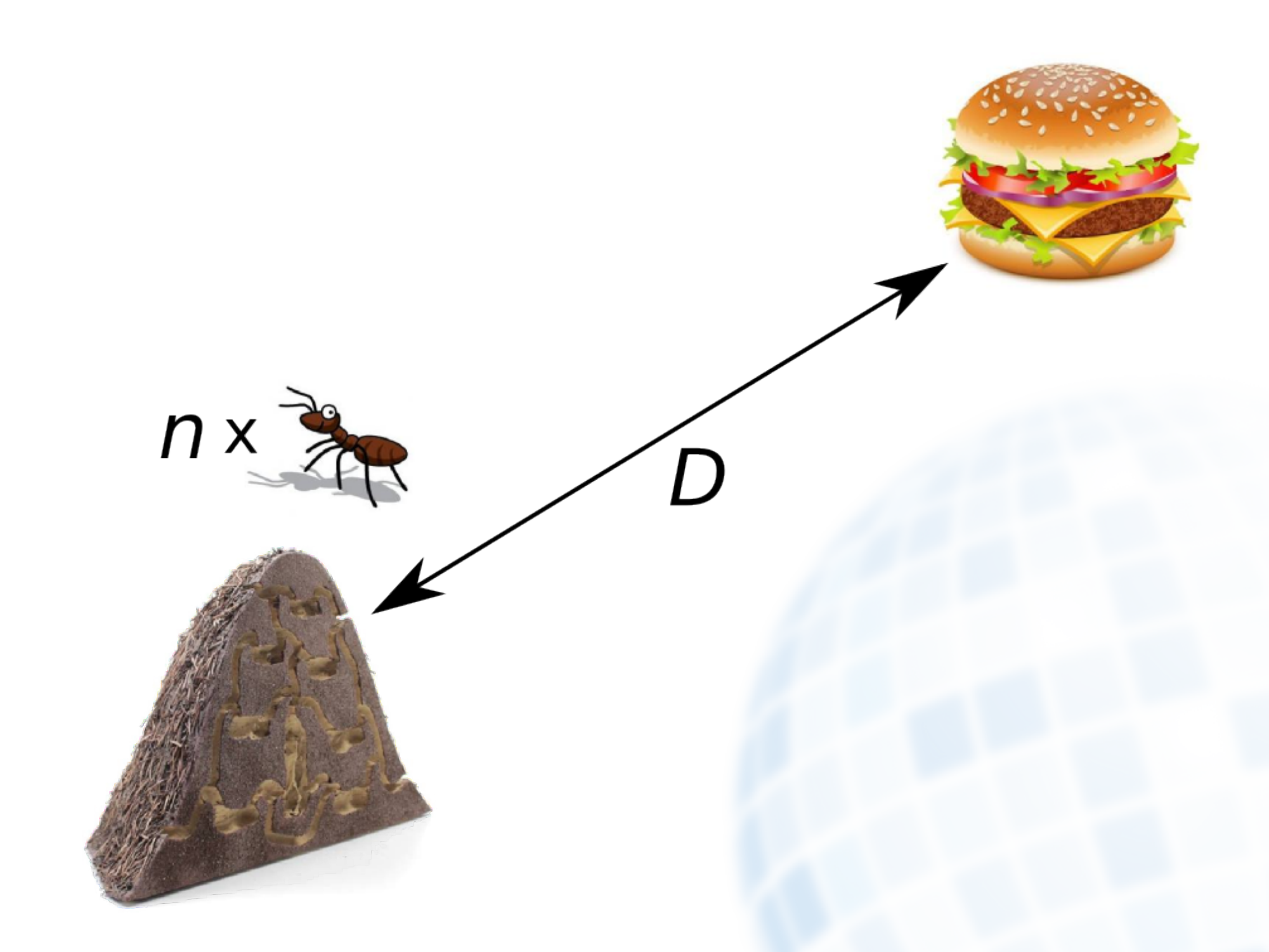
Towards More Realistic ANTS

Tobias Langner

ETH Zurich – Distributed Computing Group – www.disco.ethz.ch

n x


n x
D

n x 

D

$$\approx D + D^2/n$$

Previous Work

- ANTS problem (Ants Nearby Treasure Search) introduced by Feinerman, Korman, Lotker, Sereni [PODC 2012]

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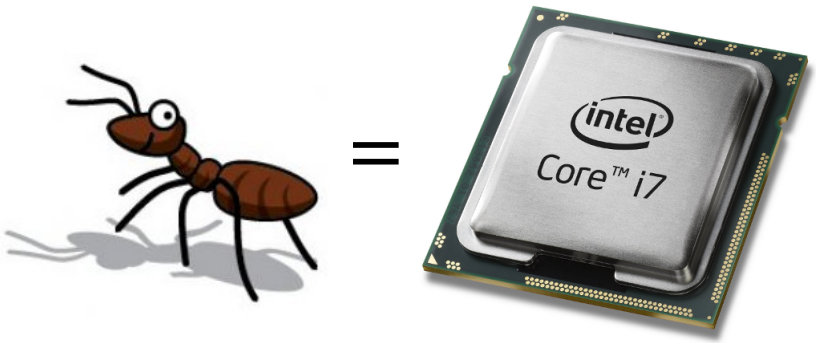

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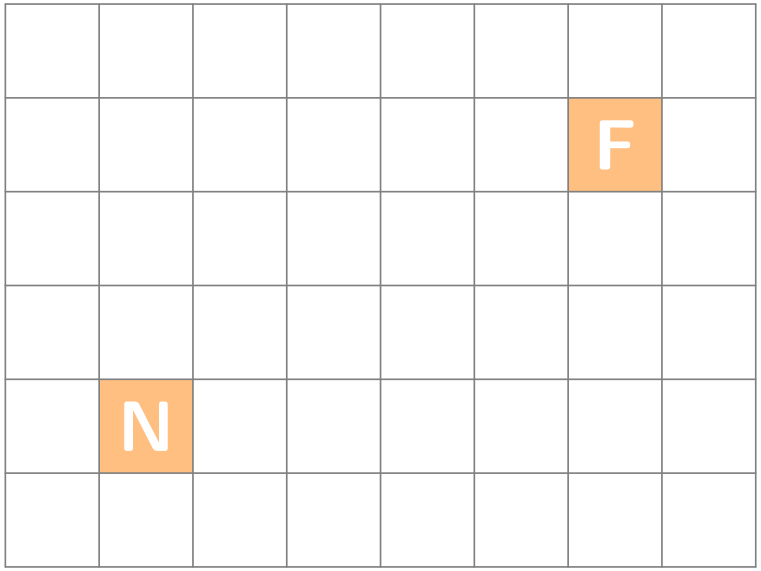
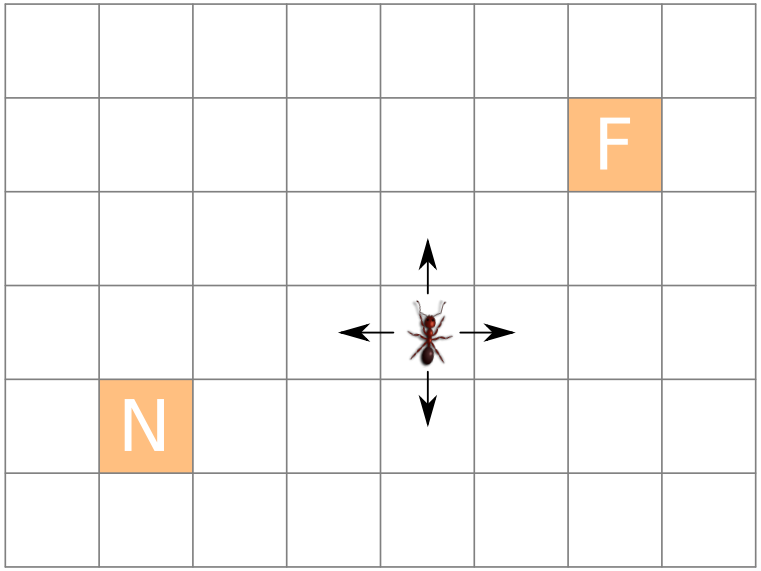
- Treasure located in **optimal** time $\approx D + D^2/n$

Model



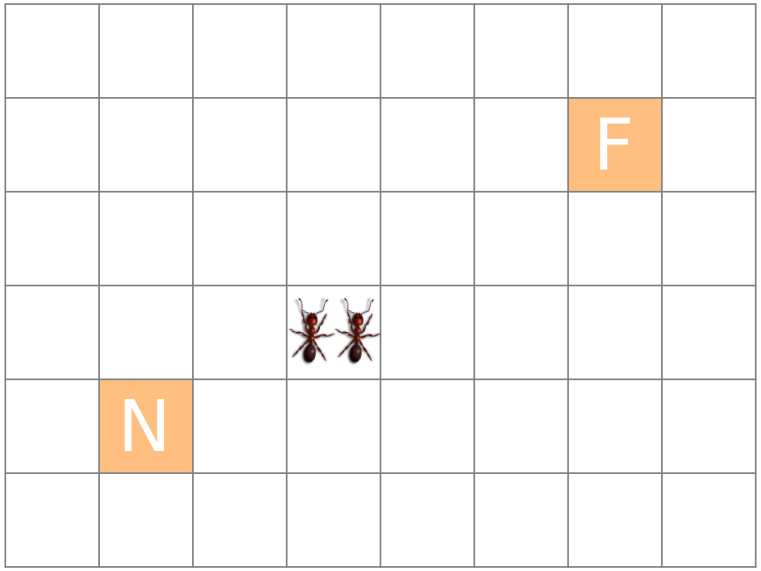
- Infinite integer grid with **nest** and **food** in distance D
- **Goal:** Starting at nest, find food fast

Model



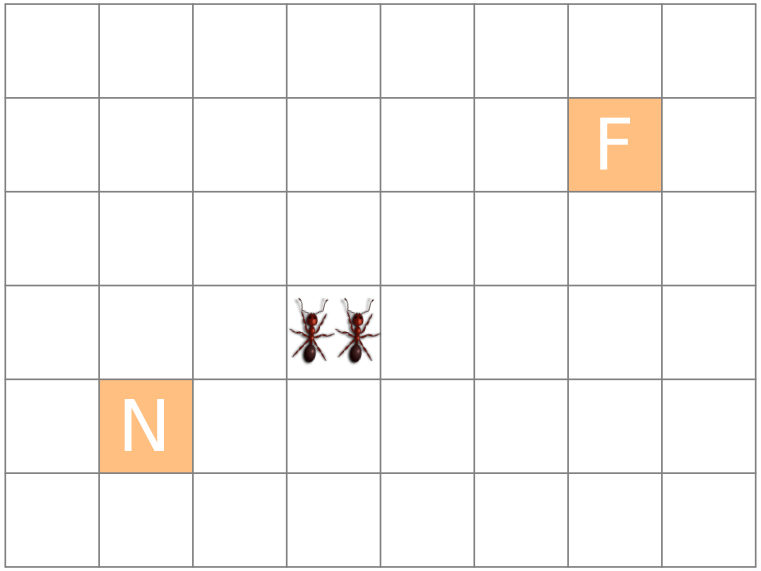
- In each step, ant can move **one cell** N, E, S, W or stay

Model



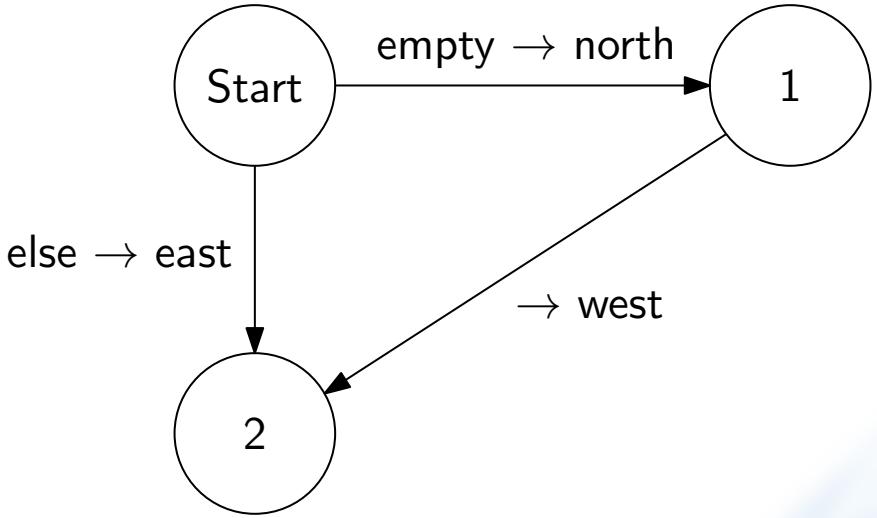
- **Communication** within cells

Model



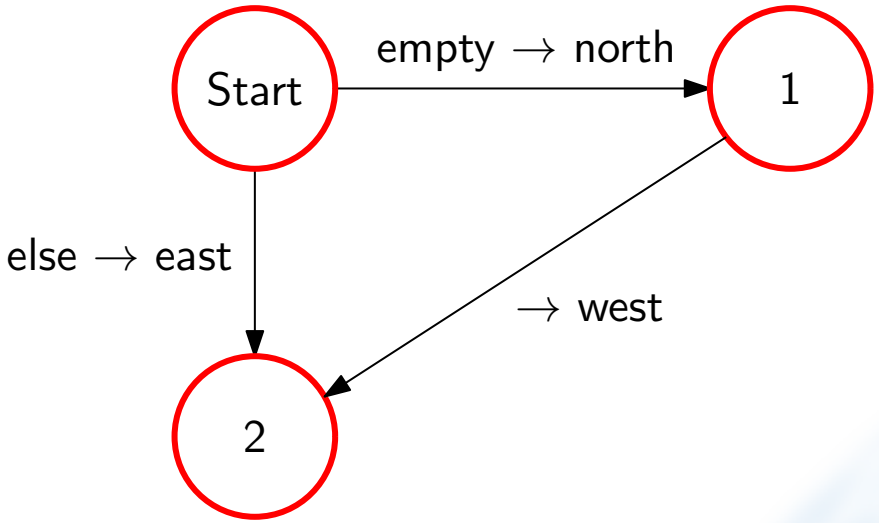
- **Communication** within cells
- For each **state**: Is there an ant with this state?
- $\Rightarrow$ **Finite** message size

Model



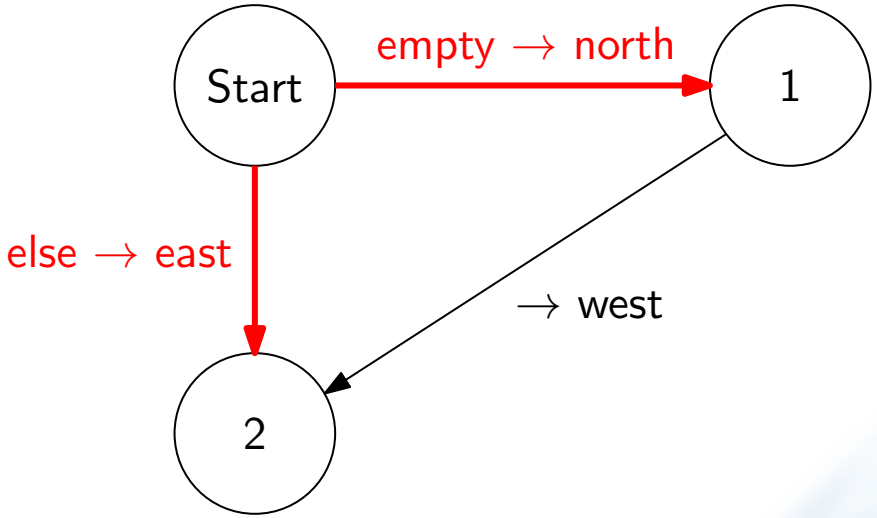
- Ants controlled by **finite automaton**

Model



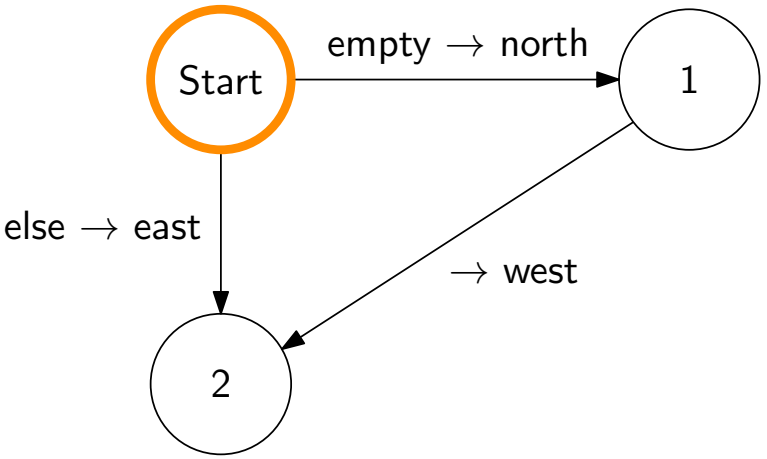
- Ants controlled by **finite automaton**
- **Constant** number of states independent of n

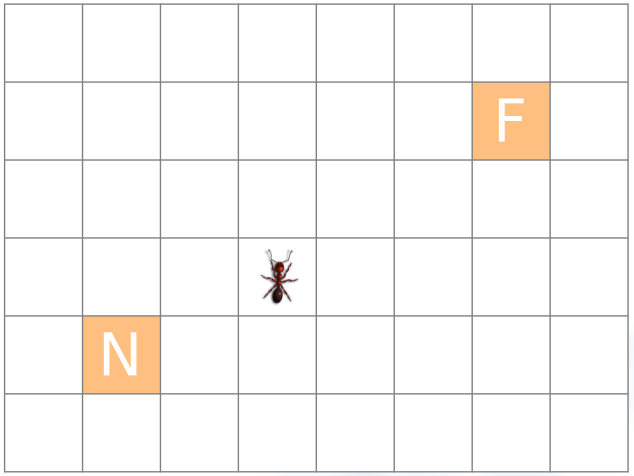
Model



- Ants controlled by **finite automaton**
- **Constant** number of states independent of n
- Arrows specify **conditions** and **movements**

Model





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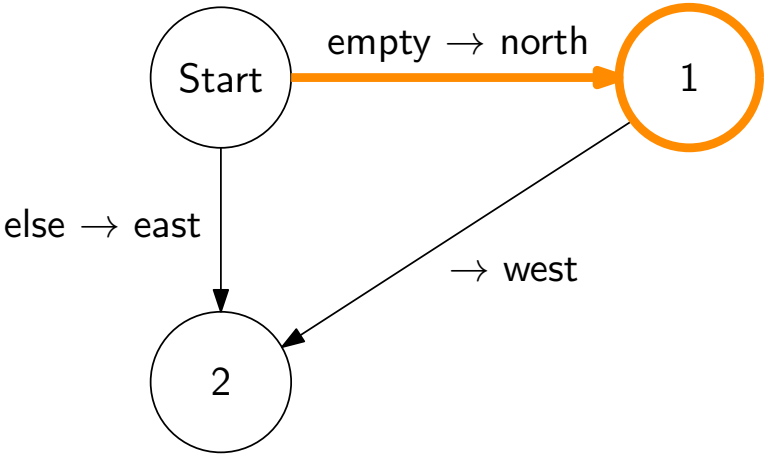

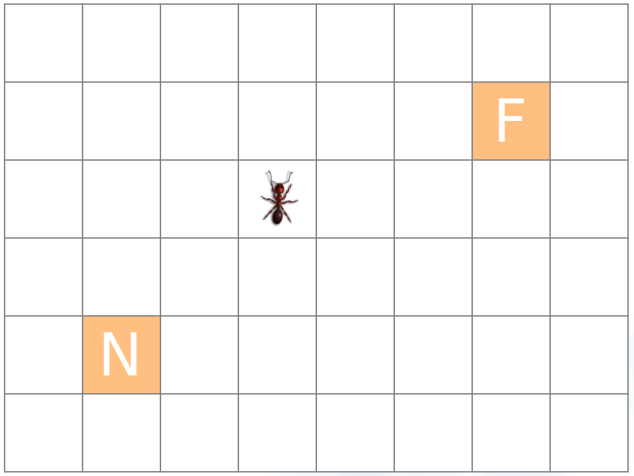

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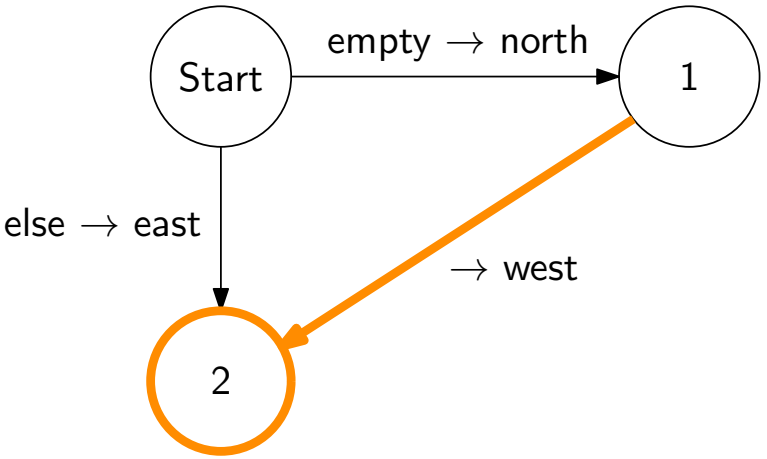

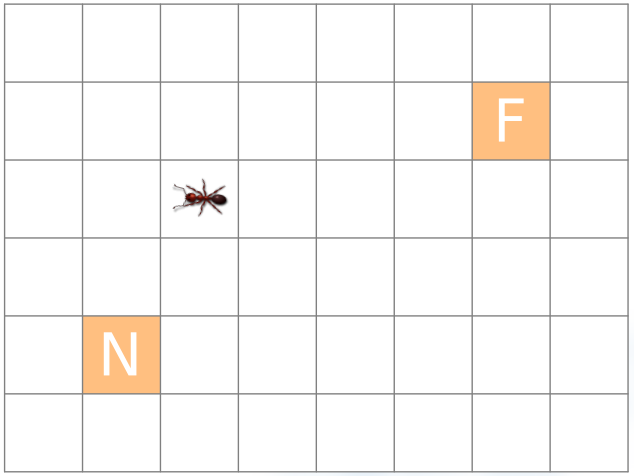

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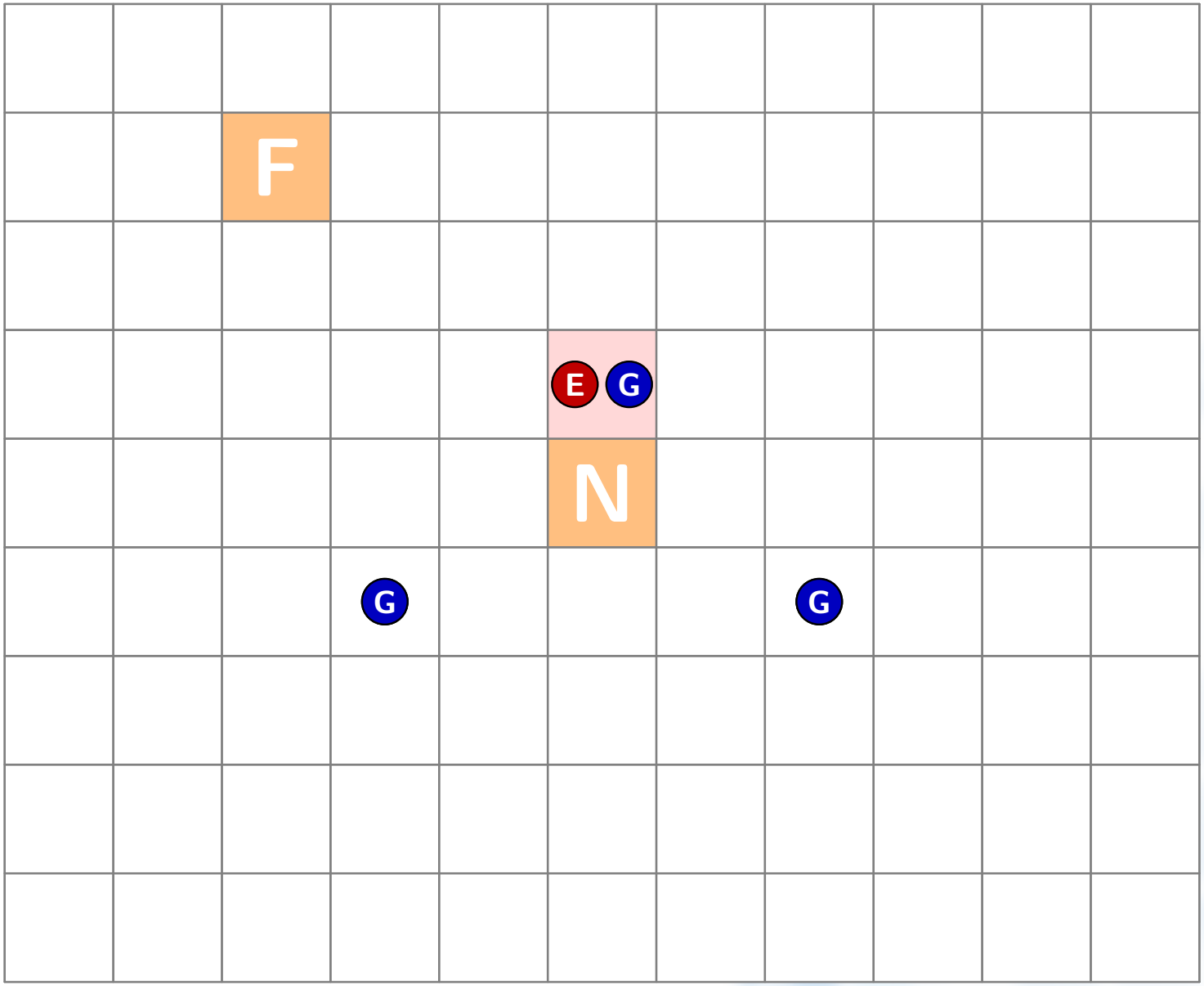
- **Constant** number of states independent of n
- Arrows specify **conditions** and **movements**

How Many Ants Do We Need to Find the Food?

Asynchronous and Deterministic

Triangle Search



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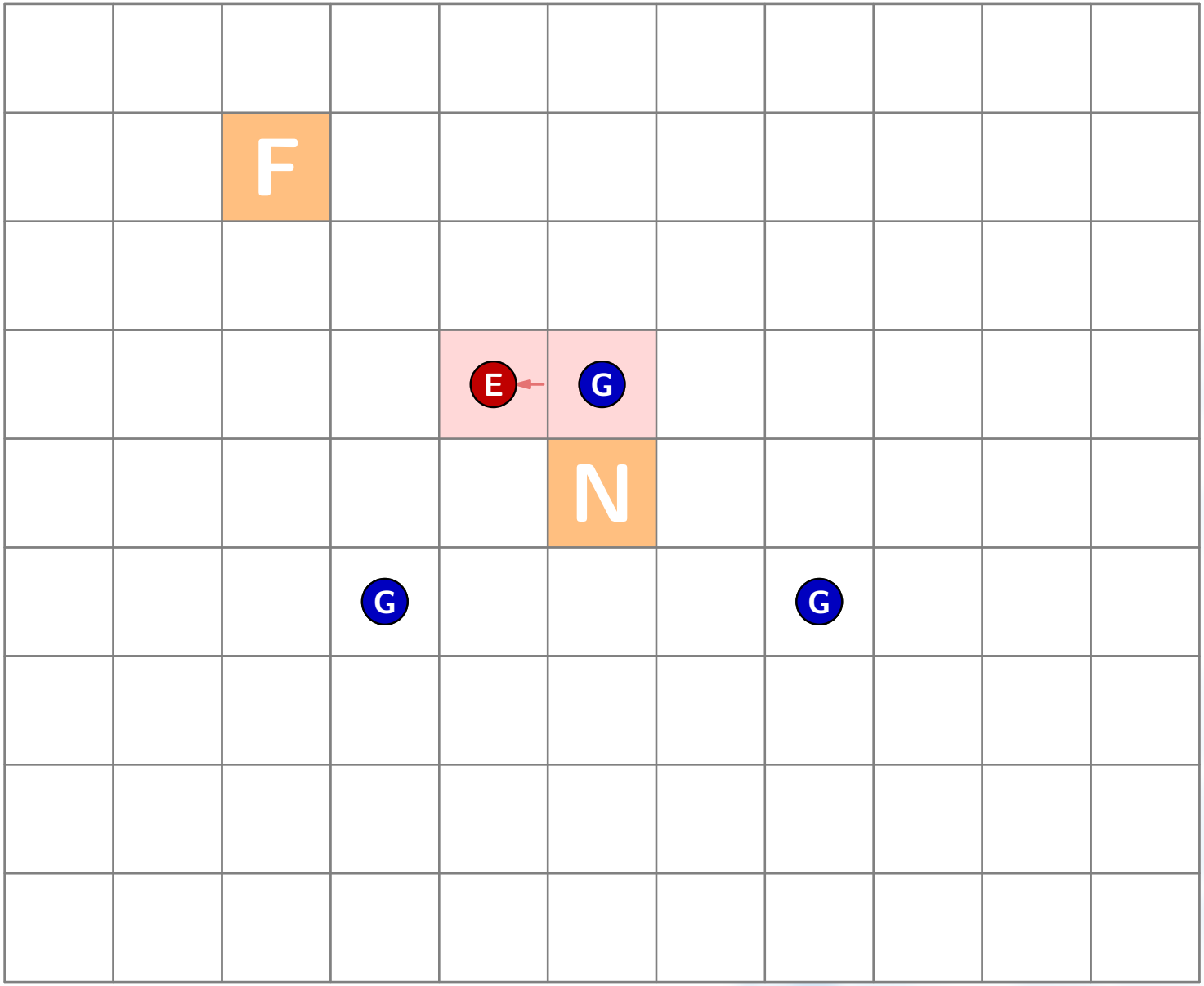

