

# Towards An Understanding of EASE and Its Properties

Stratis Ioannidis and Peter Marbach

`stratis,marbach@cs.utoronto.ca`

Department of Computer Science

University of Toronto



# Why EASE?

- Routing in mobile, wireless ad hoc networks



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- *Table-driven vs. demand-driven*



# Why EASE?

- Routing in mobile, wireless ad hoc networks
- *Table-driven vs. demand-driven*
- Exponential Age SEarch protocol:
  - Grossglauser & Vetterli [GV03]

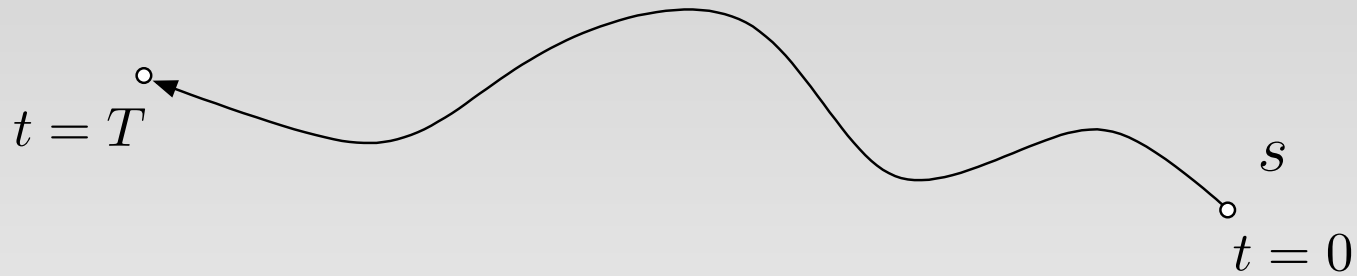


# Overview

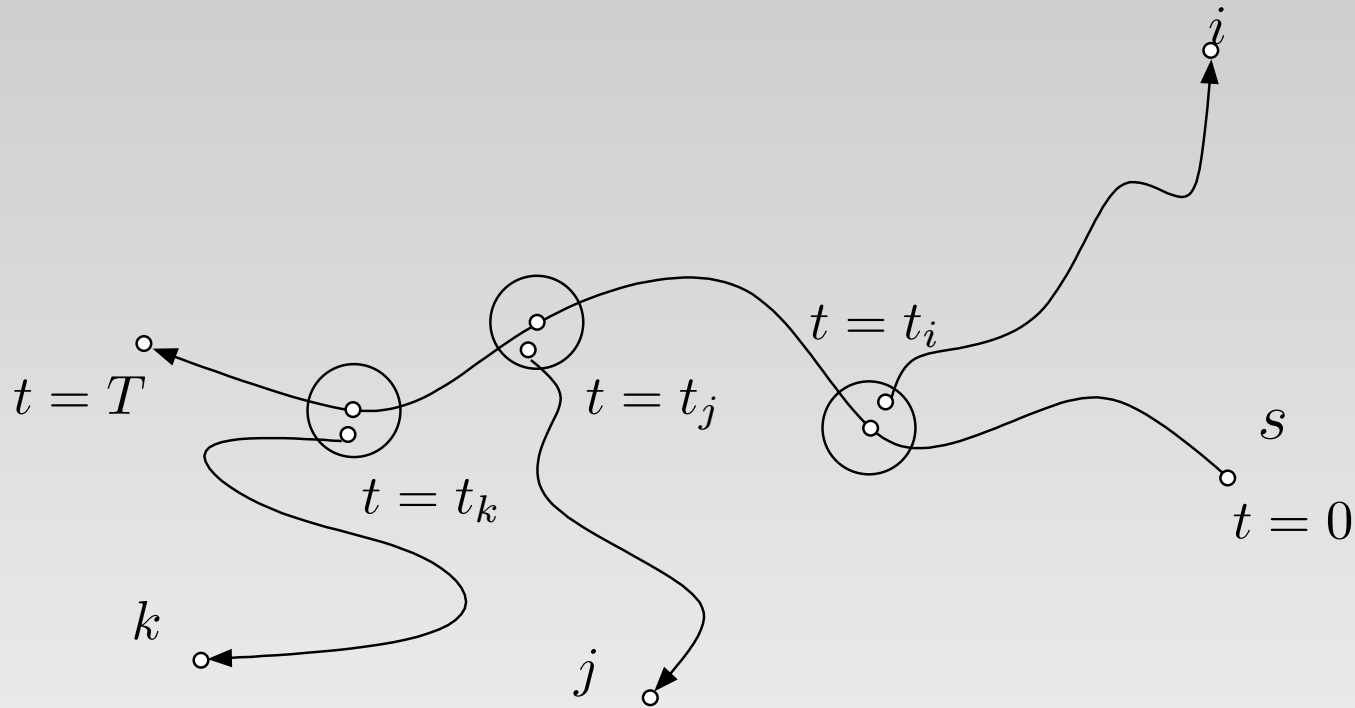
- EASE and previous results [GV03]
- Additional questions
- A Brownian motion model
  - Properties of EASE
- Results under a simplified model
  - Answers to additional questions



