Deterministic Leader Election in Multi-Hop Beeping Networks

Klaus-Tycho Förster, Jochen Seidel, Roger Wattenhofer

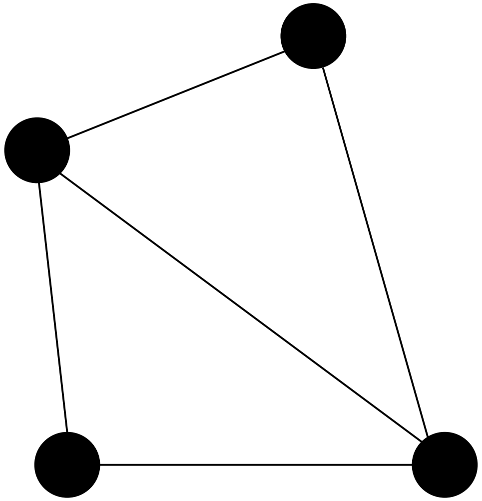
What Algorithm to take?

Deterministic

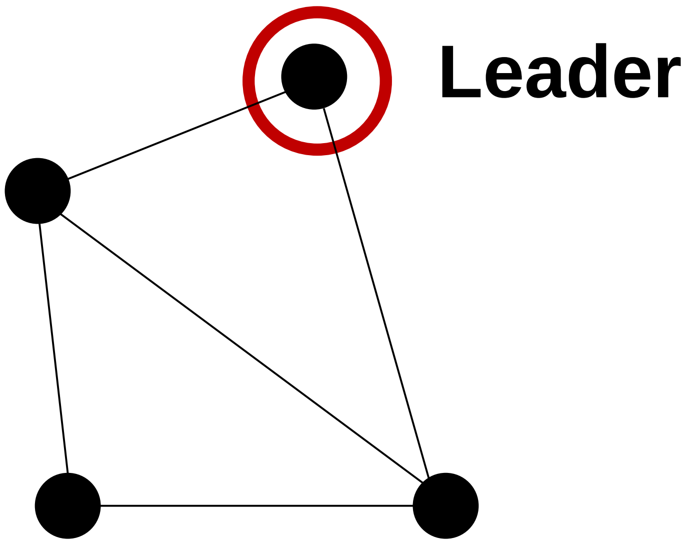
Randomization

Heuristic

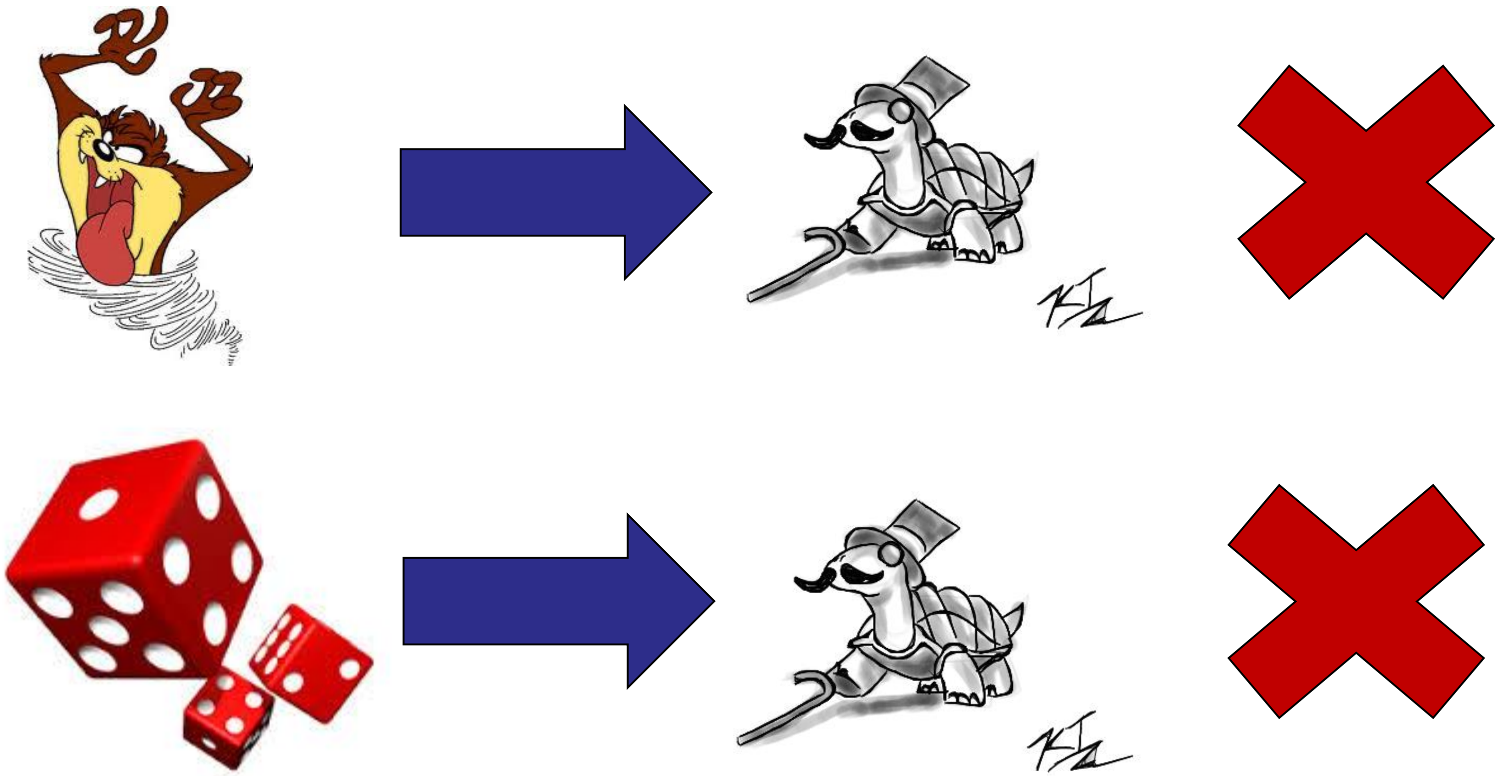
Leader Election



LeaderElection



Why deterministic leader election?



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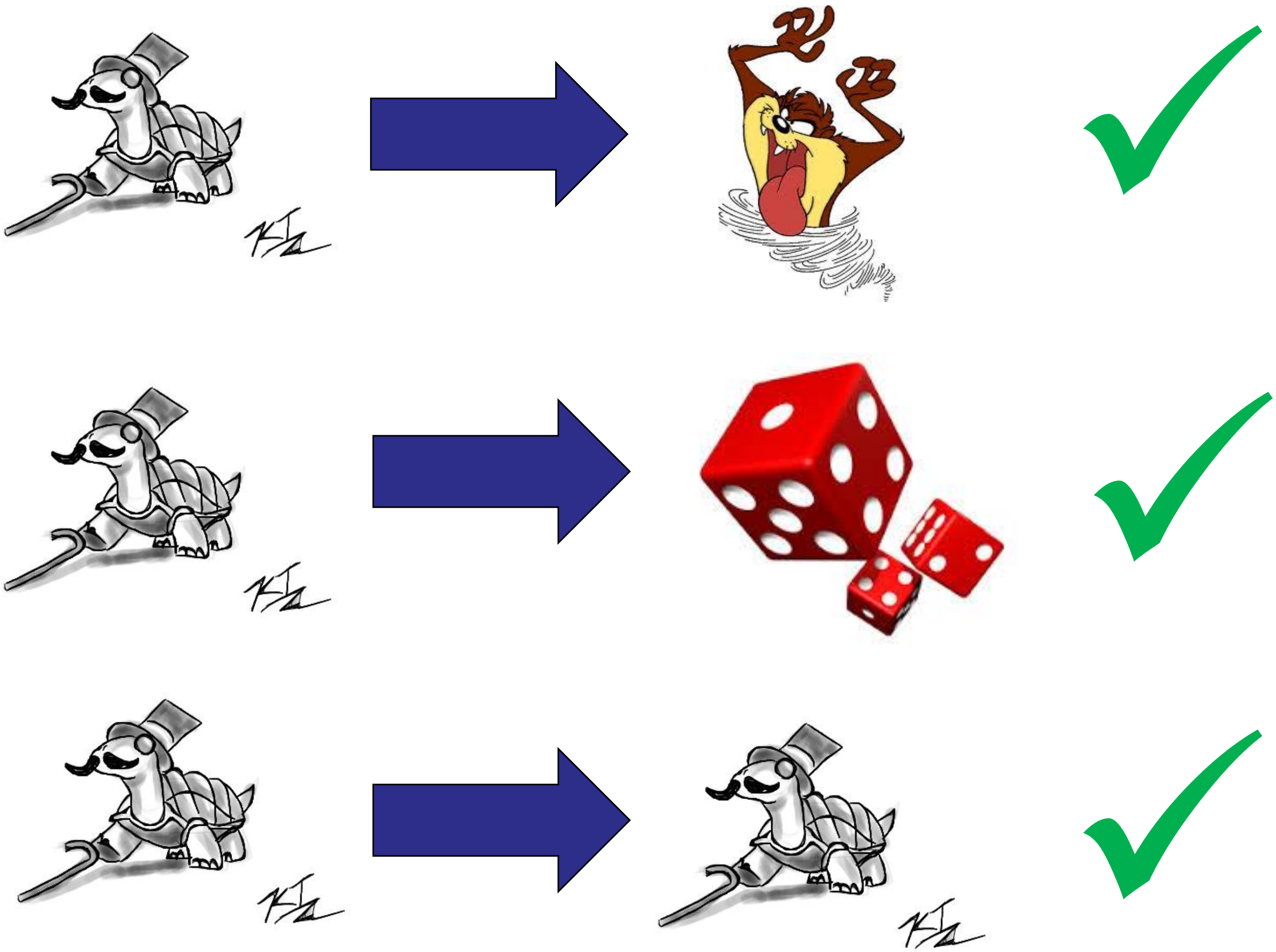