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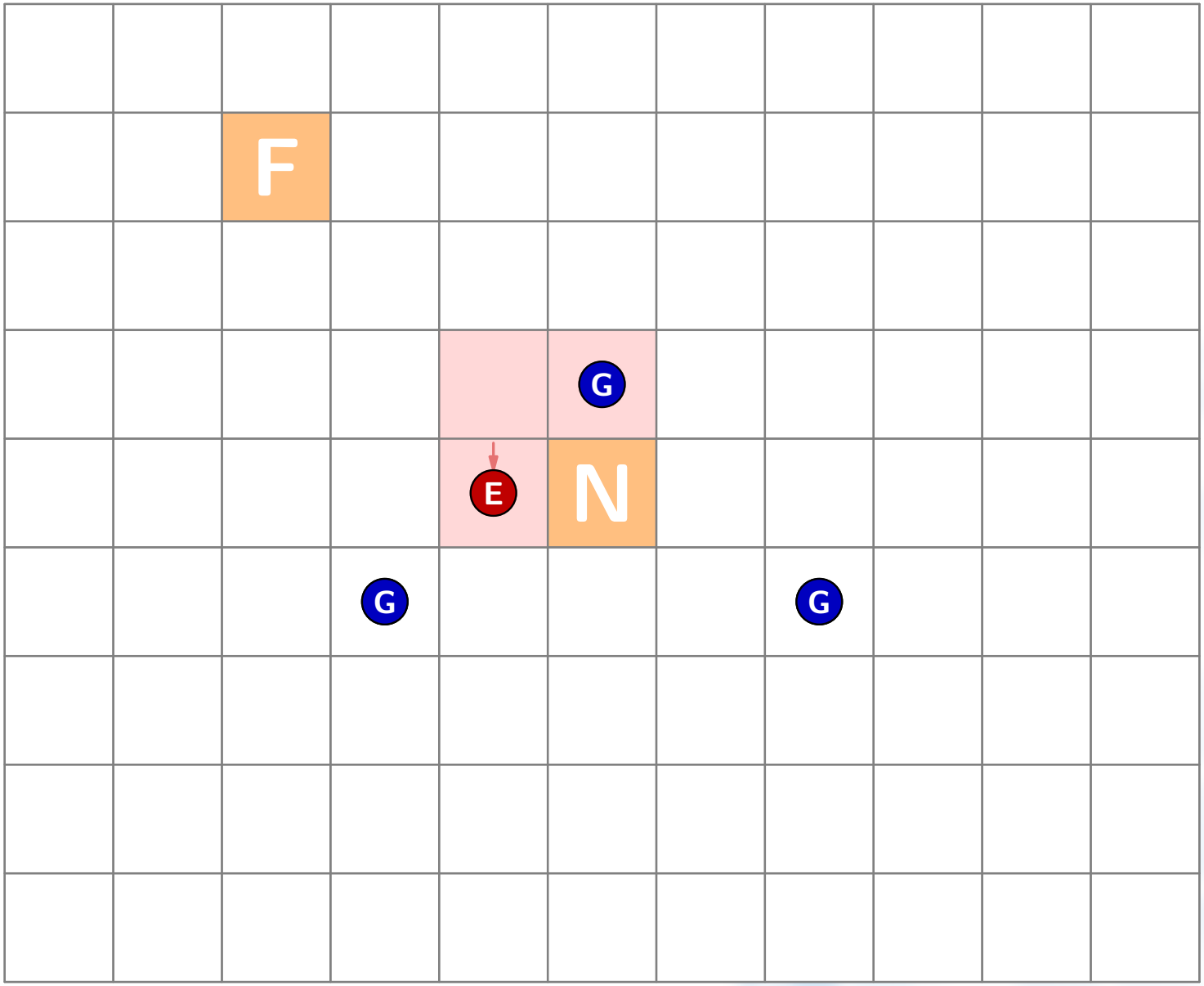

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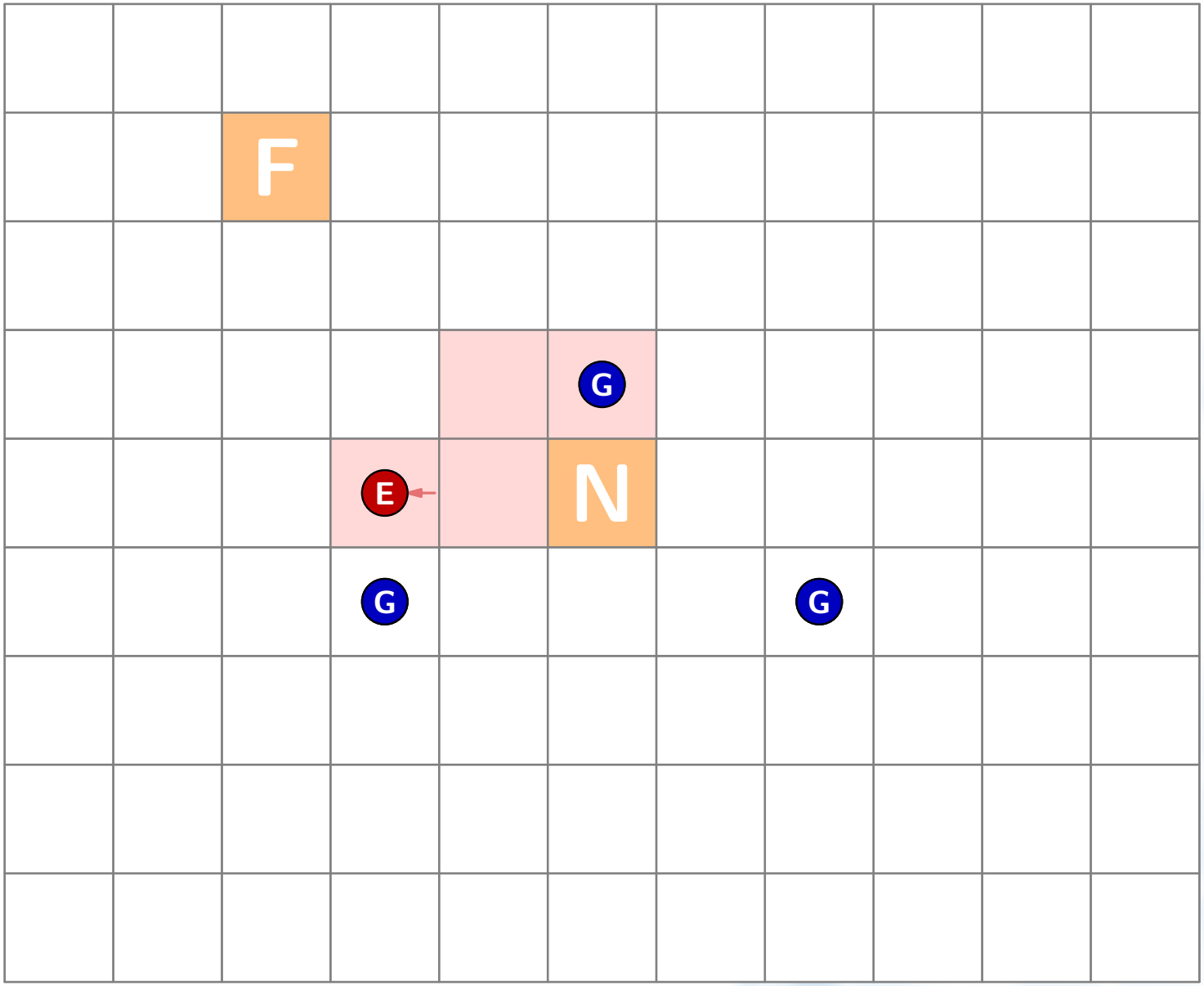

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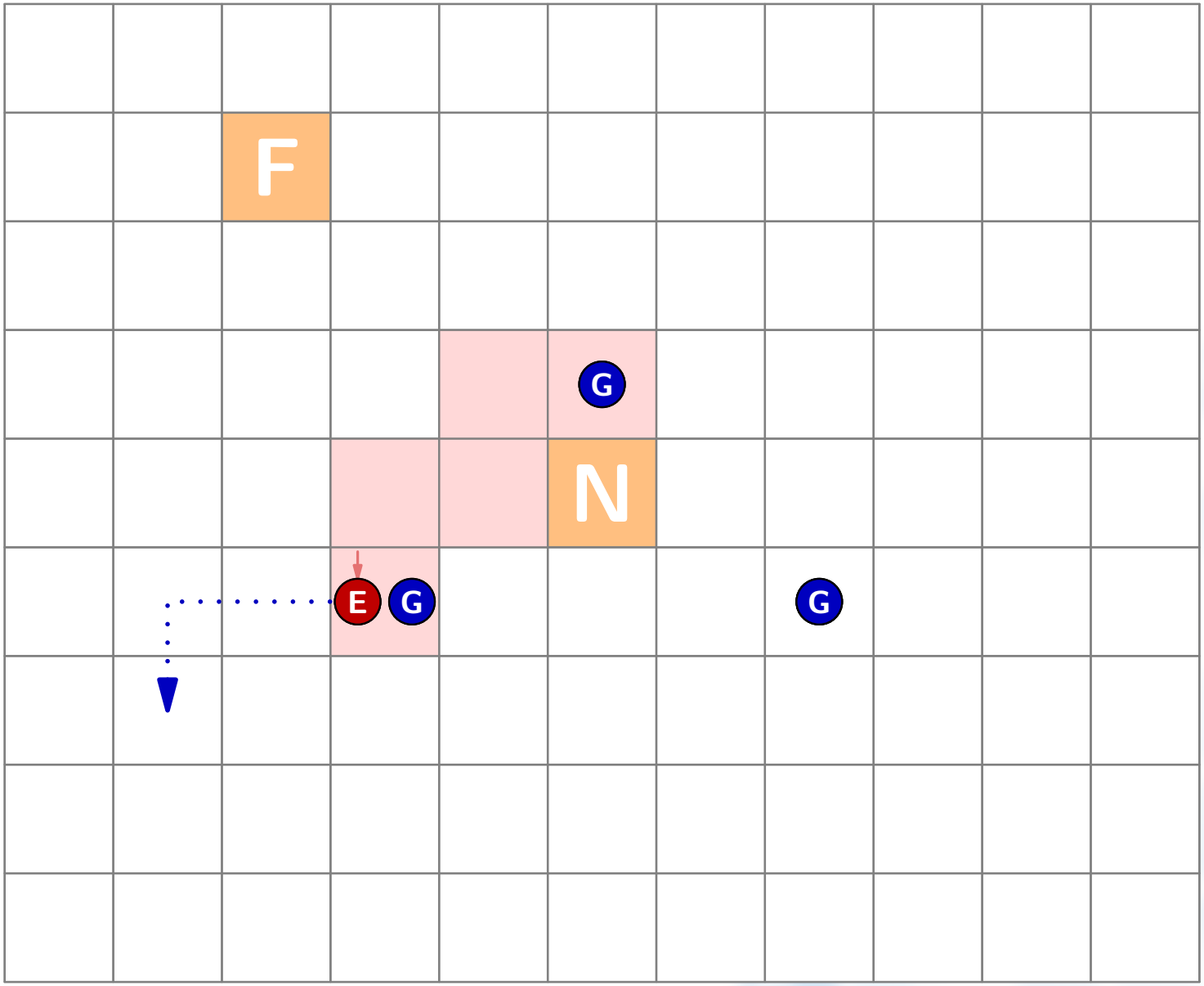

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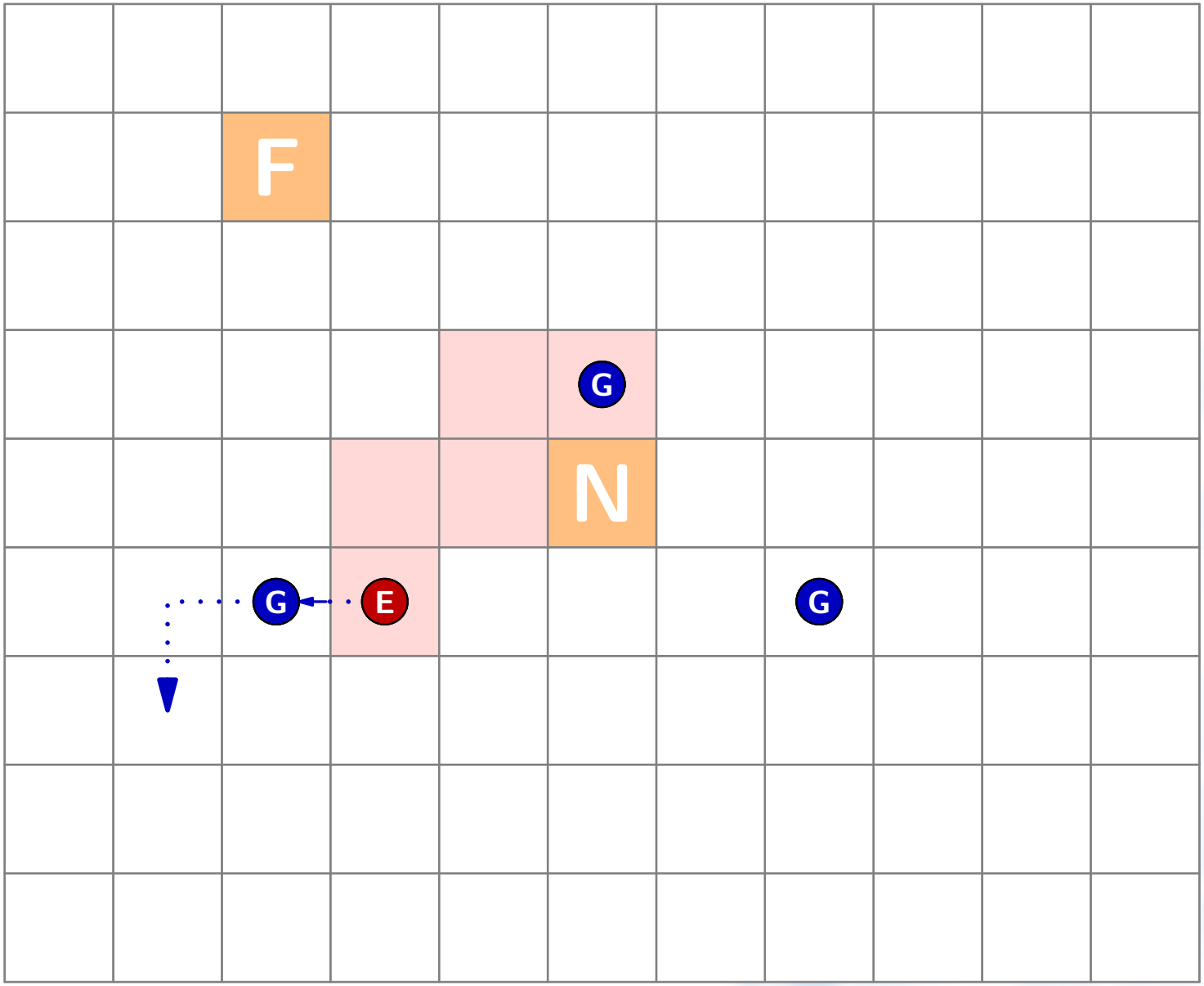

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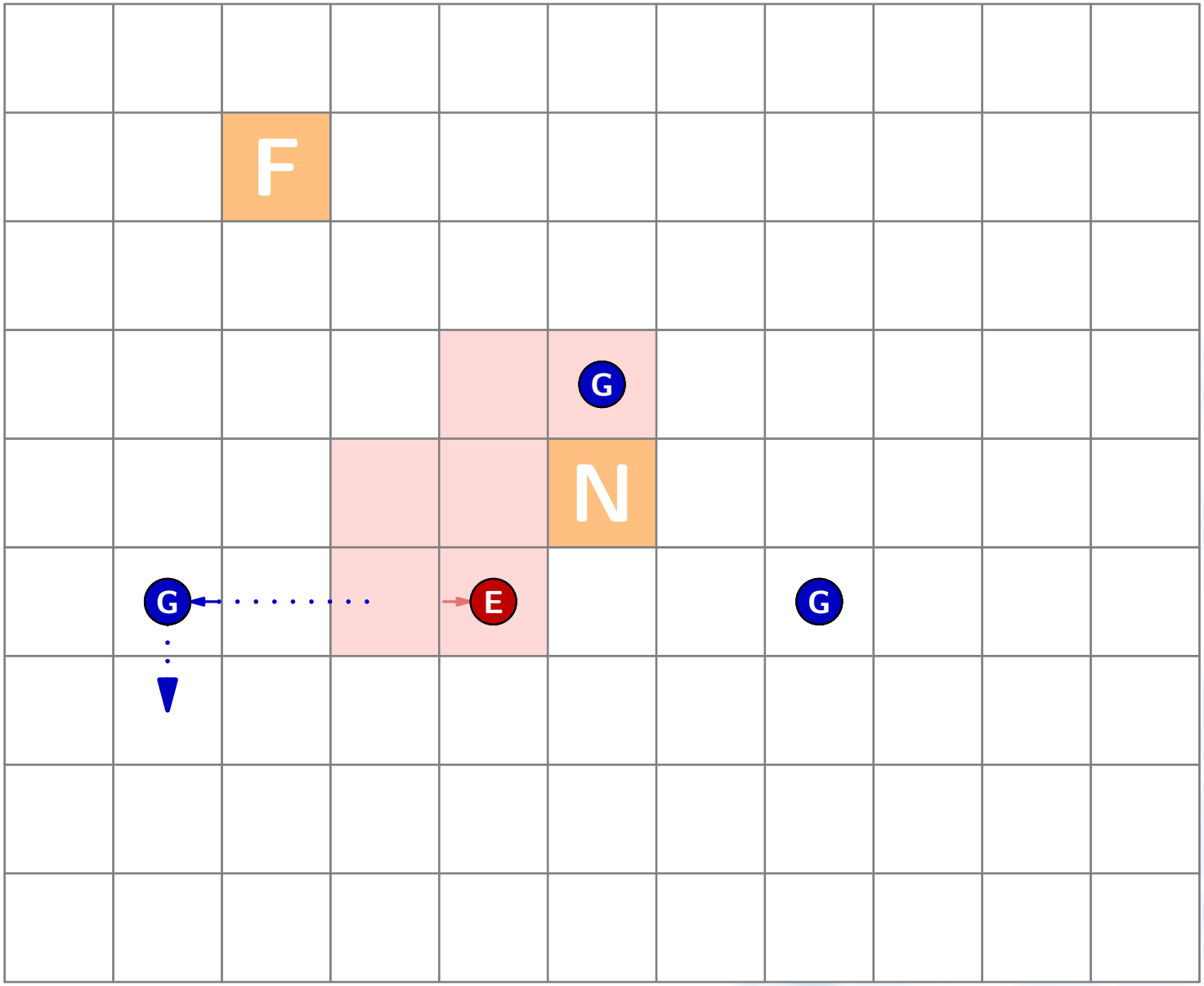

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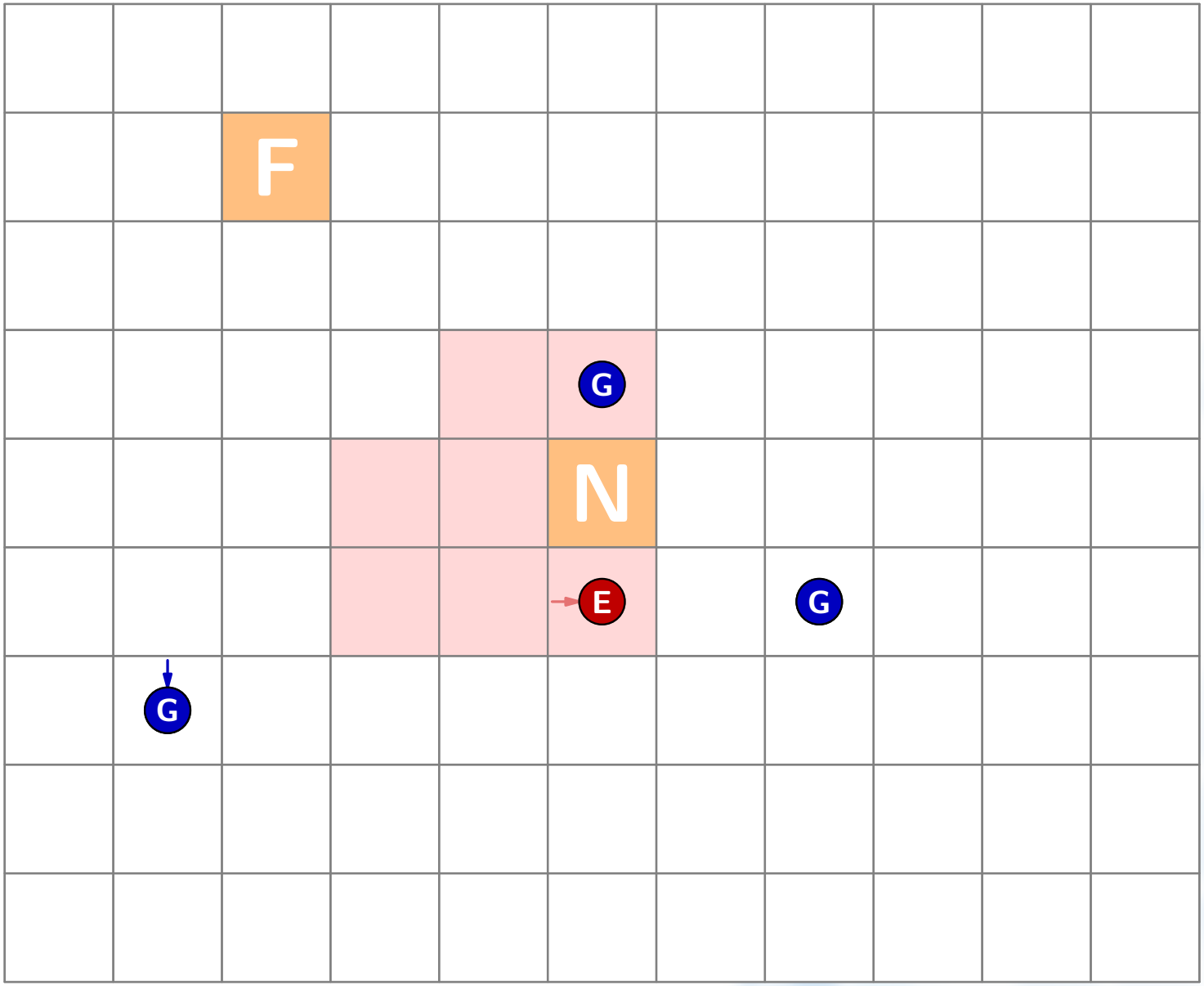

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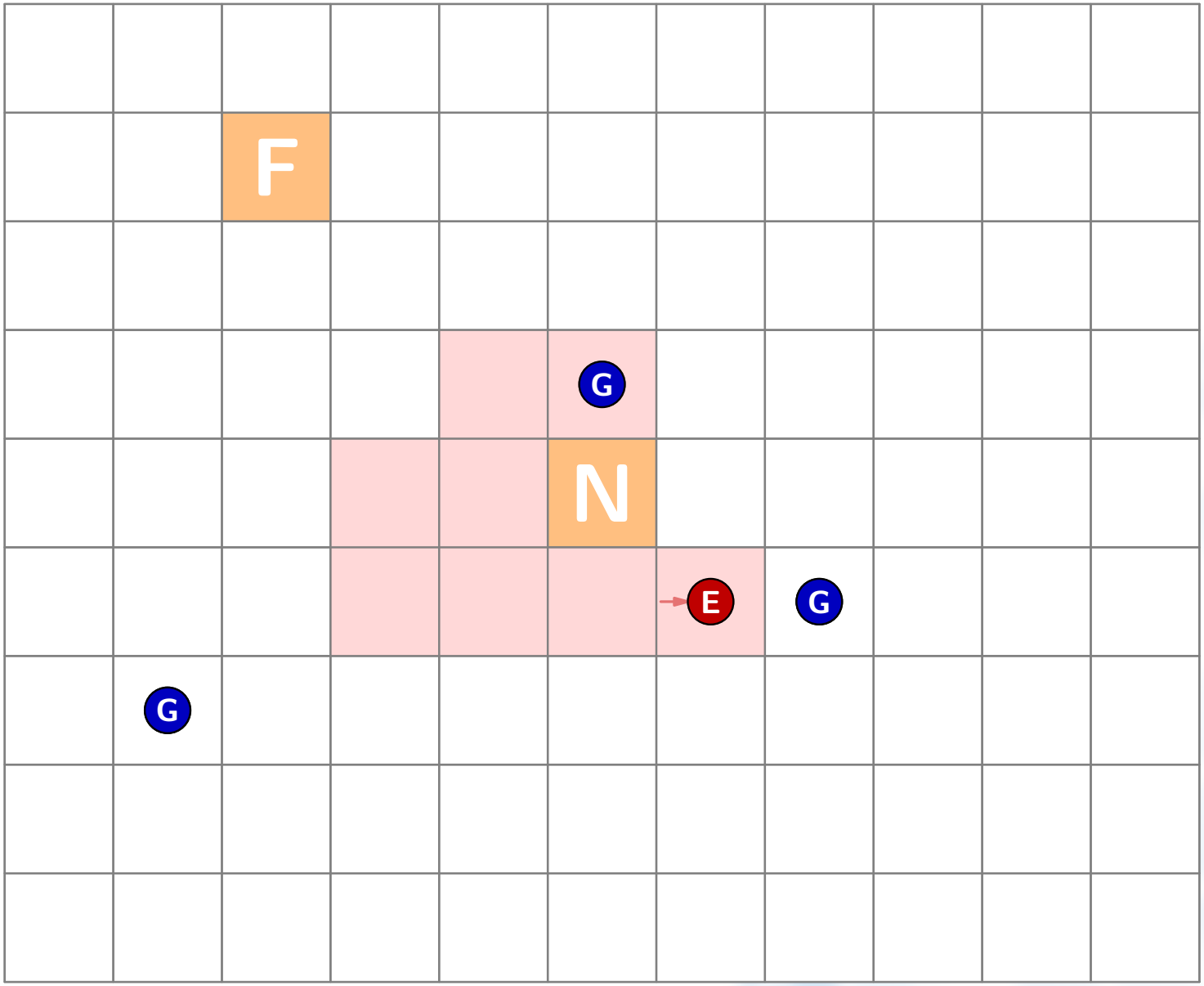

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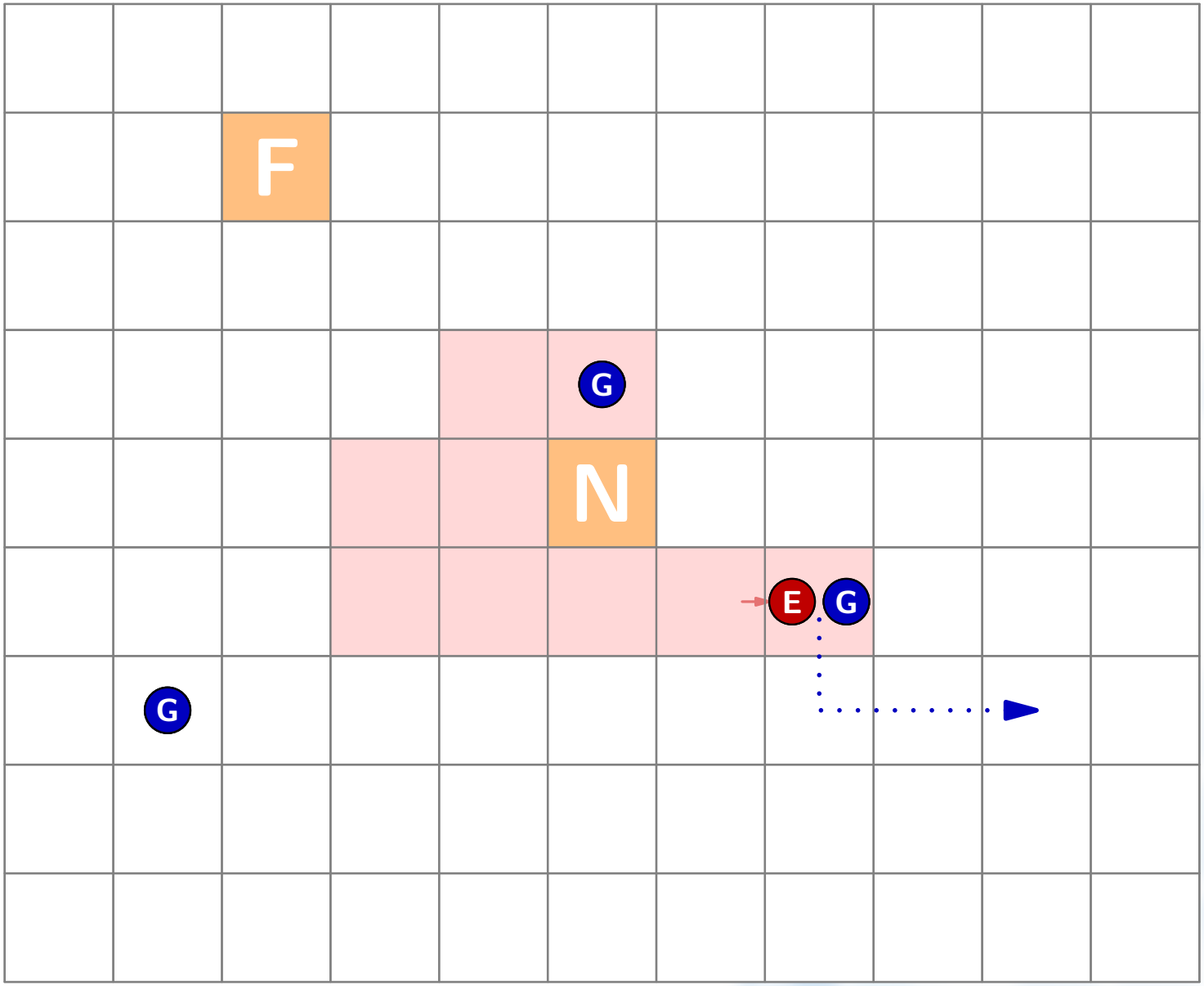

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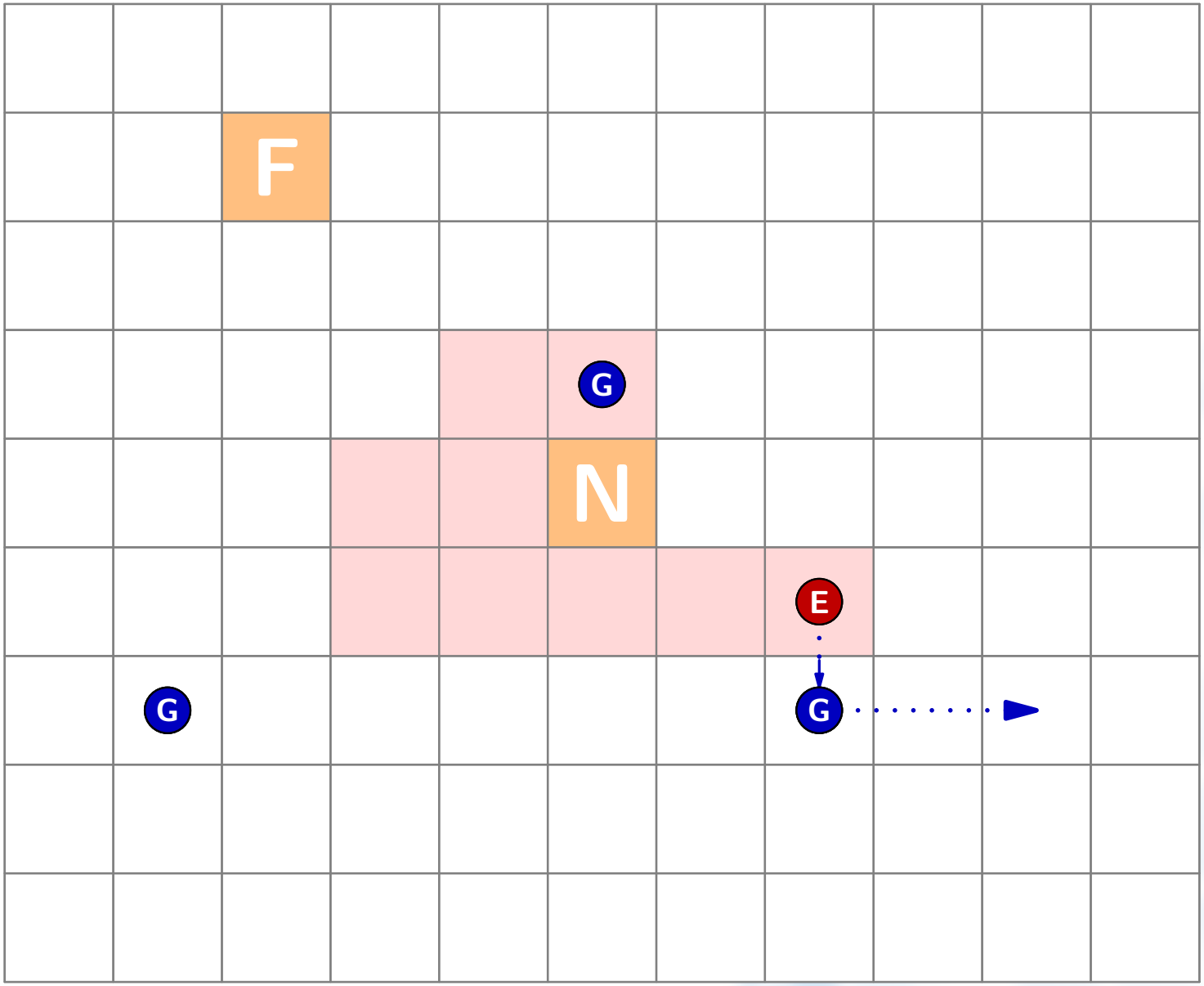