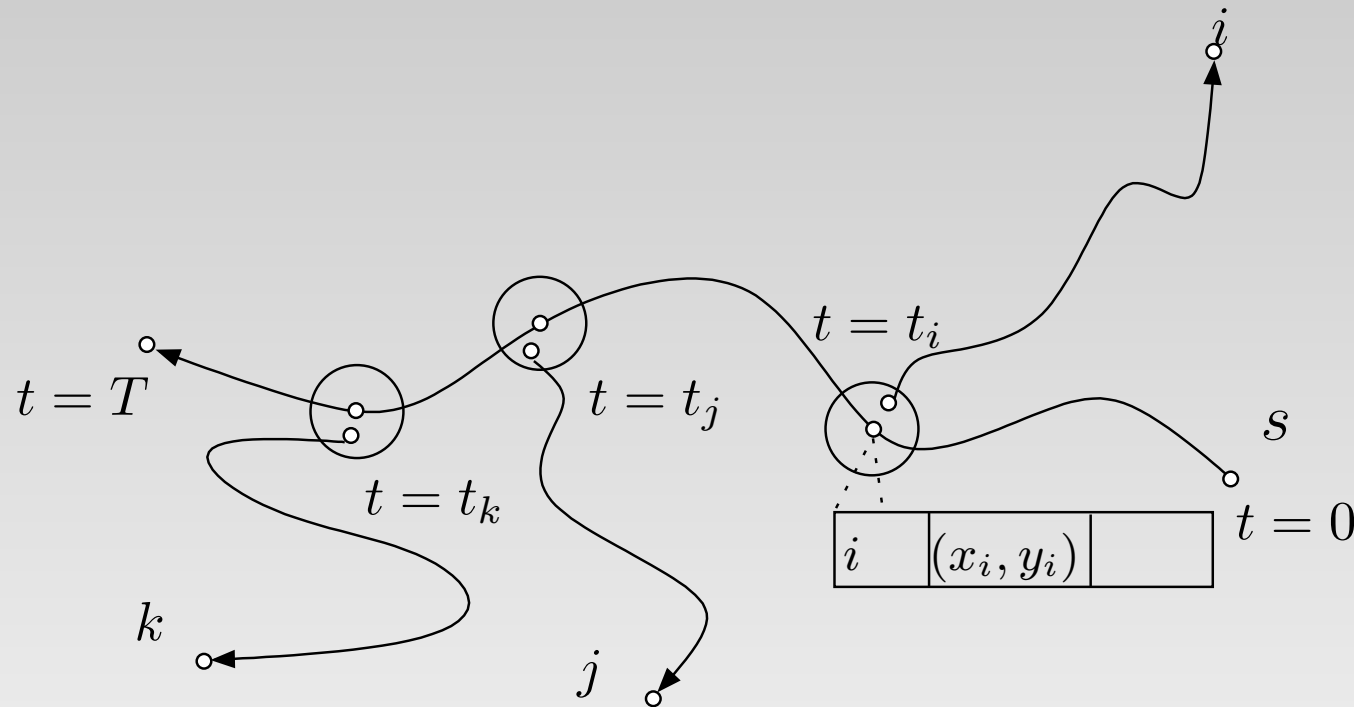
# EASE: Building routing tables



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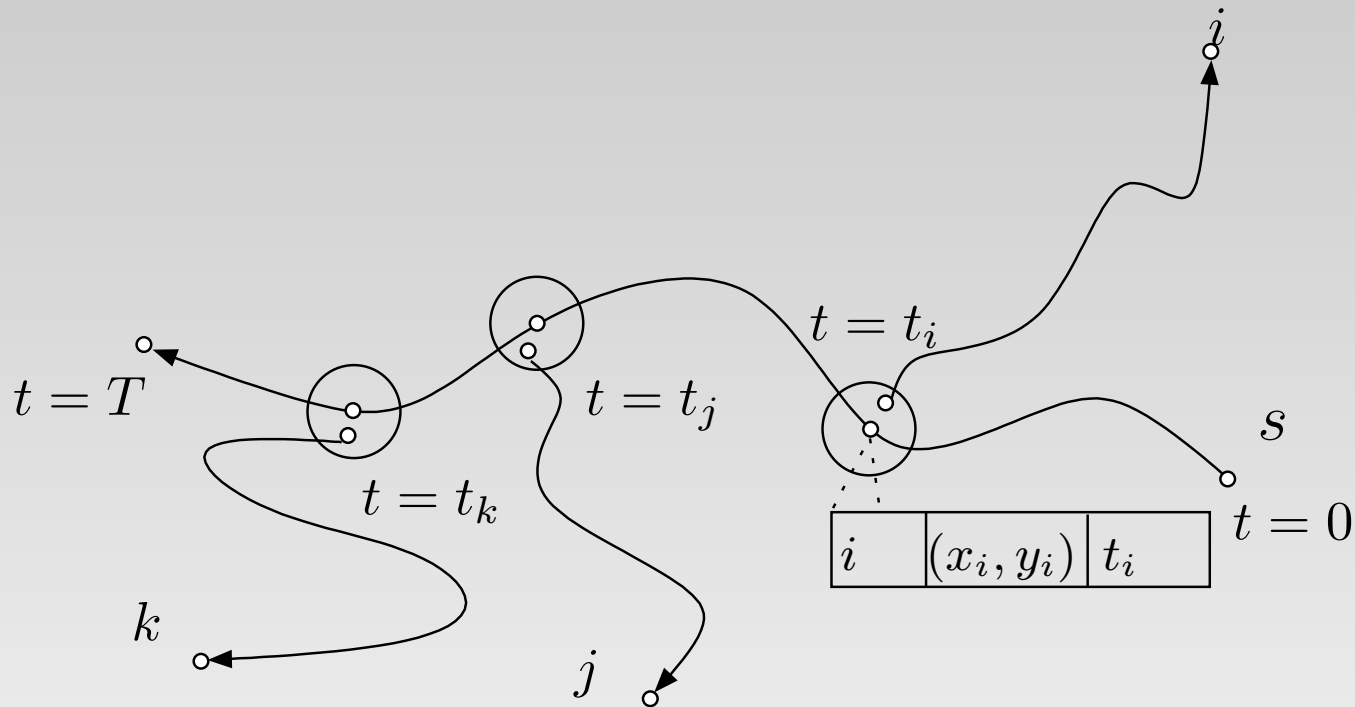
# EASE: Building routing tables



- $(x_i, y_i)$ : estimate of  $i$ 's position



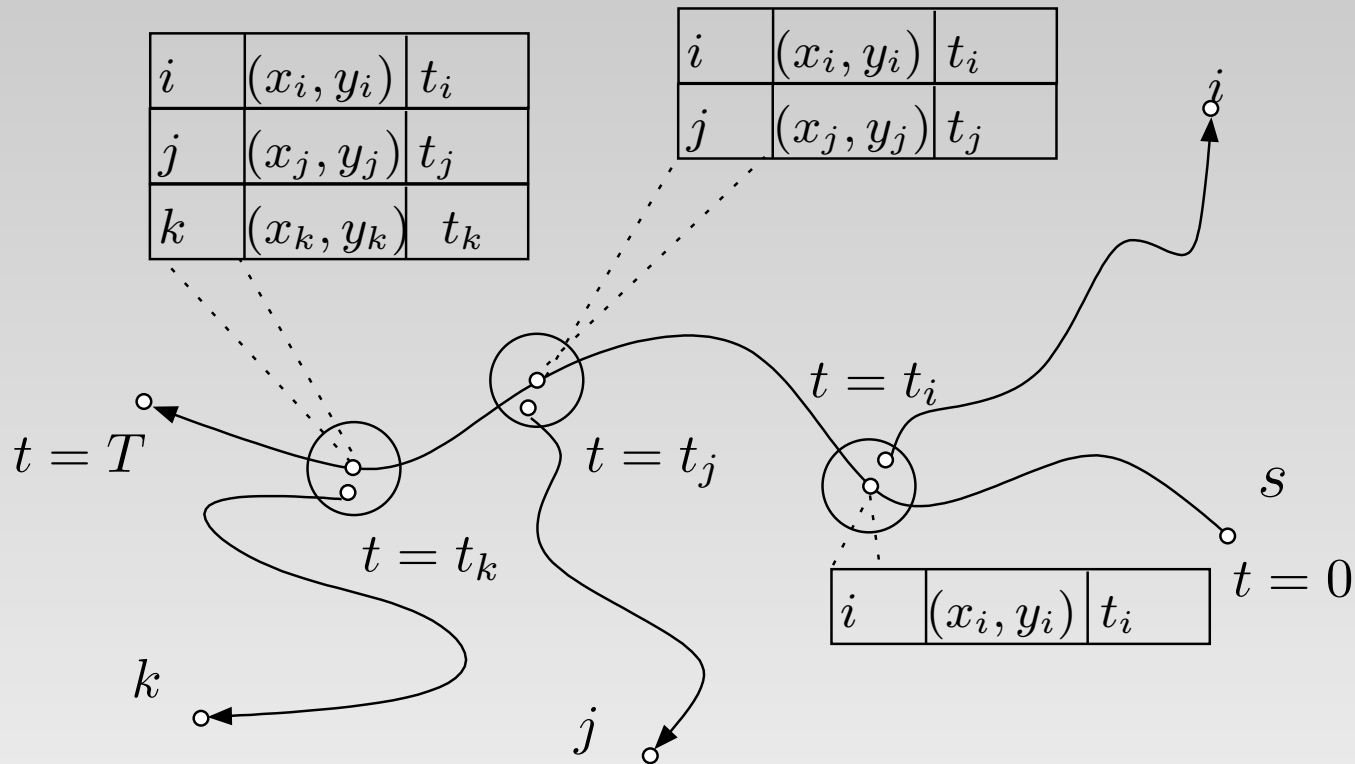
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- $(x_i, y_i)$ : estimate of  $i$ 's position
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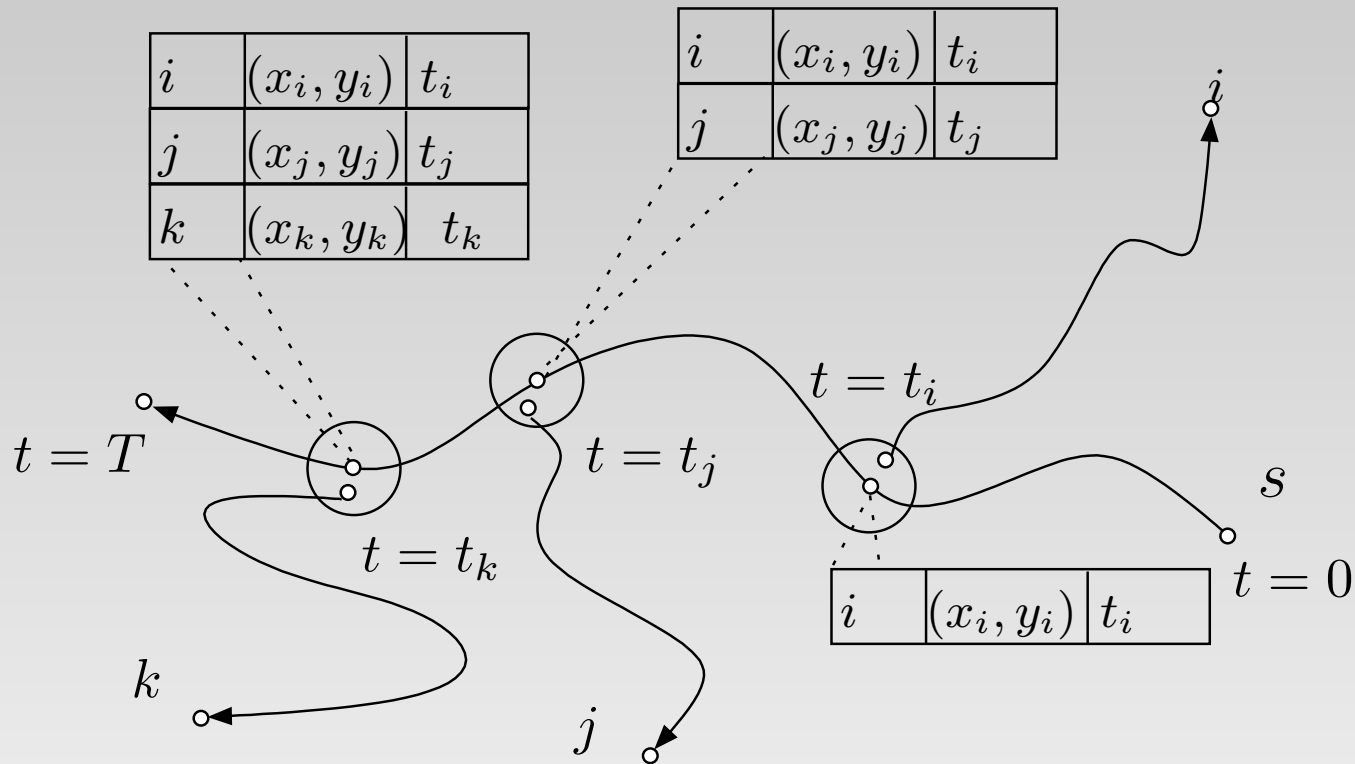
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- $(x_i, y_i)$ : estimate of  $i$ 's position
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- elapsed time  $T - t_i$ : metric of accuracy



