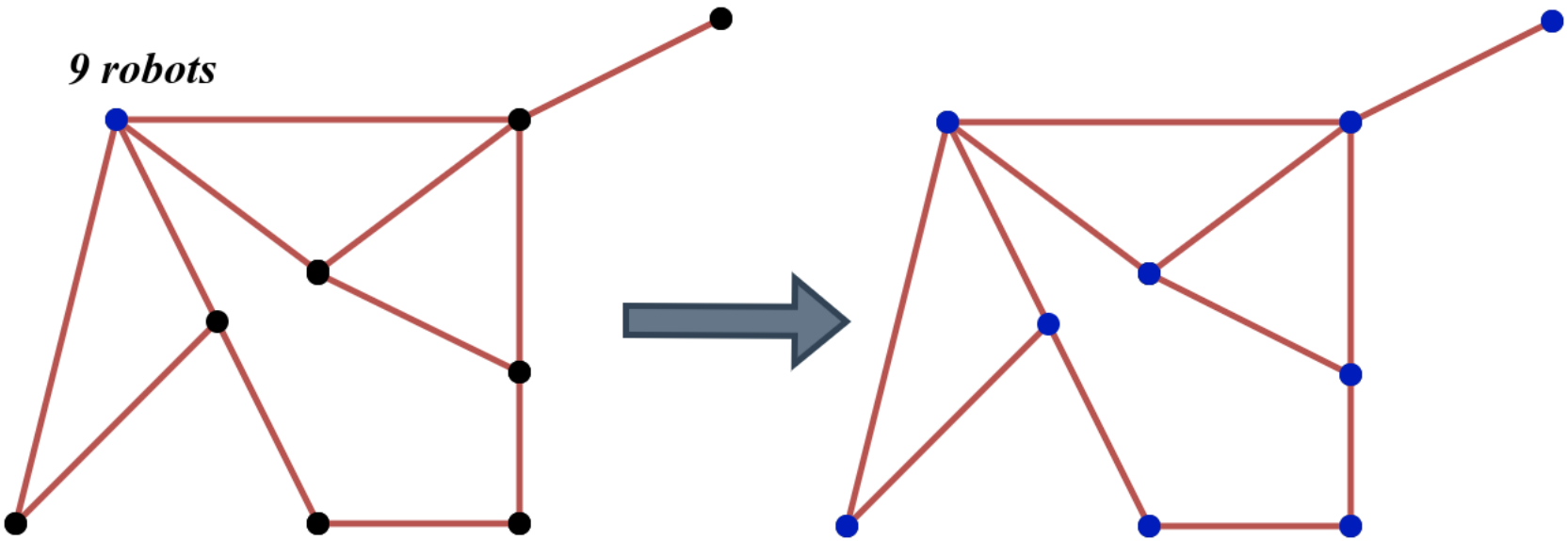


Figure: Graph G

Related problem and Application

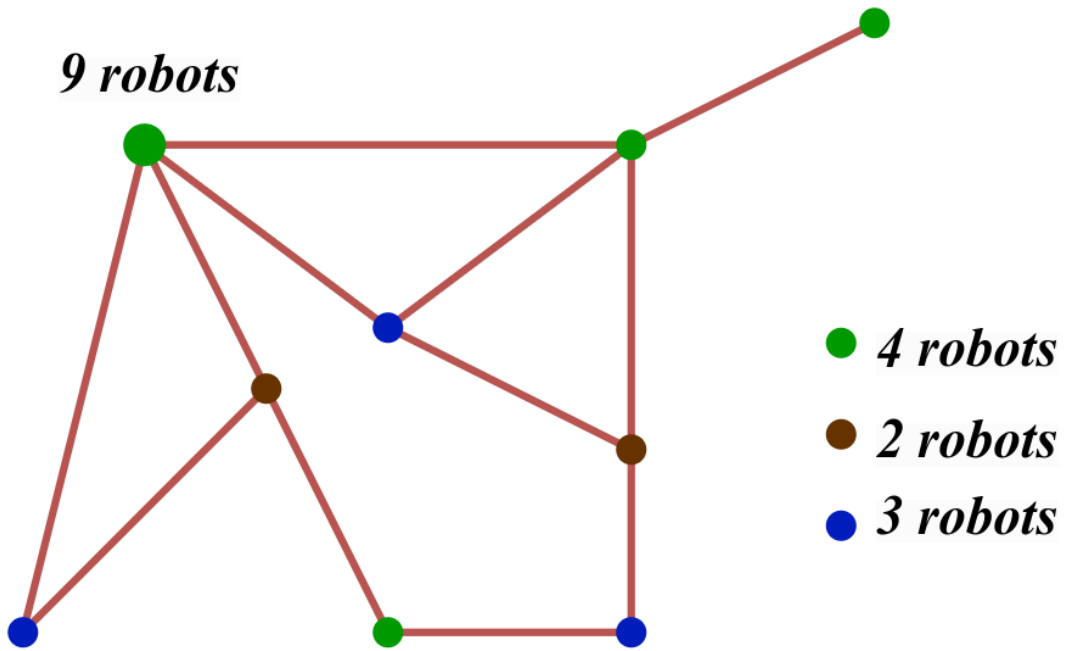
Related problem and Application

- First introduced by Augustine and Moses Jr.[1] for $k = n$[1].
- Similar problems are Scattering[2-5] , Exploration[8-12], and Load Balancing[6, 7].
- Self-driving Electric Cars and Recharging Stations.

[1] John Augustine and William K Moses Jr. Dispersion of mobile robots: a study of memory-time trade-offs. In Proceedings of the 19th ICDCN, pages 1--10, 2018[1].

Why Color-coded?

- Multiple charge stations owned by different companies.
- Electric cars or mobile robots navigate to their respective company's charge station.



Problem Statement

Problem Statement