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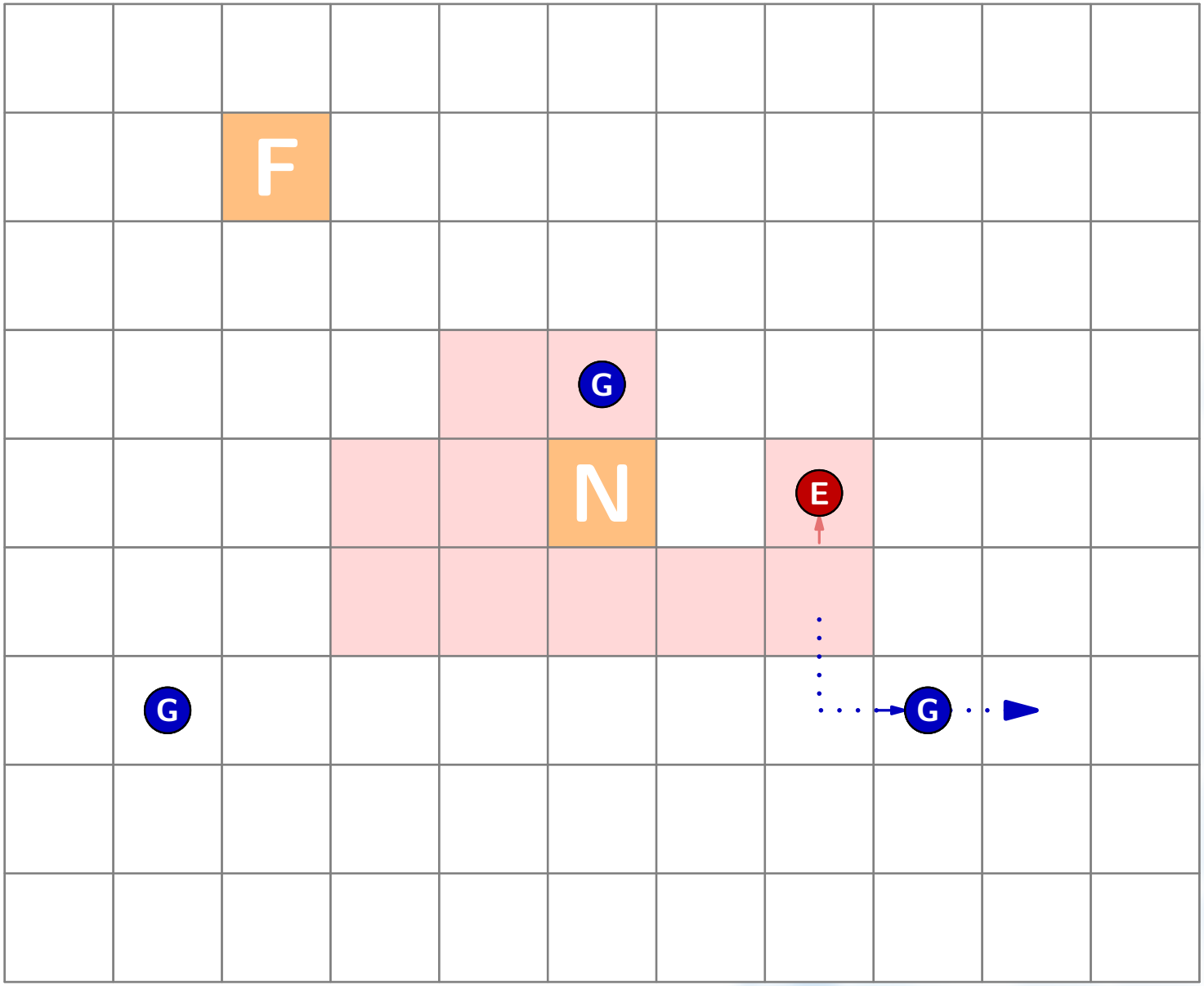

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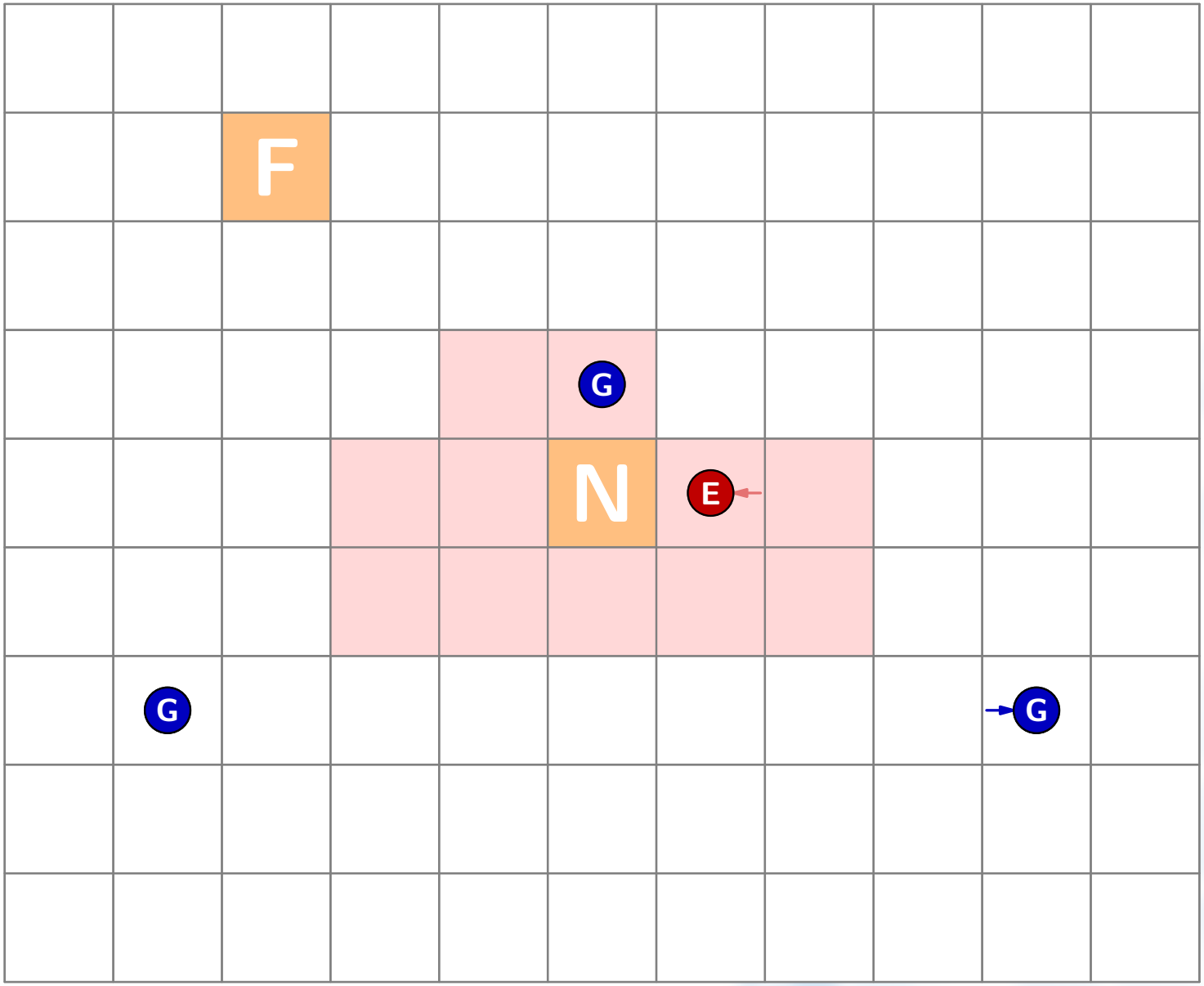

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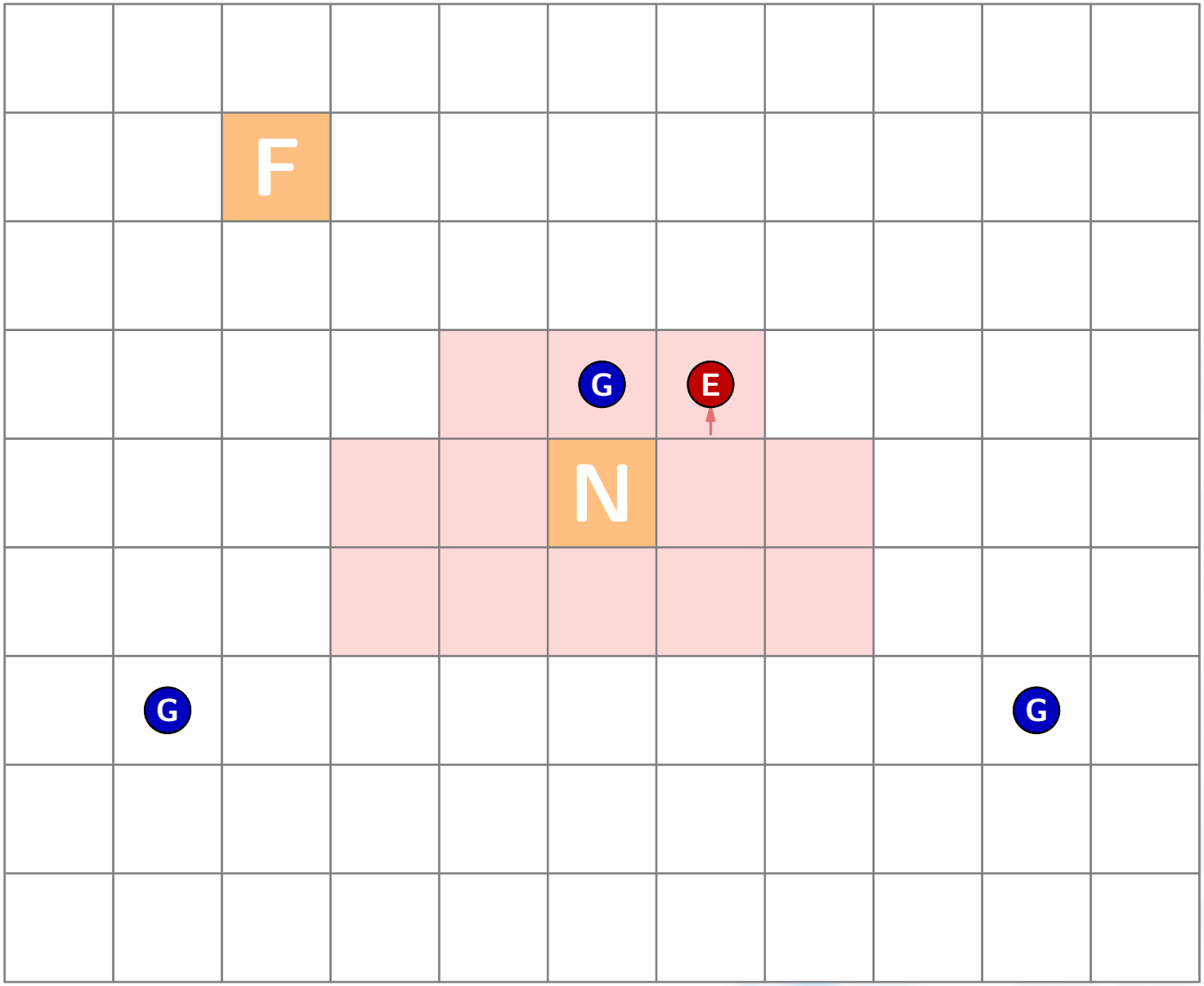

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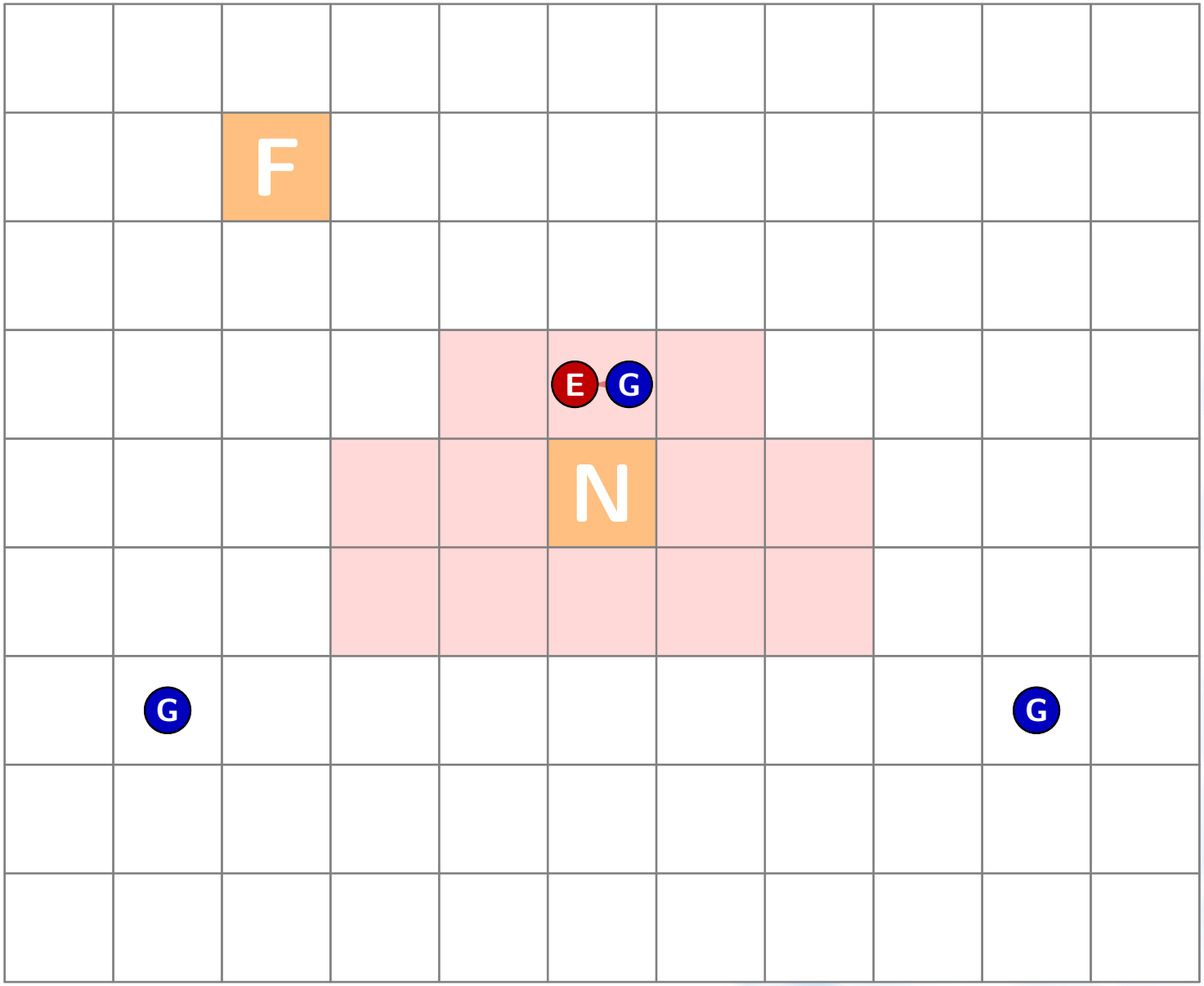

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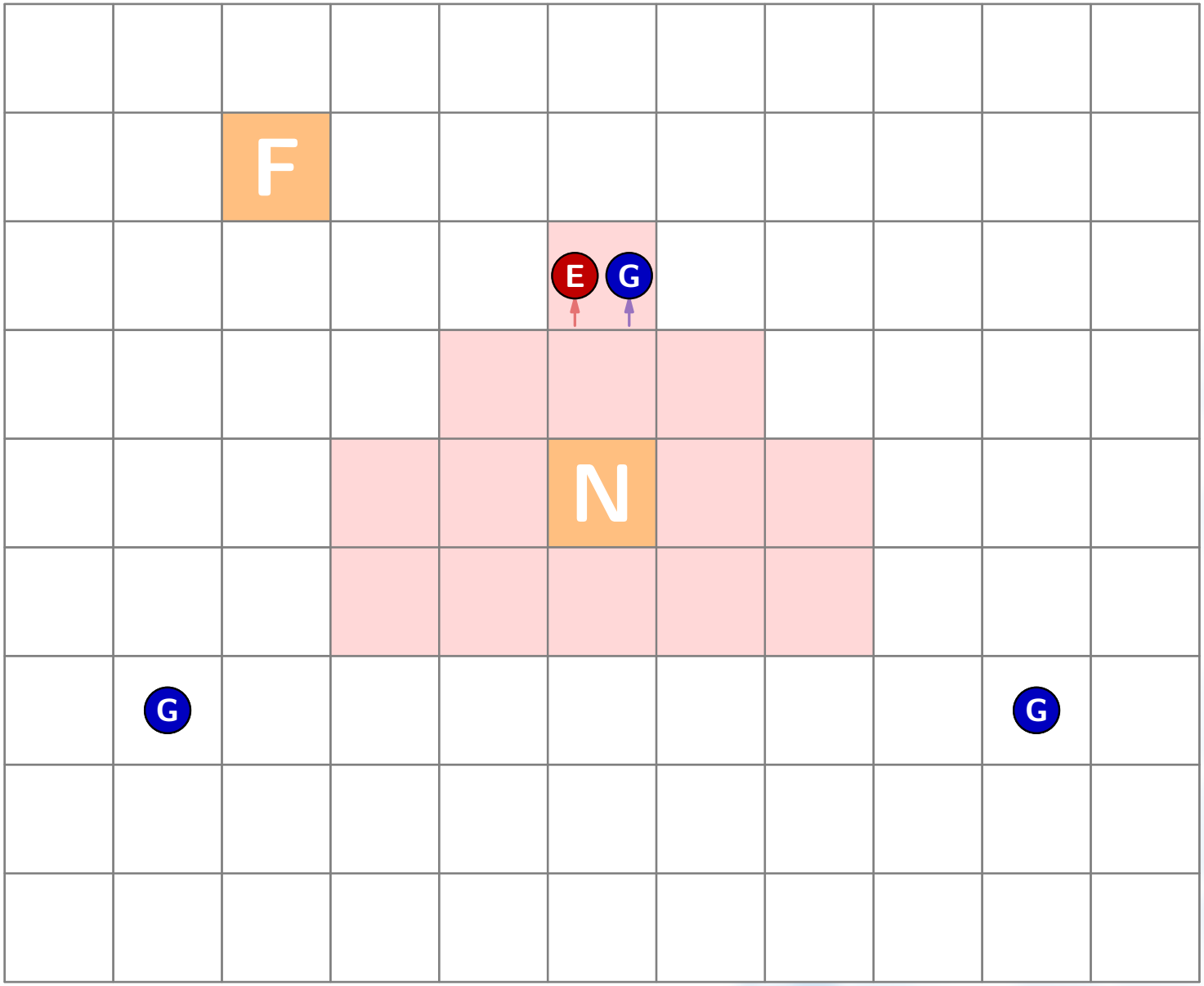

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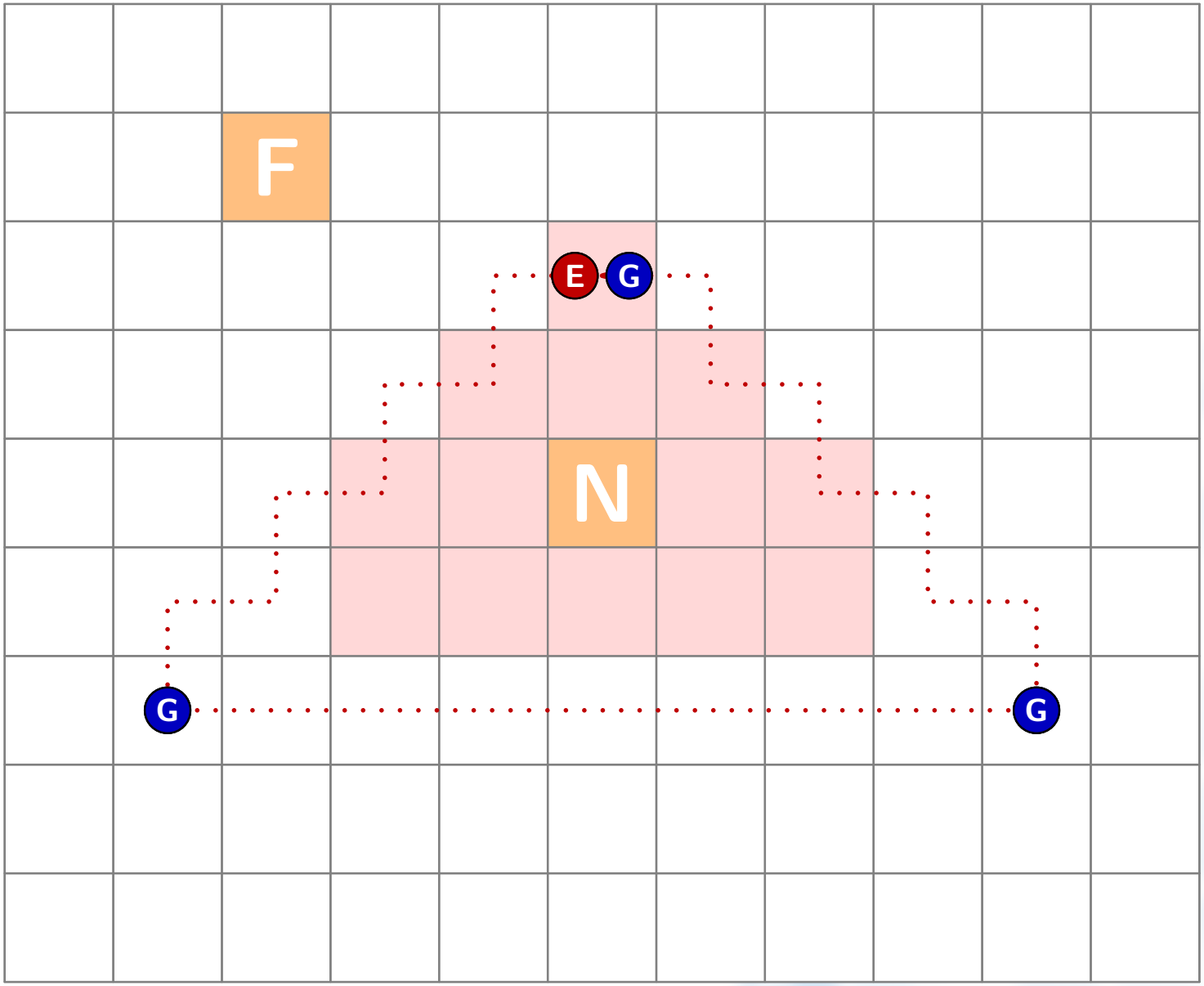

Synchronous and Deterministic

Can we do better if the ants have a common sense of time?

Diamond Search

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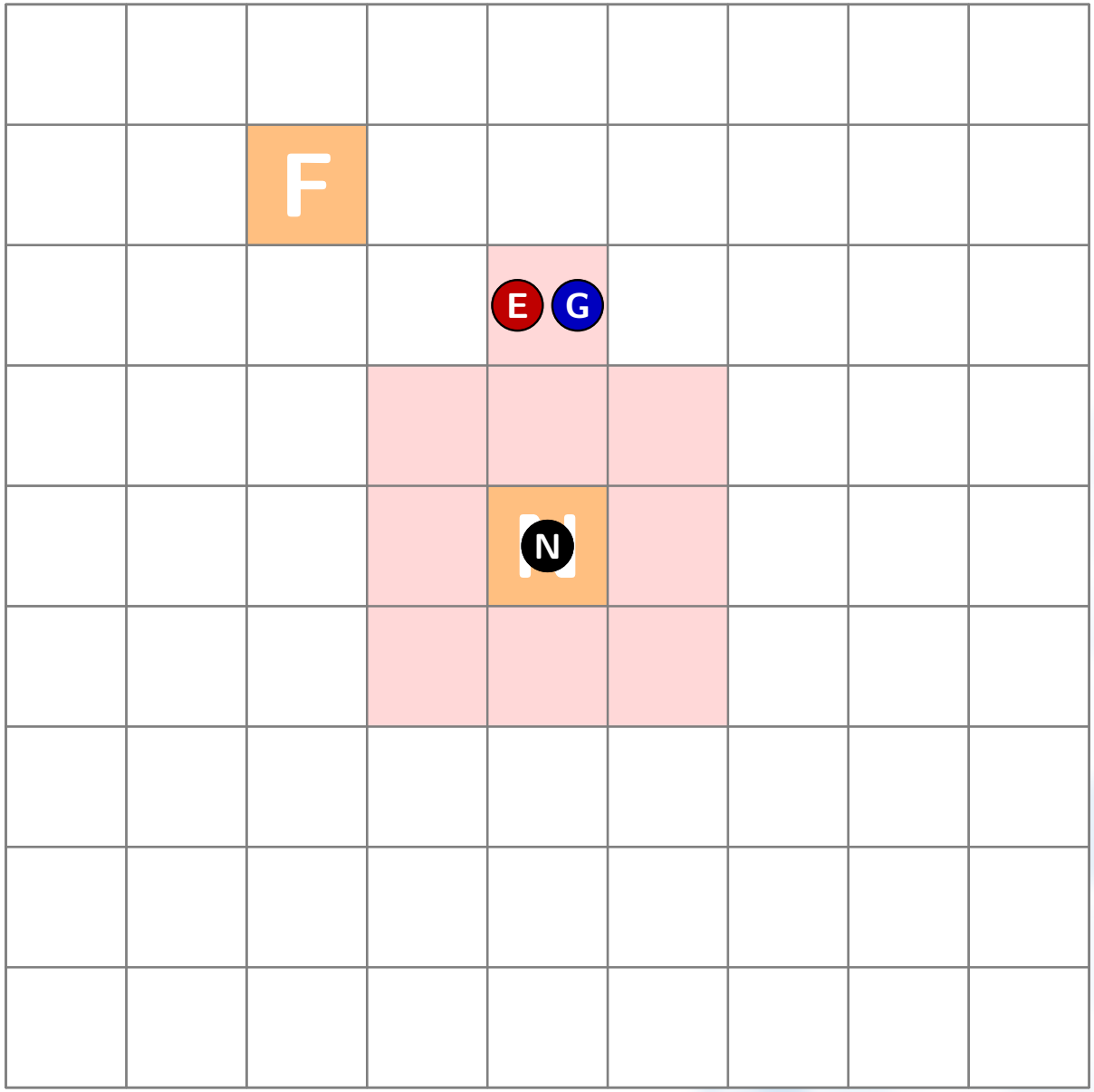

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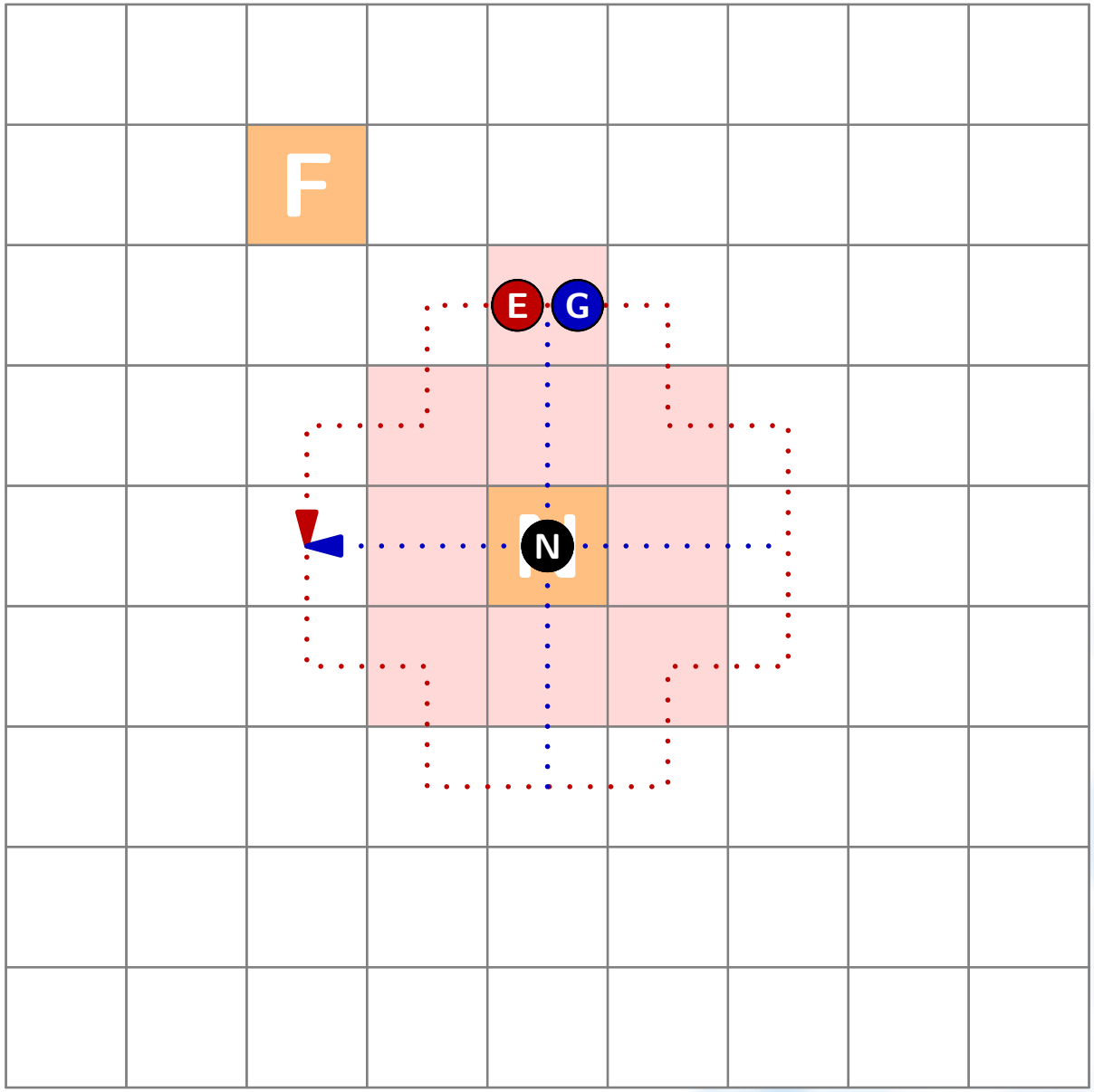