# EASE: Routing

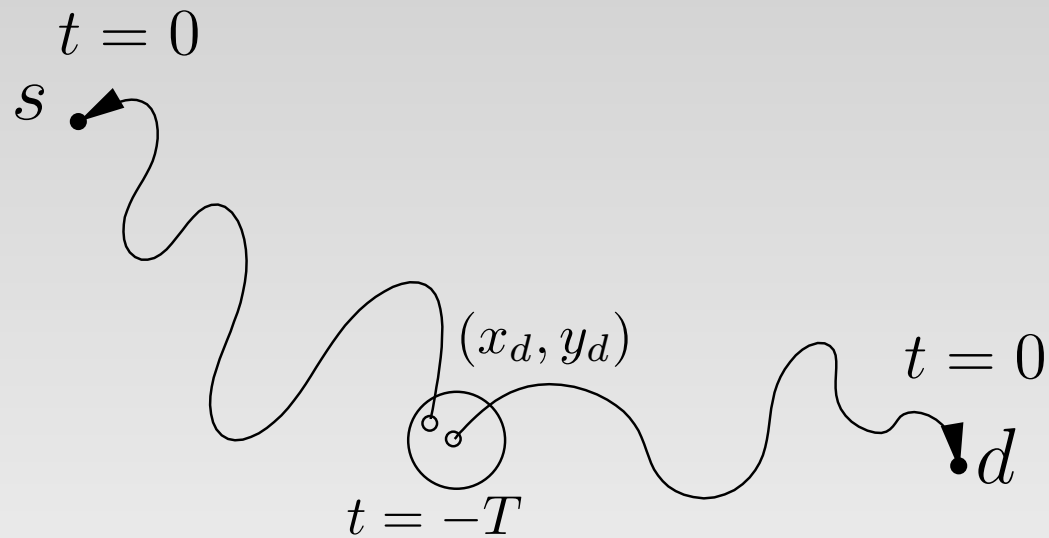
$t = 0$   
 $s \bullet$

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 $\bullet d$



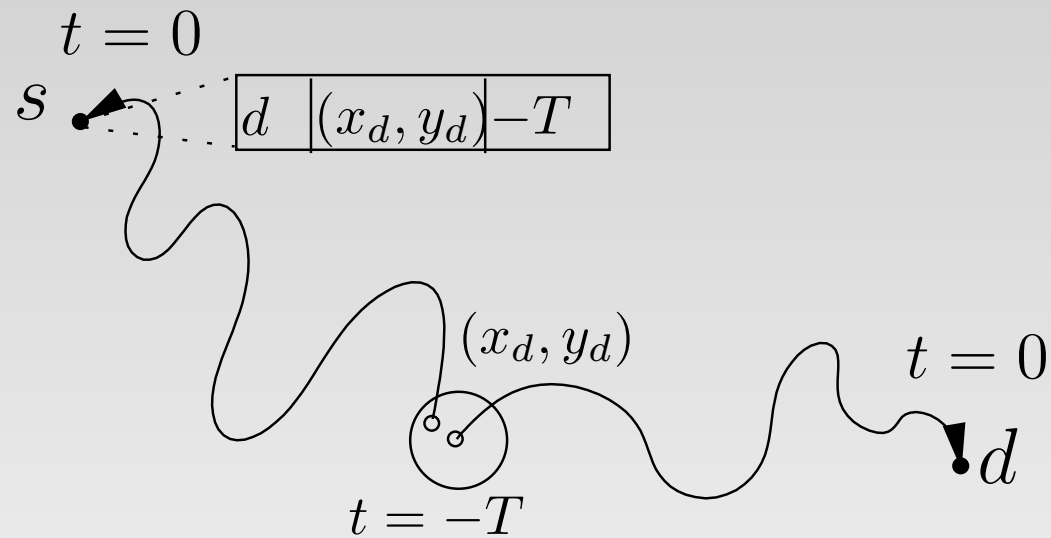
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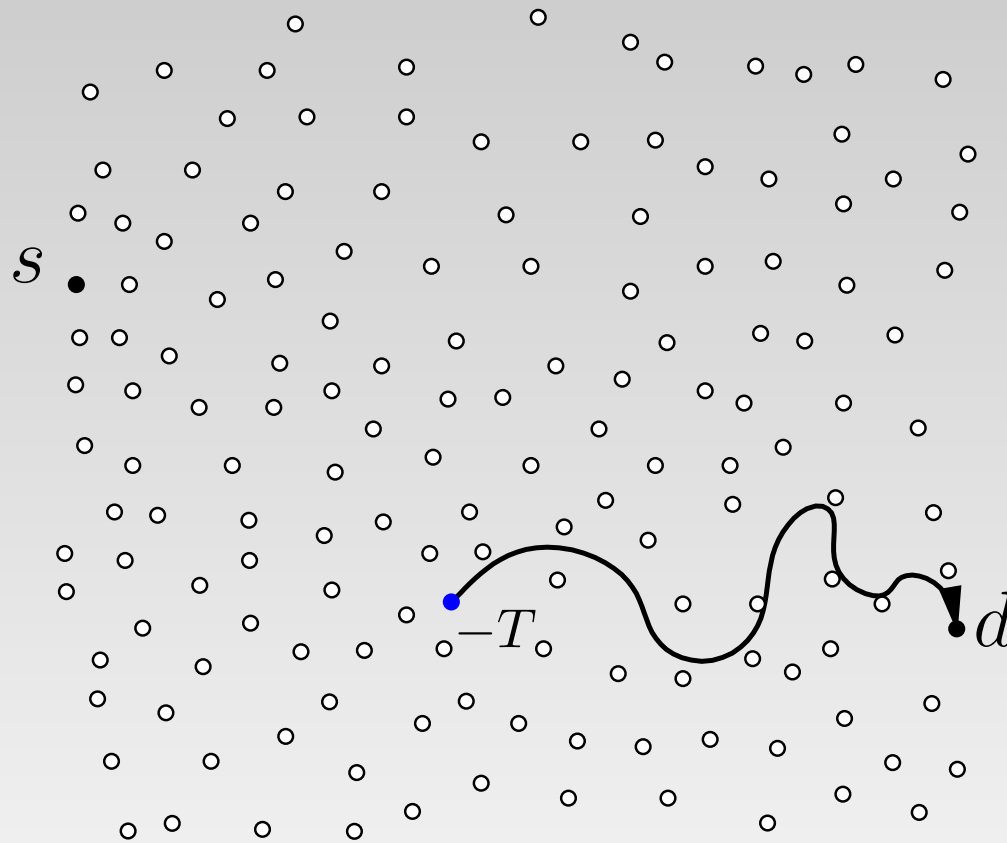
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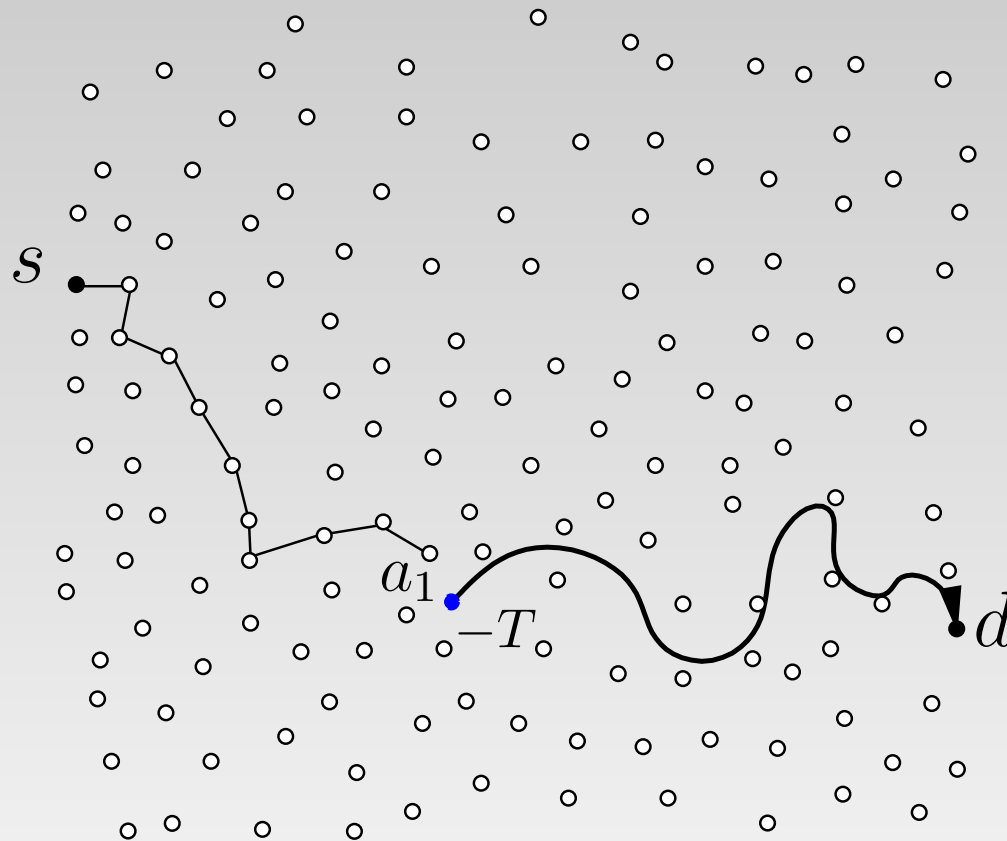


