Table des matières

<table>
<thead>
<tr>
<th>F. Fioravantes, D. Knop, J.M. Křišťan, N. Melissinos, M. Opler : Exact Algorithms and Lowerbounds for Multiagent Pathfinding</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

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<tbody>
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<td>3</td>
</tr>
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</table>
Exact Algorithms and Lowerbounds for Multiagent Pathfinding

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In the Multiagent Path Finding problem, we focus on efficiently finding non-colliding paths for a set of $k$ agents on a given graph $G$, where each agent seeks a path from its source vertex to its target. An important measure of the quality of the solution is the length of the proposed schedule $\ell$, that is, the length of a longest path (including the waiting time). In this work, we propose a systematic study under the parameterized complexity framework.

We show that the Multiagent Path Finding problem is $W[1]$-hard with respect to $k$ (even if $k$ is combined with the maximum degree of the input graph). The problem remains $\mathsf{NP}$-hard in planar graphs even if the maximum degree and the makespan $\ell$ are fixed constants. We also show that the problem remains $\mathsf{NP}$-hard even when the input graph is a tree of maximum degree five. Both of these proofs serve as improvements of the current state of the art concerning the intractability of this problem [1]. On the positive side, we show an $\mathsf{FPT}$ algorithm for $k + \ell$. As we delve further, the structure of $G$ comes into play. We give an $\mathsf{FPT}$ algorithm for $k$ plus the diameter of the graph $G$. Finally, we show that the problem is $W[1]$-hard for cliquewidth of $G$ plus $\ell$ while it is $\mathsf{FPT}$ for treewidth of $G$ plus $\ell$.

Références

Exact Algorithms and Lowerbounds for Multiagent Pathfinding

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In the MULTIAGENT PATH FINDING problem, we focus on efficiently finding non-colliding paths for a set of $k$ agents on a given graph $G$, where each agent seeks a path from its source vertex to its target. An important measure of the quality of the solution is the length of the proposed schedule $\ell$, that is, the length of a longest path (including the waiting time). In this work, we propose a systematic study under the parameterized complexity framework.

We show that the MULTIAGENT PATH FINDING problem is $W[1]$-hard with respect to $k$ (even if $k$ is combined with the maximum degree of the input graph). The problem remains $\text{NP}$-hard in planar graphs even if the maximum degree and the makespan $\ell$ are fixed constants. We also show that the problem remains $\text{NP}$-hard even when the input graph is a tree of maximum degree five. Both of these proofs serve as improvements of the current state of the art concerning the intractability of this problem [1]. On the positive side, we show an $\text{FPT}$ algorithm for $k + \ell$. As we delve further, the structure of $G$ comes into play. We give an $\text{FPT}$ algorithm for parameter $k$ plus the diameter of the graph $G$. Finally, we show that the problem is $W[1]$-hard for cliquewidth of $G$ plus $\ell$ while it is $\text{FPT}$ for treewidth of $G$ plus $\ell$.

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