Leader Election – Wireless Radio Networks

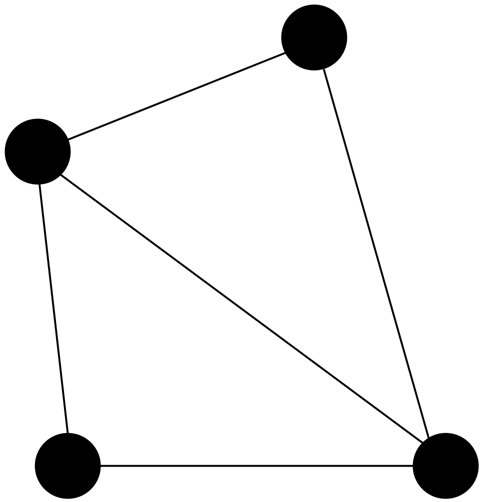
Single-Hop

- from $\Theta(\log\log n)$ [Willard, 1986] to $\Theta(n\log n)$ [Clementi et al., 2003] …
  - (depending on the model)

Multi-Hop

- with collision detection
  - (deterministic): $\Theta(n)$ [Kowalski & Pelc, 2009]
- without collision detection
  - (randomized): $\mathrm{O}(n\log n)$ [Czumaj & Rytter, 2006], $\Theta(n)$ [Chlebus et al., 2012]
  - (deterministic): $\mathrm{O}\left(n\log^{3/2} n\sqrt{\log\log n}\right)$ [Chlebus et al., 2012]
    - $\Omega(n\log n)$ [Kowalski & Pelc, 2009]
    - $\mathrm{O}(n\log^2 n\log\log n)$[Vaya, 2011]

The Beeping Model



- Each round: **beep** or **listen**
- Listen: **silence** or **beep** (at least one neighbor beeps)

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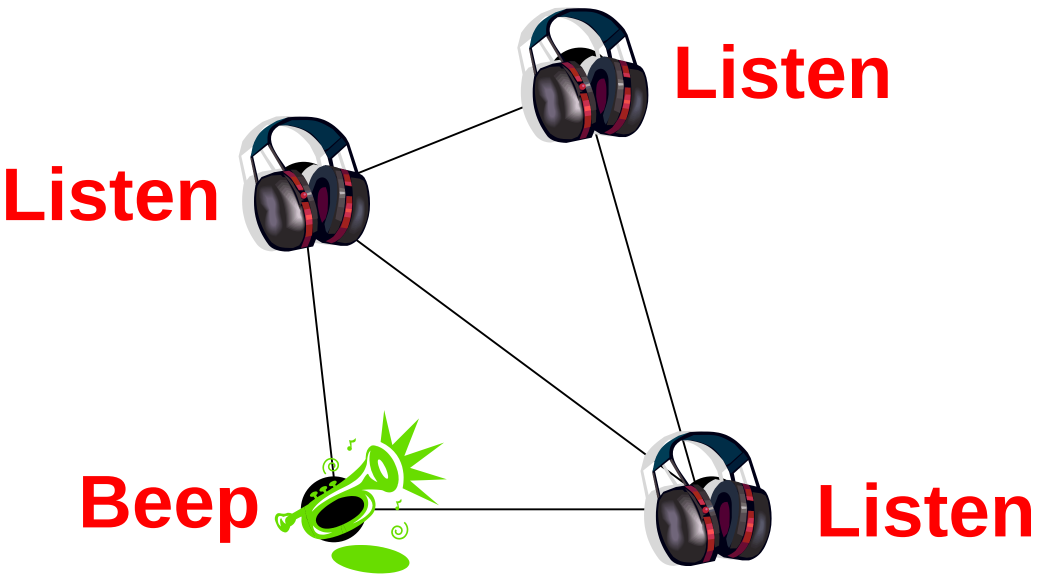

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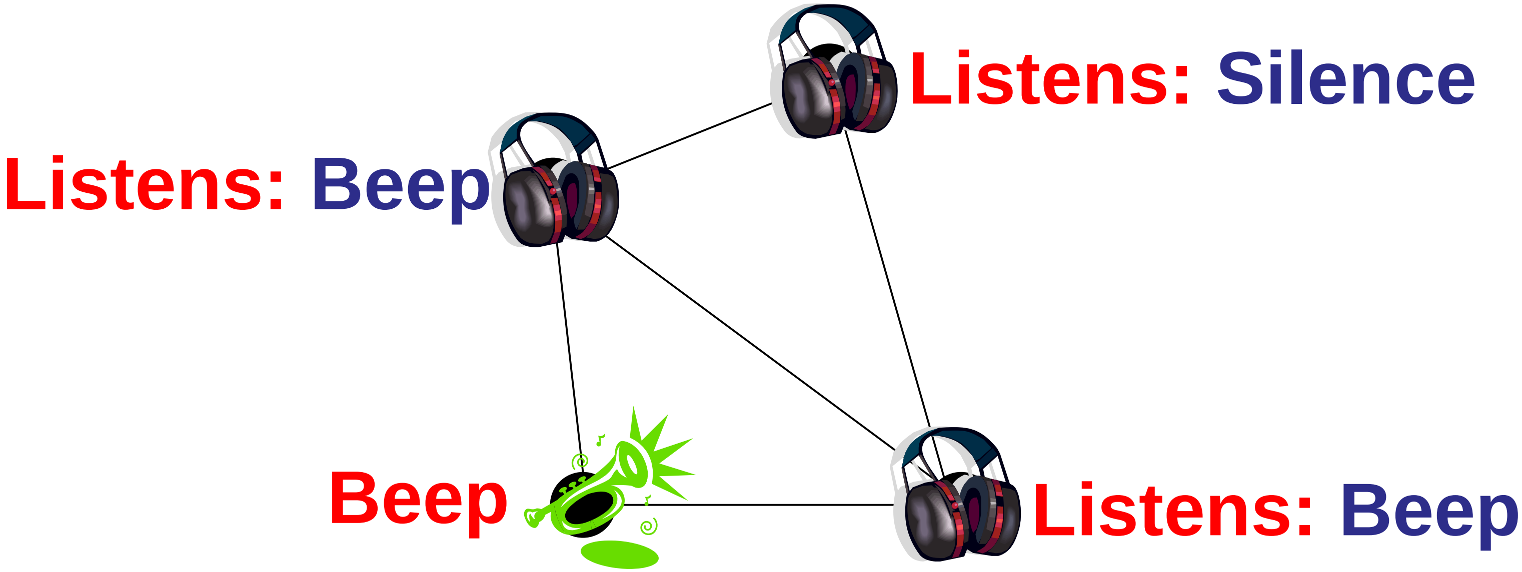