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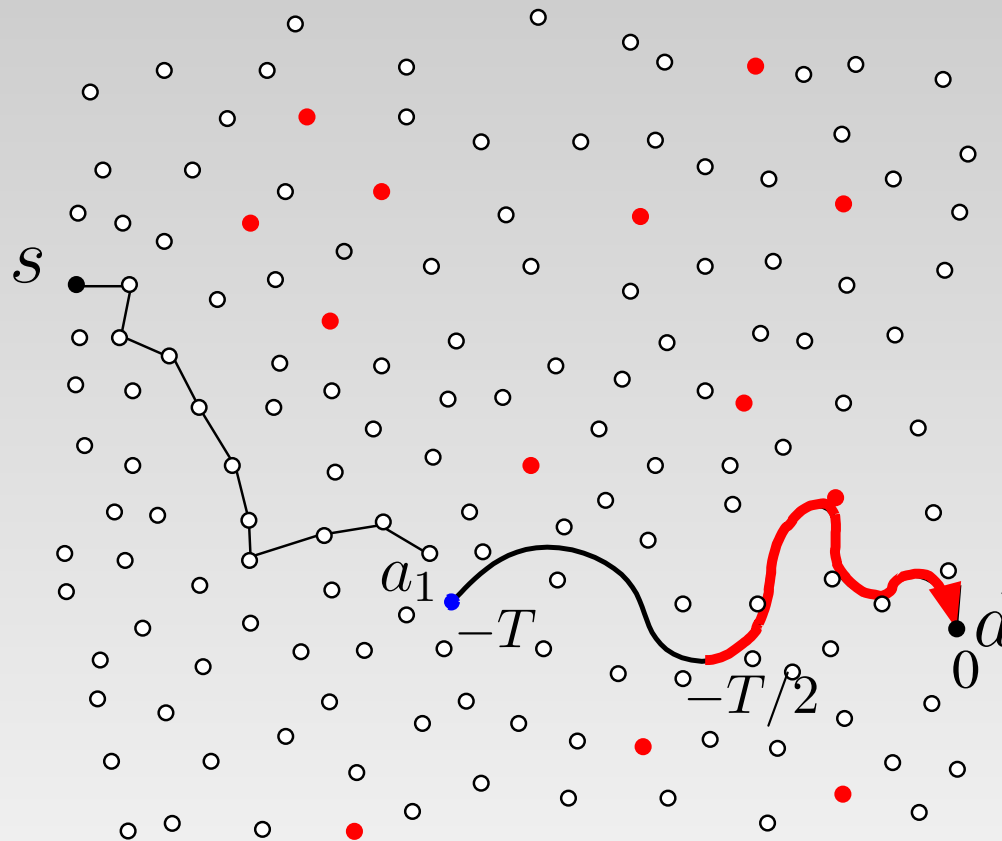


