Micro Load Balancing in Data Centers with DRILL

Soudeh Ghorbani
Brighten Godfrey
Yashar Ganjali
Amin Firoozshahian

(Presentation by Alexander Canals)

What is the problem?

- Datacenter topologies are designed to deliver high capacity

- But networks experience congestion and packet drops even with low utilisation (25%)

What is the problem?

- Existing load balancing solutions often require global congestion information and they balance at high levels: flowcells, flowlets or flows

- Control loops of those systems require multiple round trips (10s to 100s of microseconds)

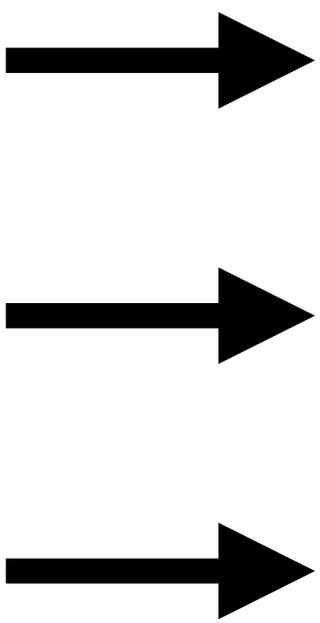
- But majority of congestion incidents are short-lived: Most microbursts that are responsible for 90% of packet-loss last for less than 3 microseconds

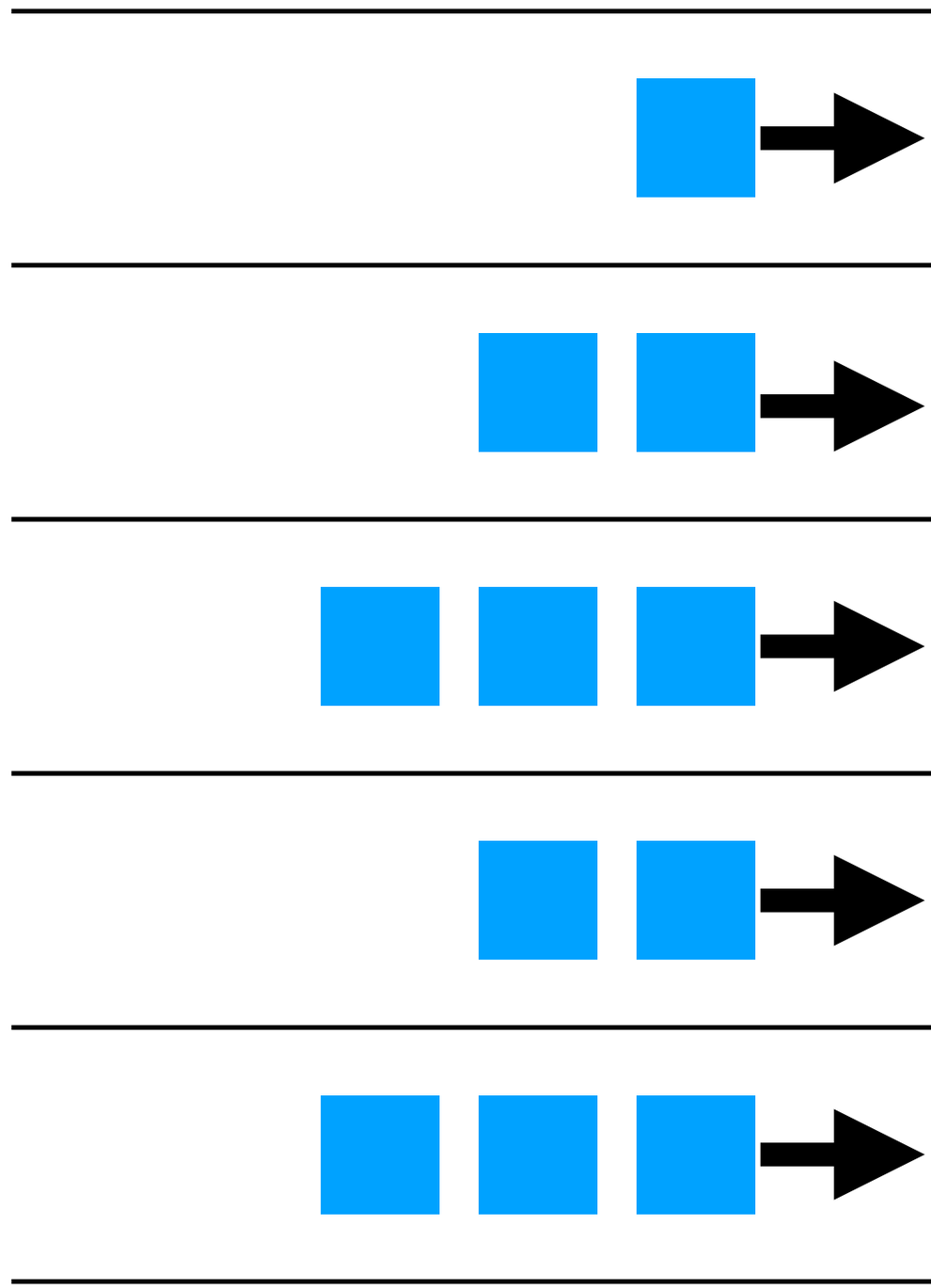
How does DRILL solve this problem?