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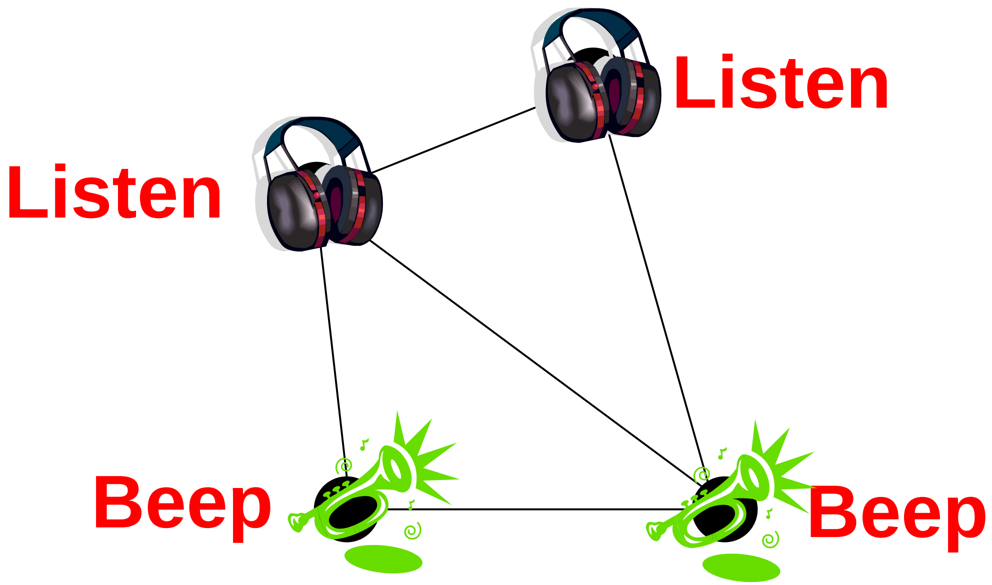

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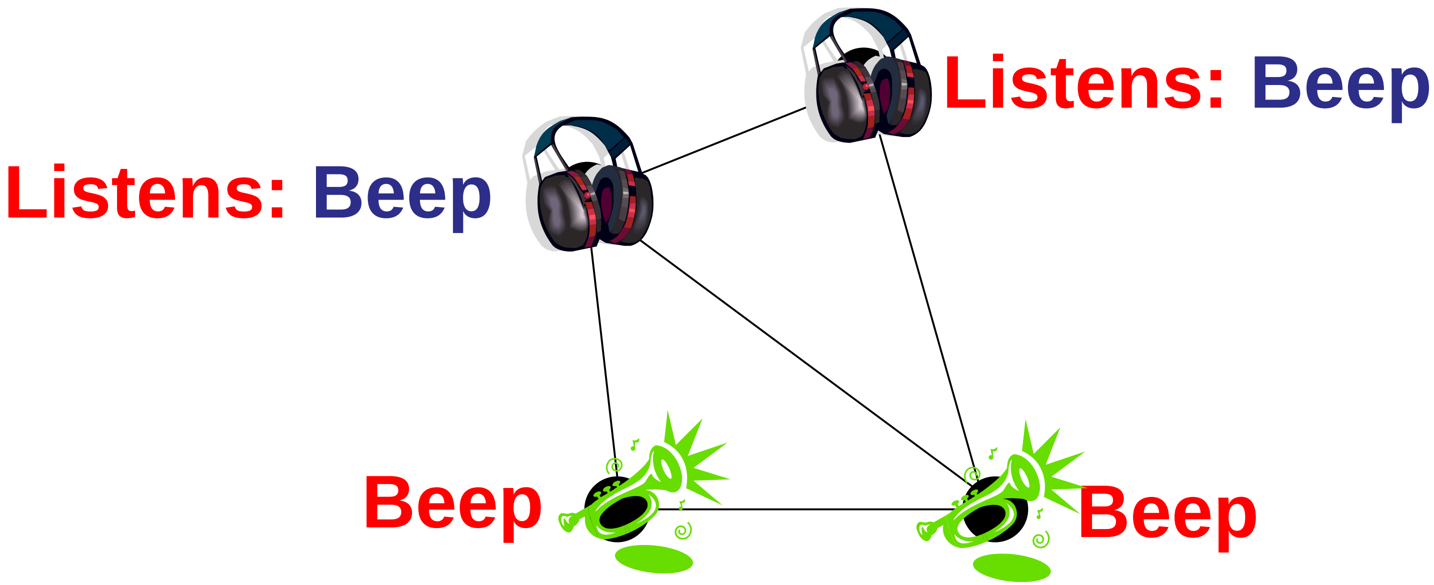

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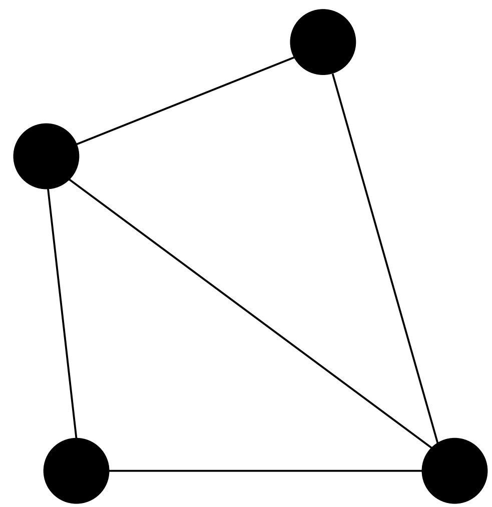
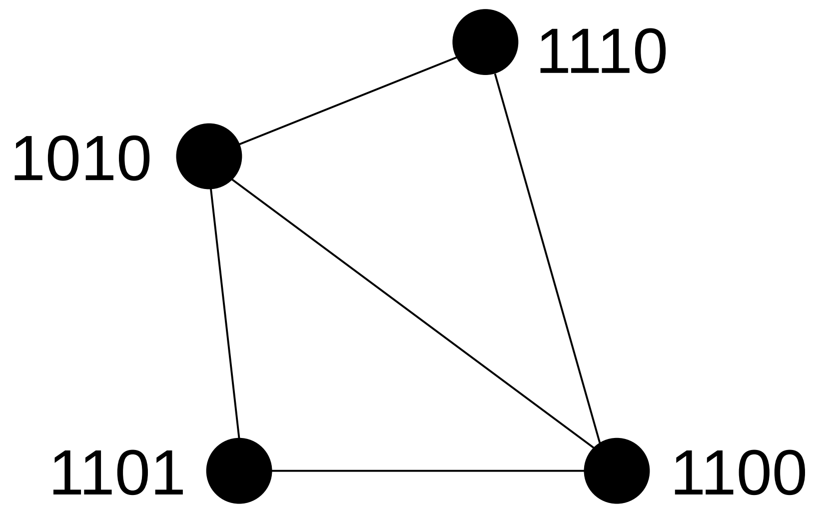
Leader Election – in the Beeping Model



- Randomized: [Ghaffari & Haeupler, 2013]
  - $O\big((D + \log n \log\log n) * min(\log\log n\,, \log n\,/D)\big)$

Deterministic Leader Election – in the Beeping Model



- Deterministic & Uniform: $O(D \log n)$ [this paper]

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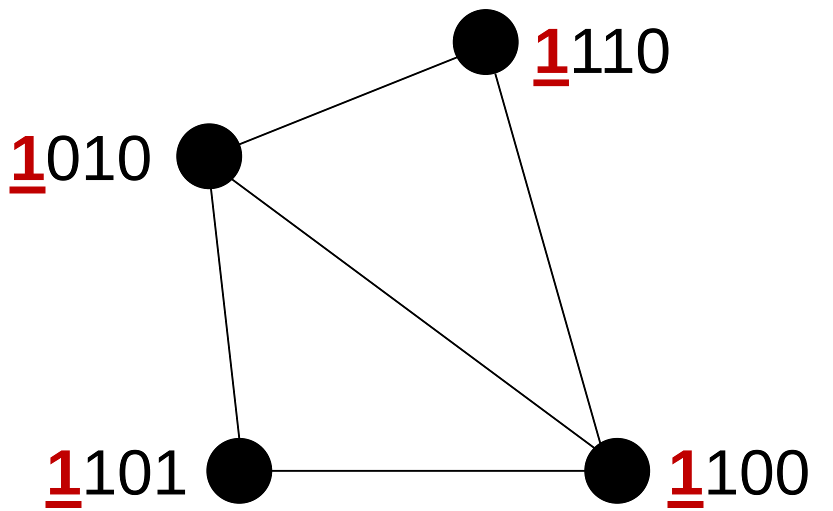

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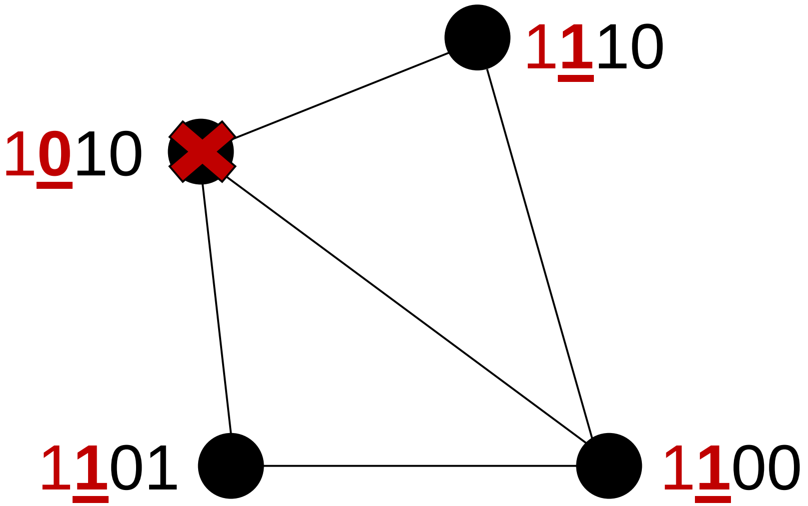