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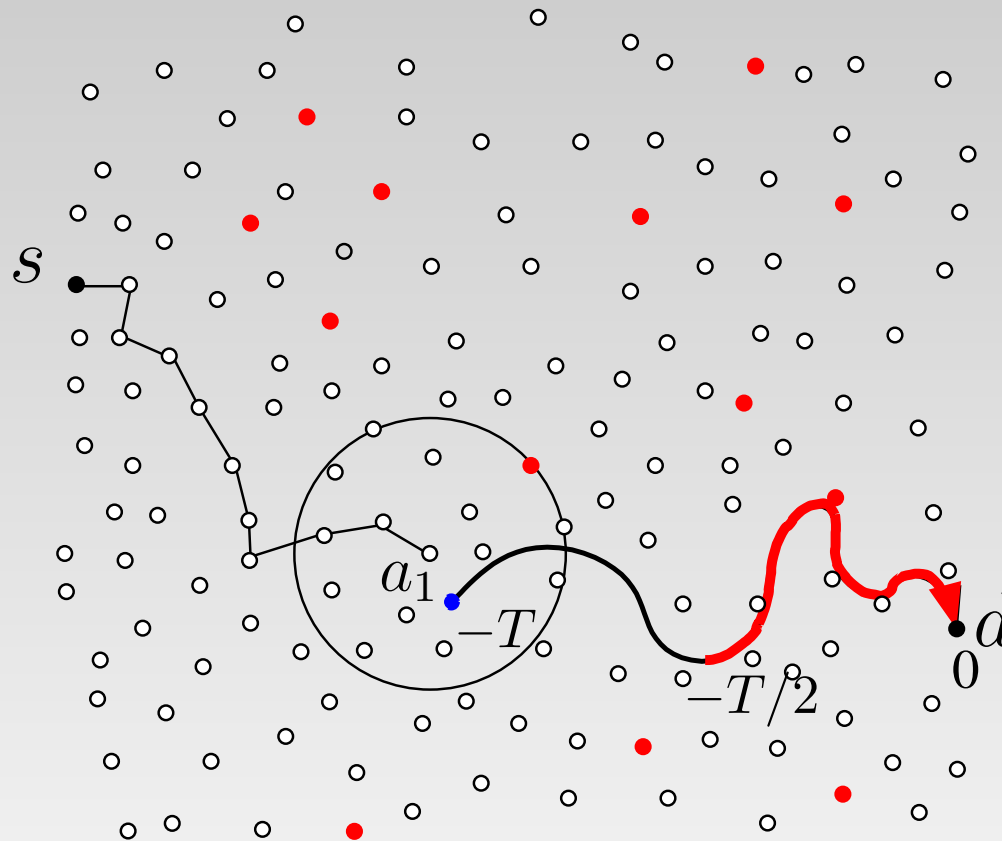
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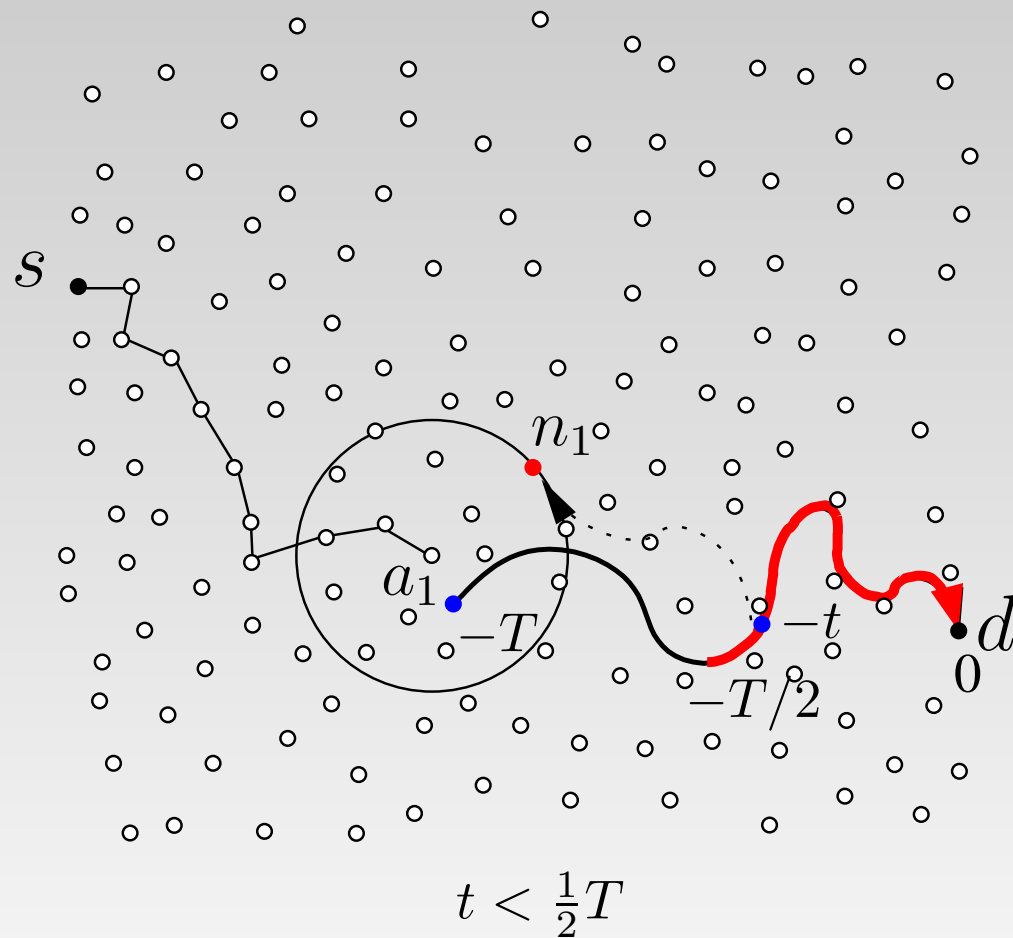
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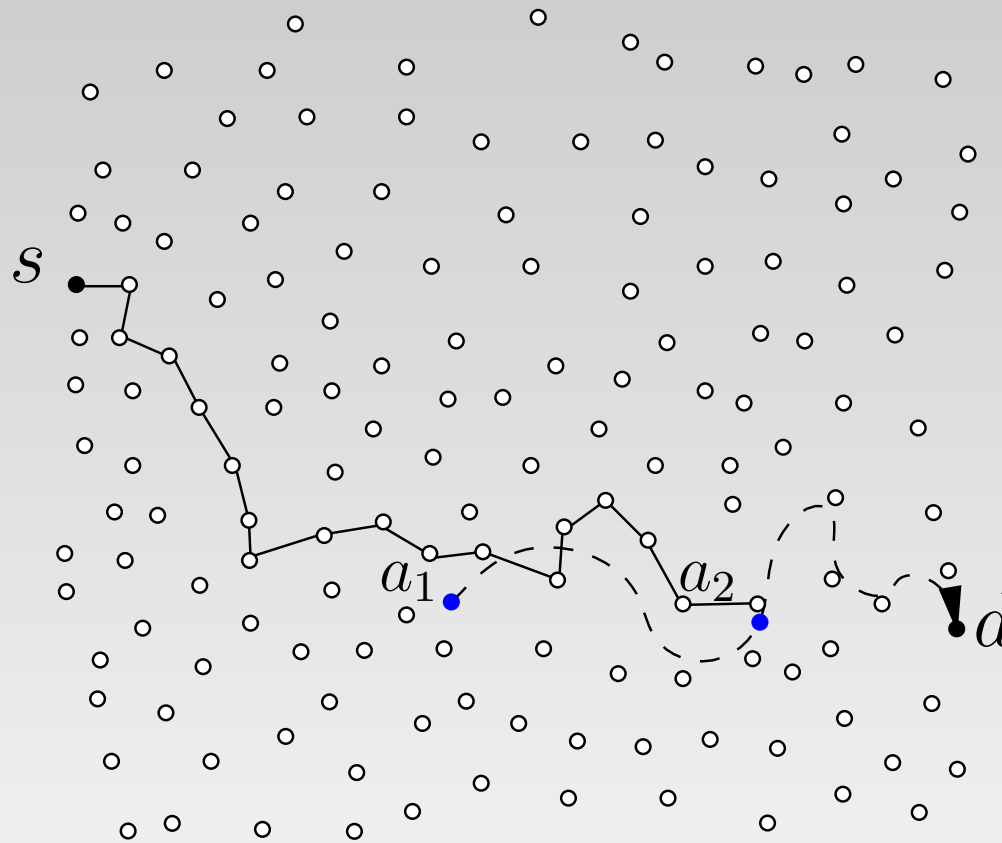
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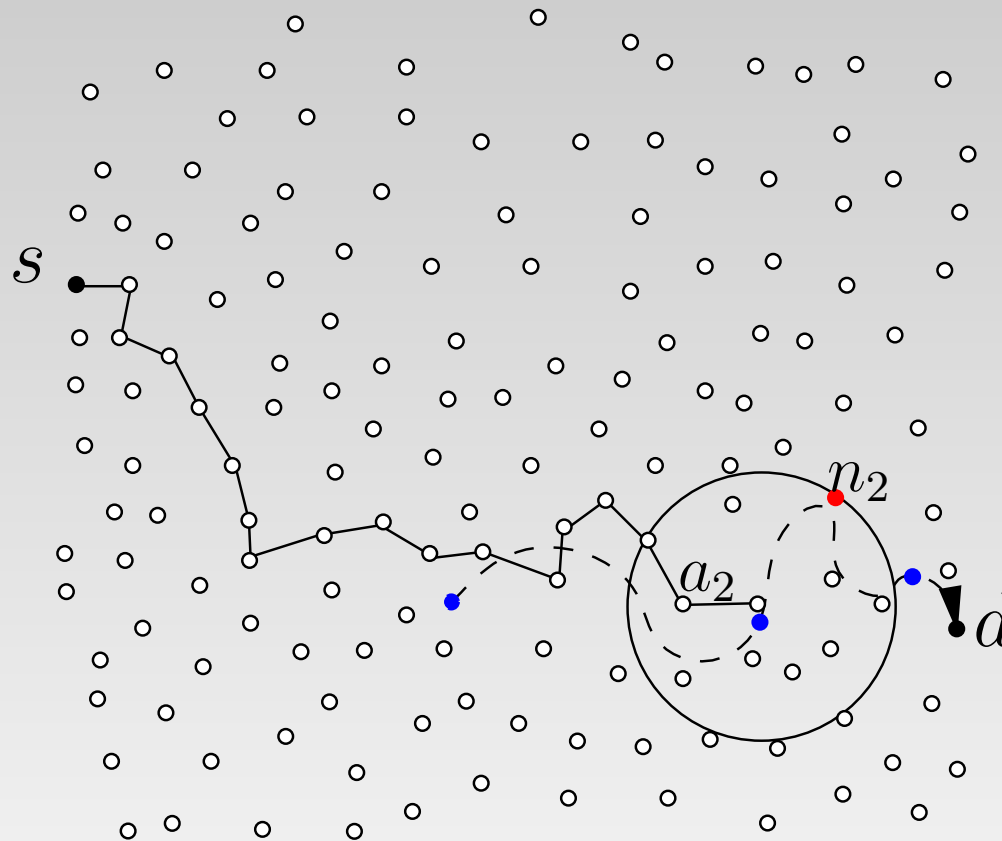
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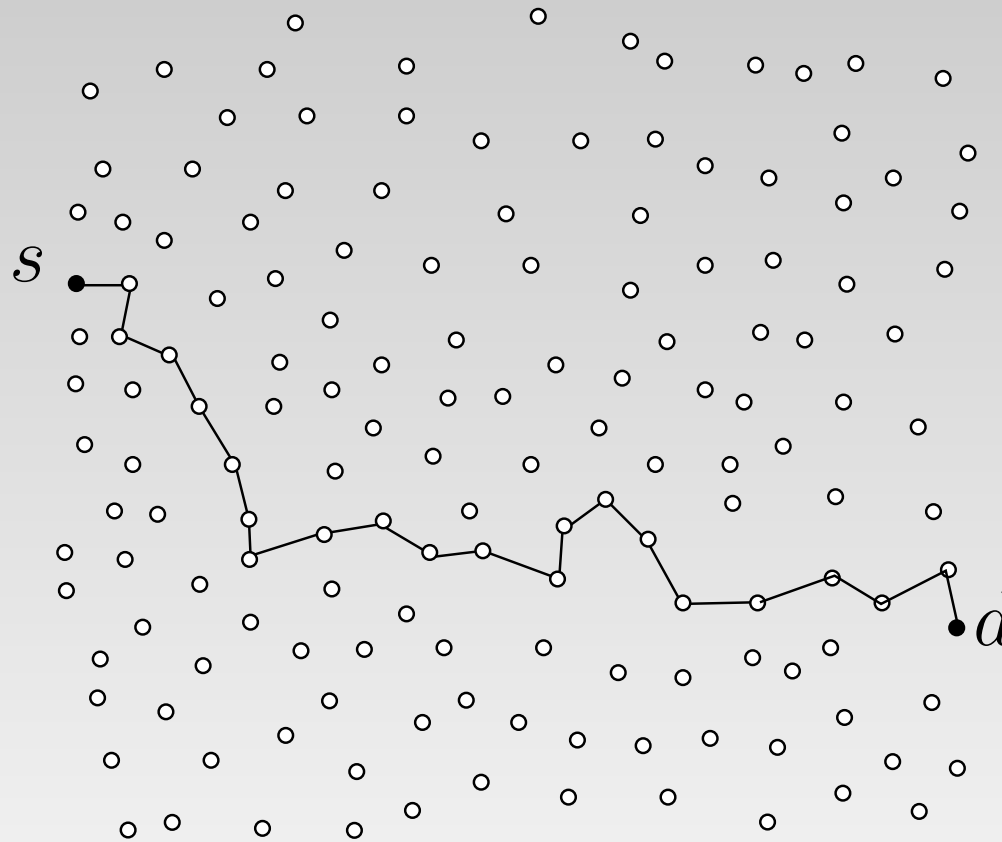
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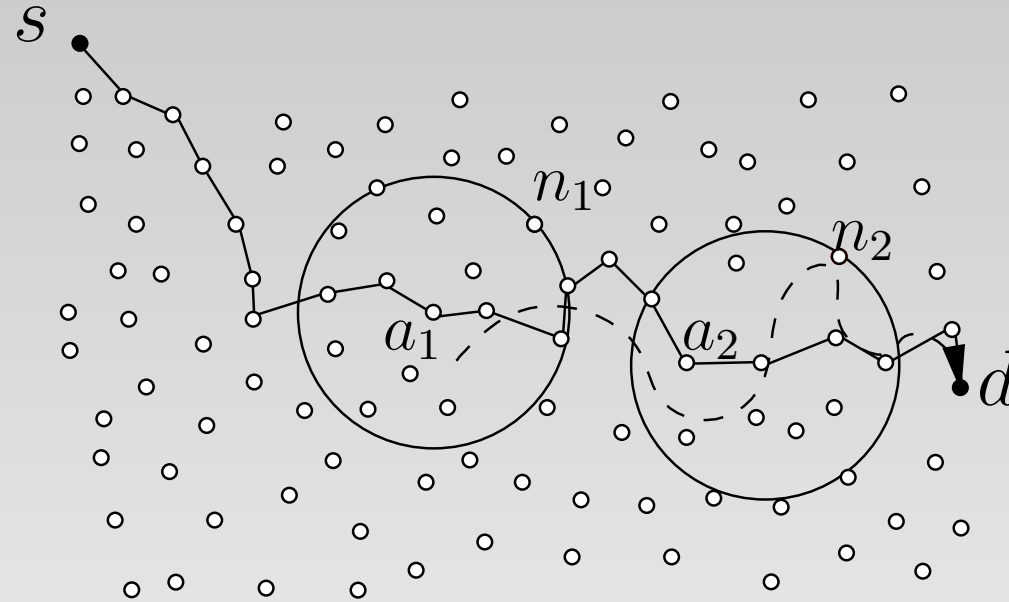
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# Results in [GV03]