- The color-coded dispersion problem on graphs involves the task of distributing a set of k colored robots among n colored nodes in such a way that there is at most one robot assigned to each node.
- **The primary objective is to ensure that each robot settles at a node that shares the same color**

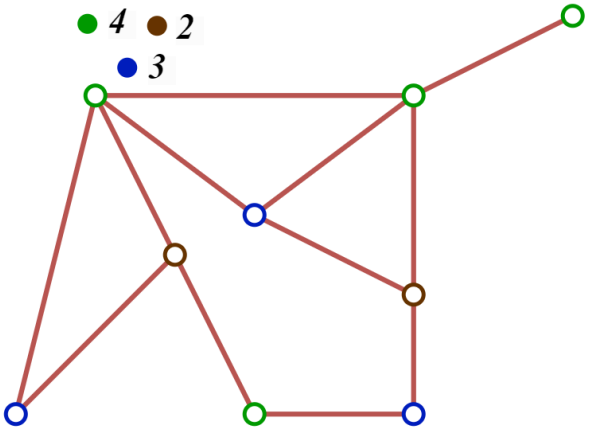
Result for Arbitrary graph

Arbitrary graph

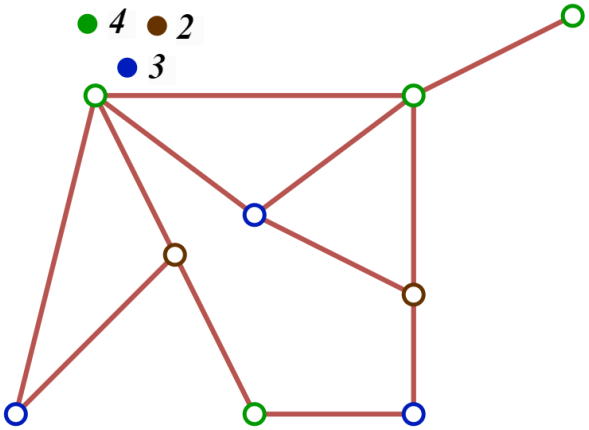
- $k = n$ i.e. number of robots is equal to the number of nodes.
- Disperse the robots by using DFS[14].[1]
- Settle that robot which has same color as node i.e. node and robot color must be same.

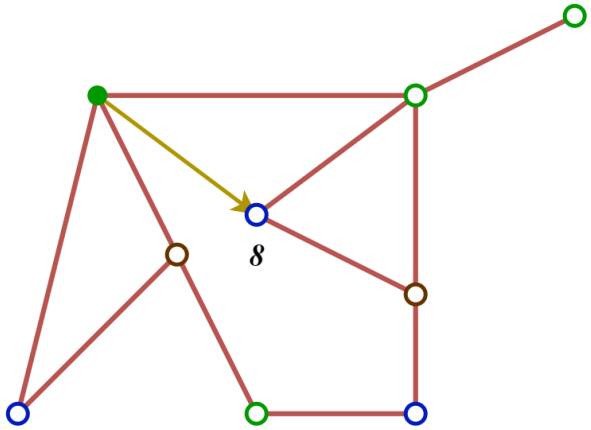
[1] Ajay D Kshemkalyani and Gokarna Sharma. Near-Optimal Dispersion on Arbitrary Anonymous Graphs.