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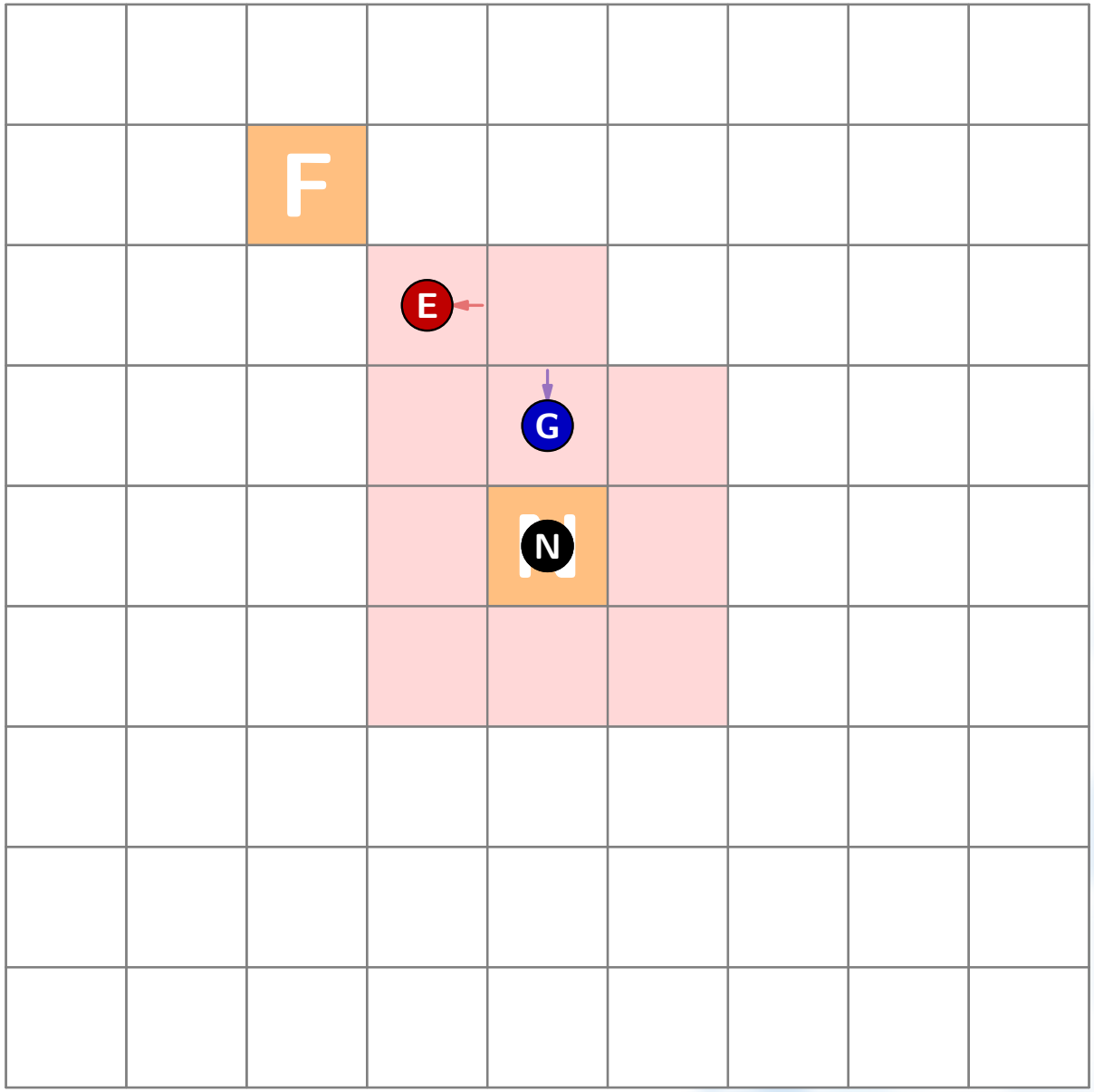

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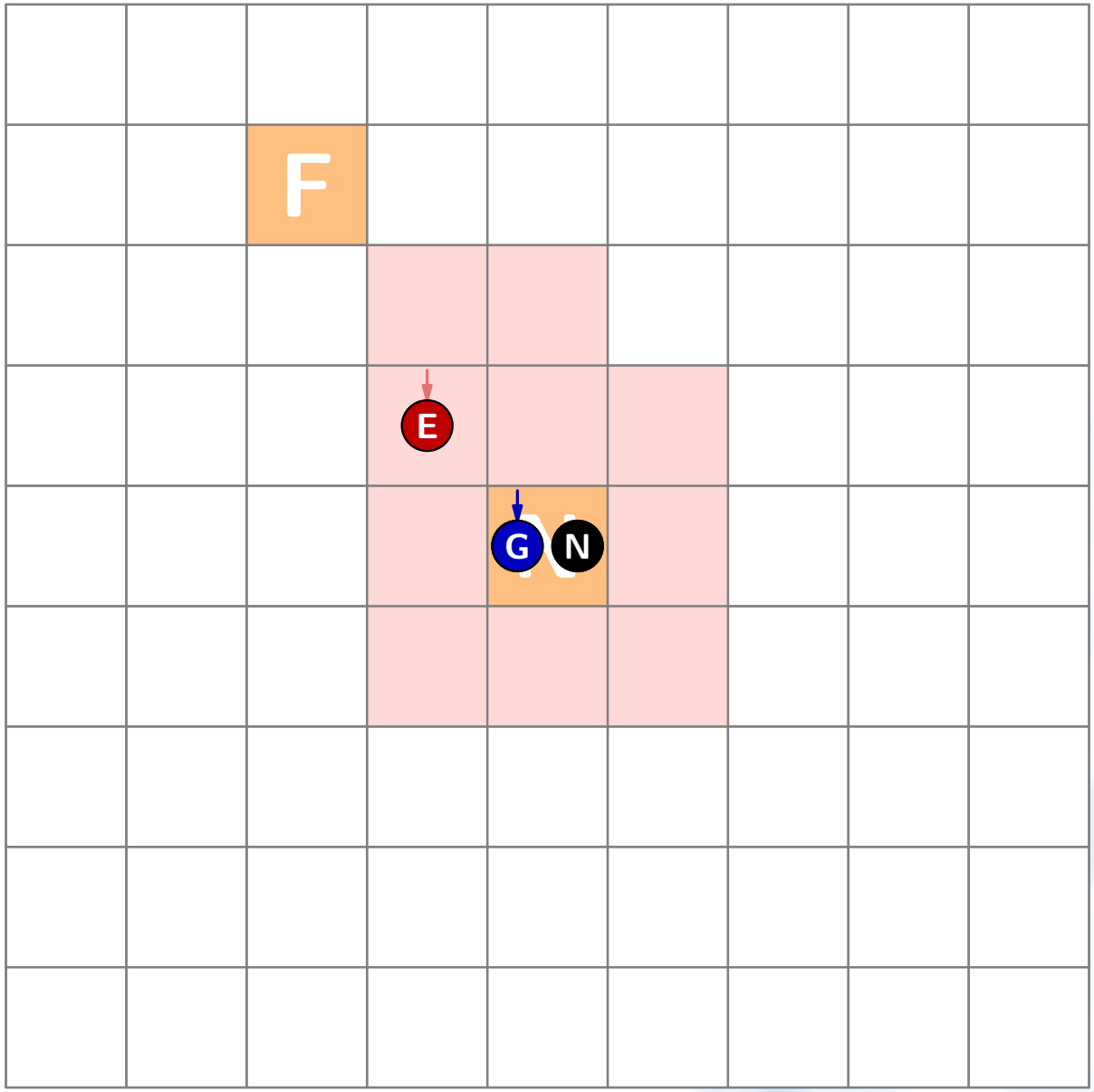

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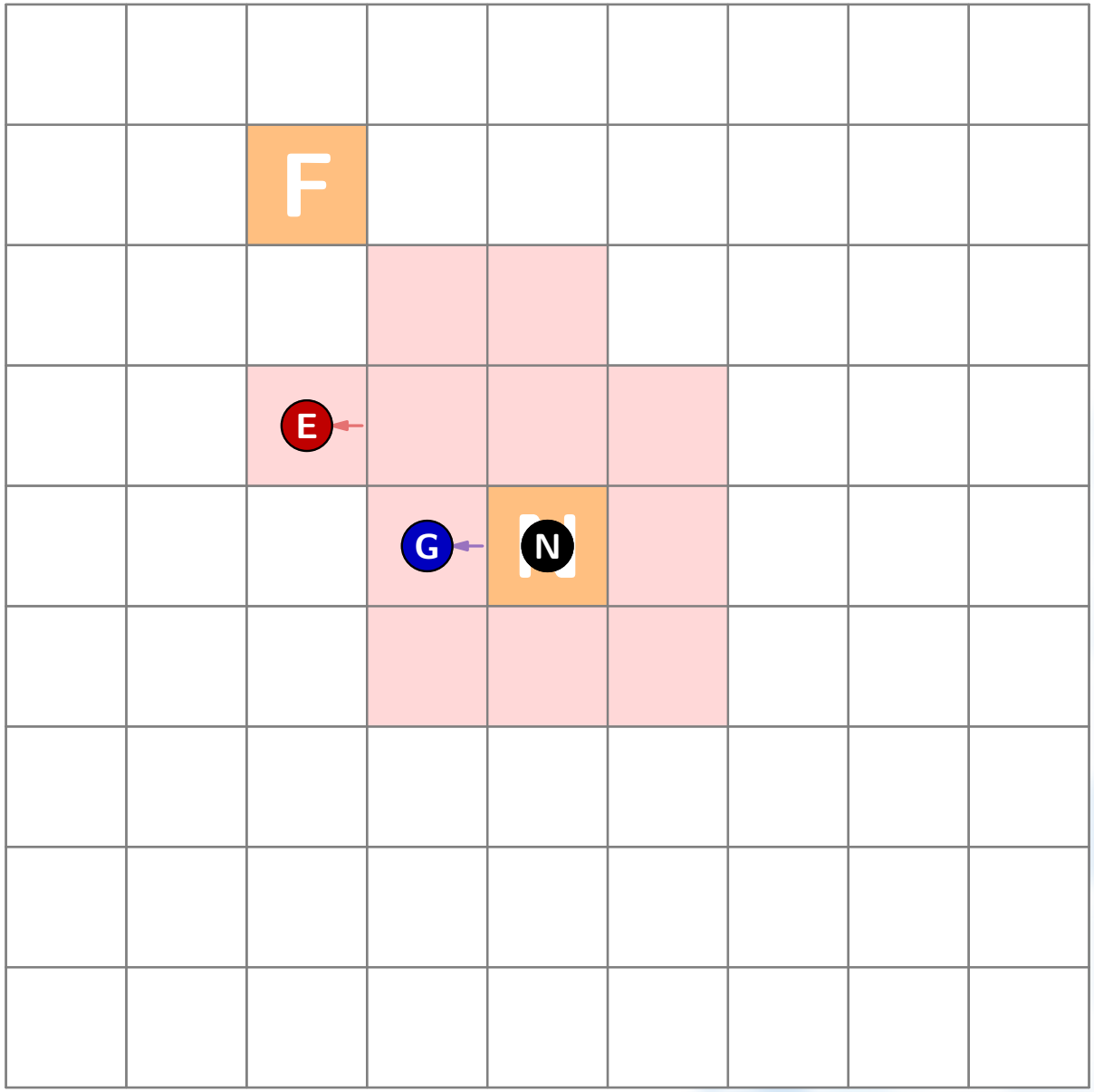

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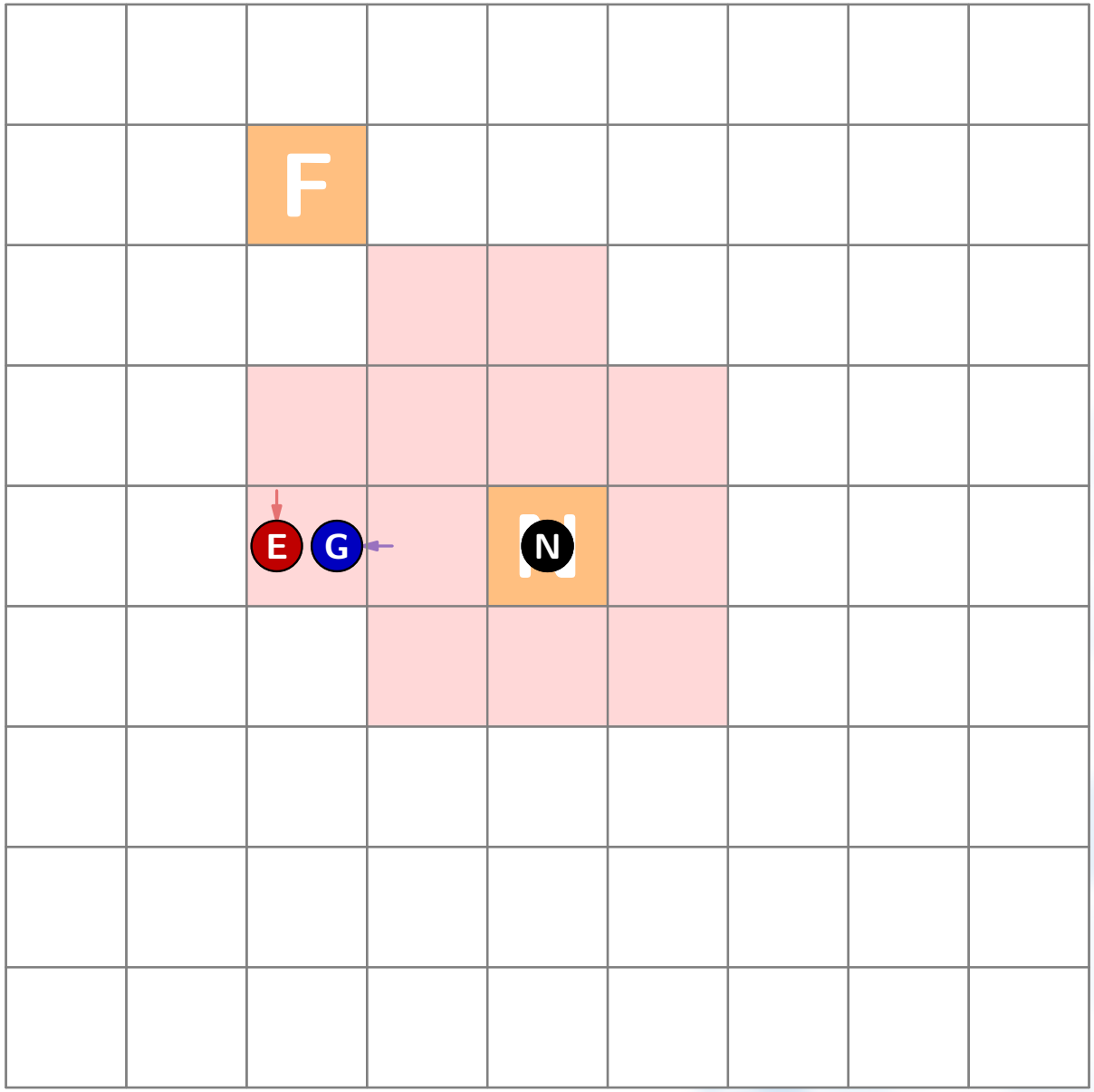

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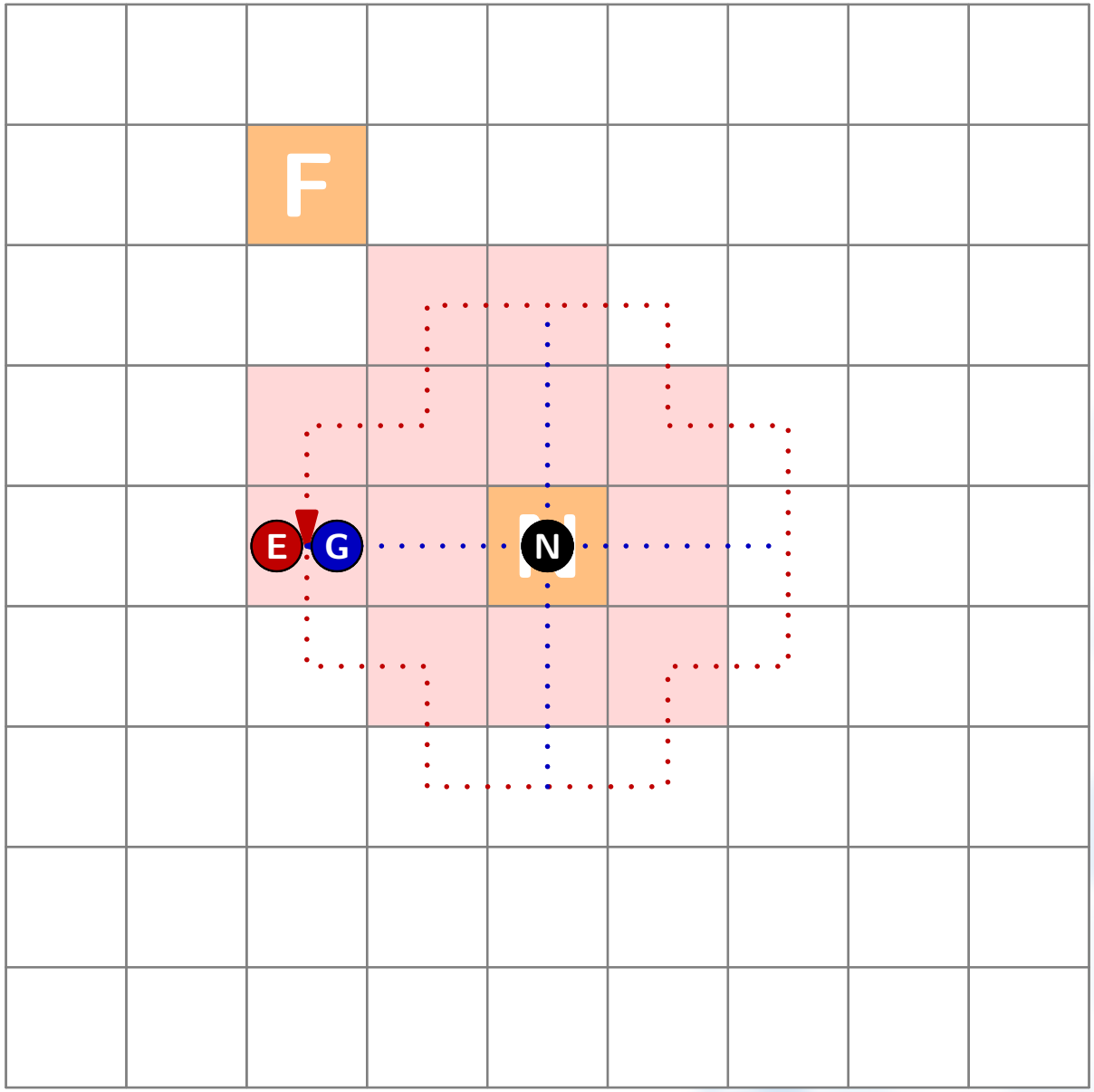

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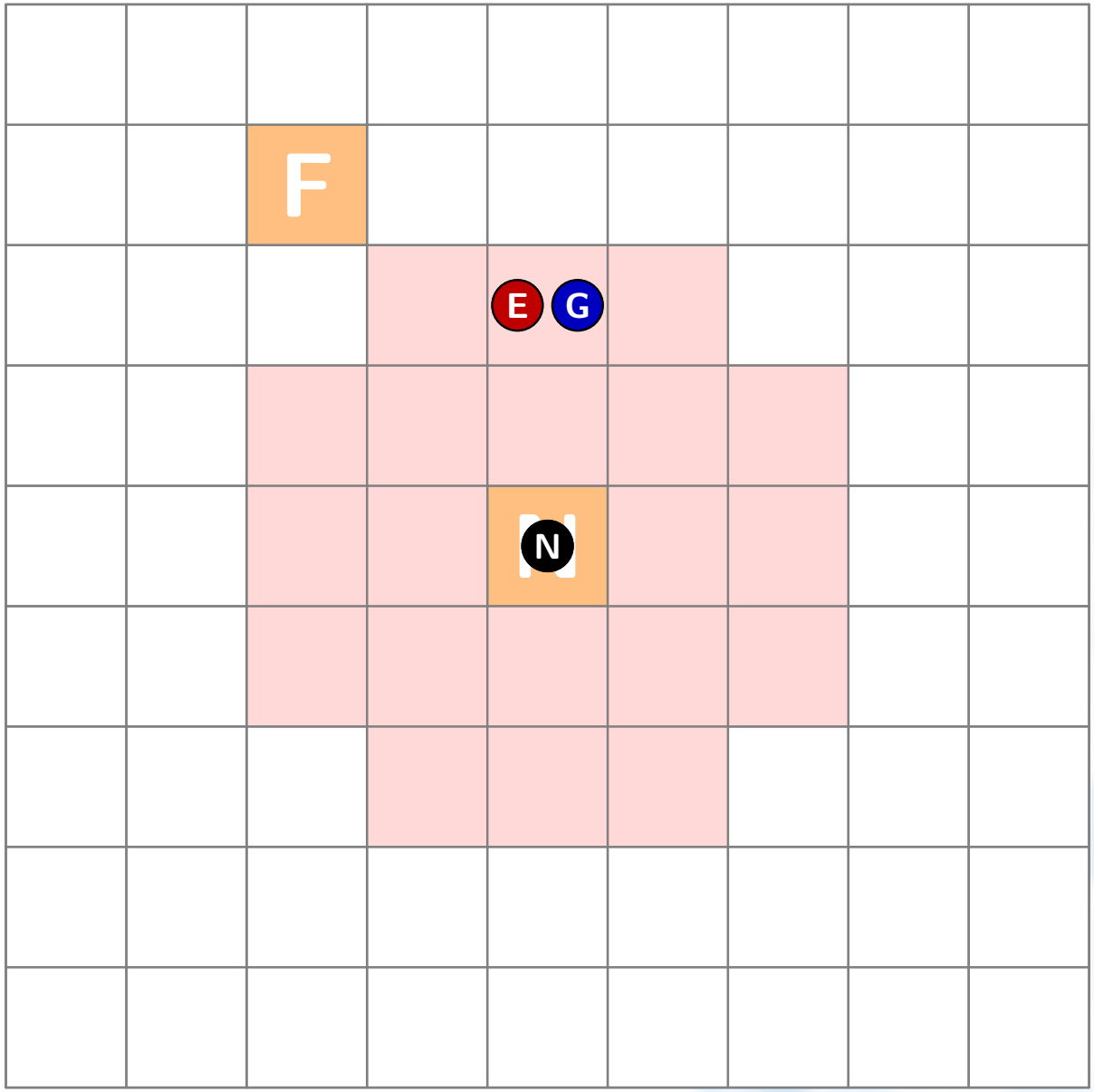

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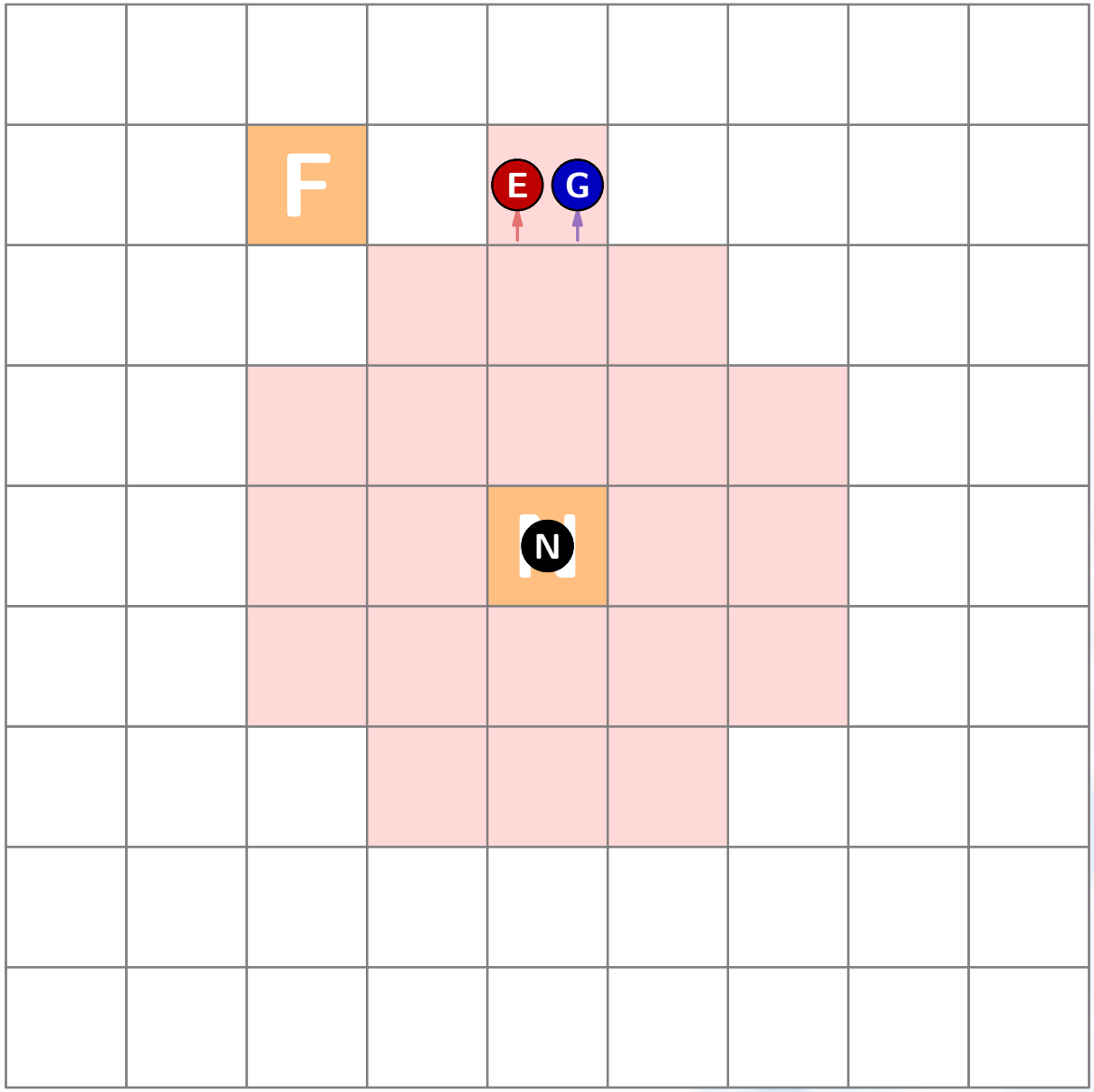