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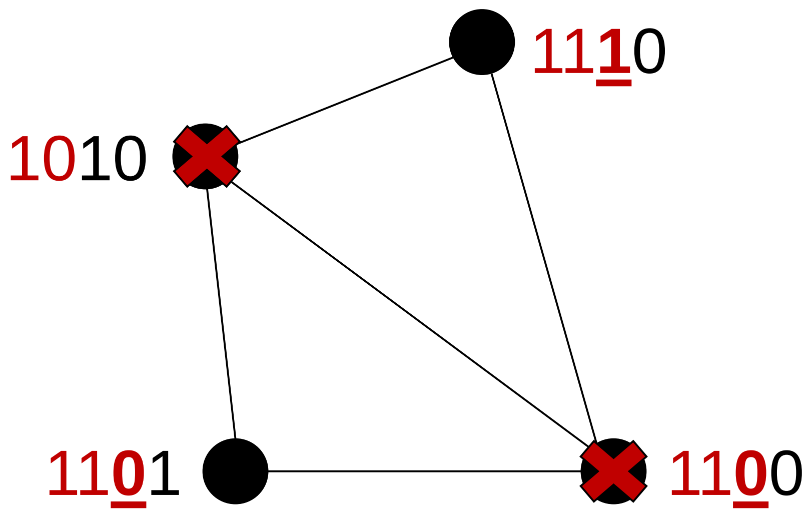

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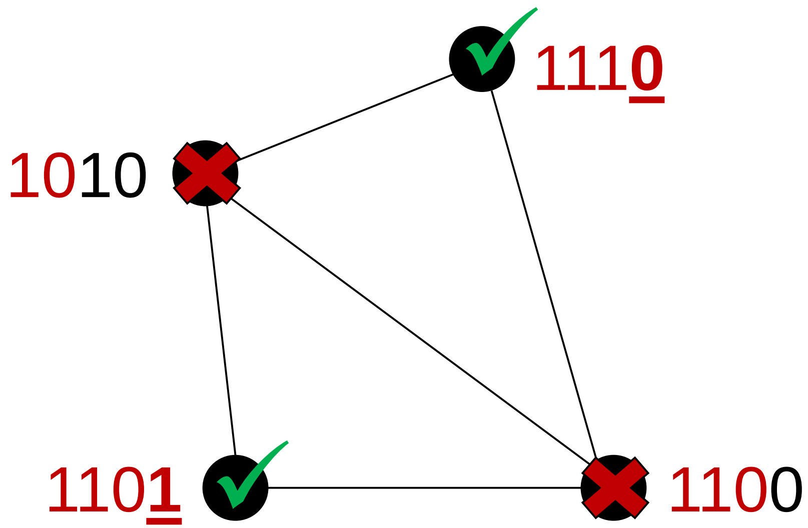

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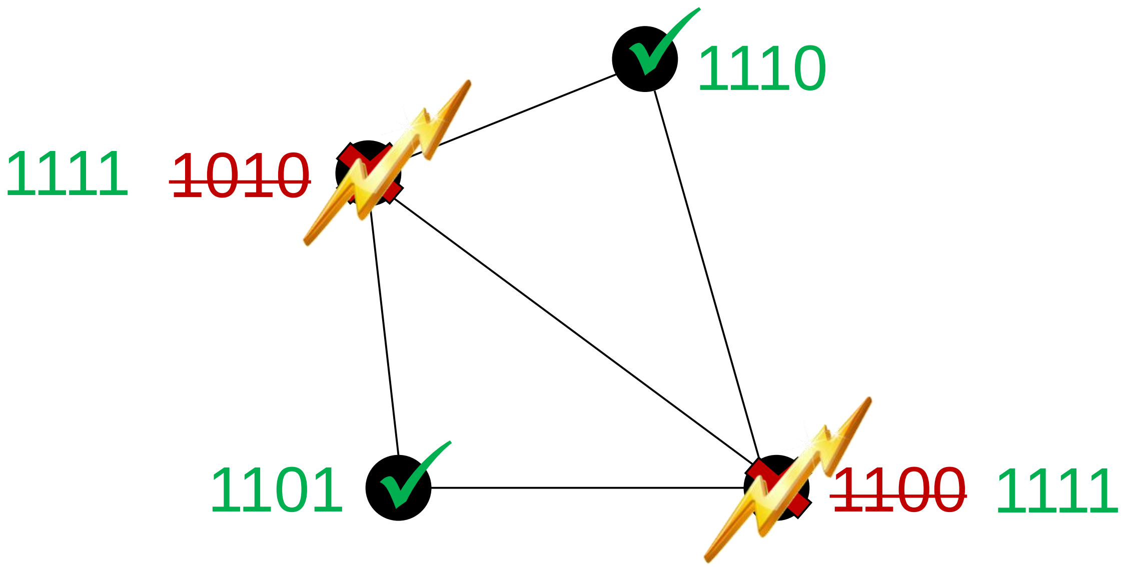
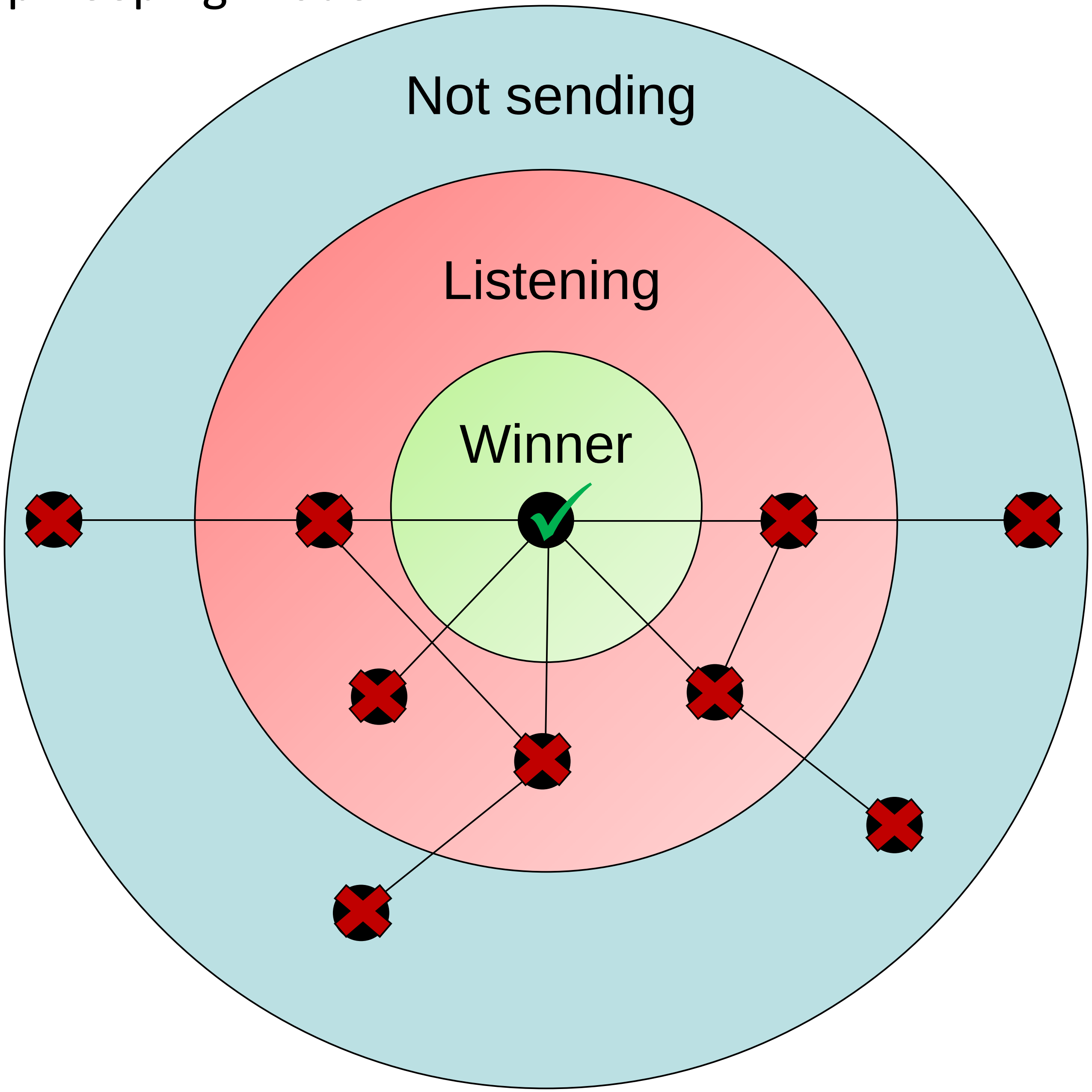