Example

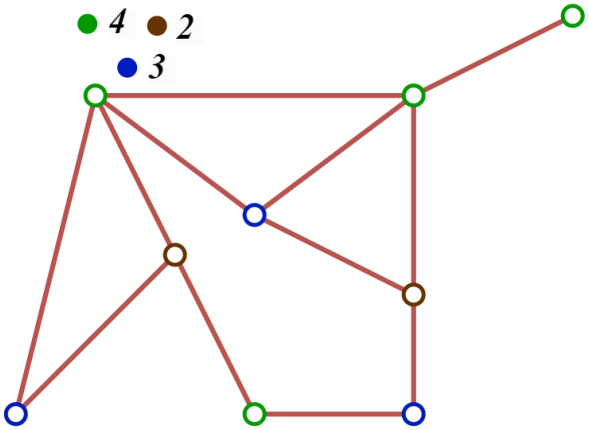


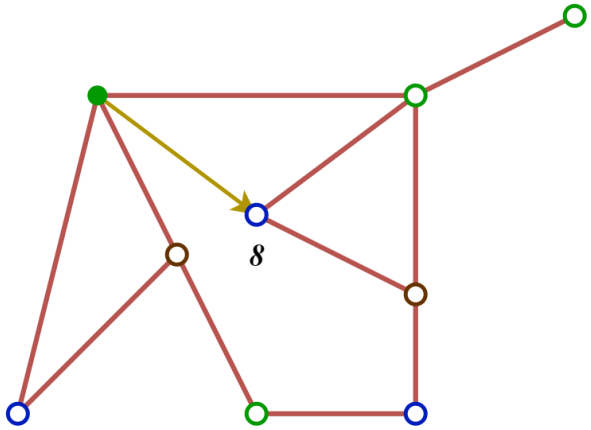
Example

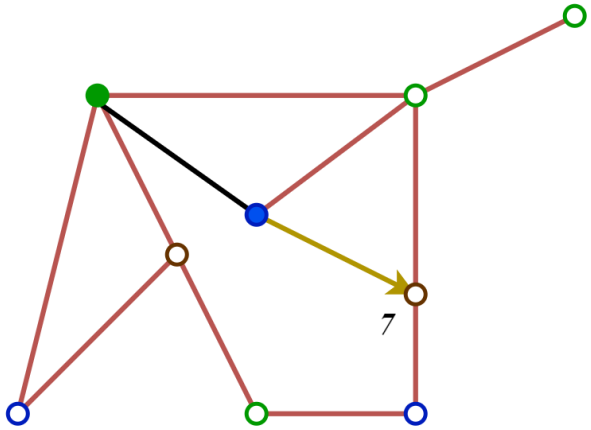




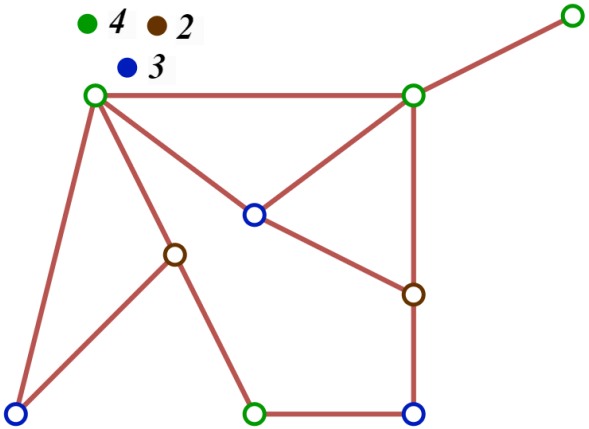
Example

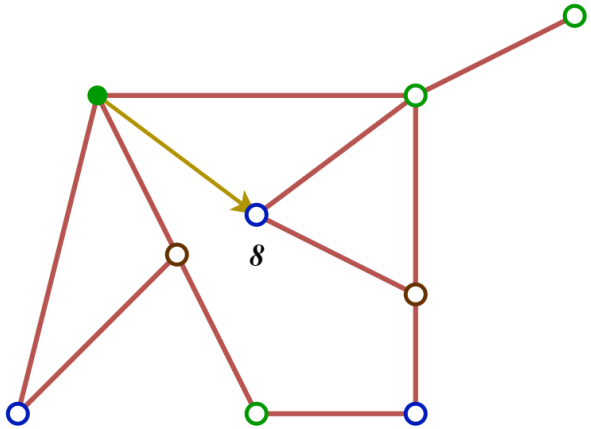


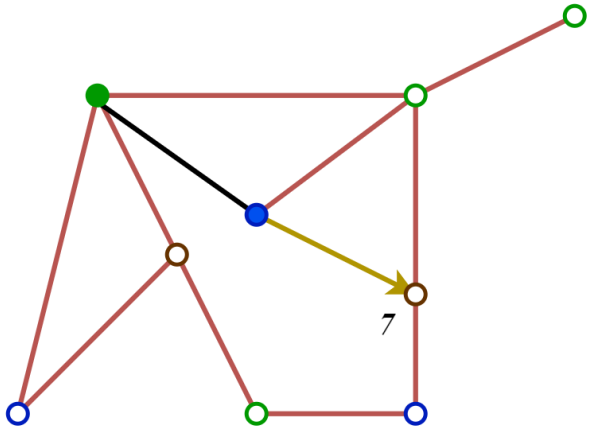


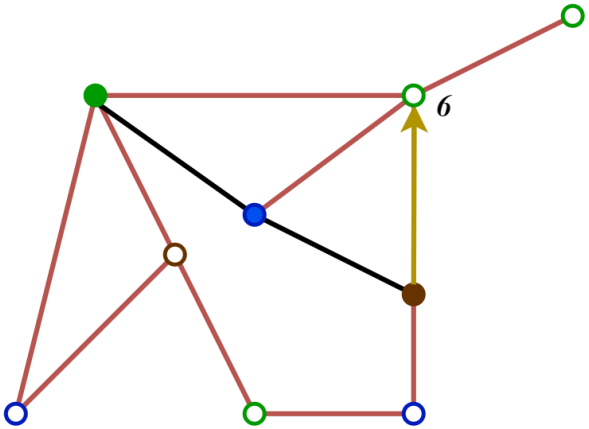


Example

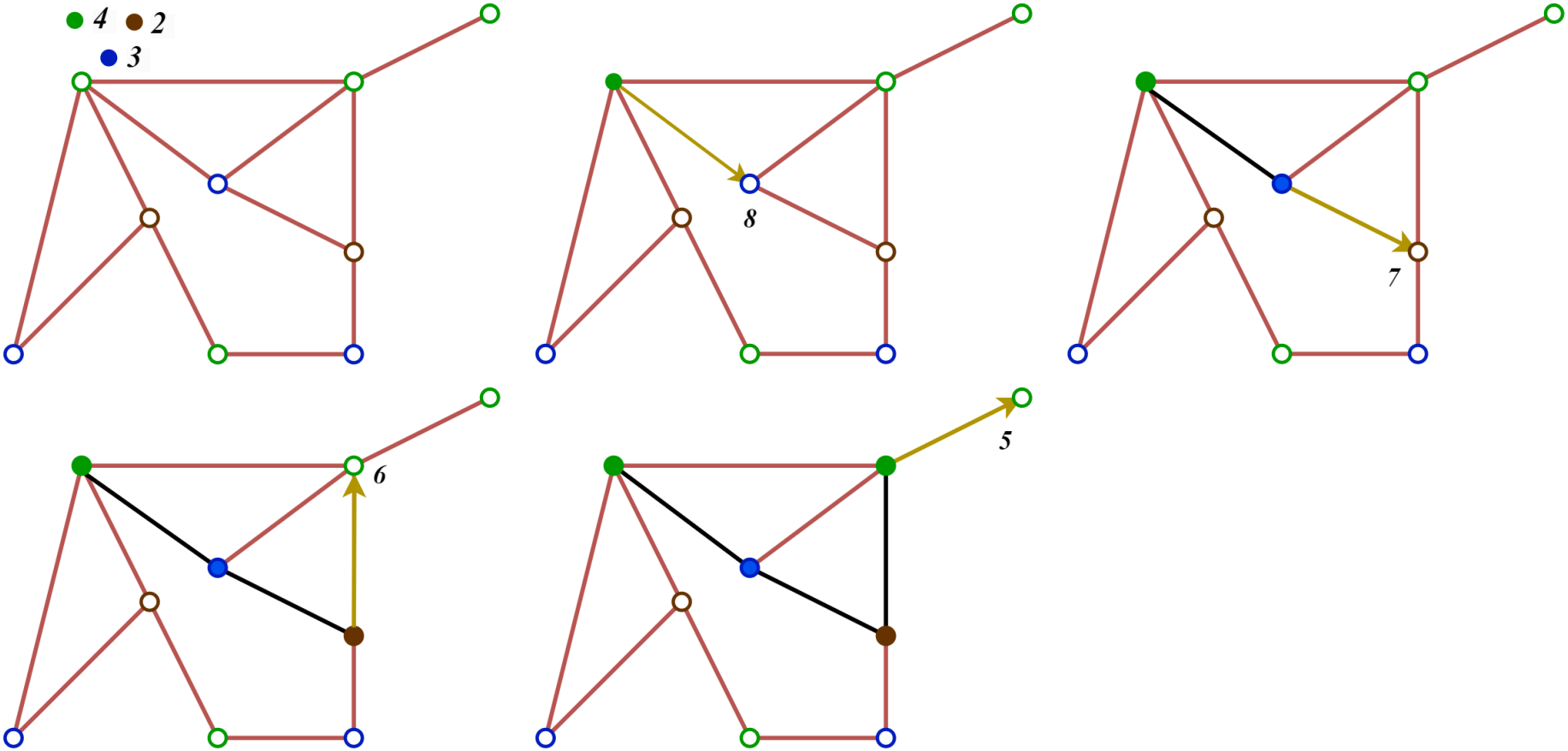




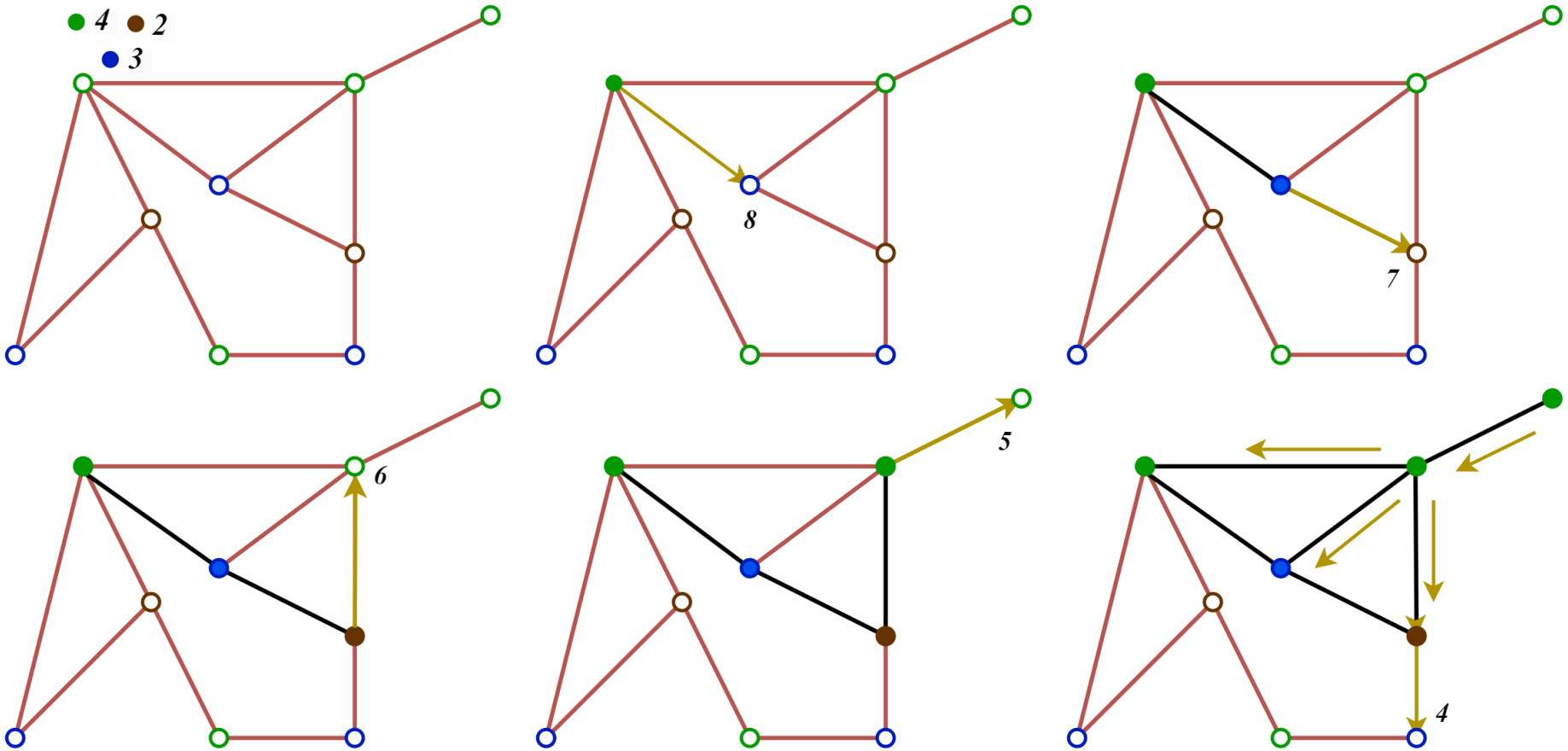




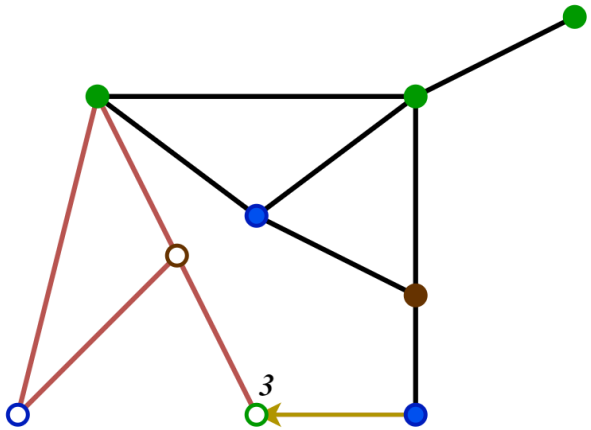
Example



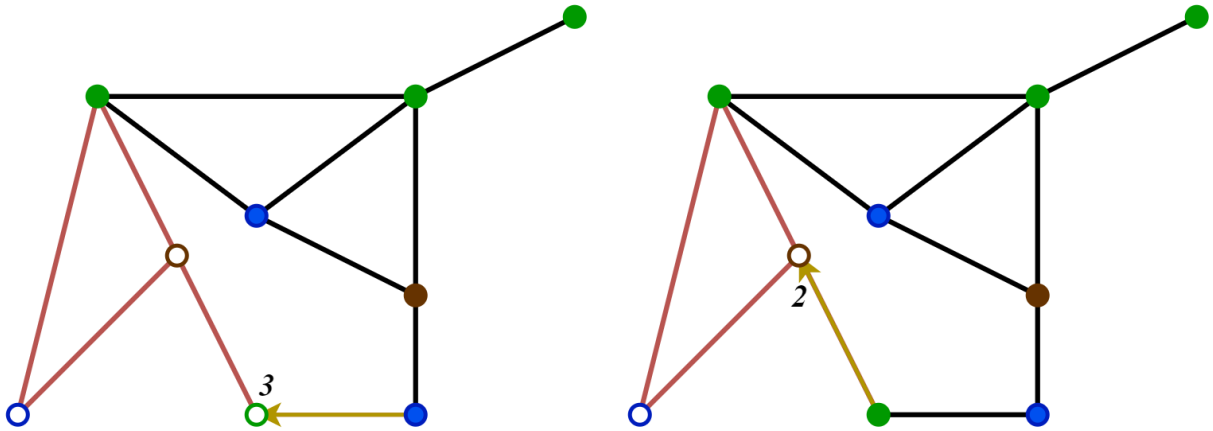
Example



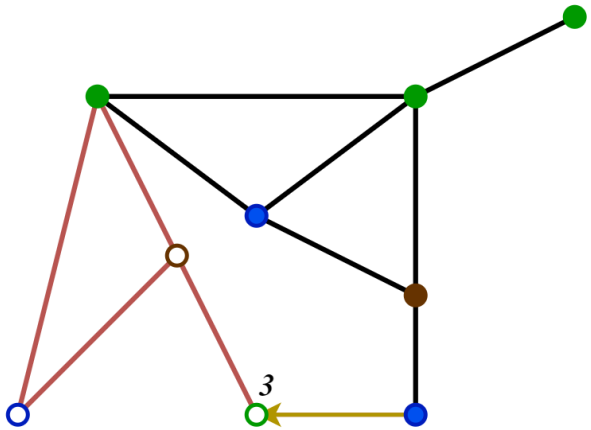