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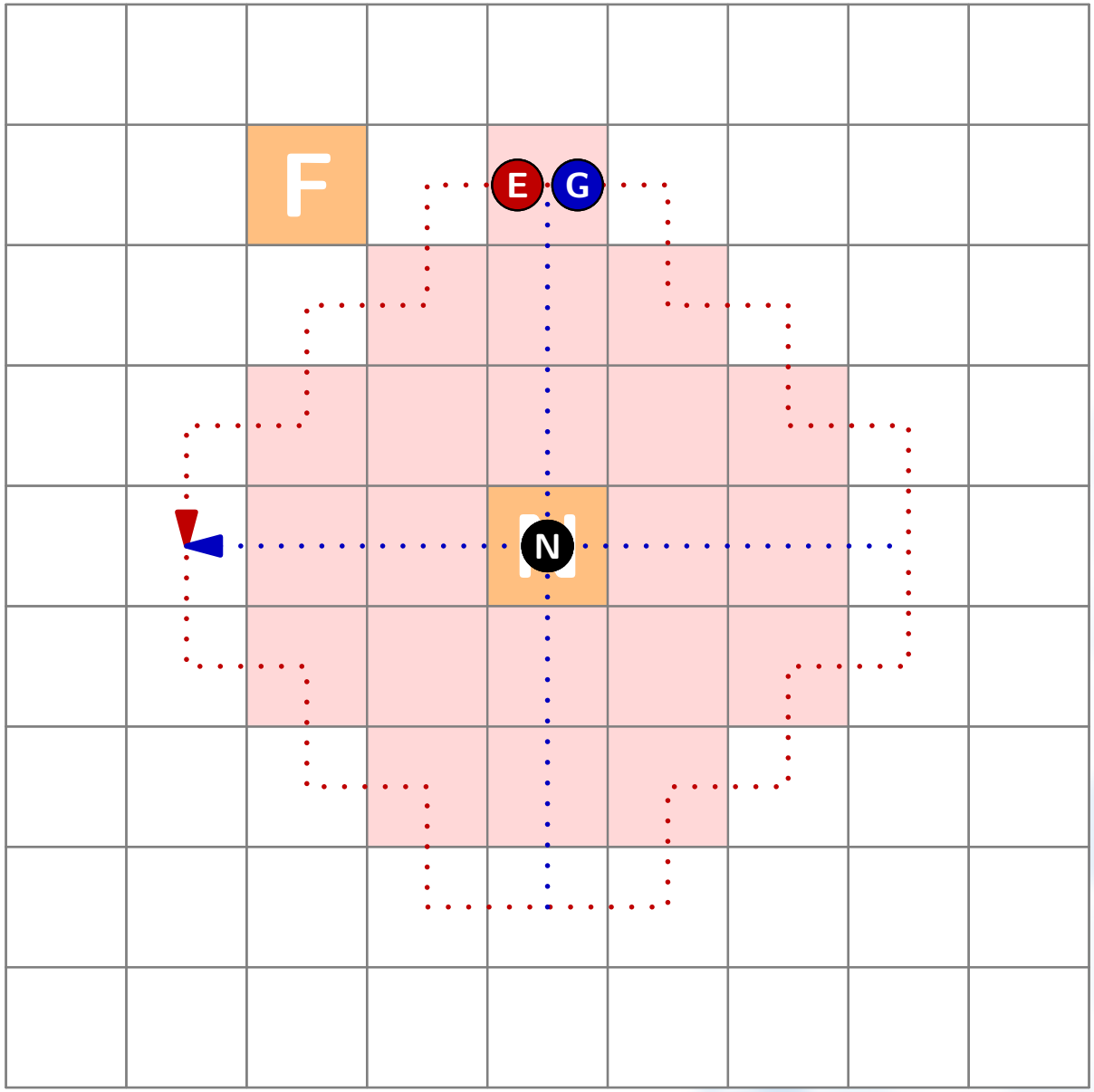
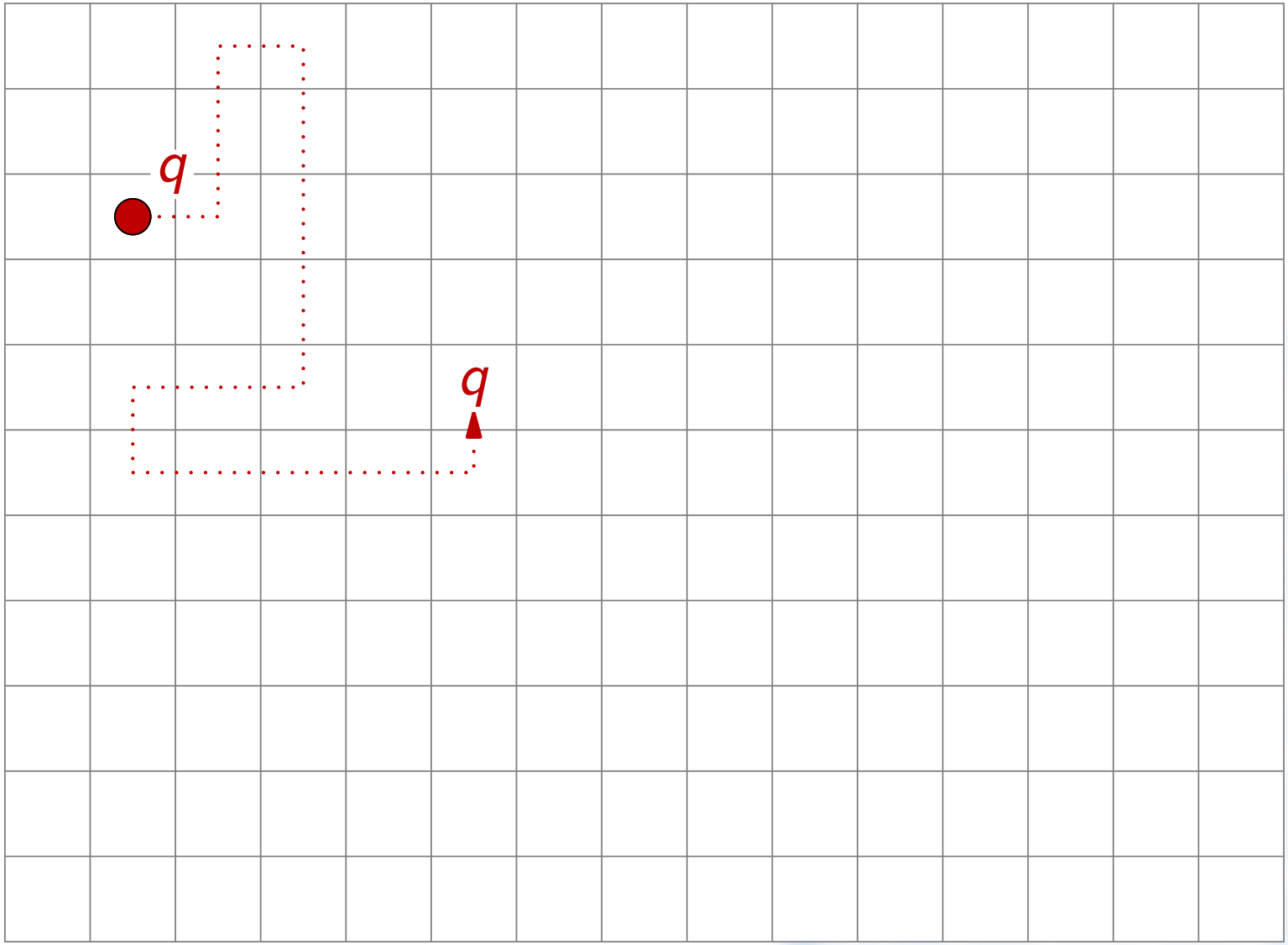


Lower Bounds

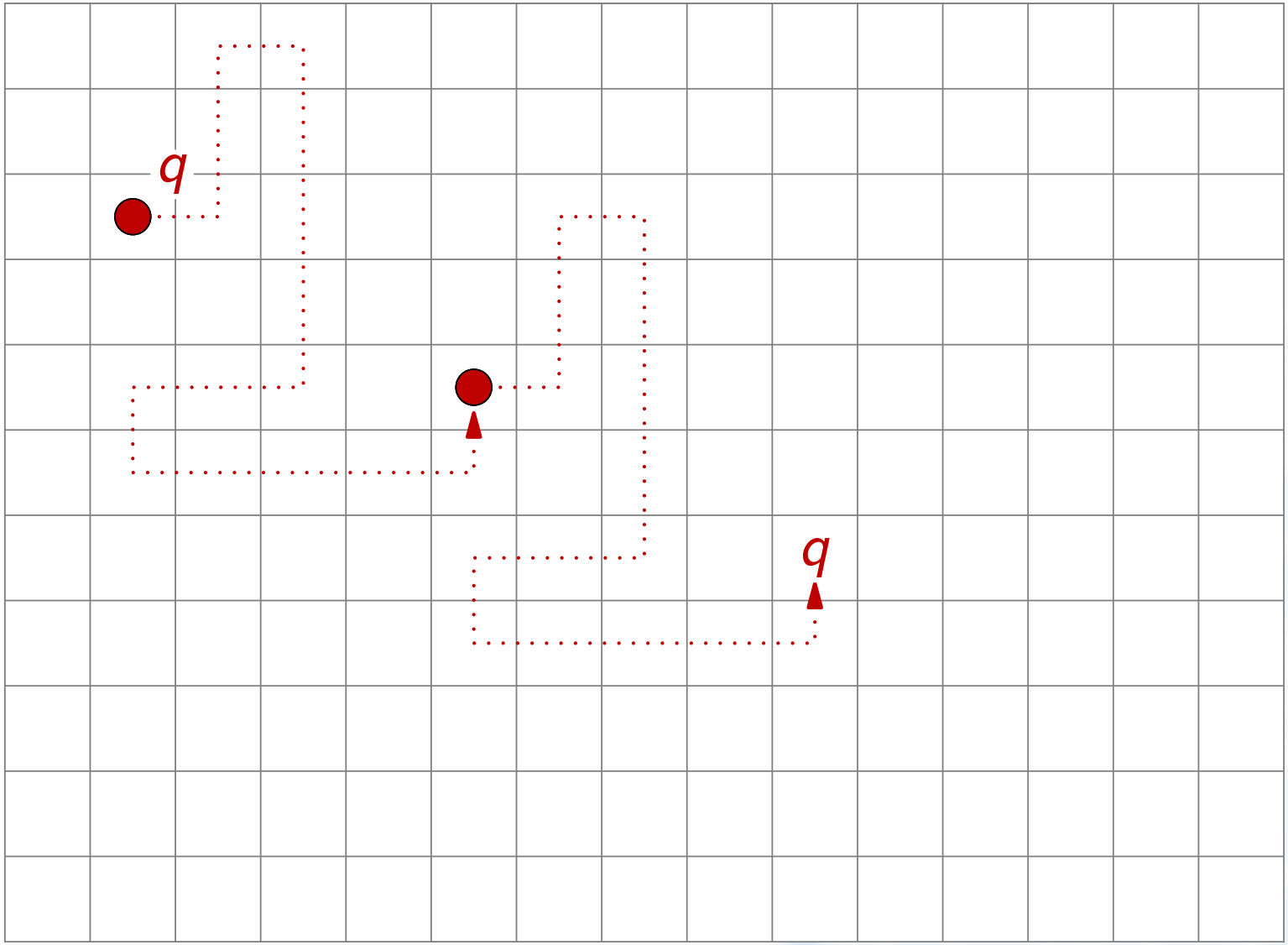
Is this any good? Can we do better?

One Ant

One Ant



One Ant



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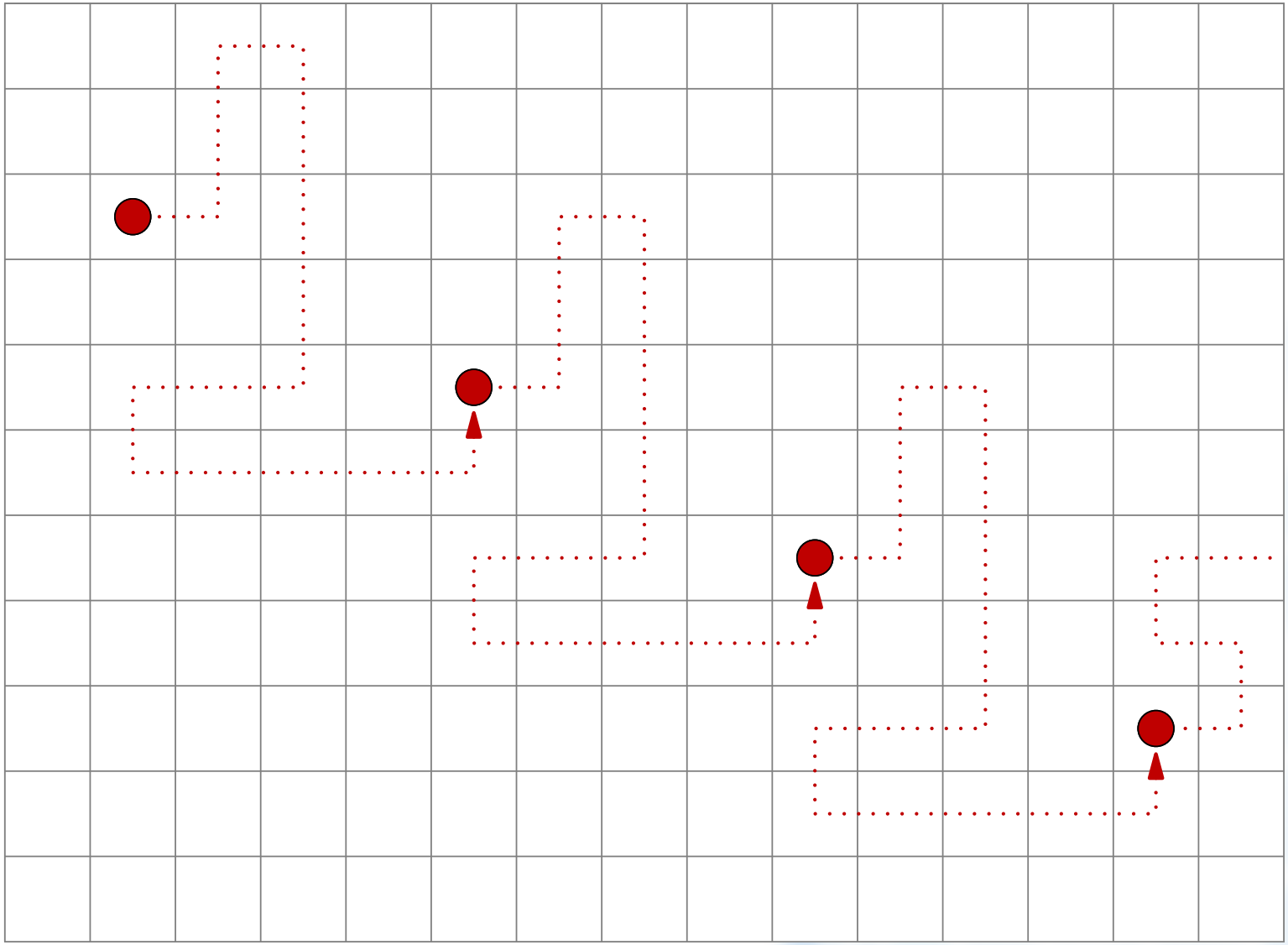

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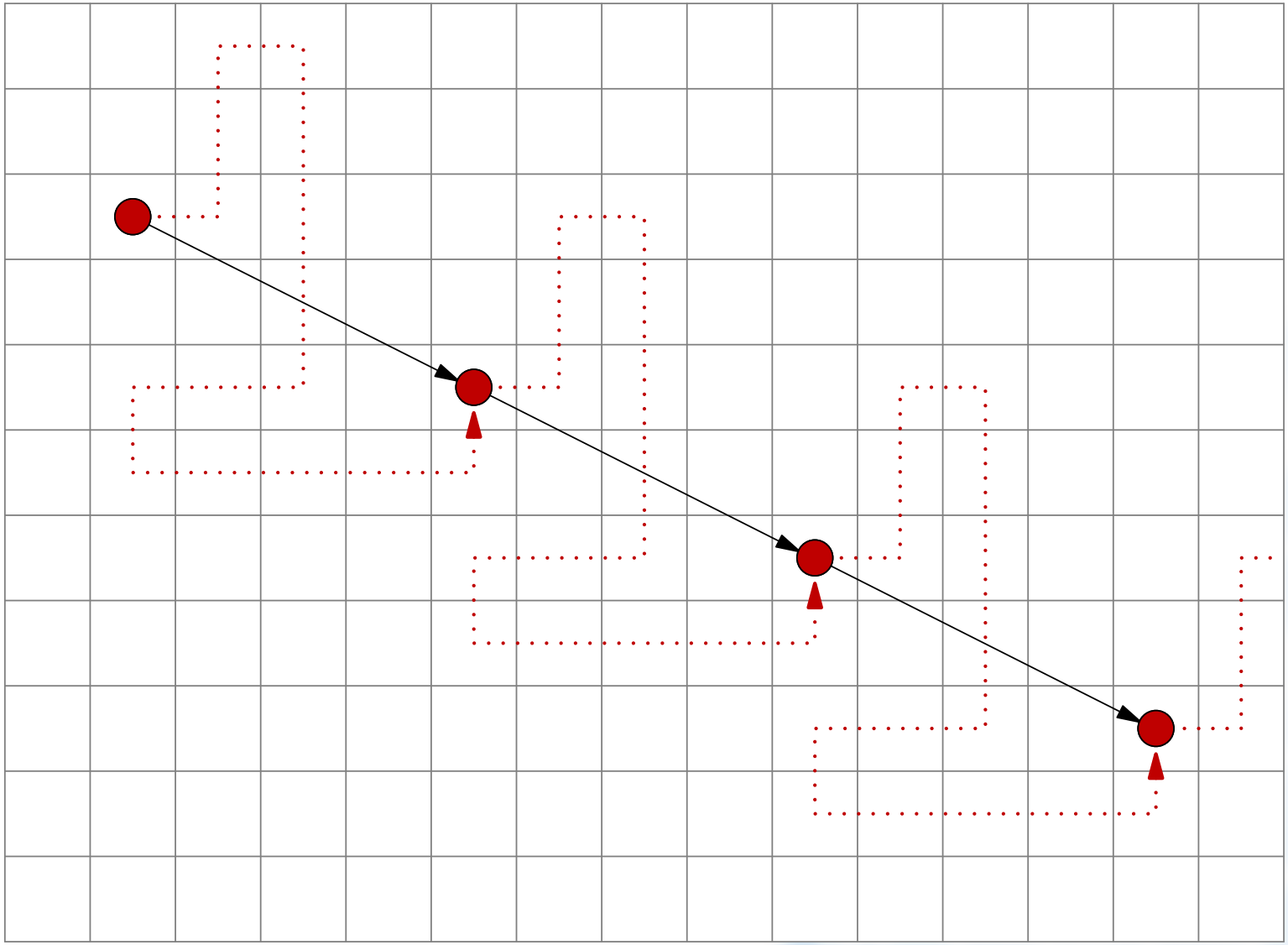

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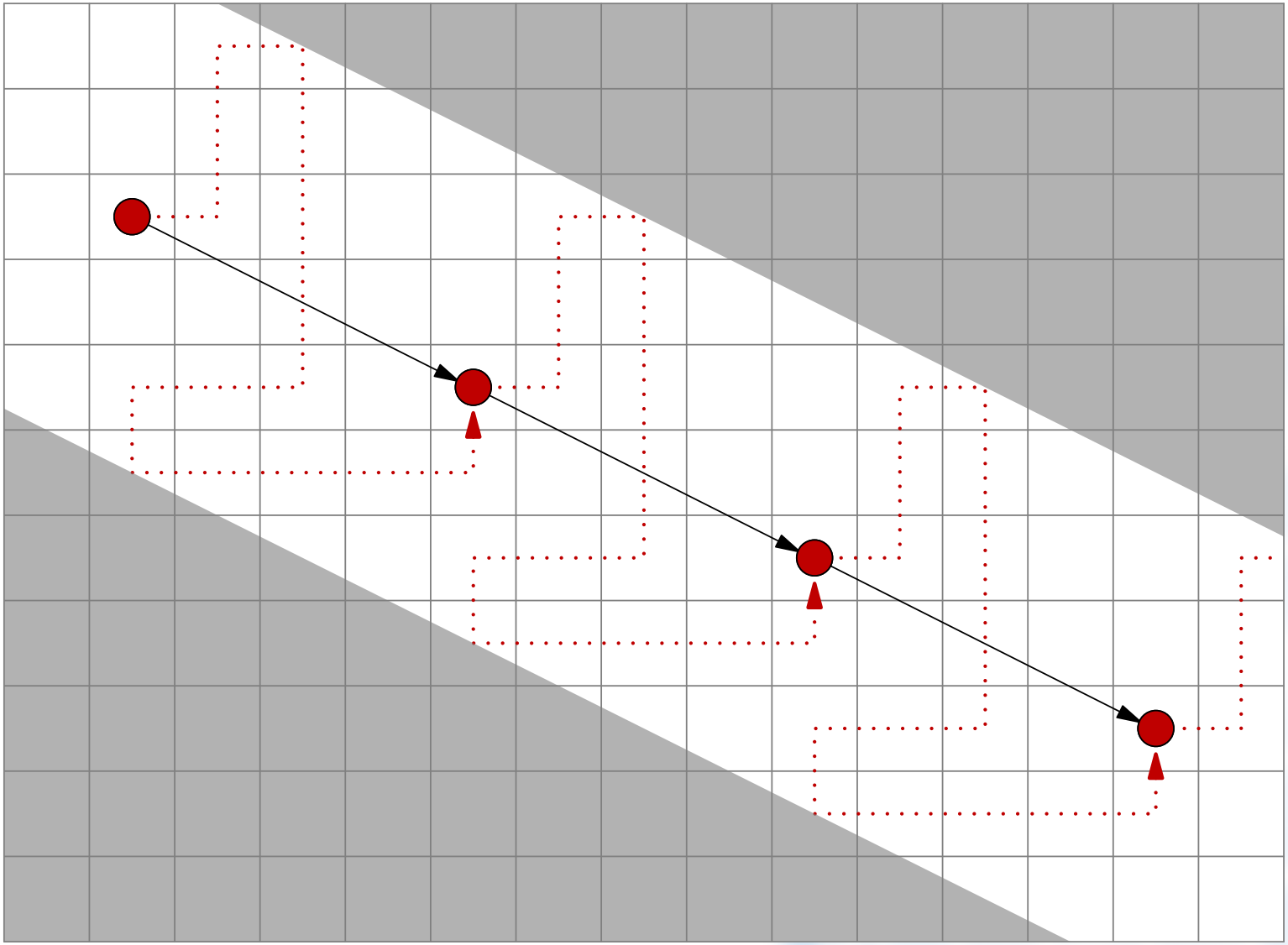
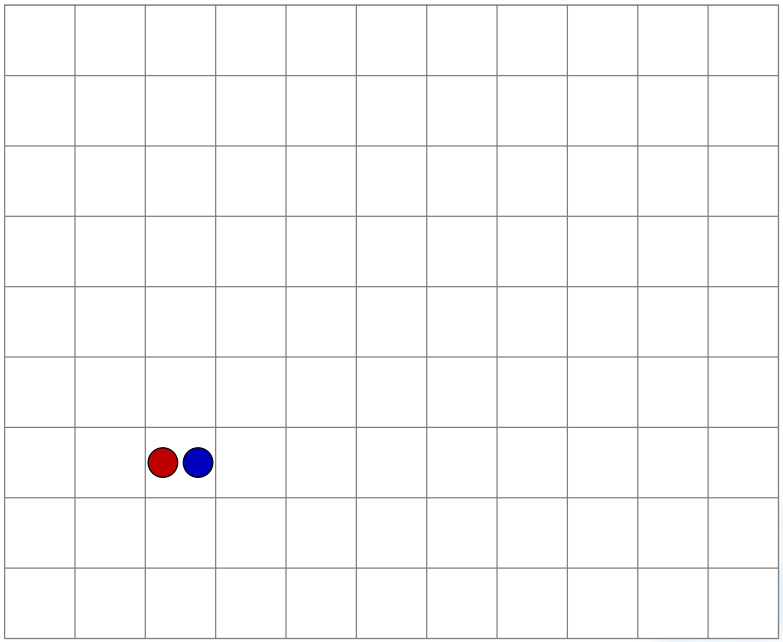


Two Ants

Observation: Ants have to meet infinitely often in states (q, q').

Two Ants



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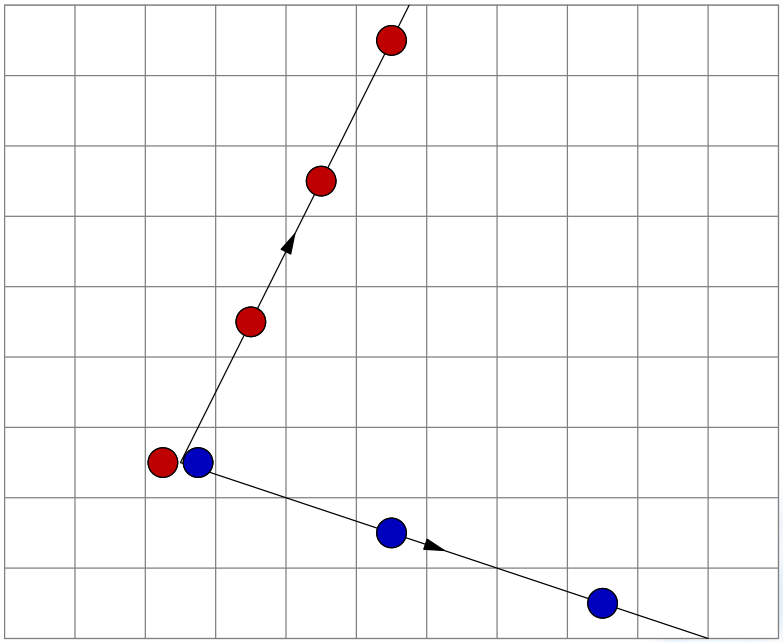

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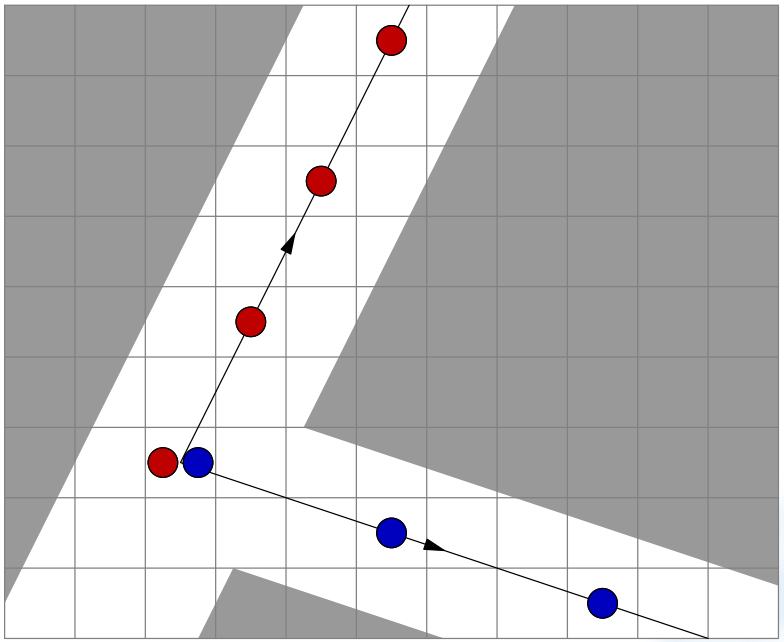

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Two Ants

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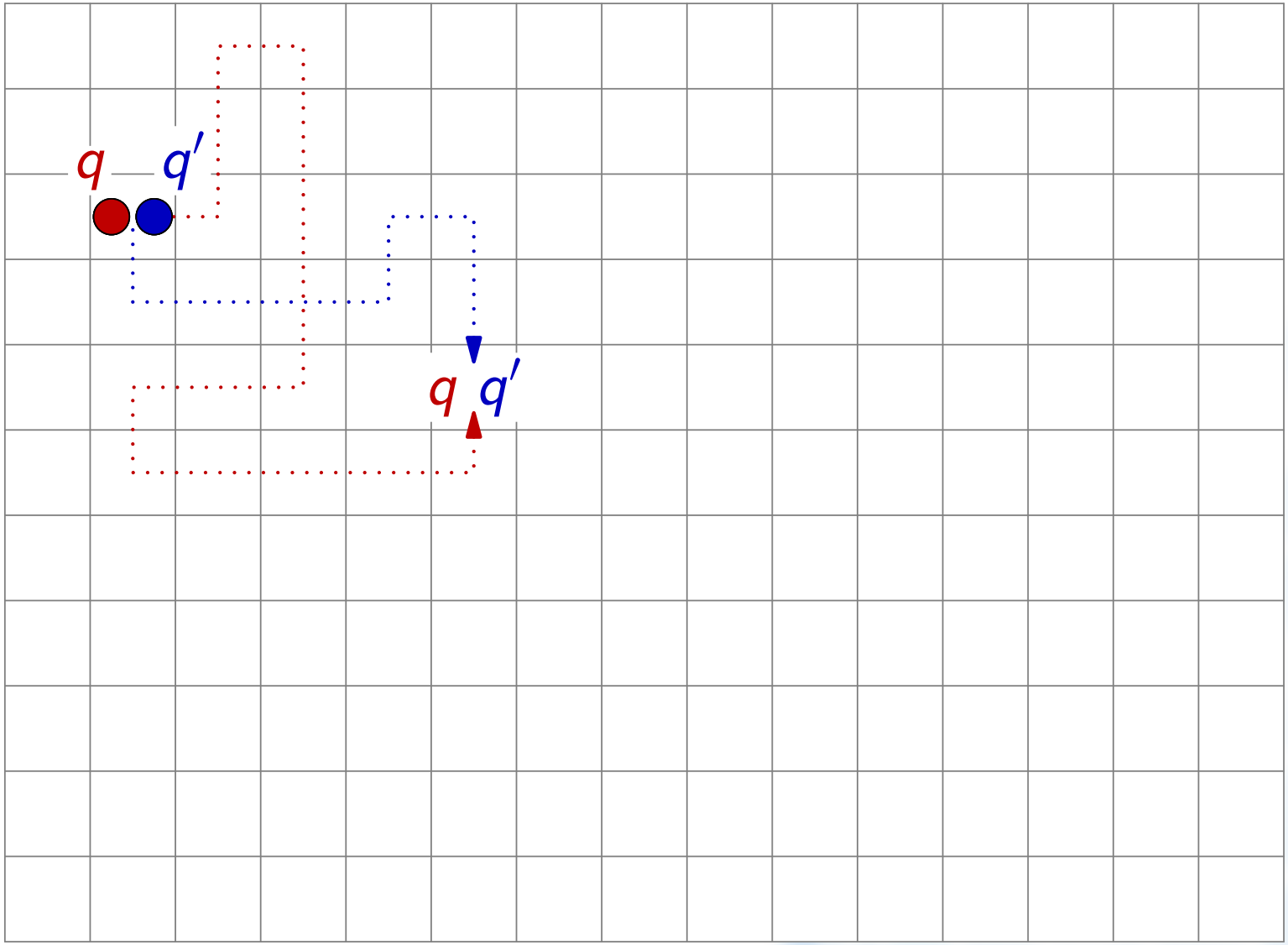
Observation: Time between such meetings is constant.