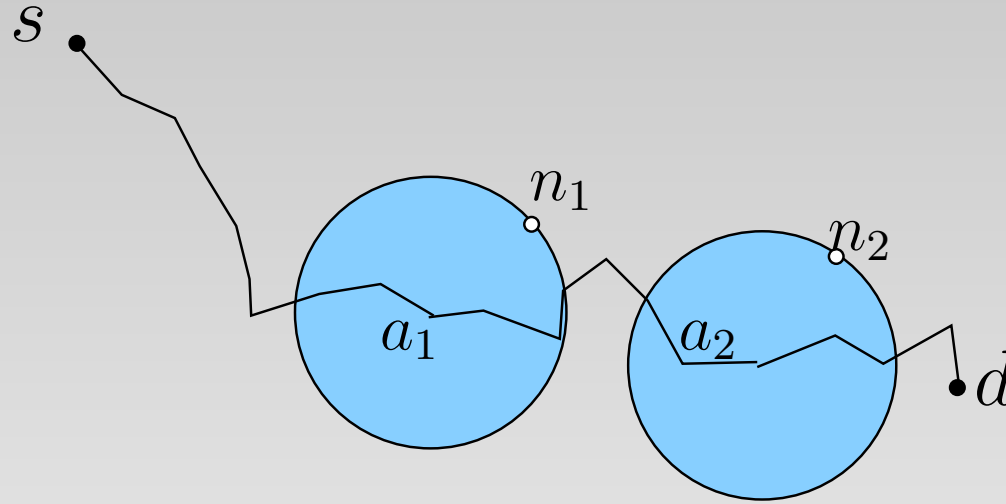


- Cost  $Q(T)$ :





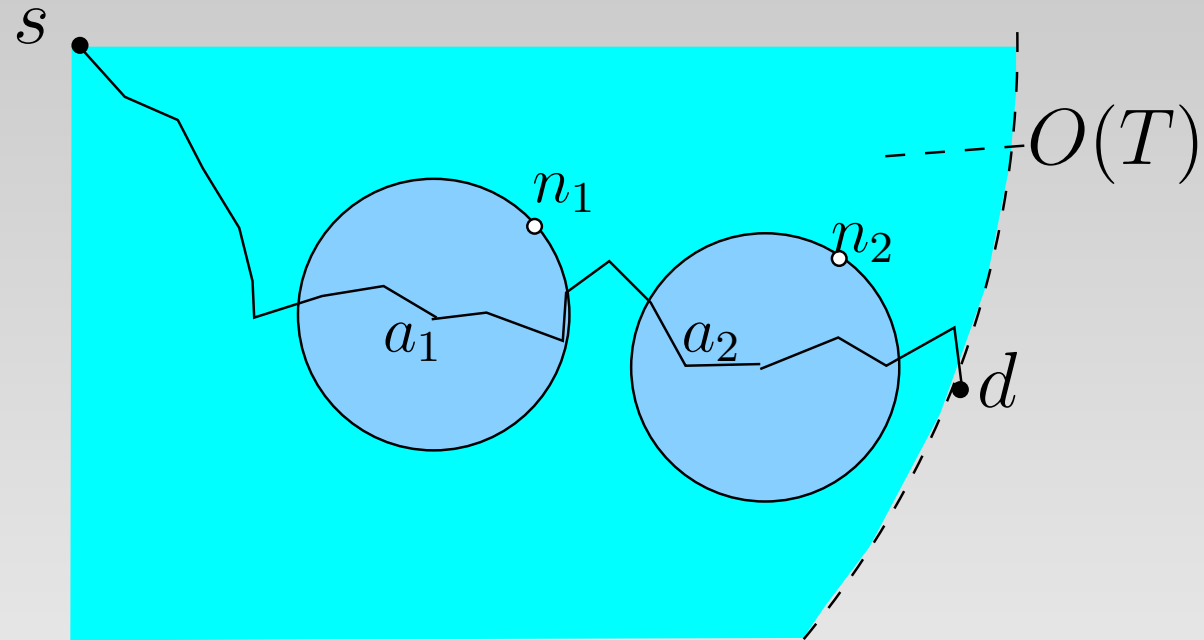
# Results in [GV03]