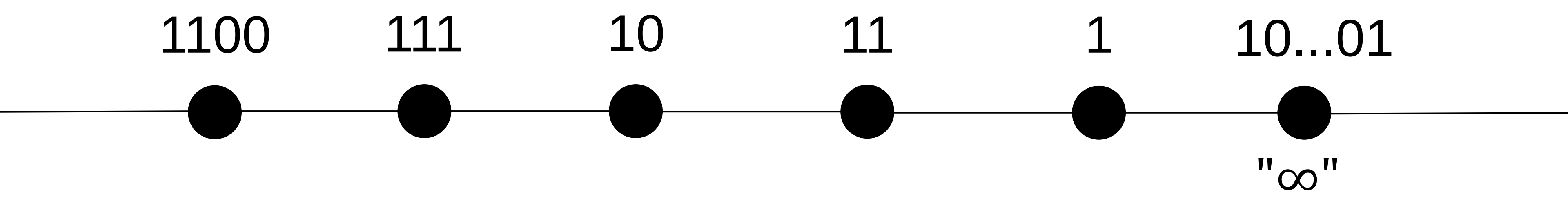
Multi-Hop Beeping Model



But what about Uniformity?

I know nothing
(I‘m Jon Snow)

IDs of different length?



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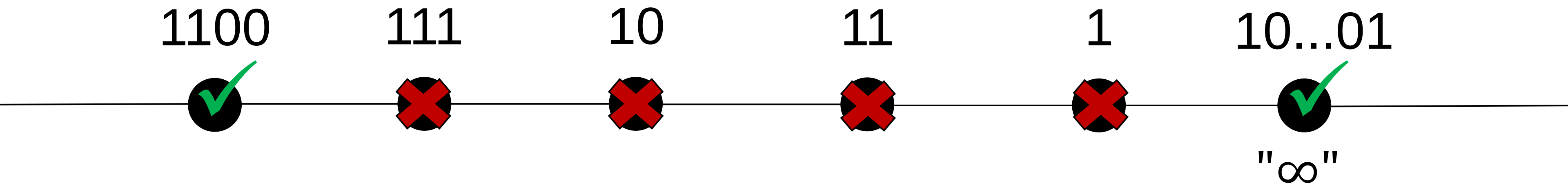

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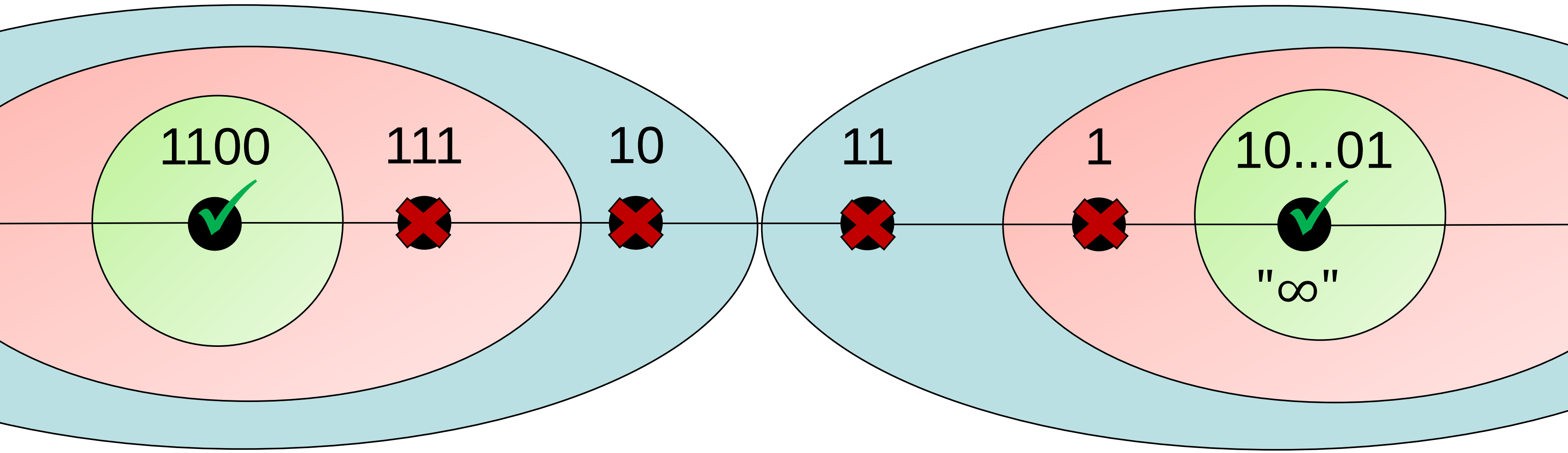

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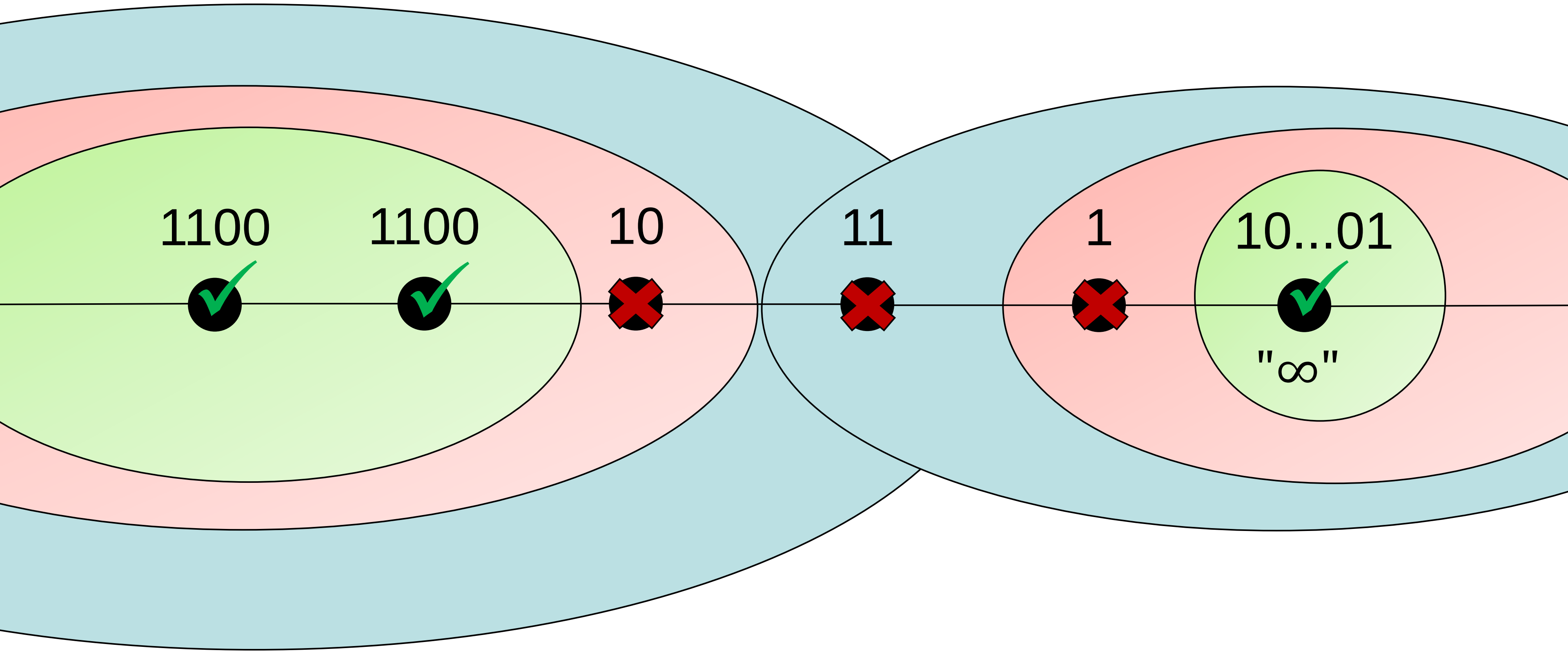