Two Ants

Two Ants



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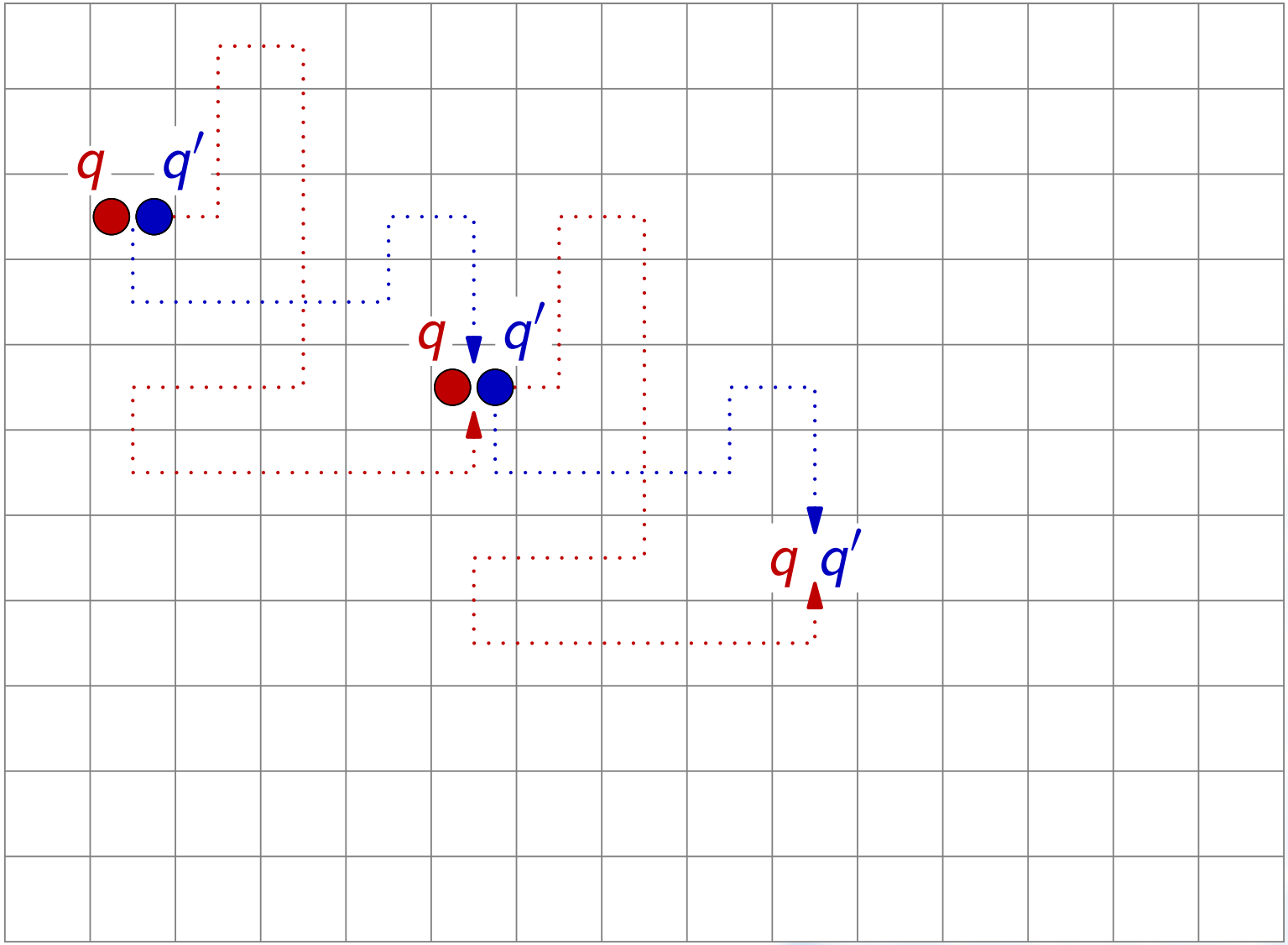

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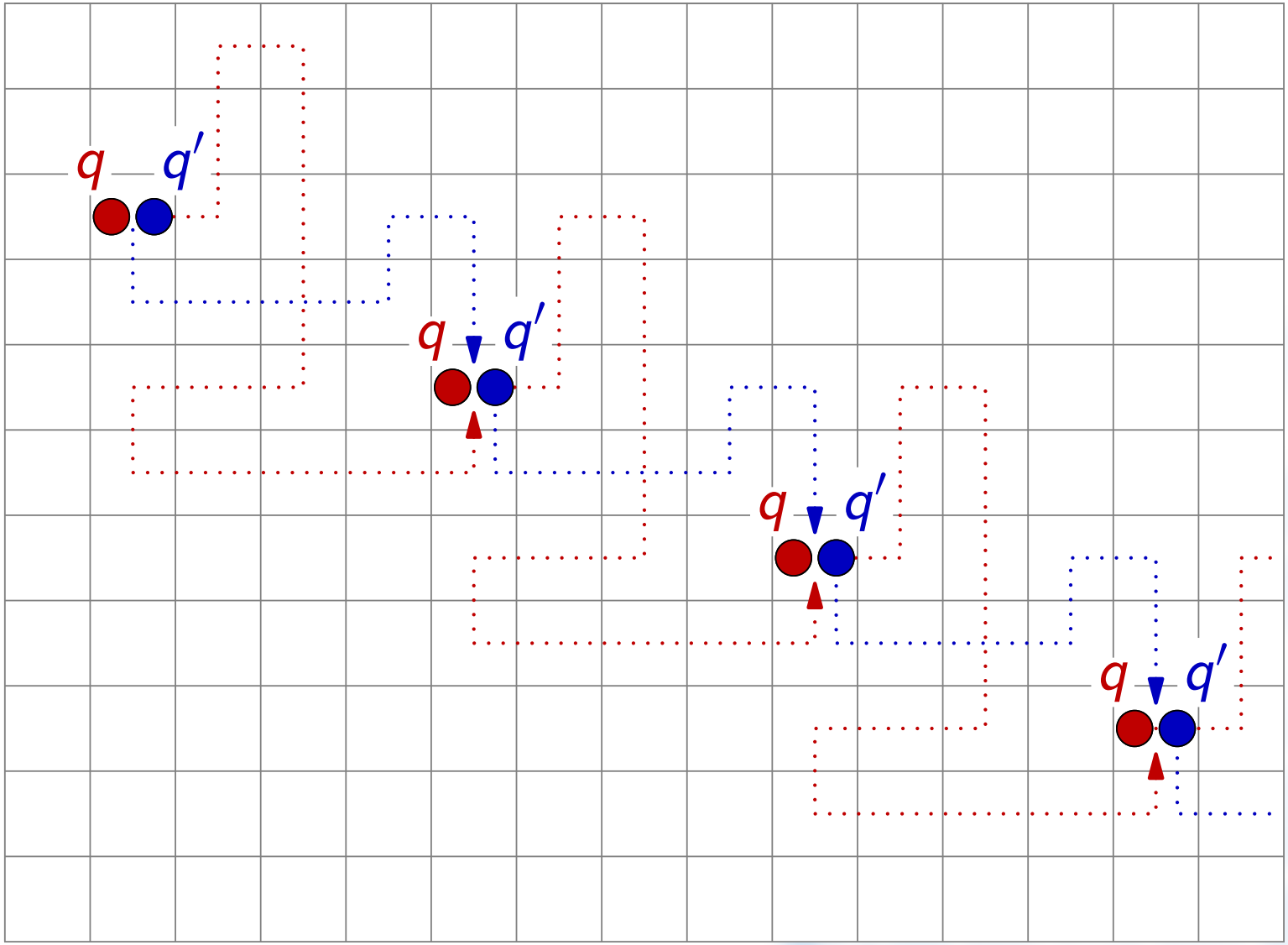

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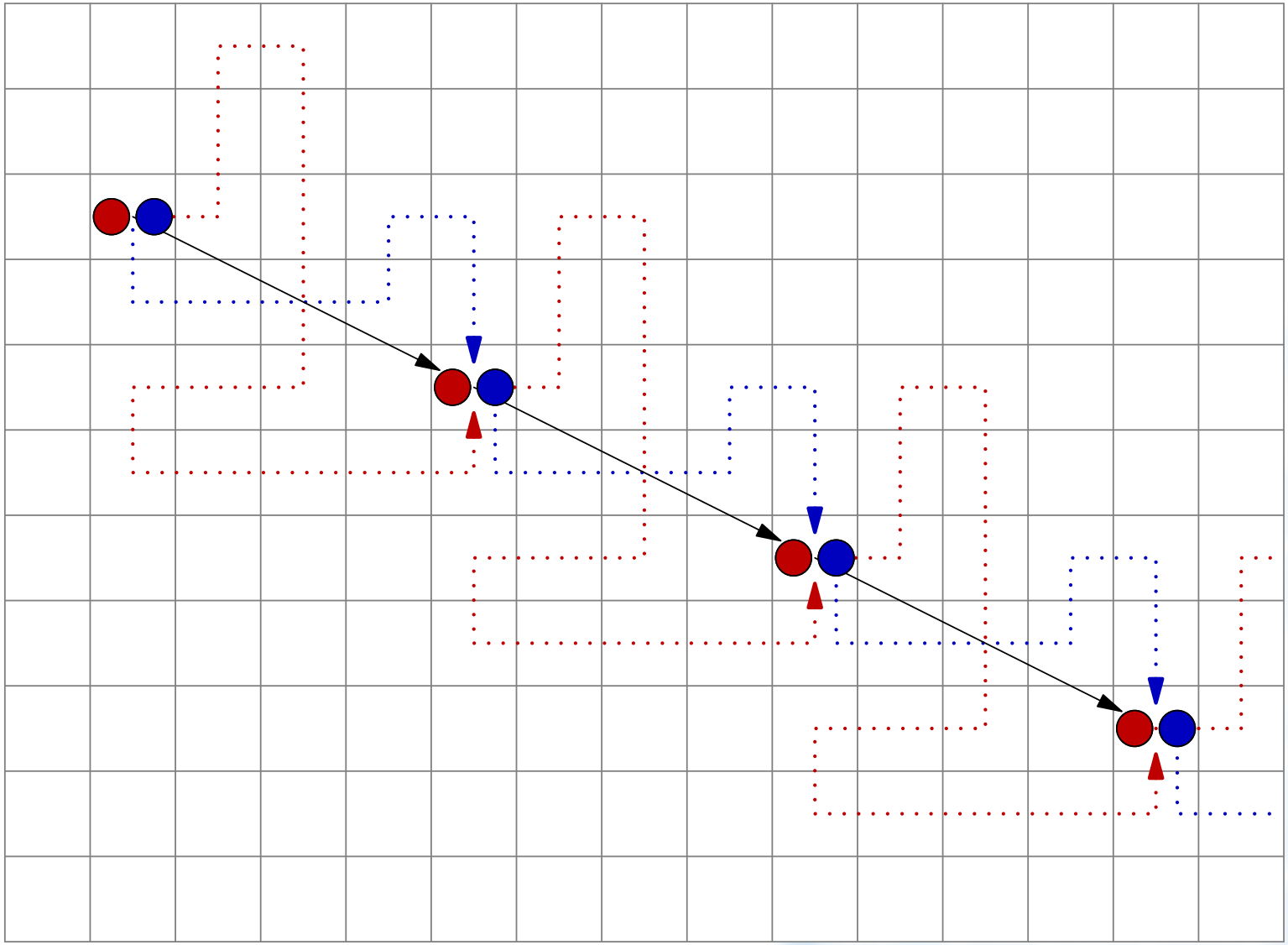

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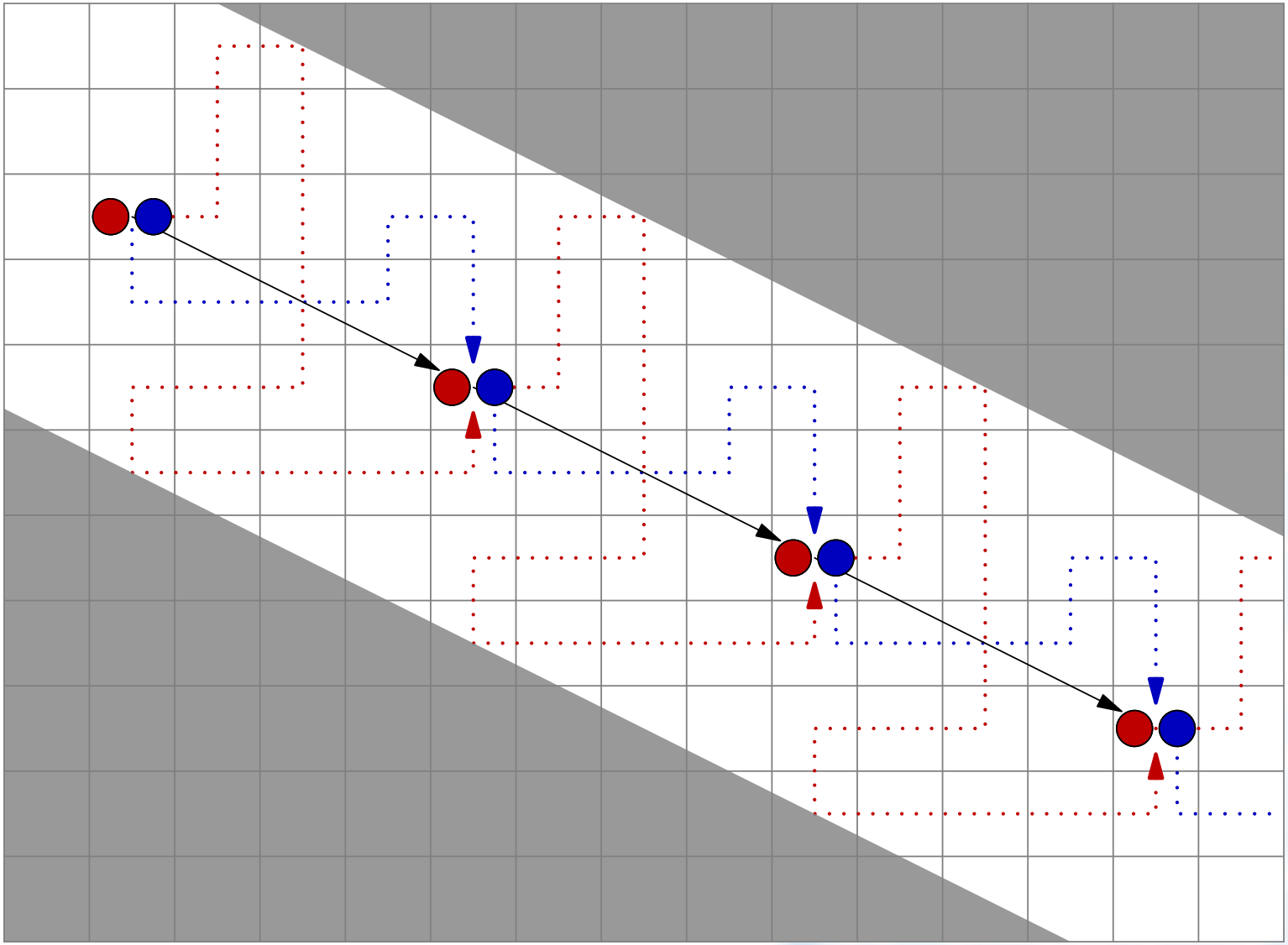

Randomization

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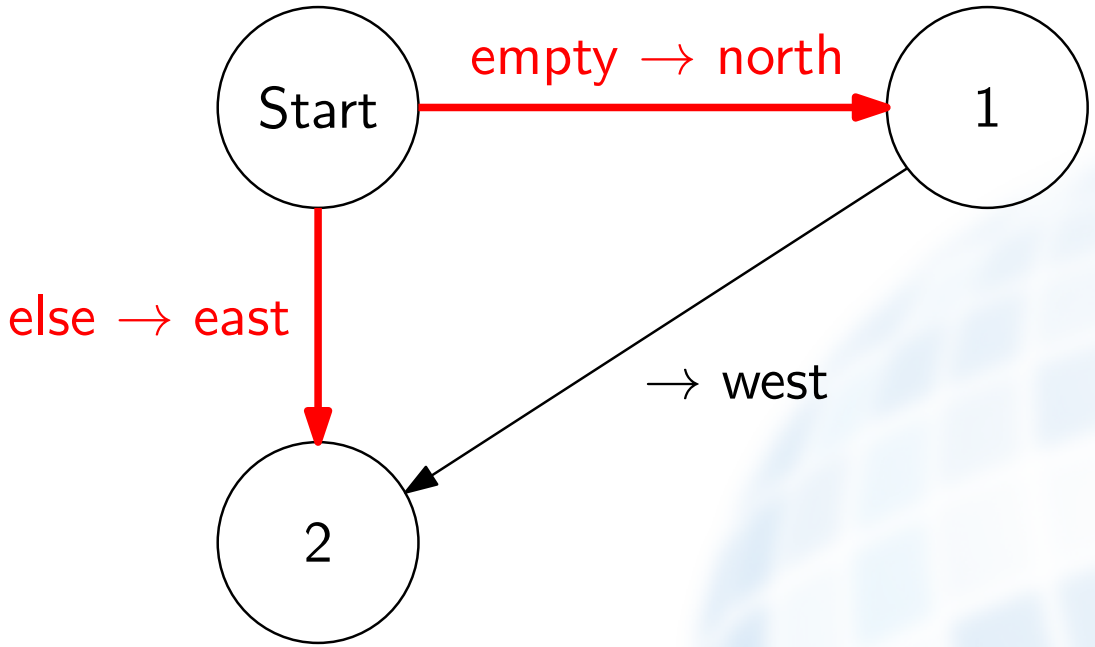

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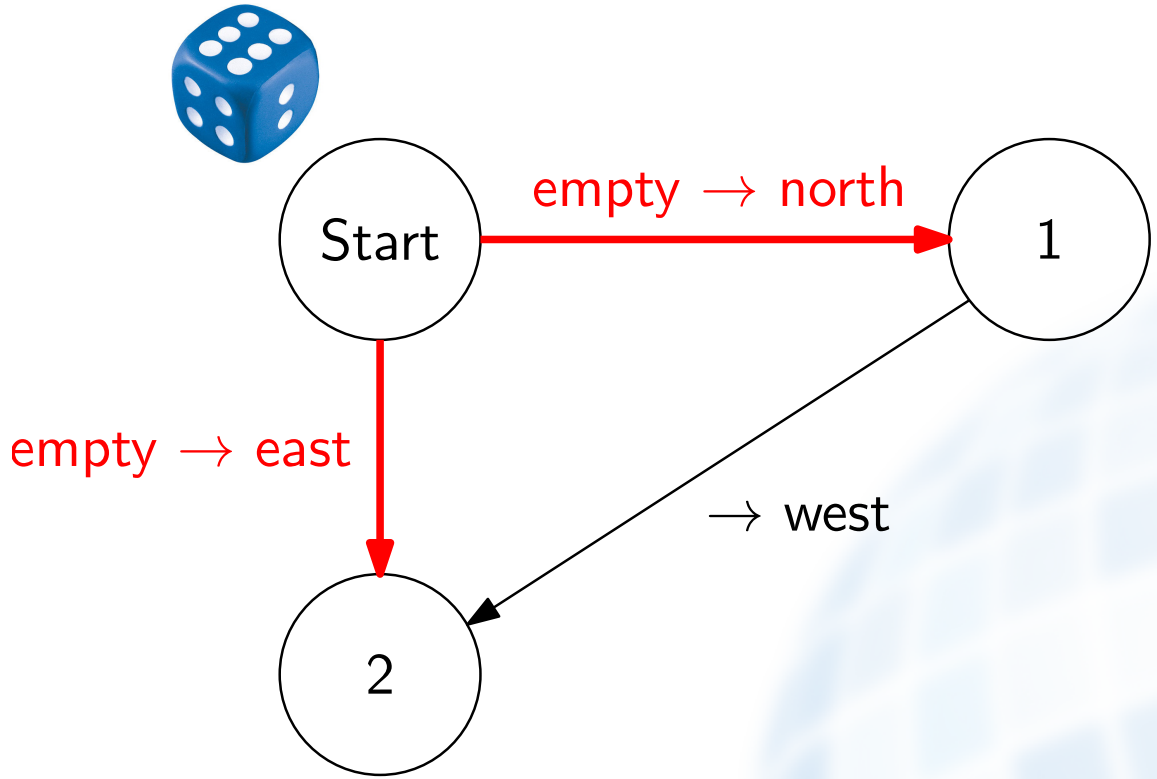
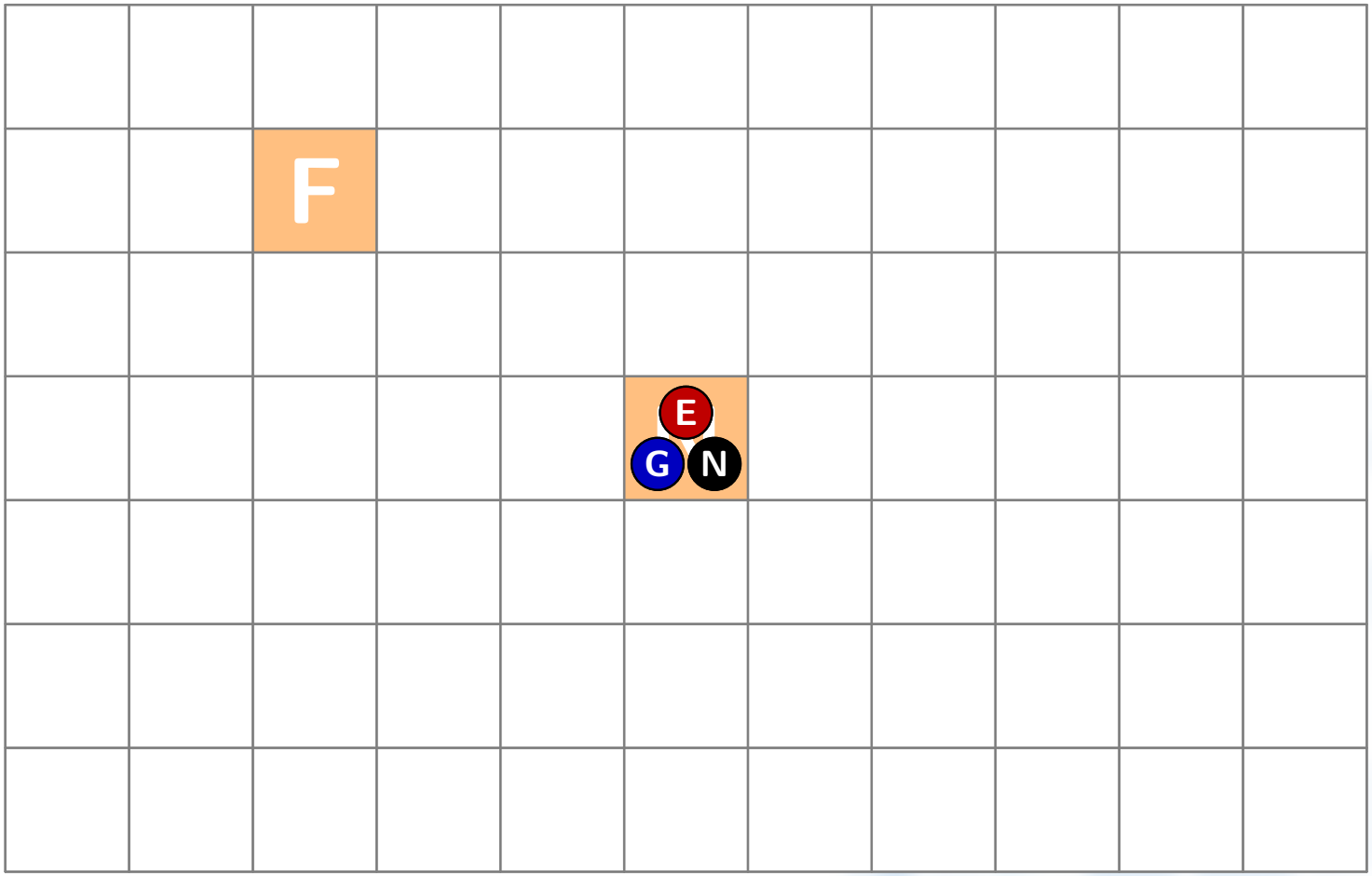
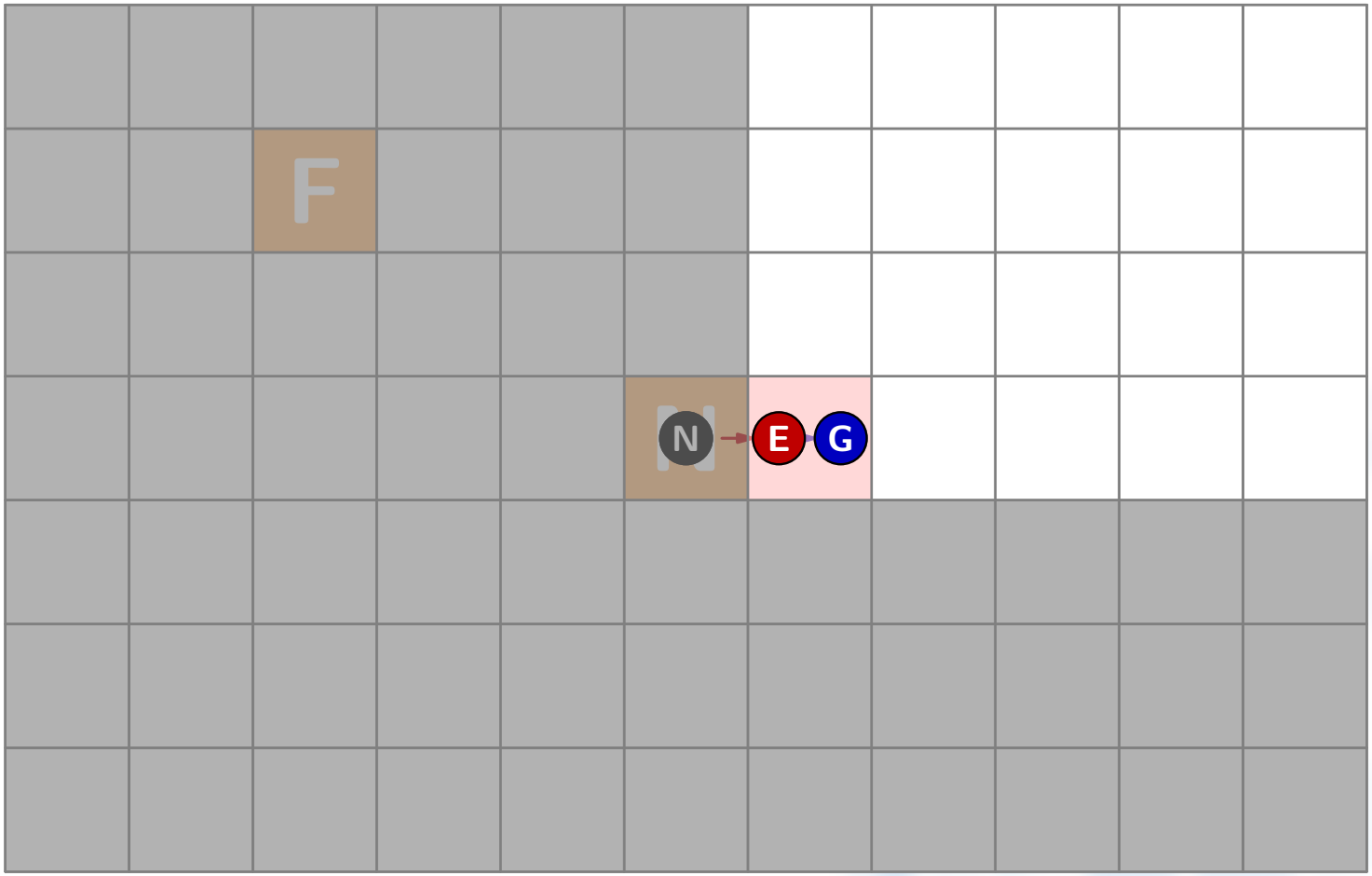