Example

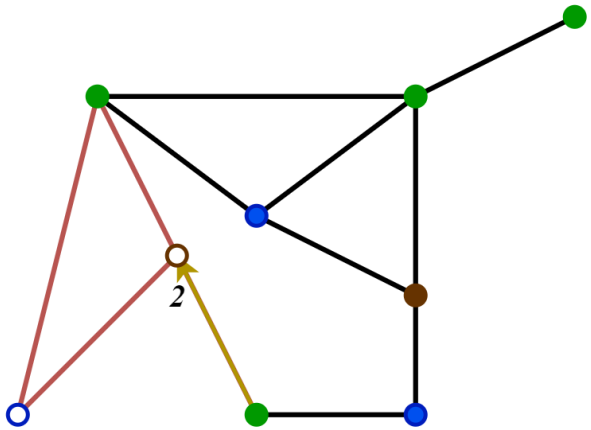


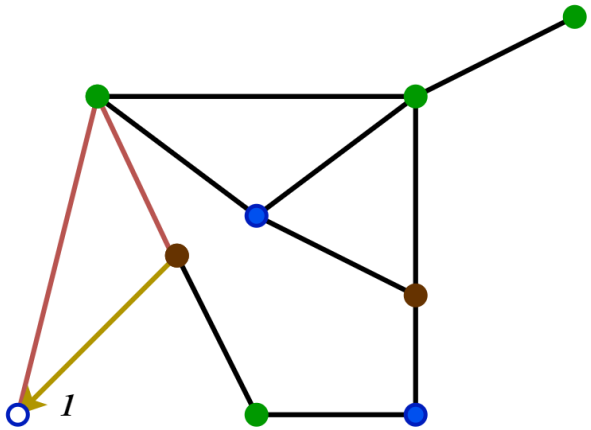
Example



Example







Example

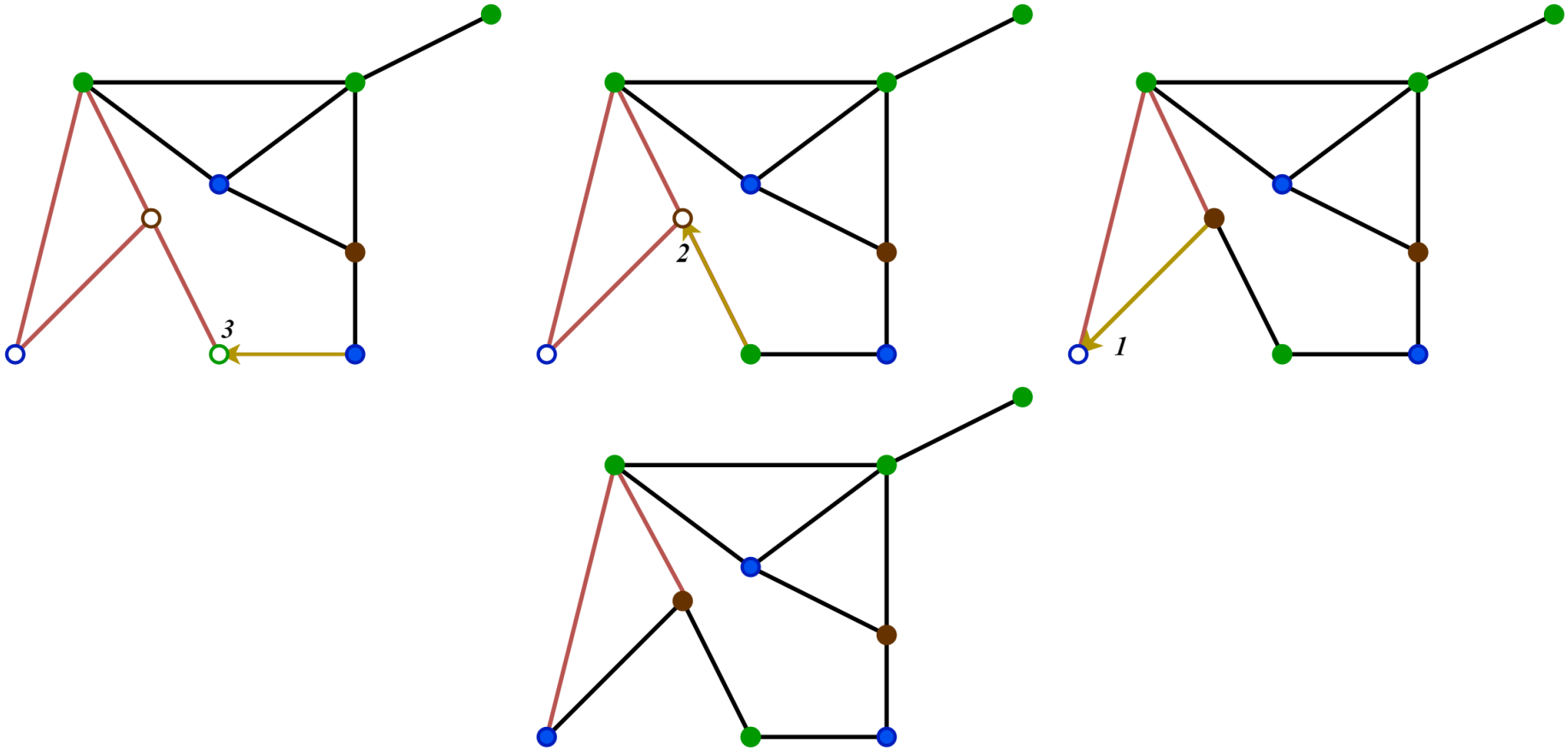


Figure: Final Configuration

Future Work

Future Work

- When faulty robots are there
  - For Trees
  - For Arbritrary graph

References

References I

[1] John Augustine and William K Moses Jr. Dispersion of mobile robots: a study of memory-time trade-offs. In *Proceedings of the 19th ICDCN*, pages 1–10, 2018.