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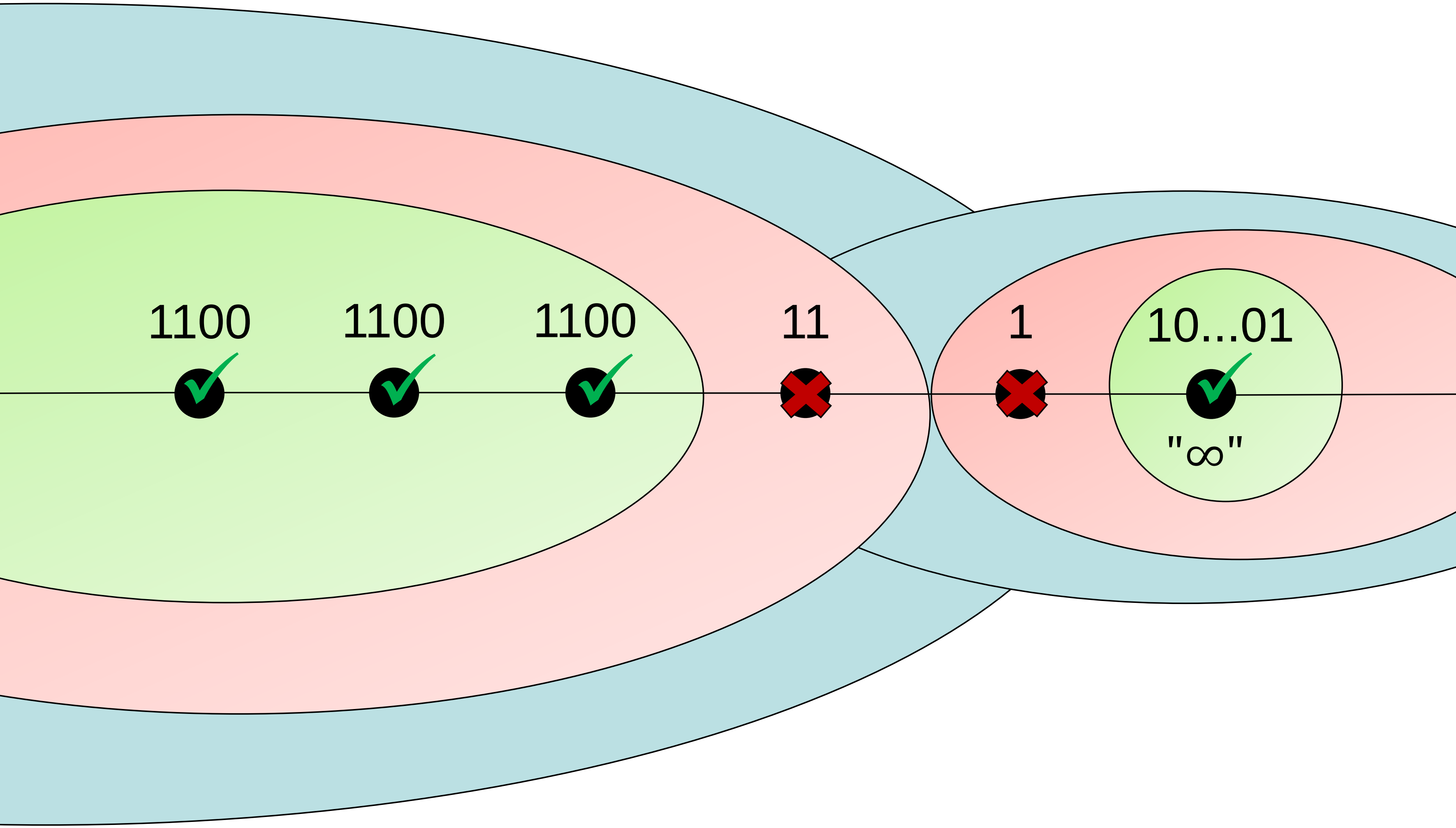

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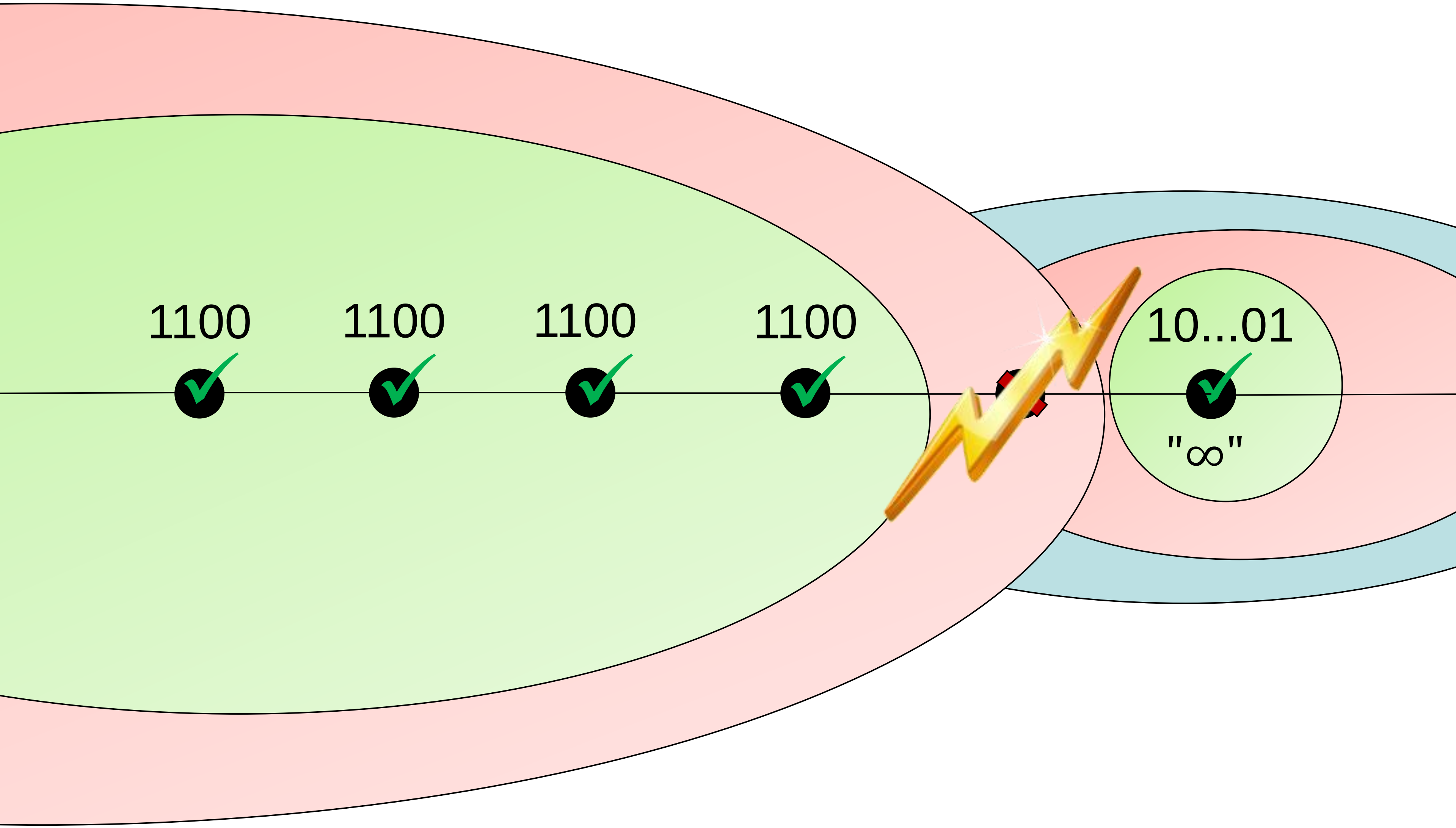