Randomization

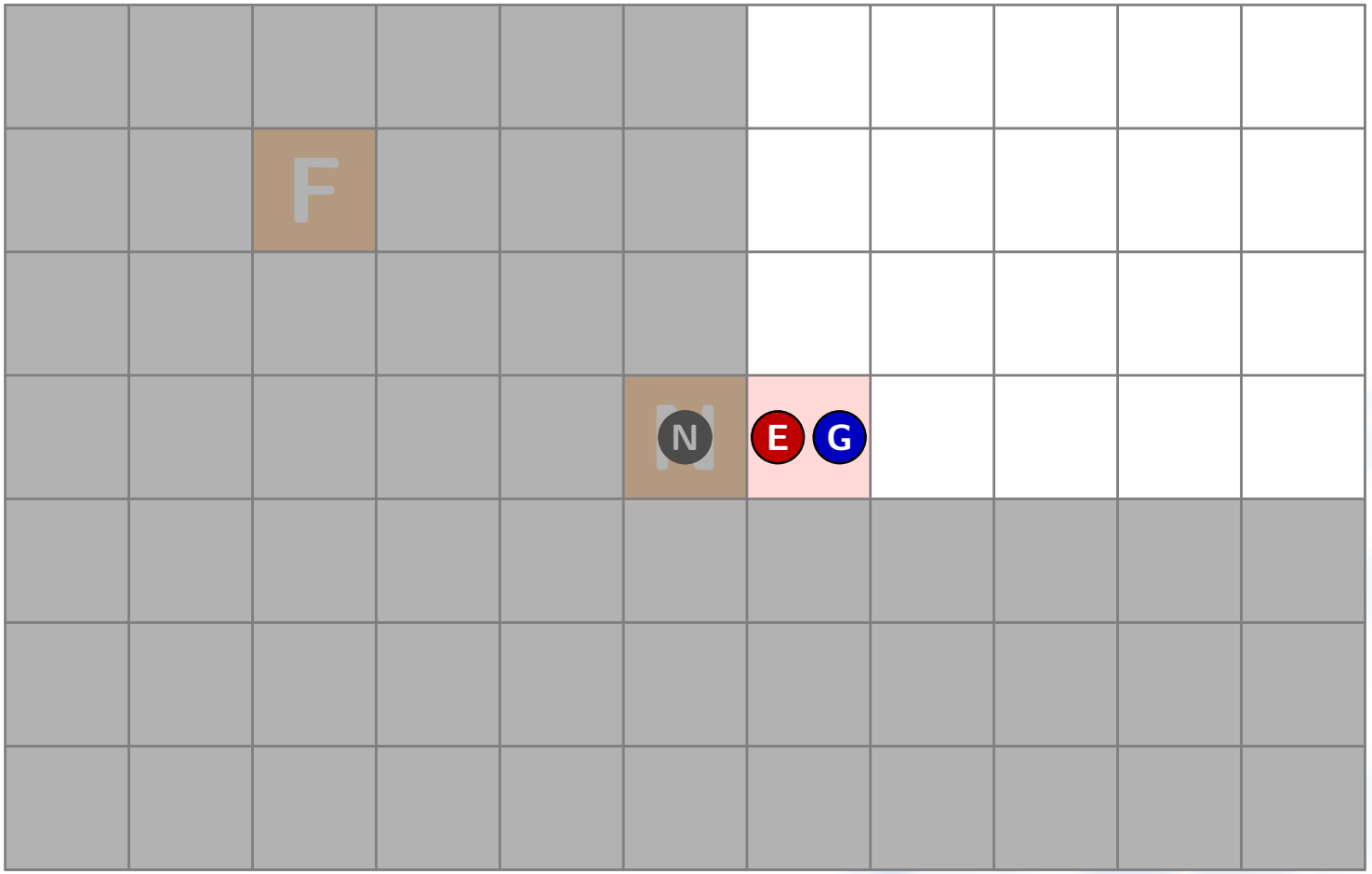
Geometric Search



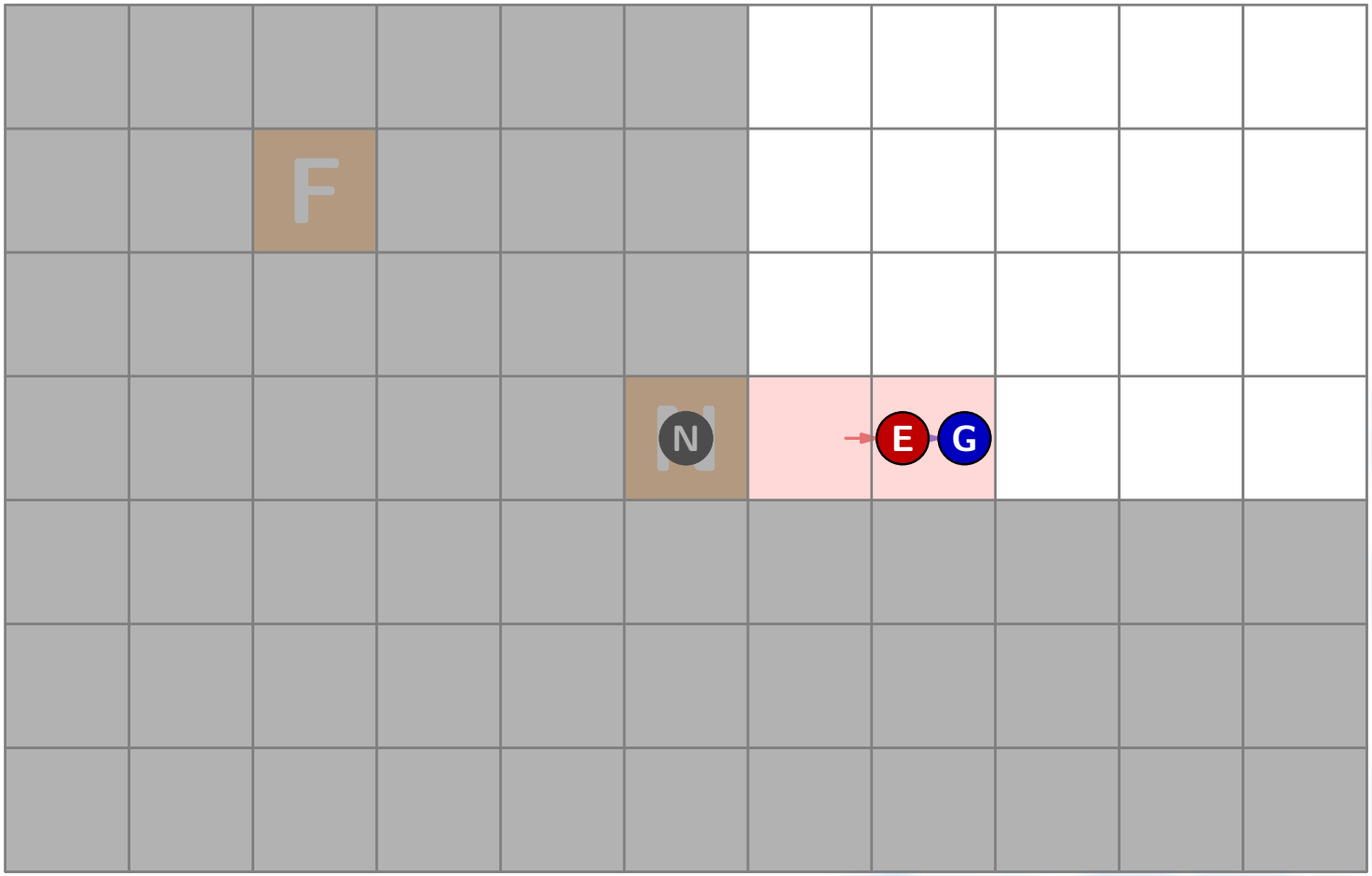
Geometric Search



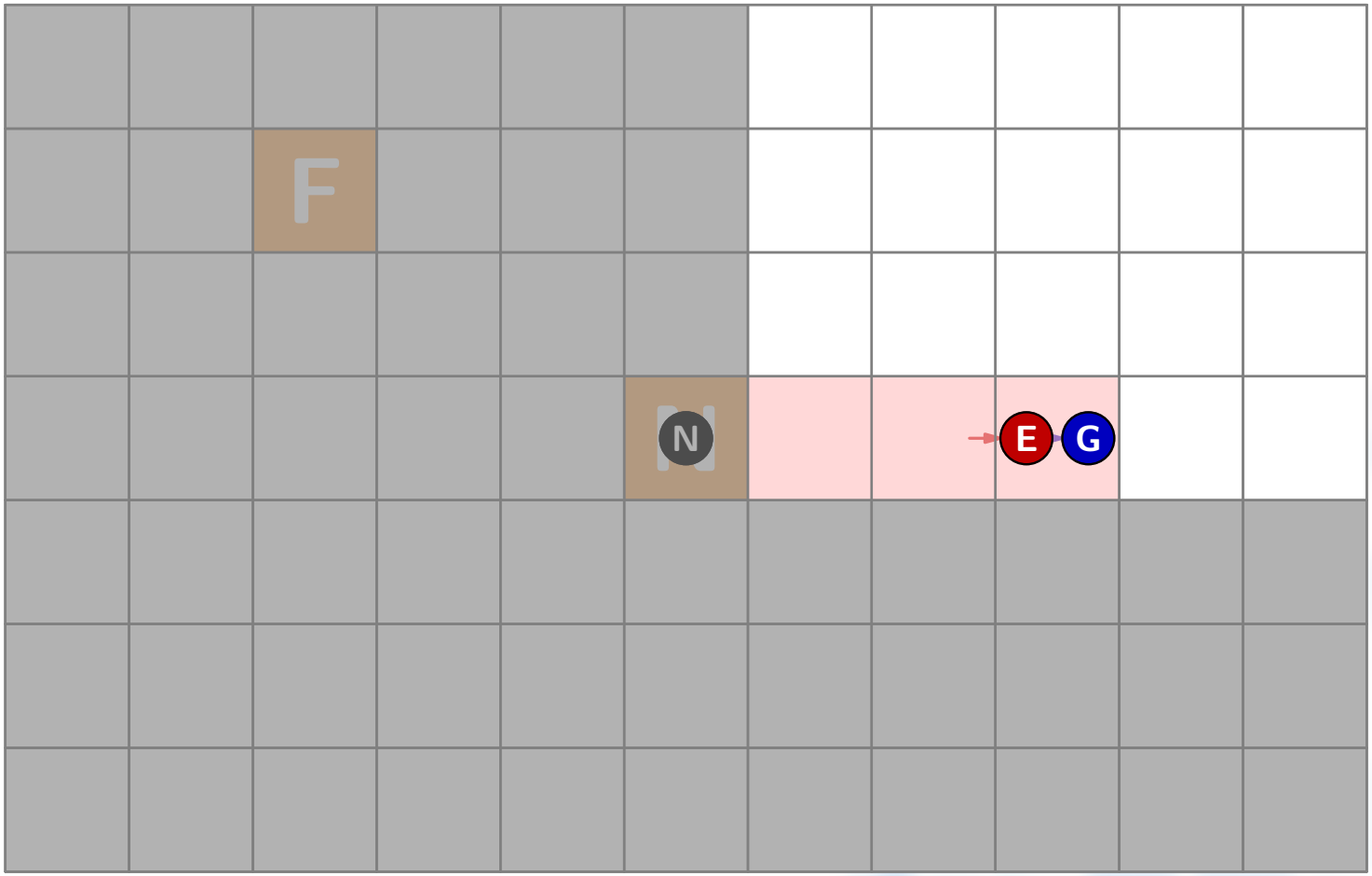
Geometric Search



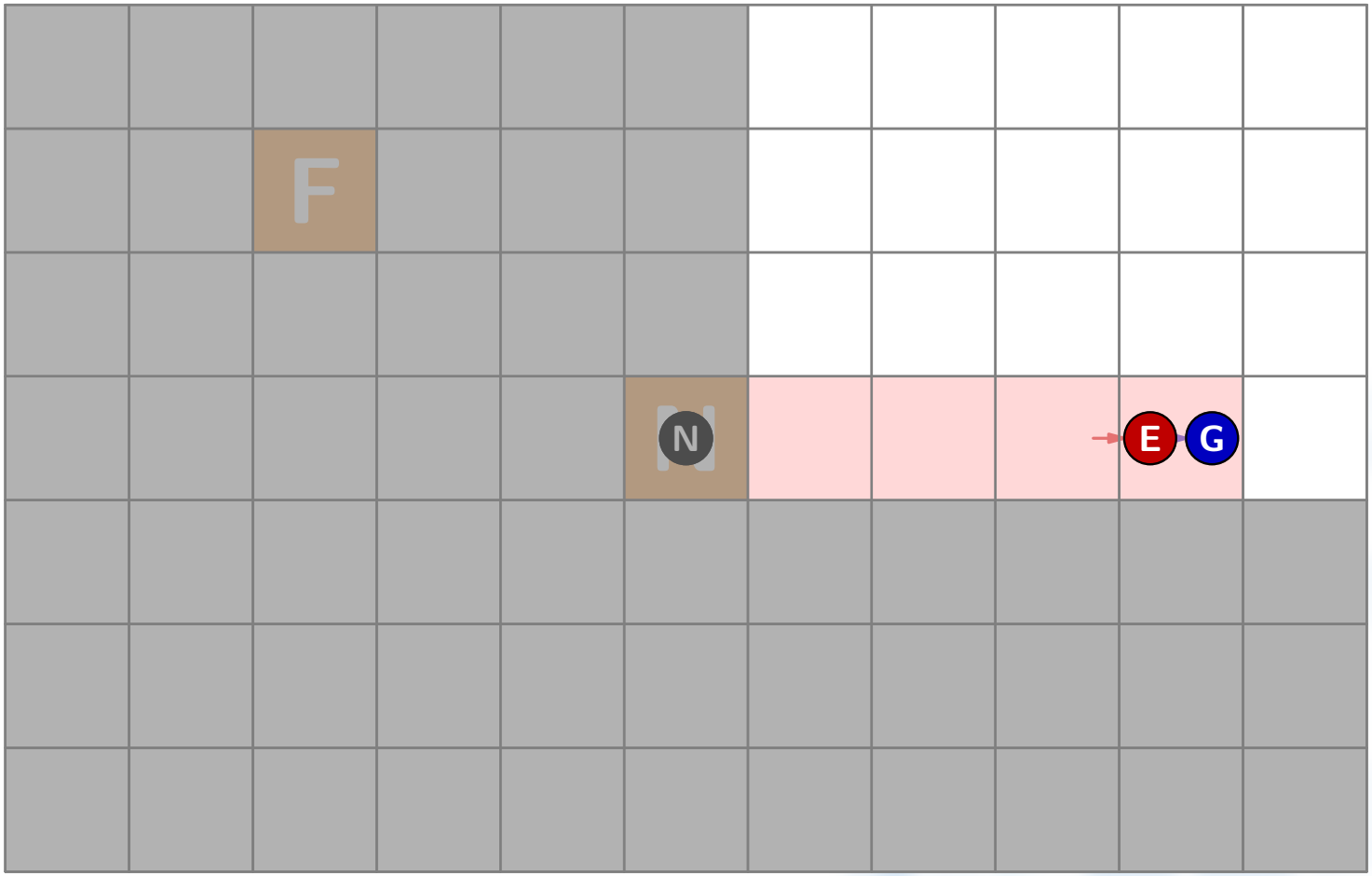
Geometric Search



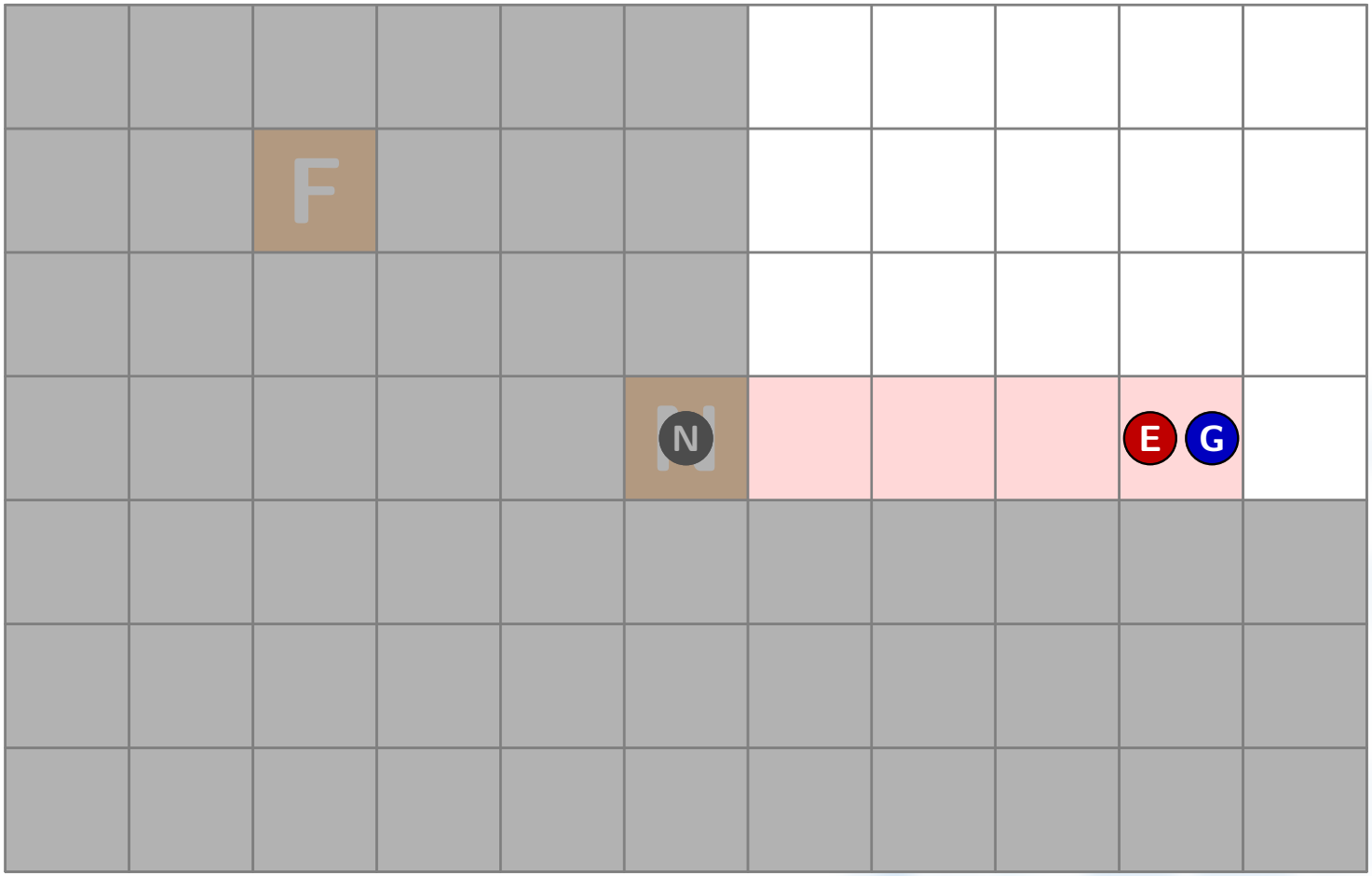
Geometric Search



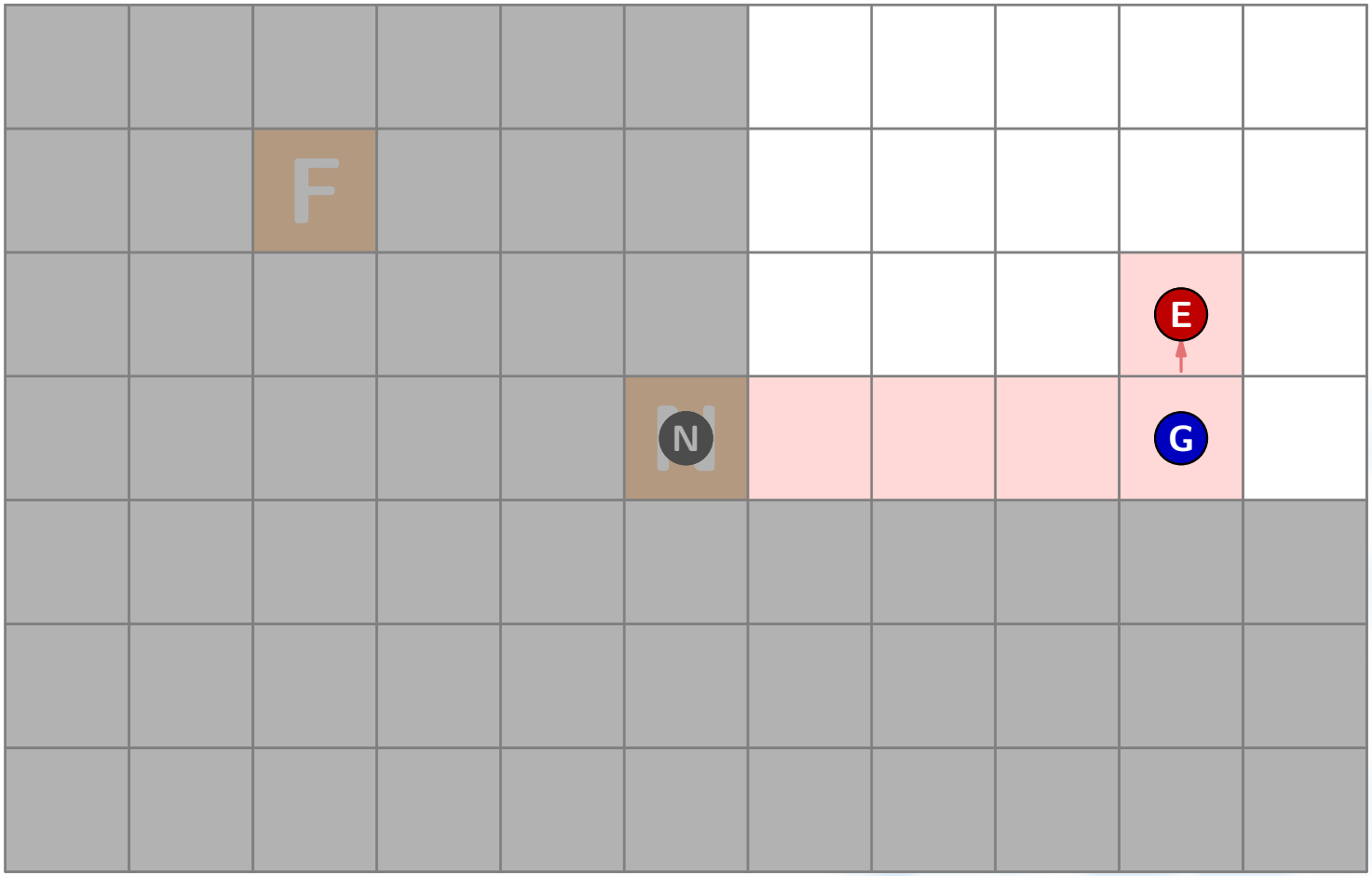
Geometric Search



Geometric Search



Geometric Search



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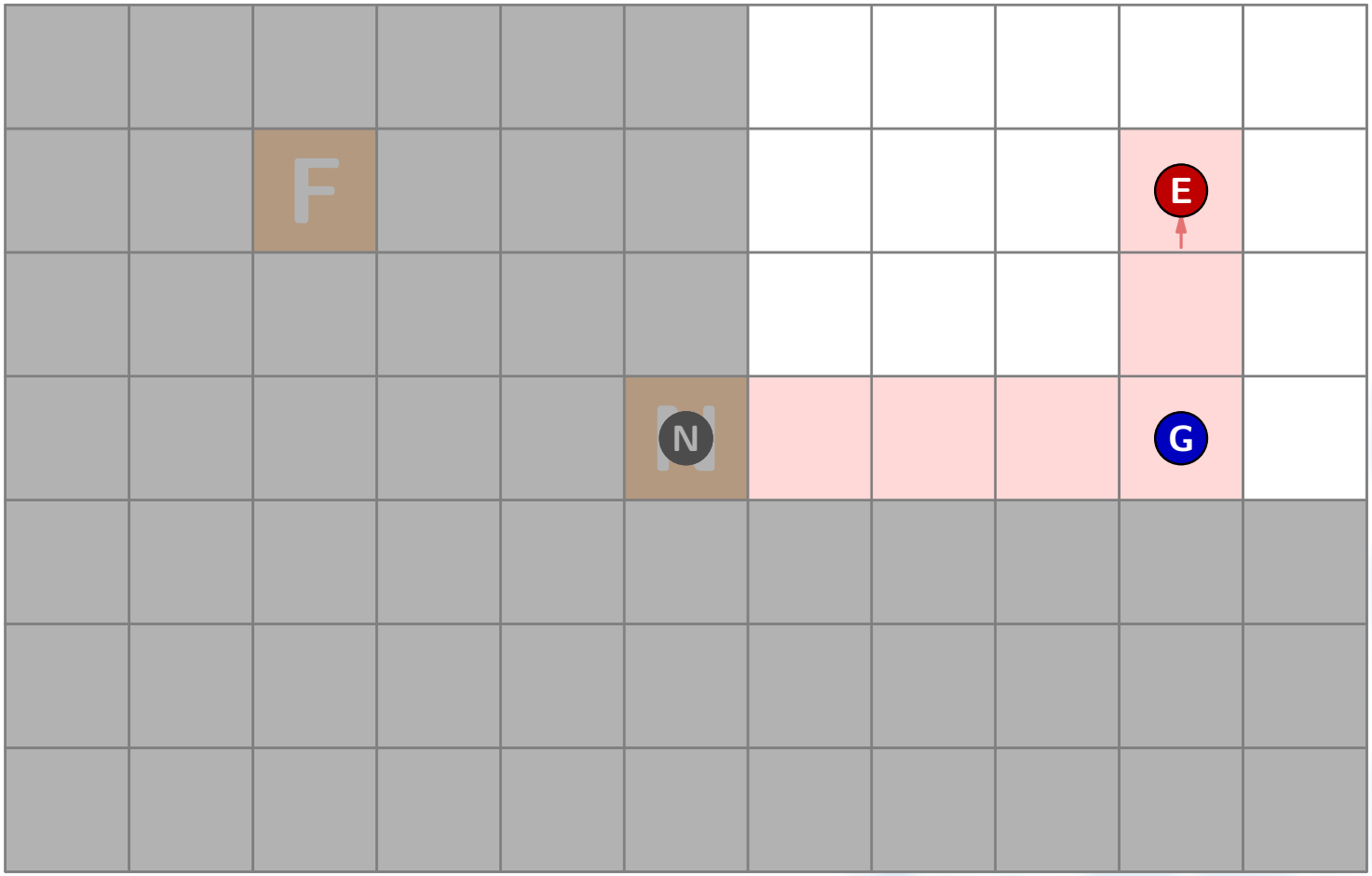
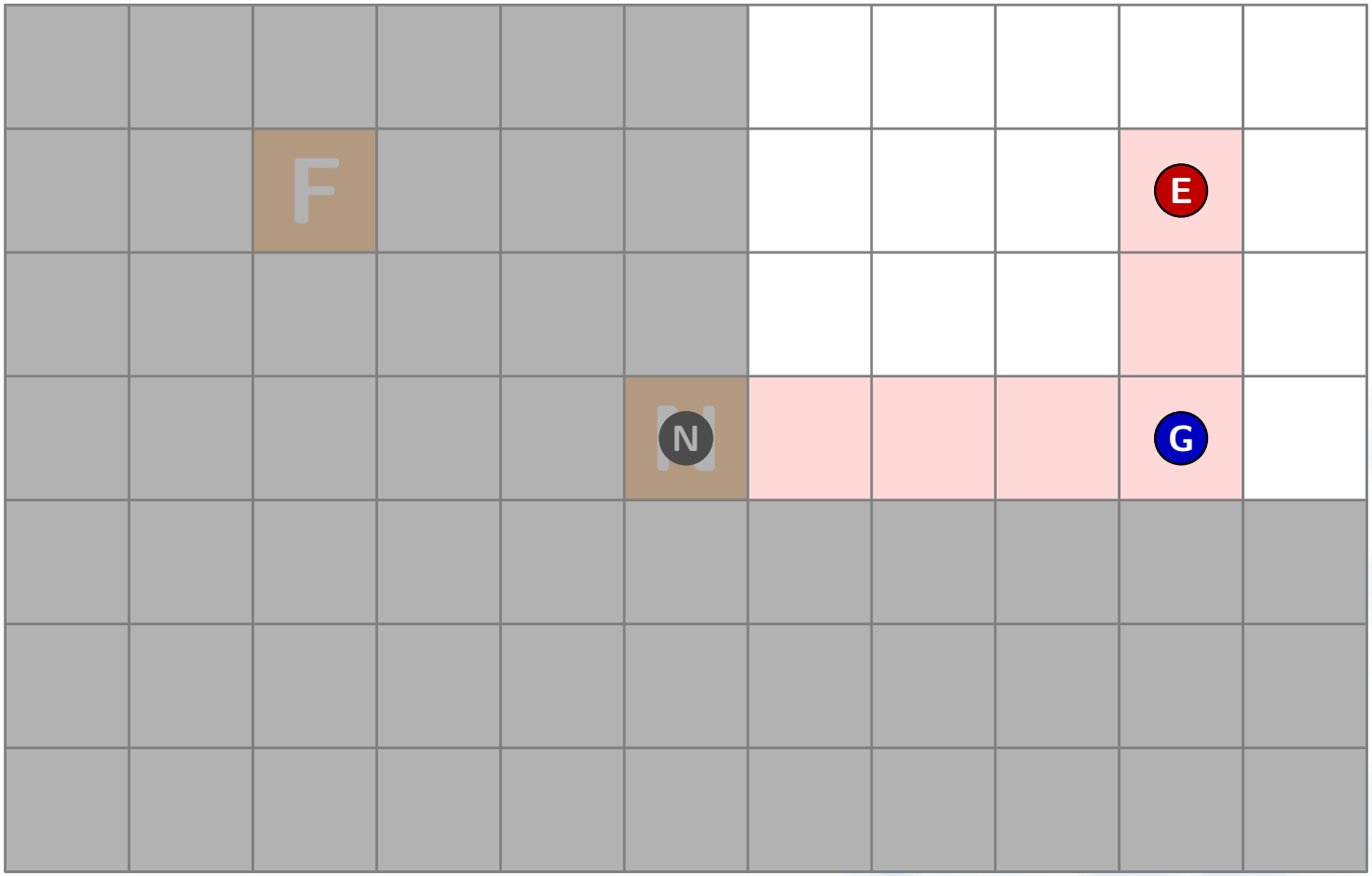


Geometric Search



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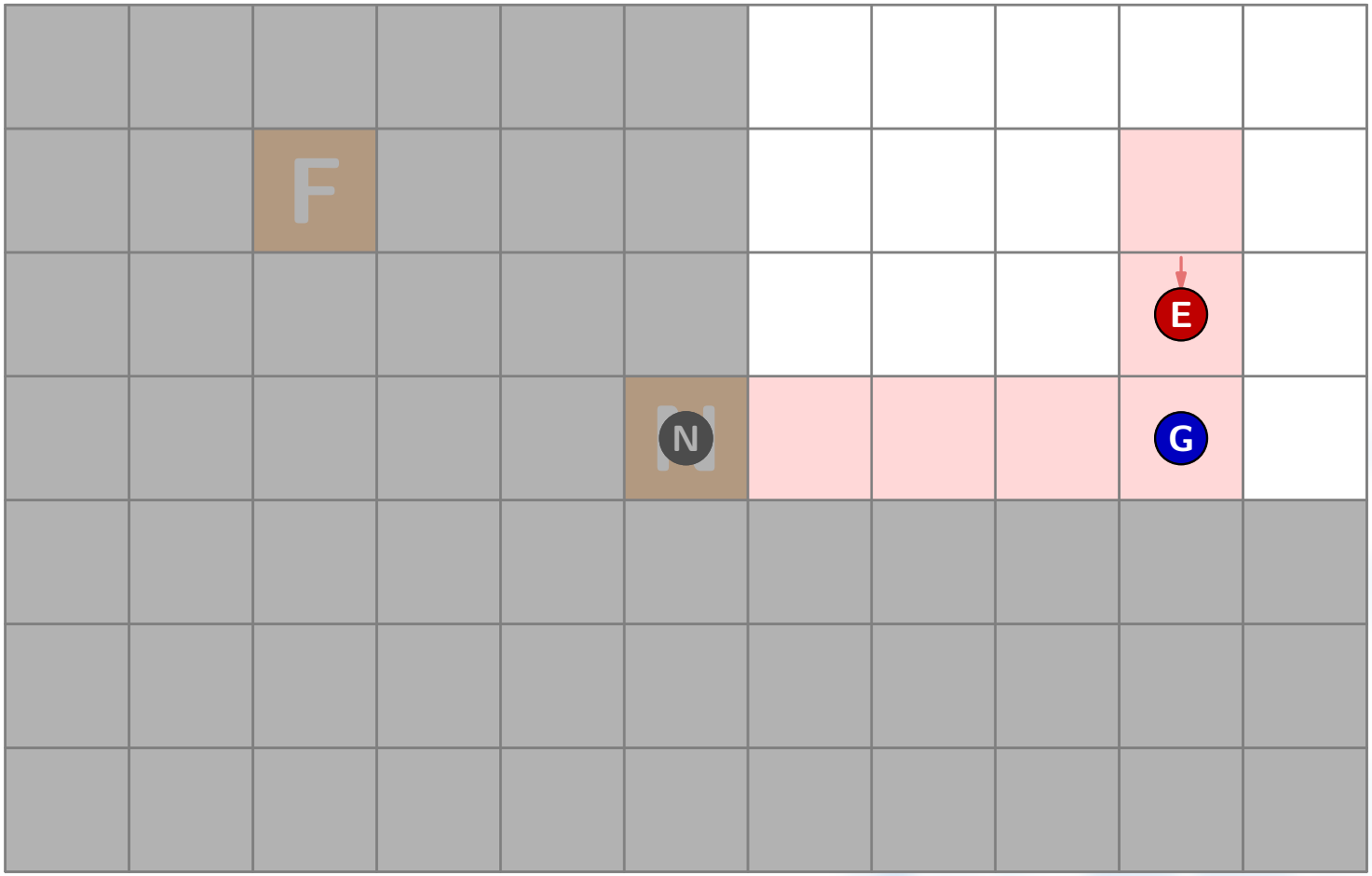

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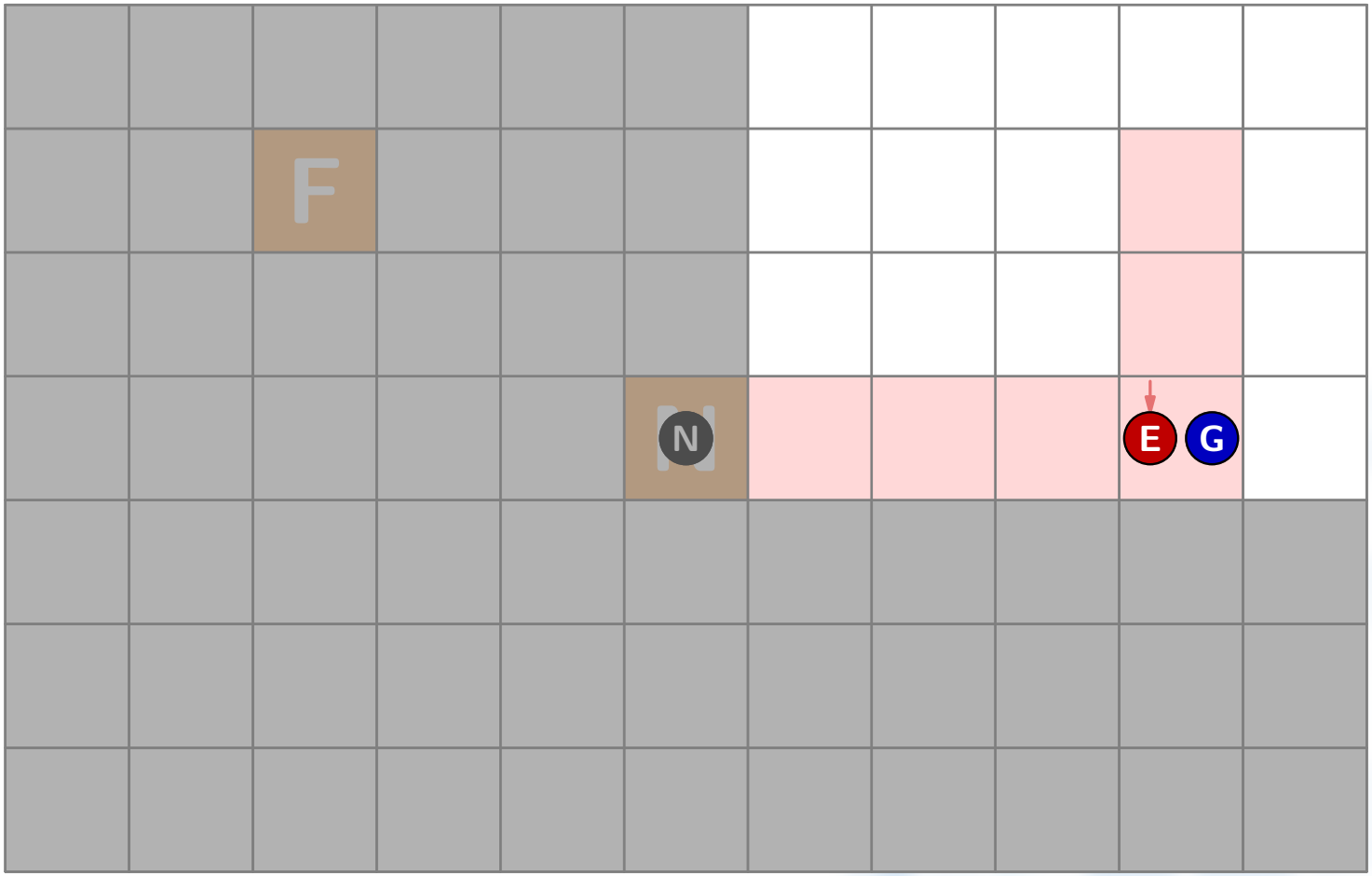