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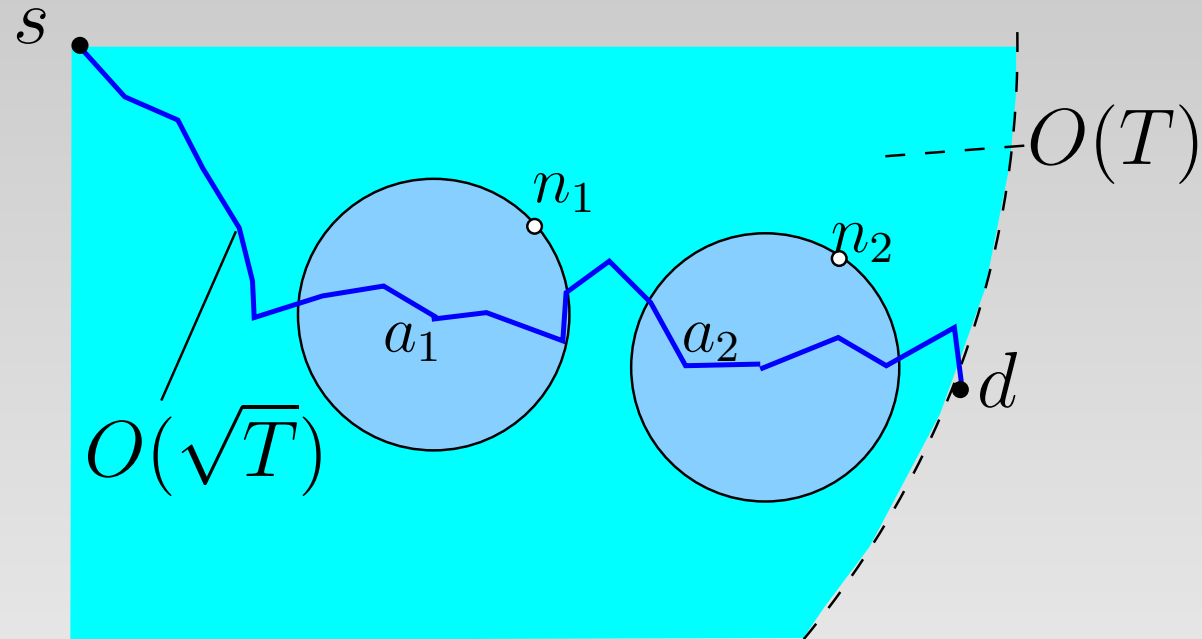
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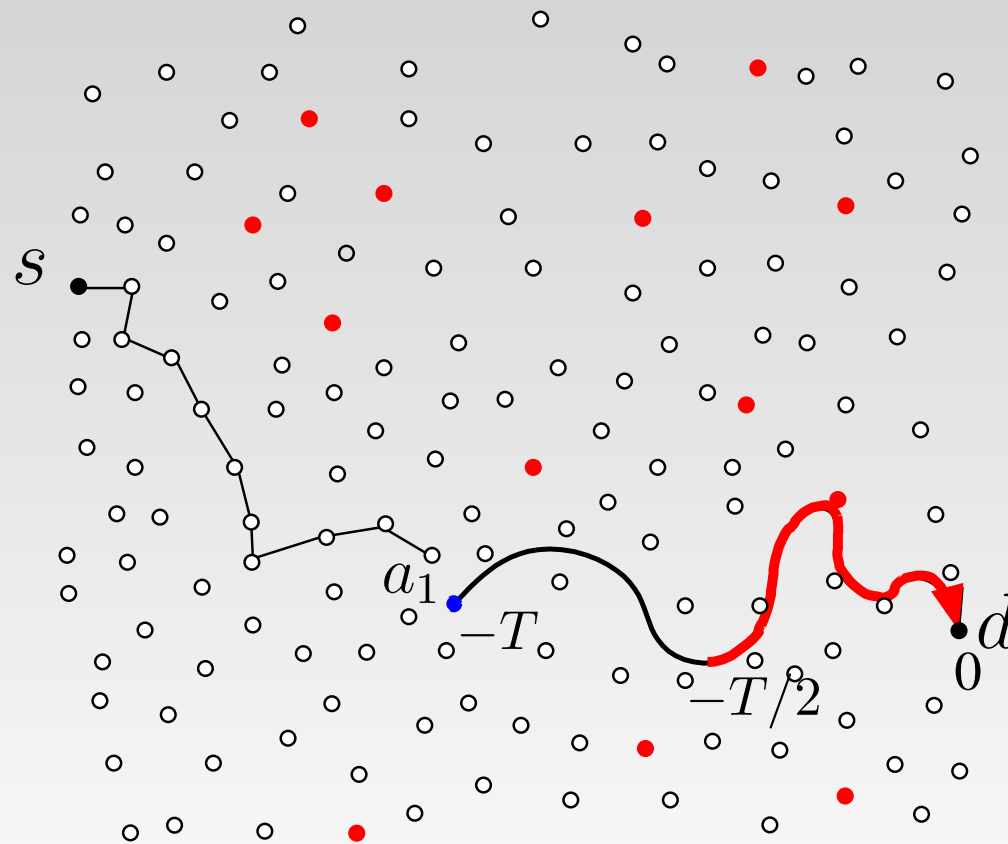


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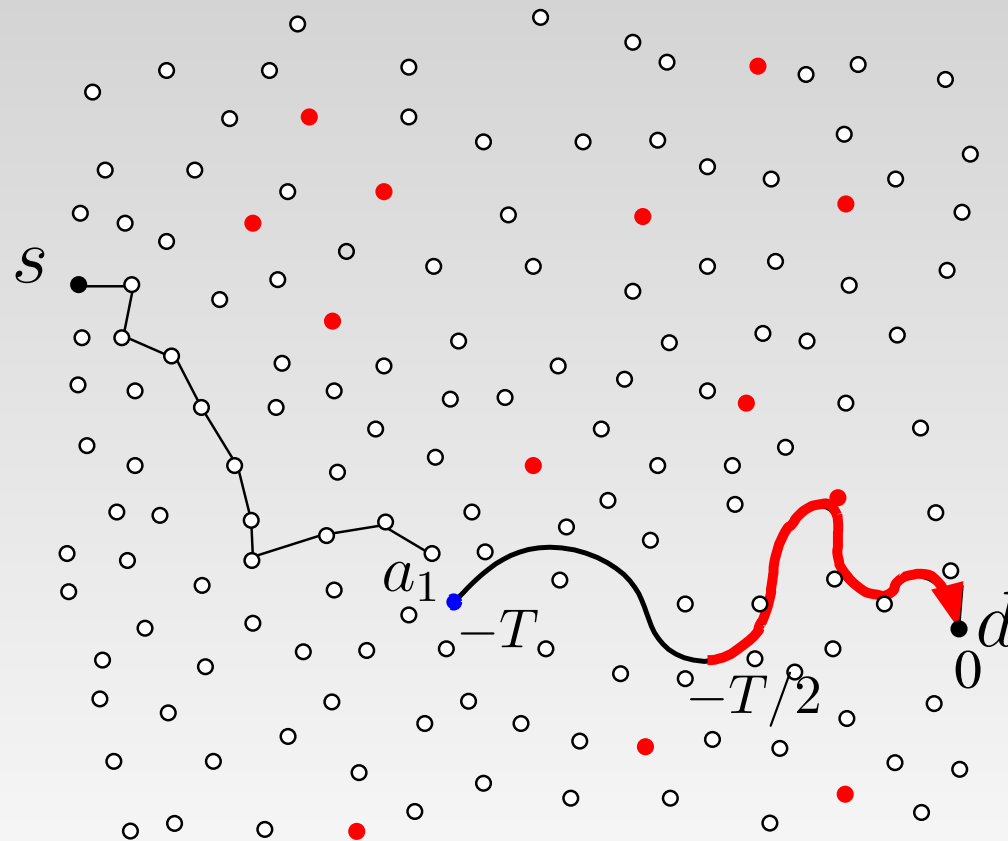
# Questions we address

- Messenger nodes:  $t < \frac{1}{2}T$



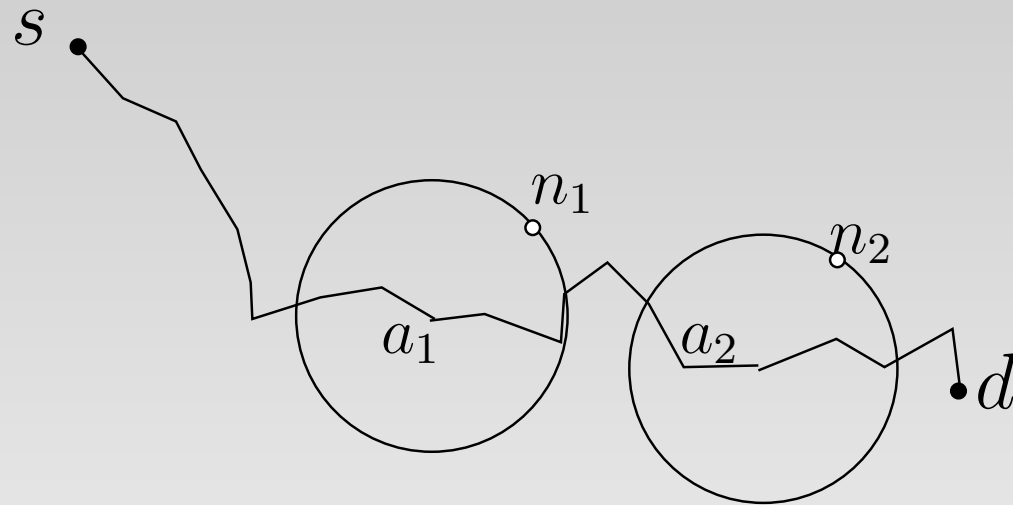
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- Messenger nodes:  $t < \gamma T$ , where  $\gamma \in [0, 1]$



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- Optimal  $\gamma$  w.r.t. cost  $Q$ ?