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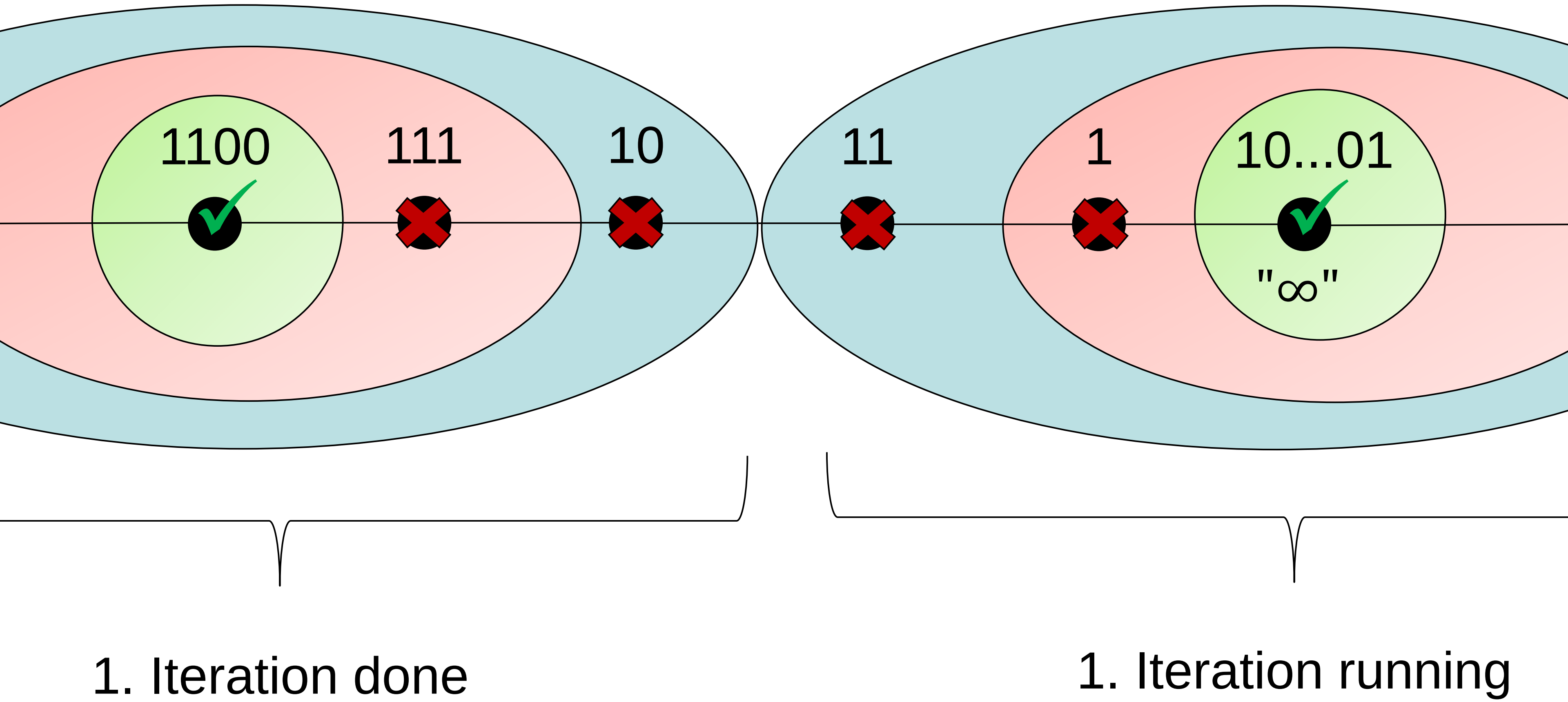

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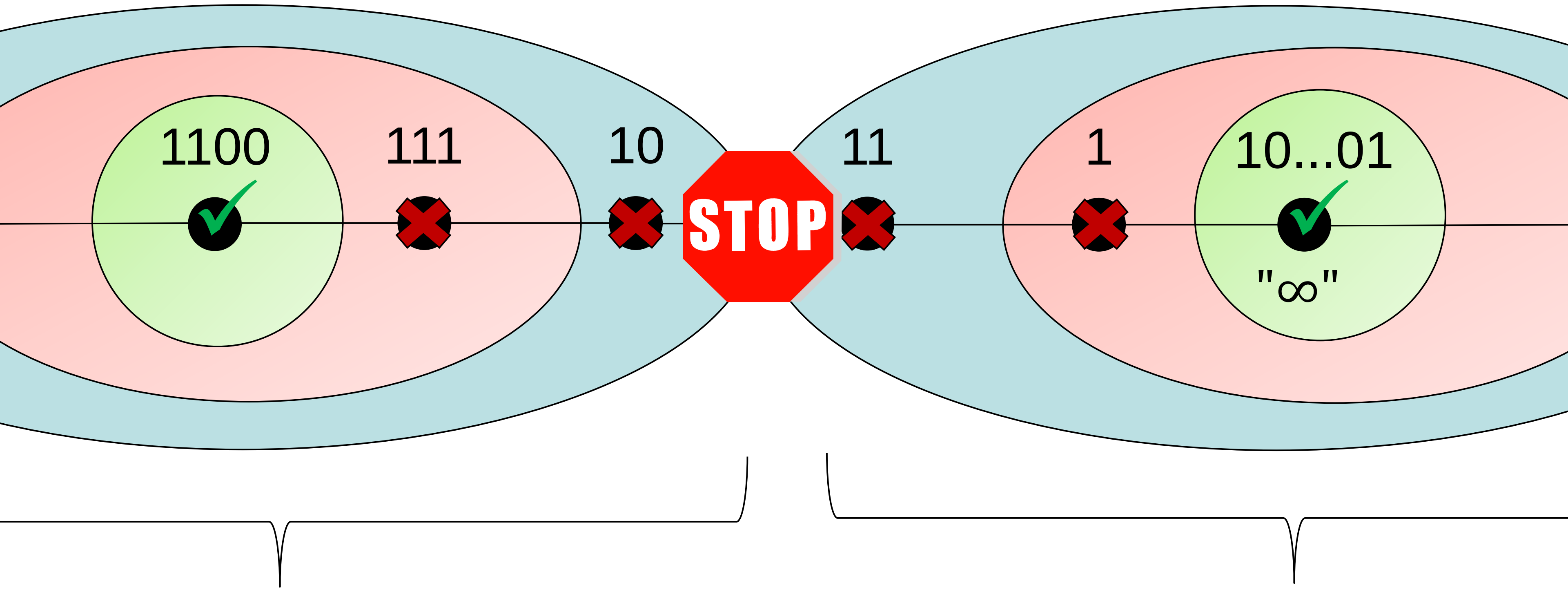

1. Iteration done

1. Iteration running

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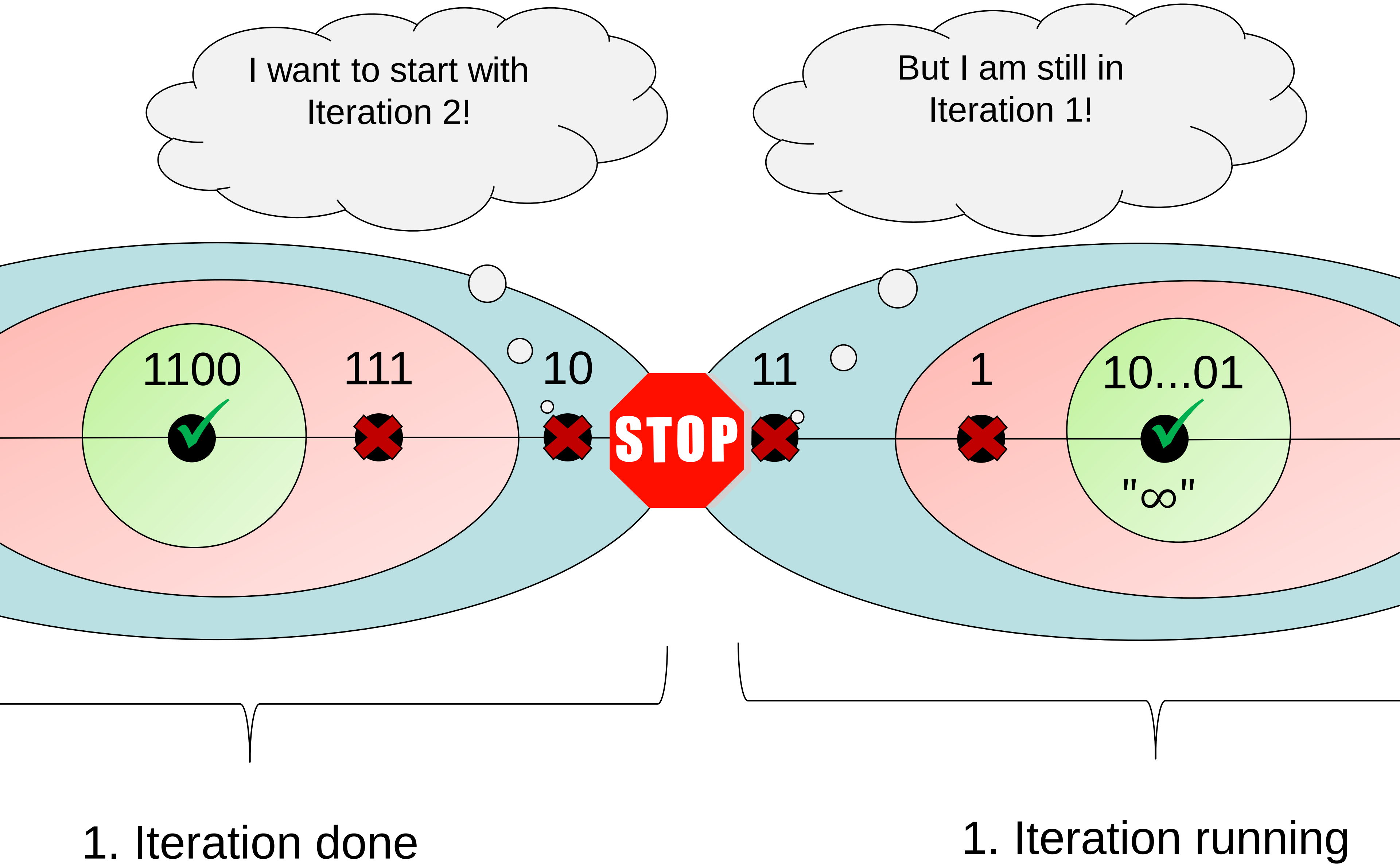