[2] Lali Barriere, Paola Flocchini, Eduardo Mesa-Barrameda, and Nicola Santoro. Uniform scattering of autonomous mobile robots in a grid. *Int. J. Found. Comput.*, 22(03):679–697, 2011.

[3] Yotam Elor and Alfred M Bruckstein. Uniform multi-agent deployment on a ring. *Theoretical Computer Science*, 412(8-10):783–795, 2011.

[4] Pavan Poudel and Gokarna Sharma. Time-optimal uniform scattering in a grid. In *Proceedings of the 20th ICDCN*, pages 228–237, 2019.

[5] Masahiro Shibata, Toshiya Mega, Fukuhito Ooshita, Hirotsugu Kakugawa, and Toshimitsu Masuzawa. Uniform deployment of mobile agents in asynchronous rings. In *Proceedings of the 2016 ACM Symposium on PODC*, pages 415–424, 2016.

References II

[6] George Cybenko. Dynamic load balancing for distributed memory multiprocessors. *JPDC*, 7(2):279–301, 1989.

[7] Raghu Subramanian and Isaac D Scherson. An analysis of diffusive load-balancing. In *Proceedings of the sixth annual ACM SPAA*, pages 220–225, 1994.

[8] Evangelos Bampas, Leszek Gasieniec, Nicolas Hanusse, David Ilcinkas, Ralf Klasing, and Adrian Kosowski. Euler tour lock-in problem in the rotor-router model: I choose pointers and you choose port numbers. In *DISC*, pages 423–435. Springer, 2009.

