\[ \approx D + \frac{D^2}{n} \]
ANTS problem (Ants Nearby Treasure Search) introduced by Feinerman, Korman, Lotker, Sereni [PODC 2012]
Previous Work

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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
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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Model

- Ants controlled by finite automaton
- 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
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Triangle Search
Synchronous and Deterministic

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

F
E
G
N
Diamond Search
Diamond Search
Lower Bounds

Is this any good? Can we do better?
One Ant

\[ q \]
One Ant
One Ant
One Ant
One Ant
One Ant
Observation: Ants have to meet infinitely often in states \((q, q')\).
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Observation: Ants have to meet infinitely often in states $(q, q')$. 
**Observation:** Ants have to meet infinitely often in states \((q, q')\).

**Observation:** Time between such meetings is constant.
Two Ants

$q, q'$
Two Ants
Two Ants
Two Ants
Two Ants
Two Ants
Randomization
Randomization

Start

→ west

empty → north

→ west

else → east

2

1
Randomization

- Start → west
- Empty → east
- Empty → north
- 2 → west

1

Dice roll: 1
Geometric Search
Geometric Search
Geometric Search
Geometric Search
Geometric Search
Geometric Search
Geometric Search
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Geometric Search
Geometric Search
Geometric Search
Geometric Search
Geometric Search
Geometric Search
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
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