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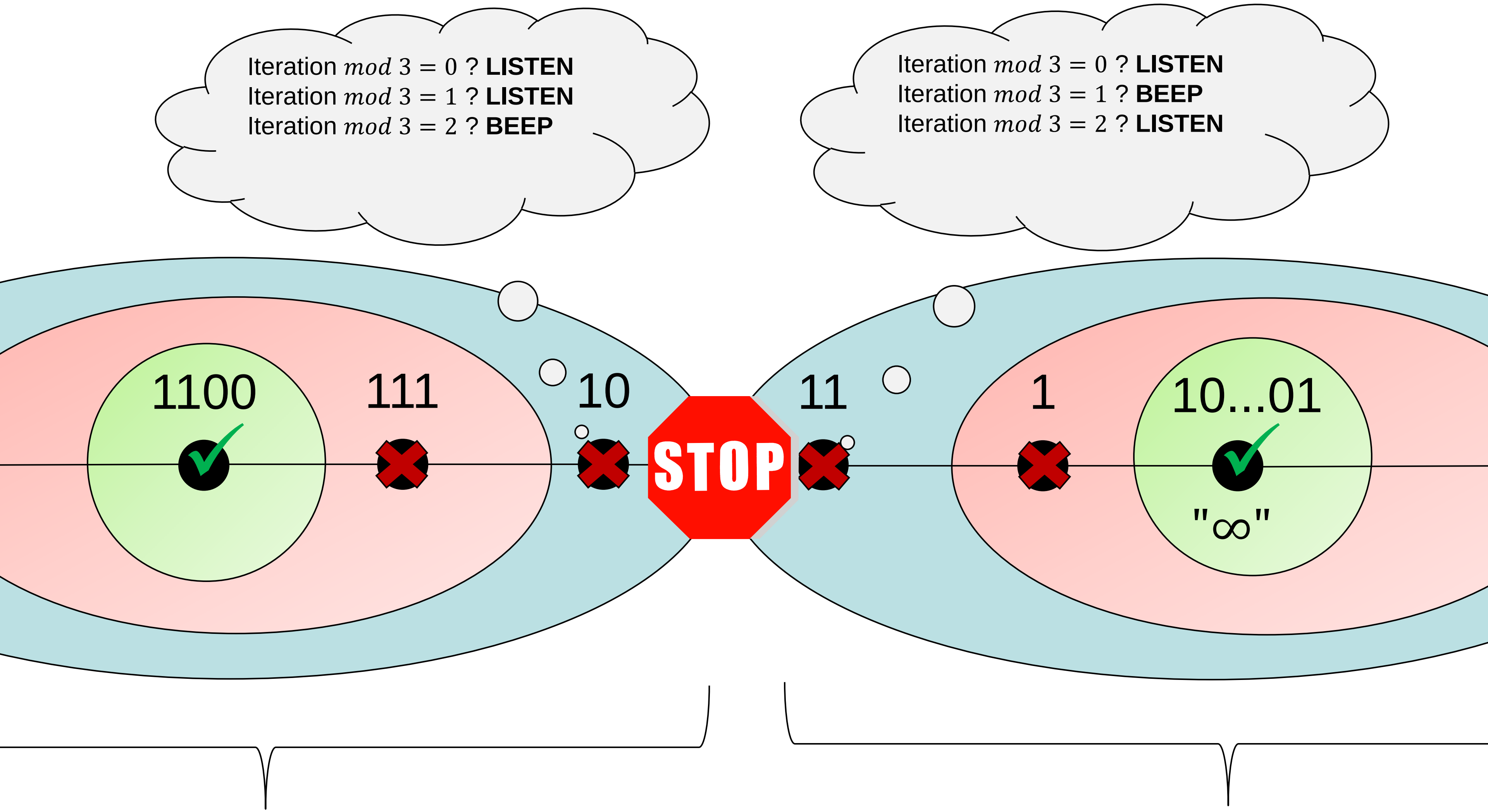
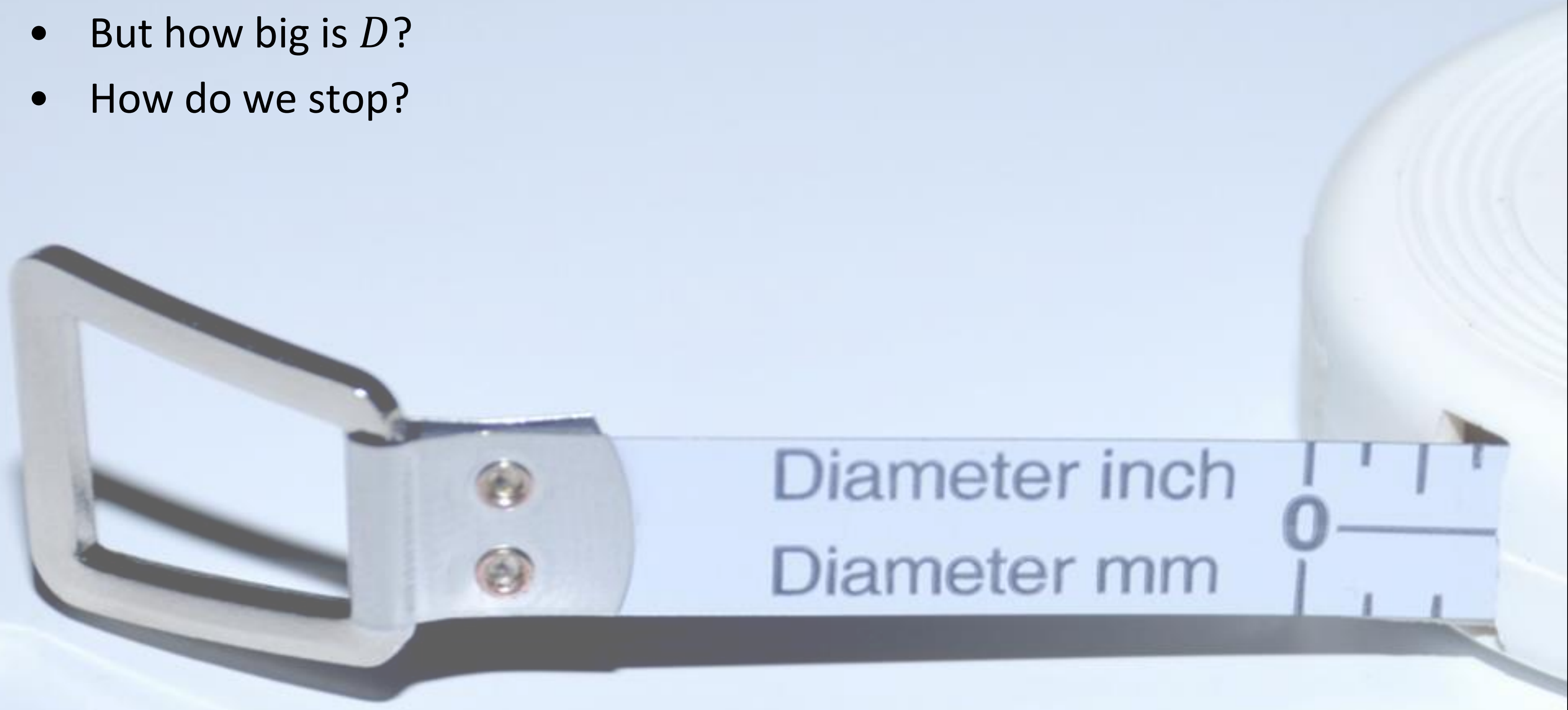


1. Iteration done

1. Iteration running

Quiescence?

- Repeat the campaigning process D times -> $O(D \log n)$
- But how big is D?
- How do we stop?



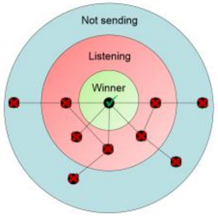
Quiescence?

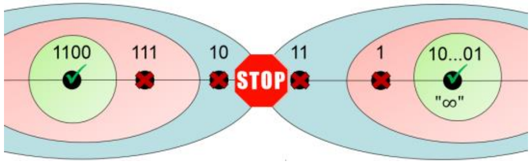
Solution: Overlay Onion Network

Conclusion

- Multi-Hop Leader Election in the Beeping Model
  - $O(D \log n)$ rounds
  - Deterministic
  - Uniform
  - Quiescent

- Combines
  - a local campaigning algorithm
  - a technique to sequentially execute algorithms
  - an overlay onion network





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