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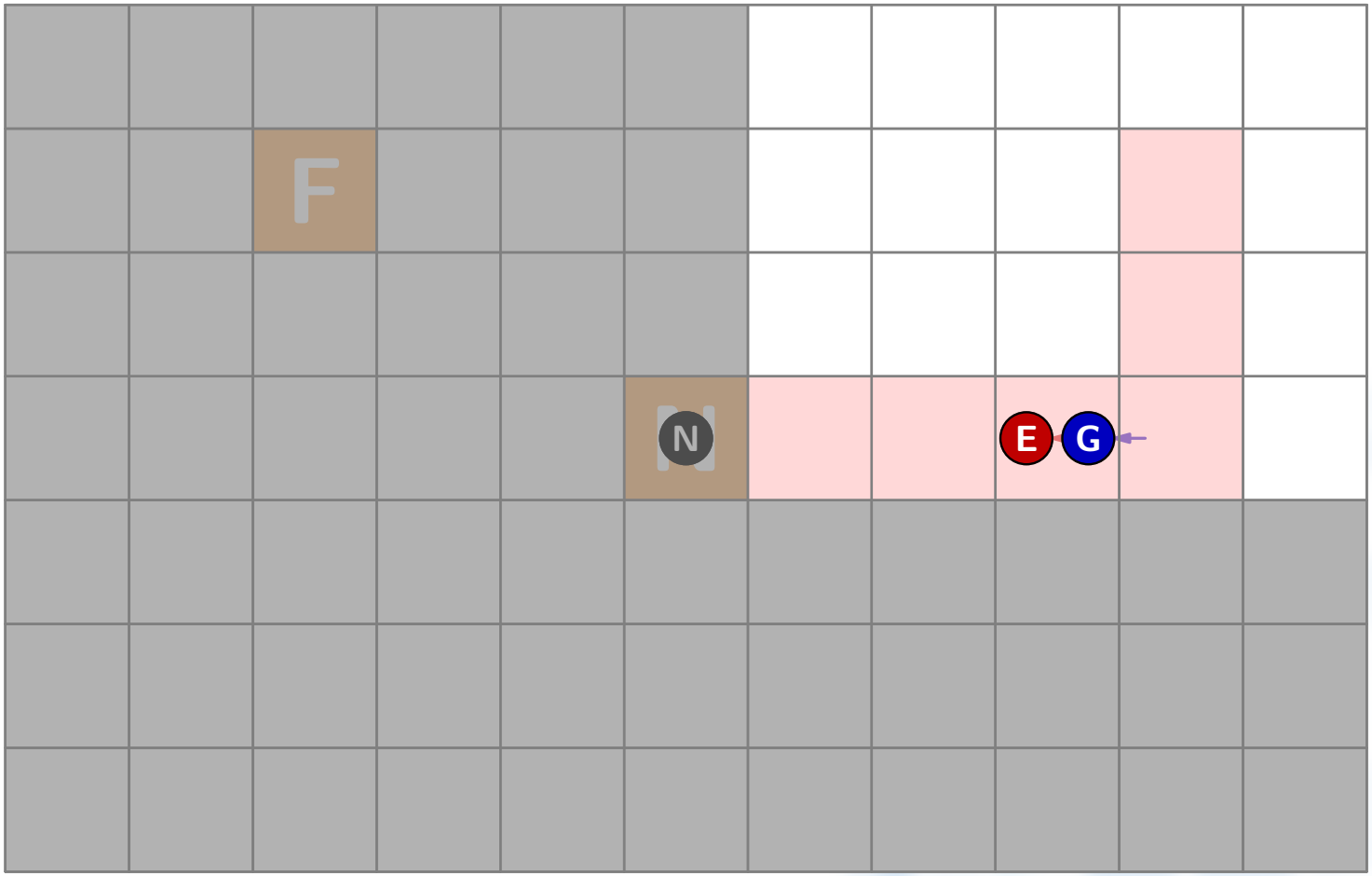
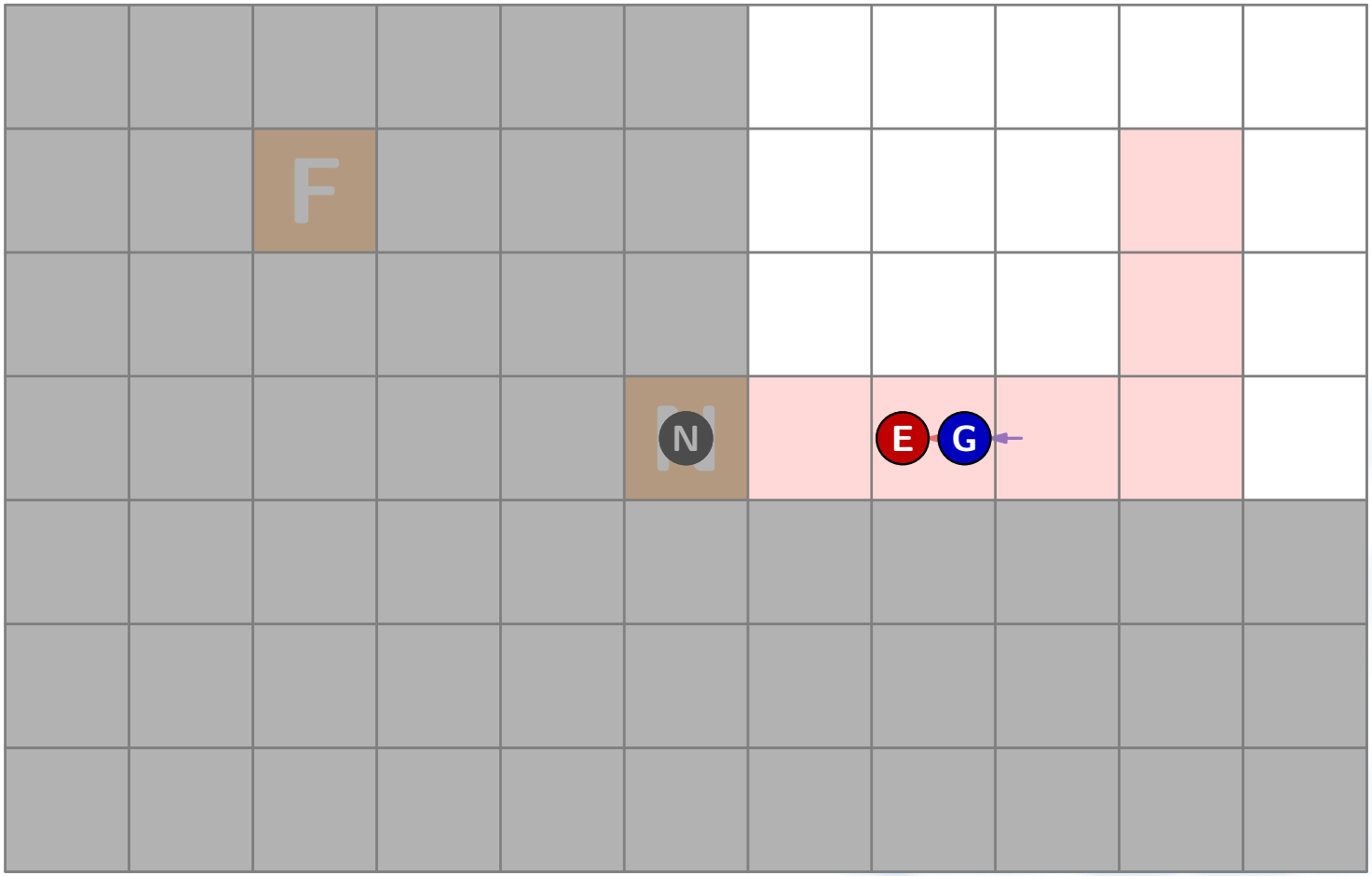


Geometric Search



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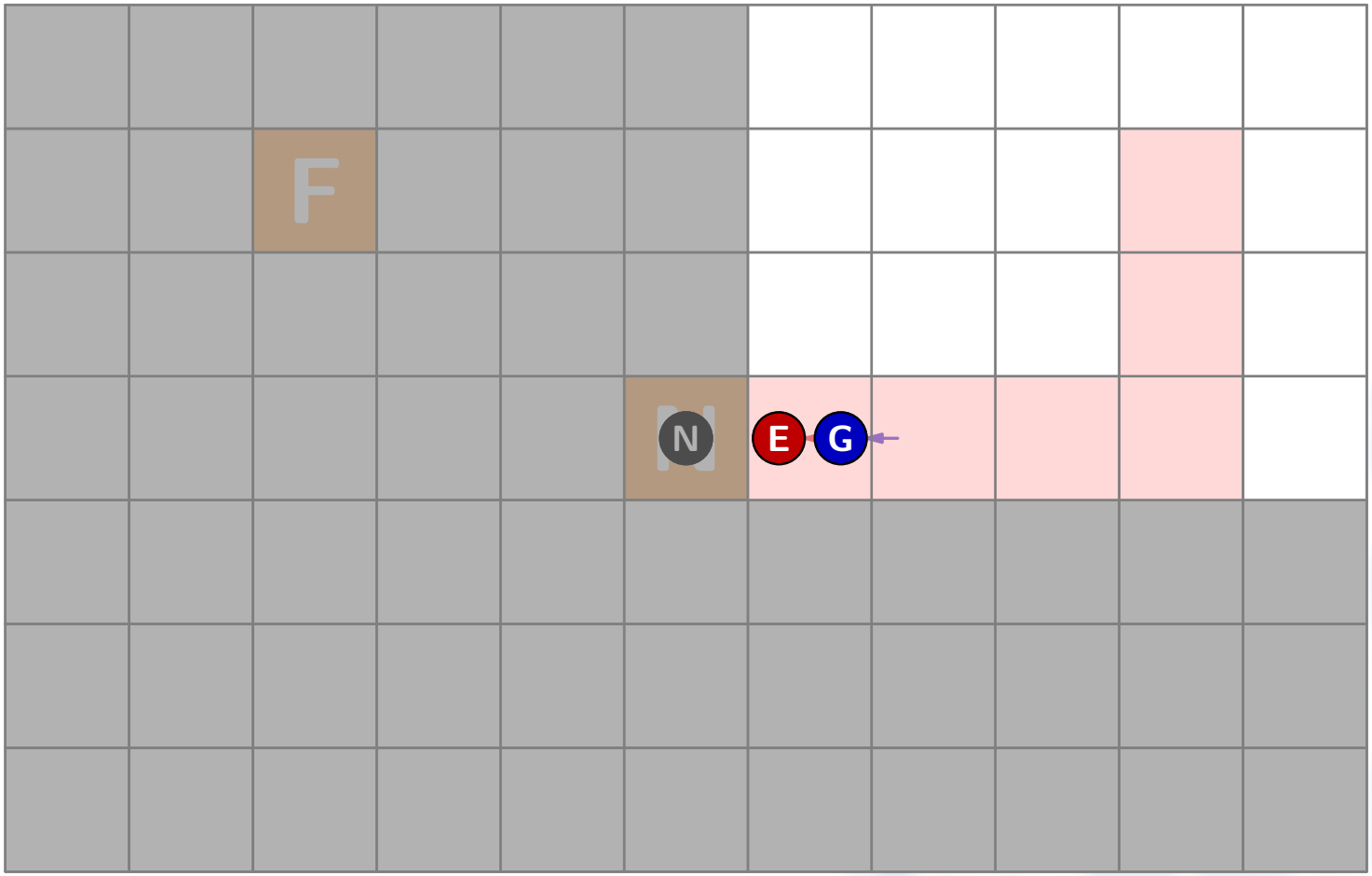
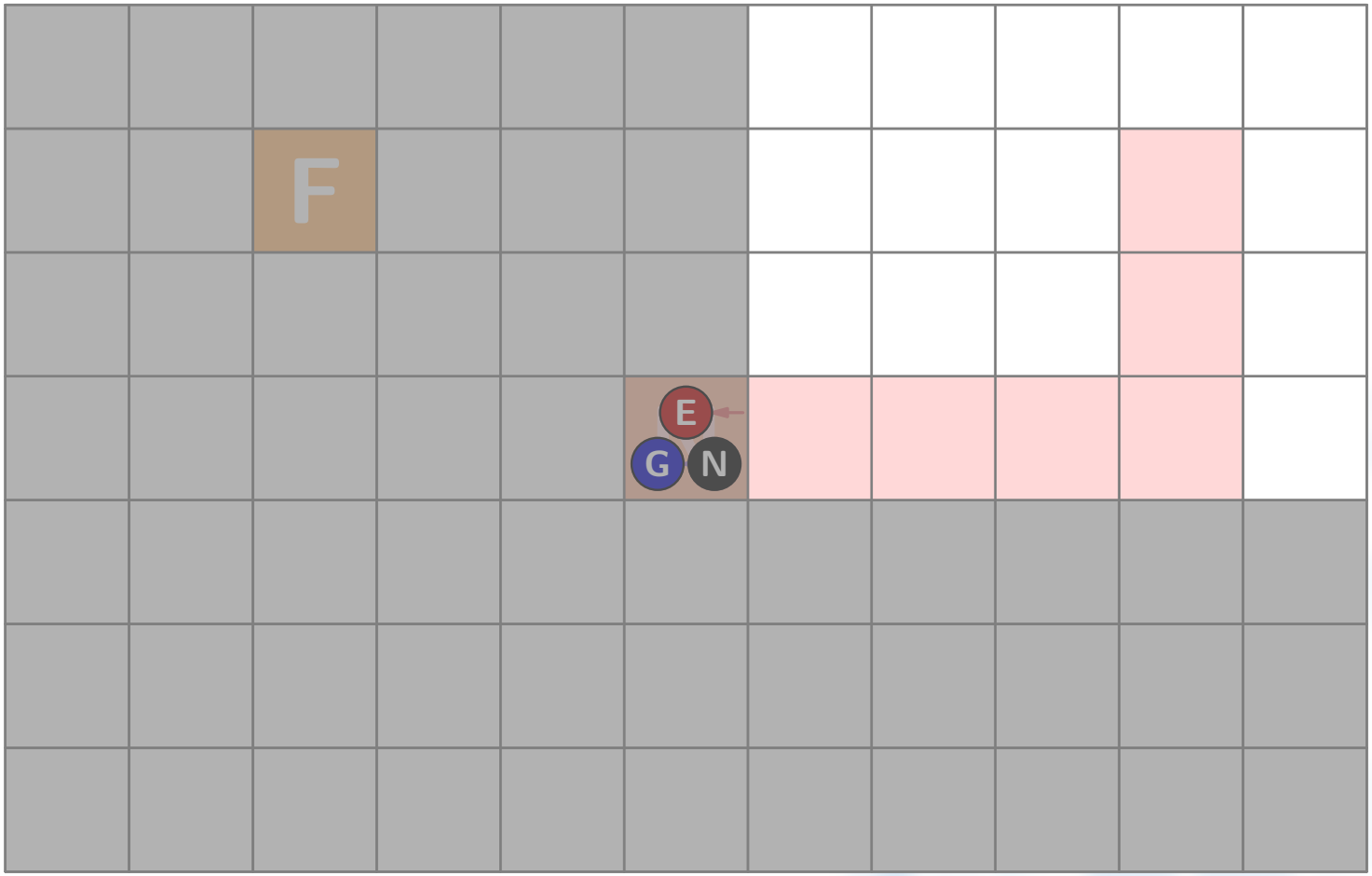
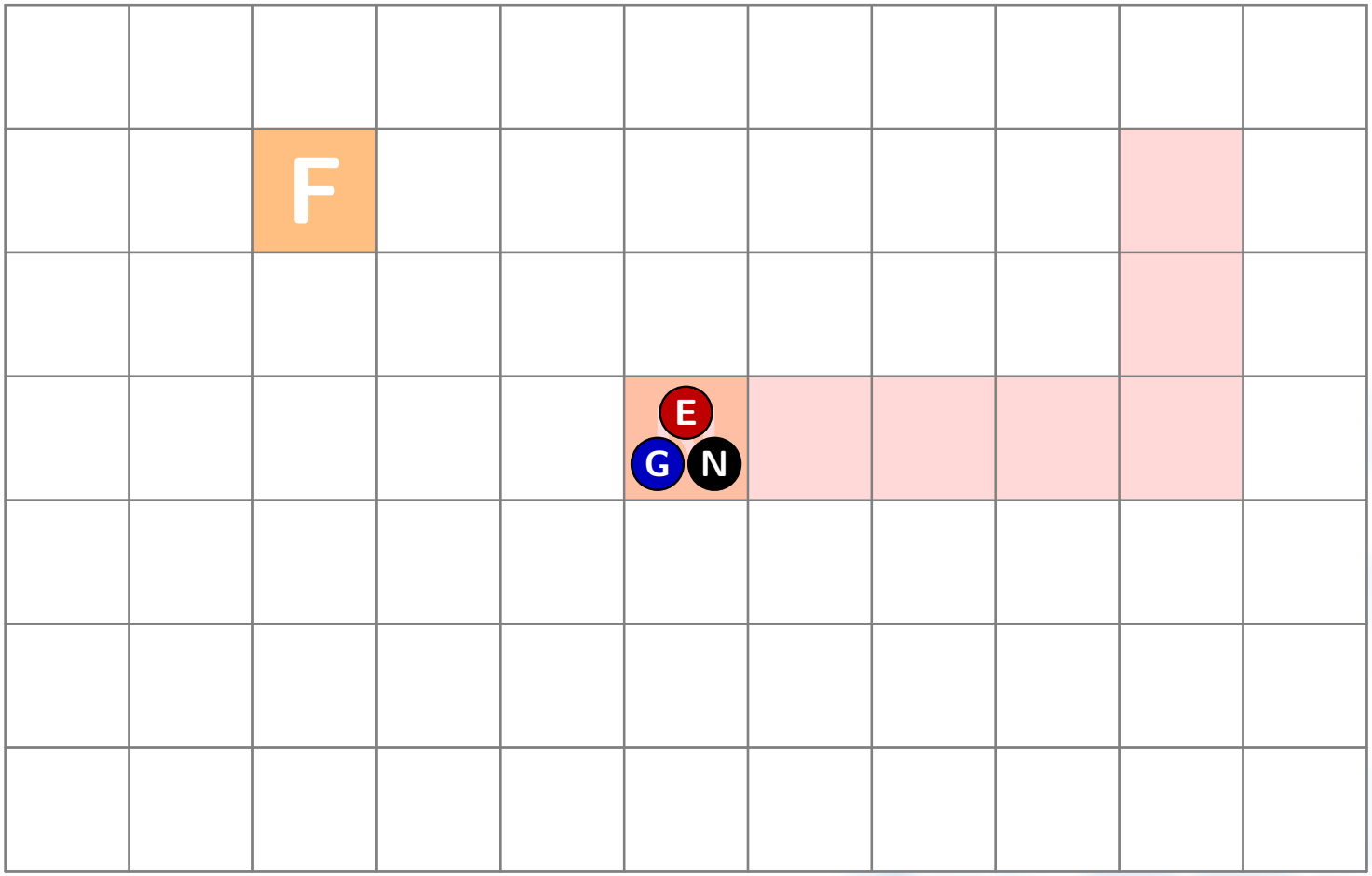


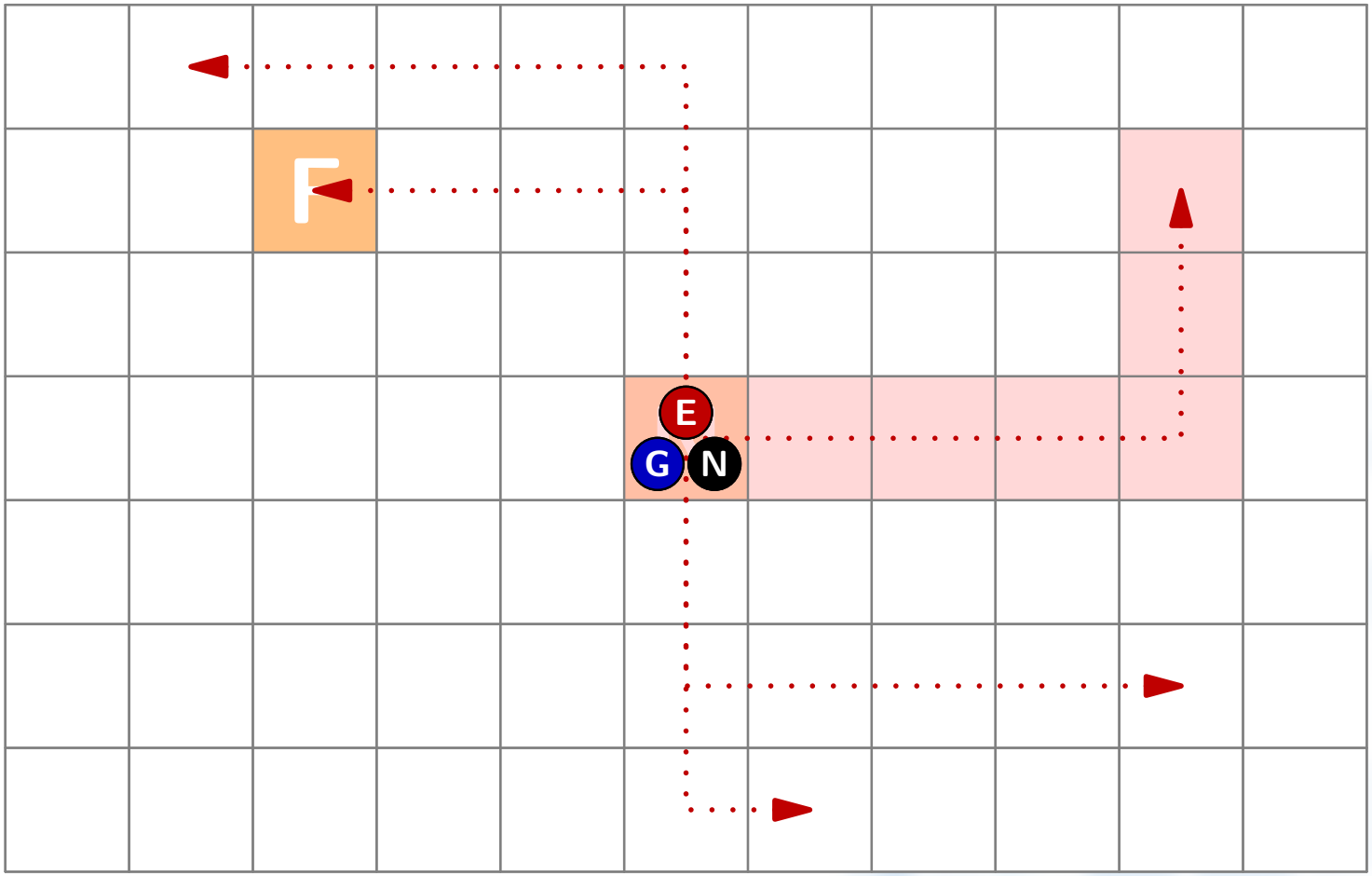
Geometric Search



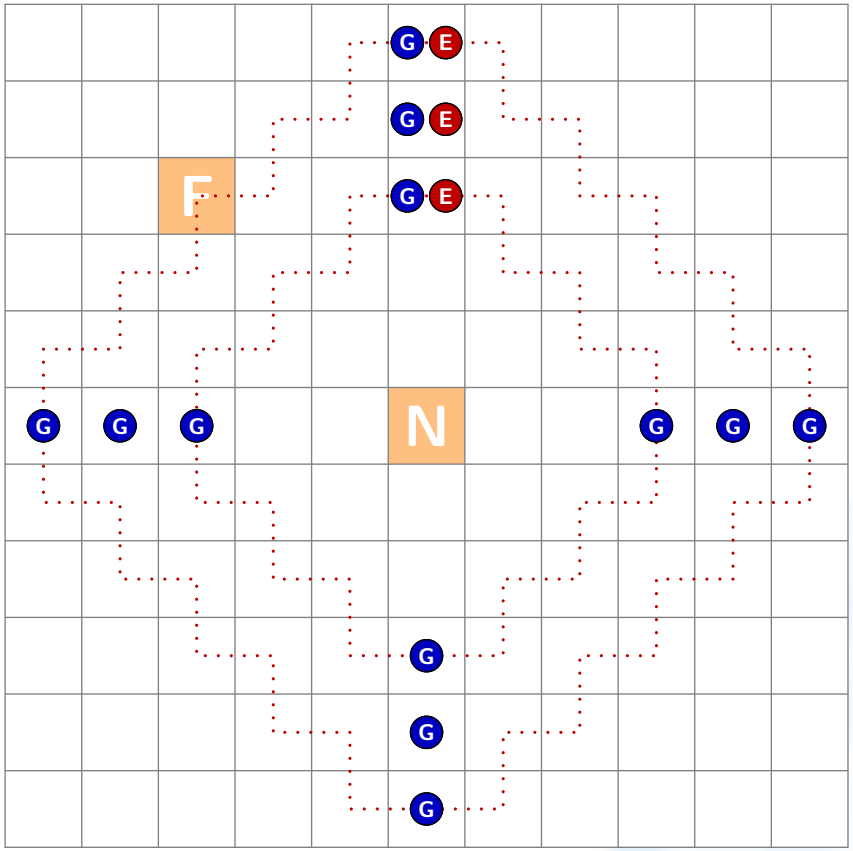
Geometric Search



Geometric Search



Parallelization

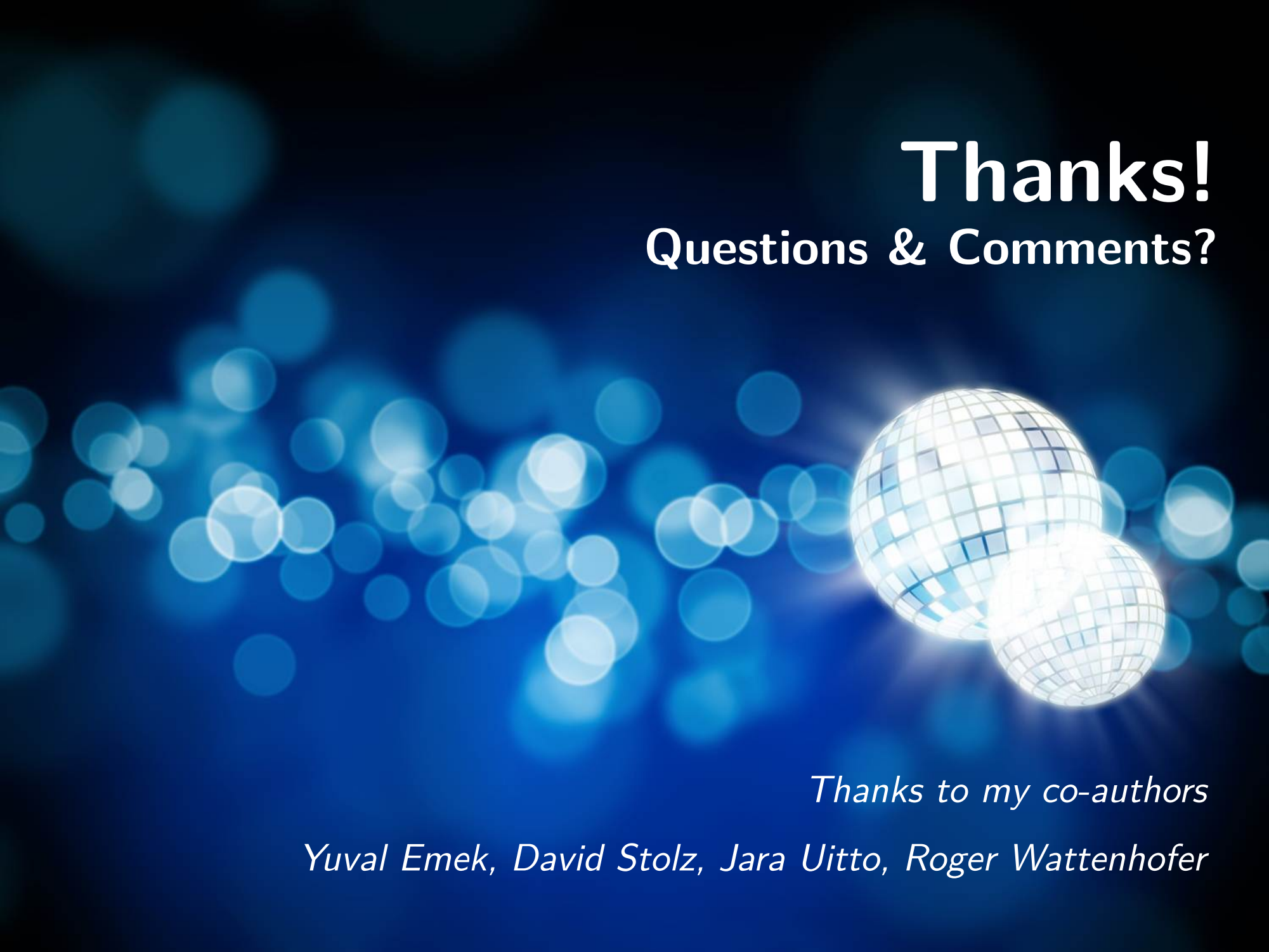


- Works in asynchronous deterministic setting
- Optimal speed-up, runtime $\approx D + D^2/n$

Fault-Tolerance

- See talk at DISC by Jara Uitto: **Fault-Tolerant ANTS**

Diamond Search in Real Life


Thanks!
Questions & Comments?
Thanks to my co-authors
Yuval Emek, David Stolz, Jara Uitto, Roger Wattenhofer