[9] Reuven Cohen, Pierre Fraigniaud, David Ilcinkas, Amos Korman, and David Peleg. Label-guided graph exploration by a finite automaton. *ACM Transactions on Algorithms (TALG)*, 4(4):1–18, 2008.

[10] Dariusz Dereniowski, Yann Disser, Adrian Kosowski, Dominik Pajak, and Przemysław Uznański. Fast collaborative graph exploration. *Information and Computation*, 243:37–49, 2015.

References III

[11] Pierre Fraigniaud, David Ilcinkas, Guy Peer, Andrzej Pelc, and David Peleg. Graph exploration by a finite automaton. *Theoretical Computer Science*, 345(2-3):331–344, 2005.

[12] Artur Menc, Dominik Pajak, and Przemysław Uznański. Time and space optimality of rotor-router graph exploration. *Information Processing Letters*, 127:17–20, 2017.

[13] Ajay D Kshemkalyani, Anisur Rahaman Molla, and Gokarna Sharma. Fast dispersion of mobile robots on arbitrary graphs. In *ALGOSENSORS*, pages 23–40. Springer, 2019.

[14] Ajay D Kshemkalyani and Gokarna Sharma. Near-optimal dispersion on arbitrary anonymous graphs. *arXiv preprint arXiv:2106.03943*, 2021.

THANK YOU