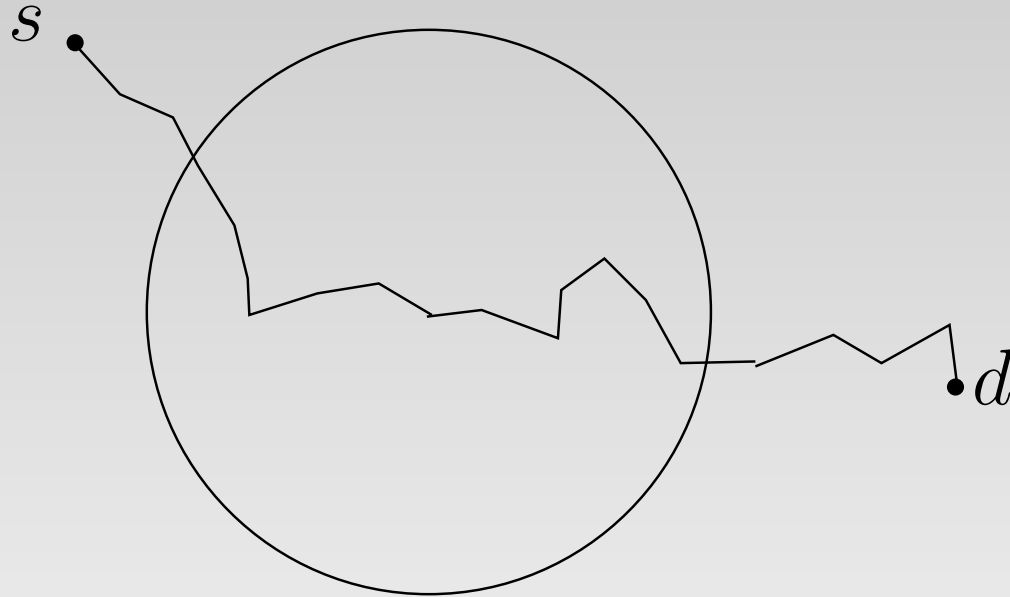
$$- \gamma = \frac{1}{2}$$





# Questions we address

- Optimal  $\gamma$  w.r.t. cost  $Q$ ?



- $\gamma = \frac{1}{3}$ : *fewer* messenger nodes, *better* accuracy



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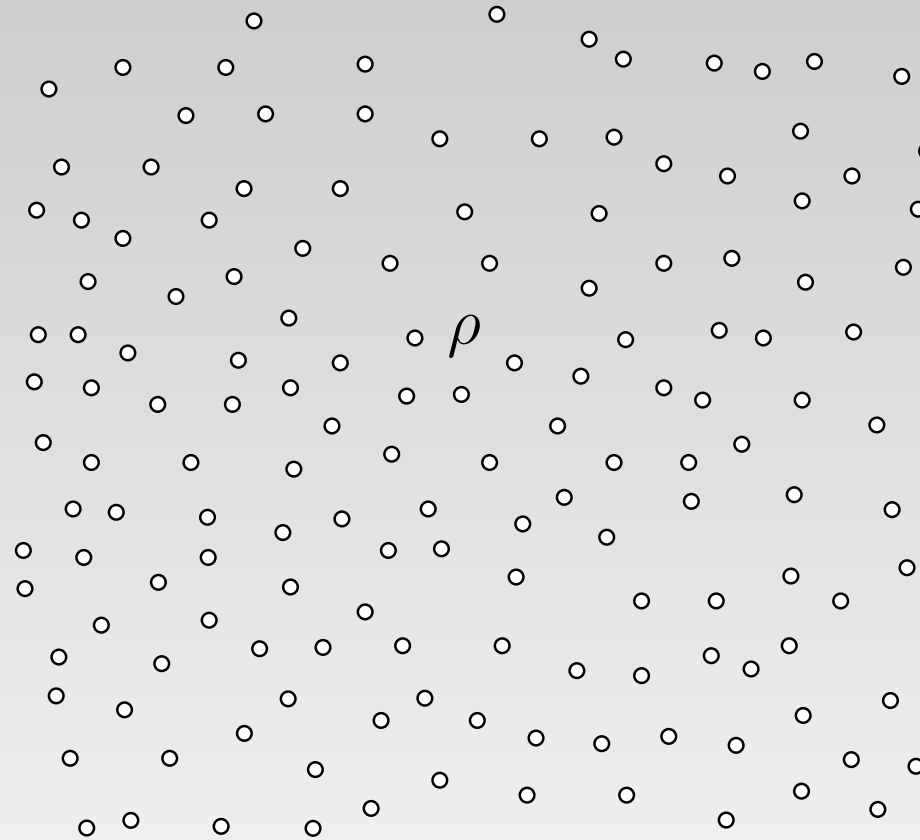


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- Optimal  $\gamma$  w.r.t. cost  $Q$ ?
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- density  $\rho$ ?



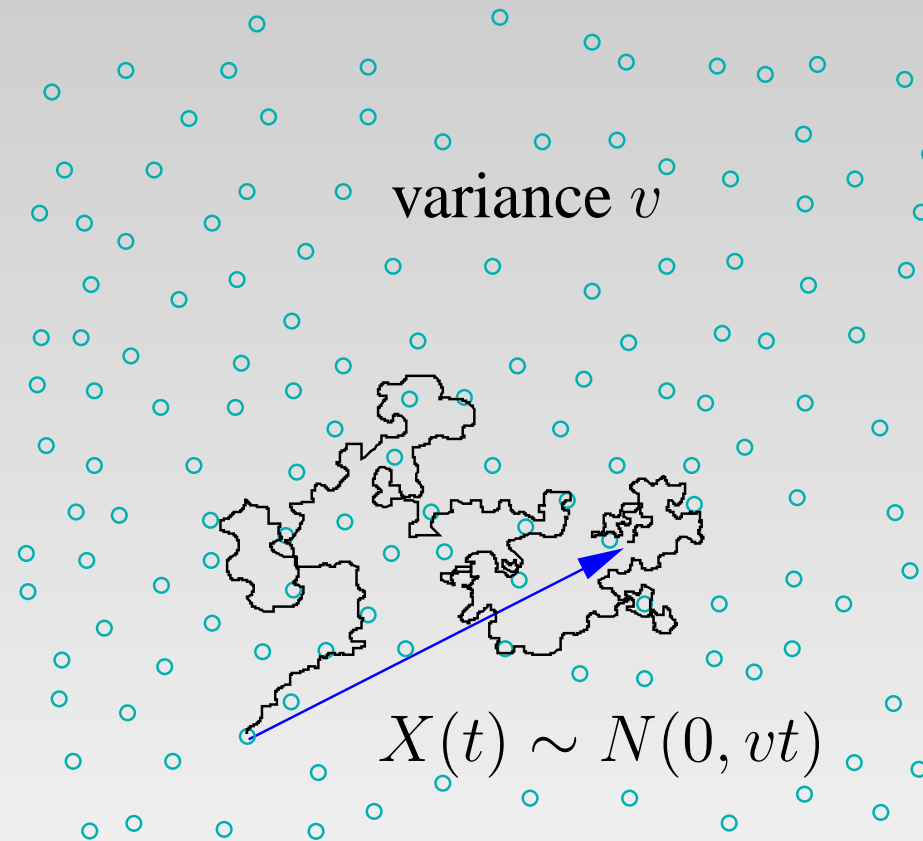
# Network Model



Poisson field in  $\mathbb{R}^2$  with density  $\rho$



# Mobility Model



Brownian motions



# Properties of BM model

Destination:	Fixed path	BM (as in model)



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# A simplified model

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# Motivation

- Open questions posed answered under the simplified model.
- Analysis gives insight on working with original model.
- Similar to [GV03].



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$$Q(T) \leq \frac{1}{\rho} \left( \frac{1}{4} \log^2 T + (c(v) + o(1)) \log T \right)$$



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- $v?$ 
  - EASE cost asymptotically indifferent to variations of  $v$
- $\rho?$ 
  - EASE overhead indifferent to variations of  $\rho$ .



# Towards an analysis of EASE

## Summary:

- A BM model for EASE
- Results under a simplified model



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- Mathematical tools used on the simplified model useful in addressing original model.



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- A BM model for EASE
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## Insights:

- Mathematical tools used on the simplified model useful in addressing original model.
- Current work: an analysis under the original model.



**Thank you!**



# References

- [GV03] Matthias Grossglauser and Martin Vetterli. Locating nodes with EASE: Mobility diffusion of last encounters in ad hoc networks. In *IEEE Infocom2003*, San Francisco, 2003.

@



# EASE and traditional protocols

Proactive

EASE

Reactive



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Tables contain  
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