- Load balancing decisions local to each switch
- Micro load-balancing: microsecond timescales; per-packet decisions
- For every incoming packet, the switch compares the queue lengths of the output ports and picks the one with the shortest queue
- For topological changes (asymmetry) more global path planning might be necessary

Input ports

Output ports with queues





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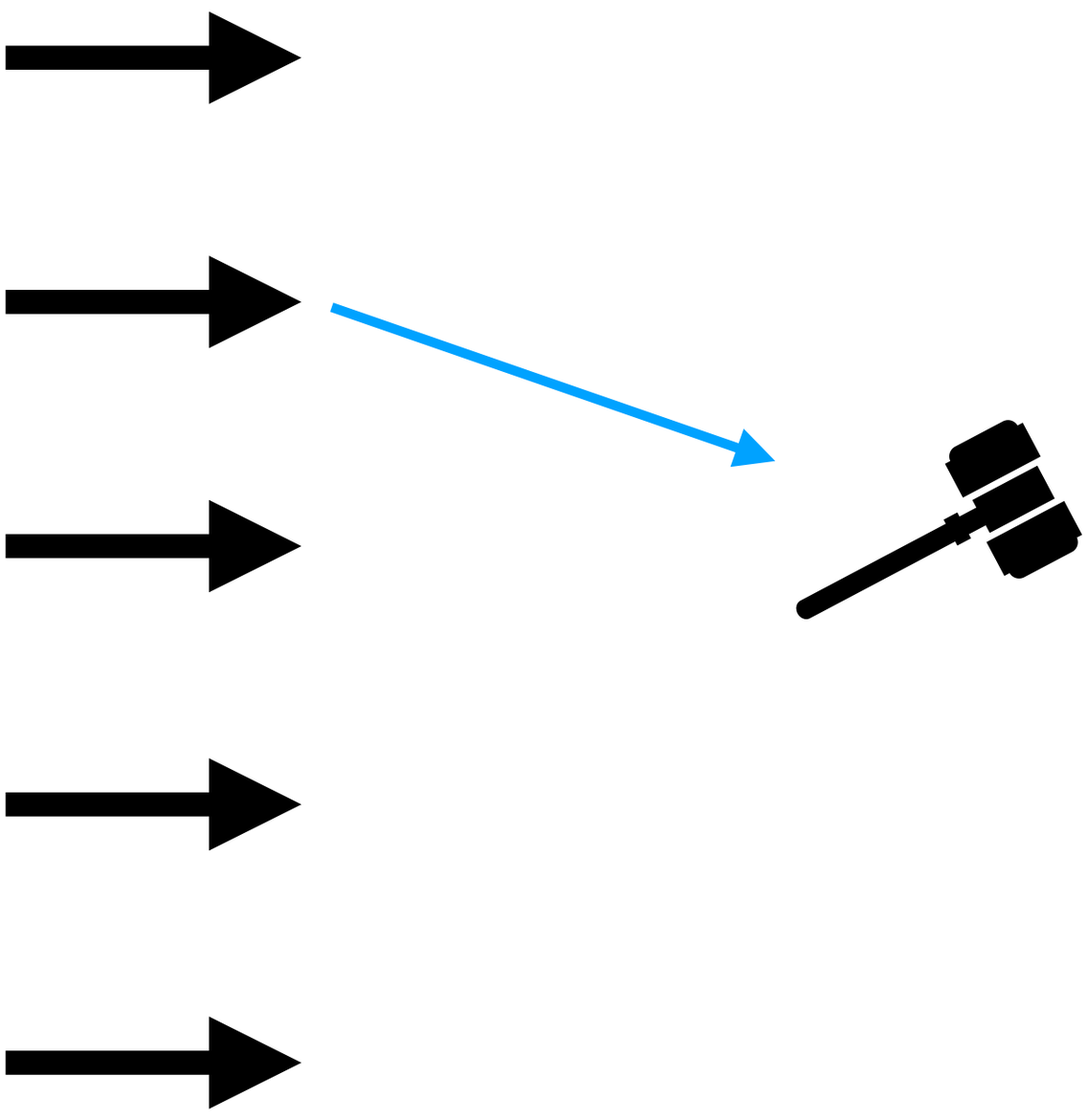
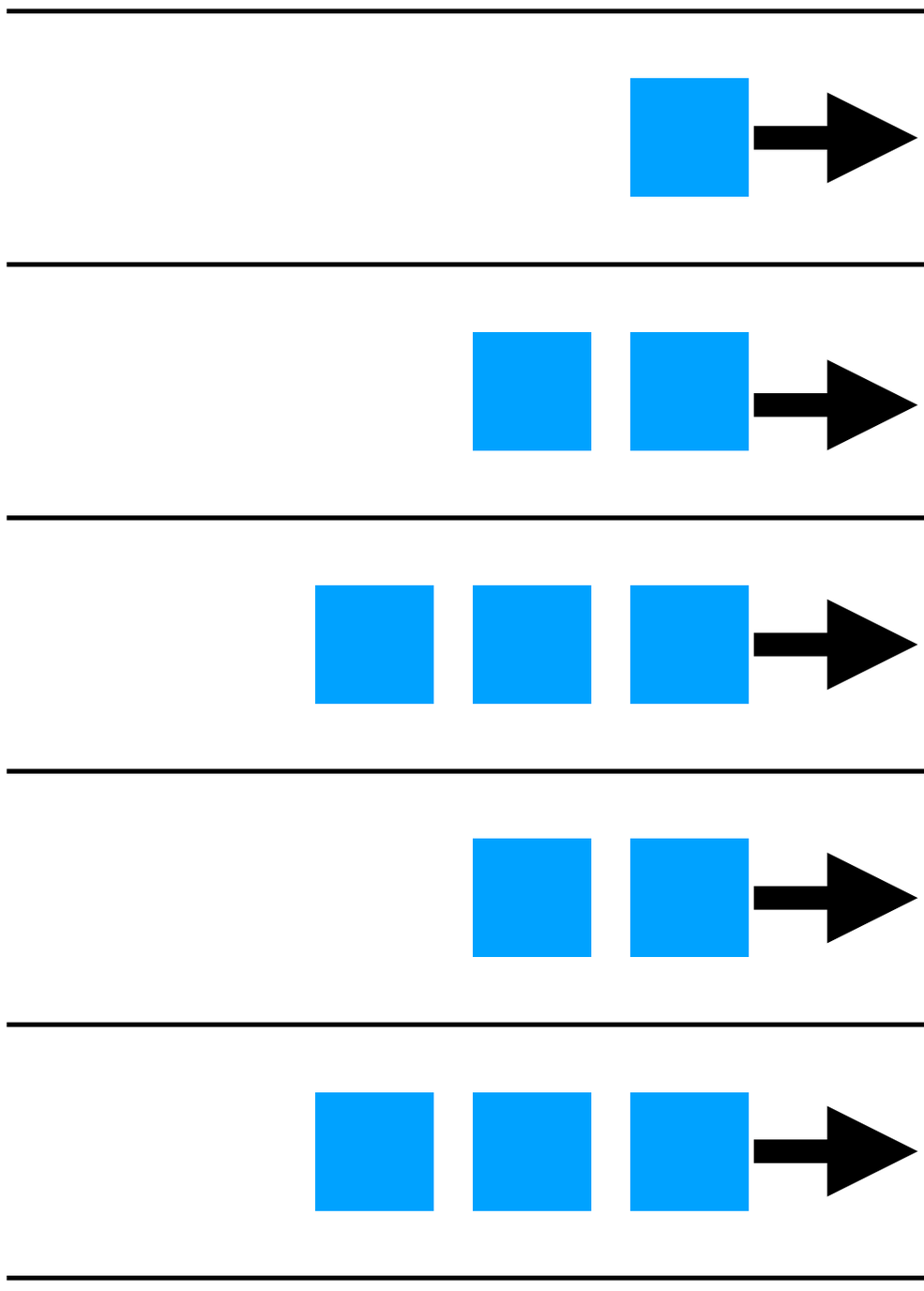


Output ports with queues



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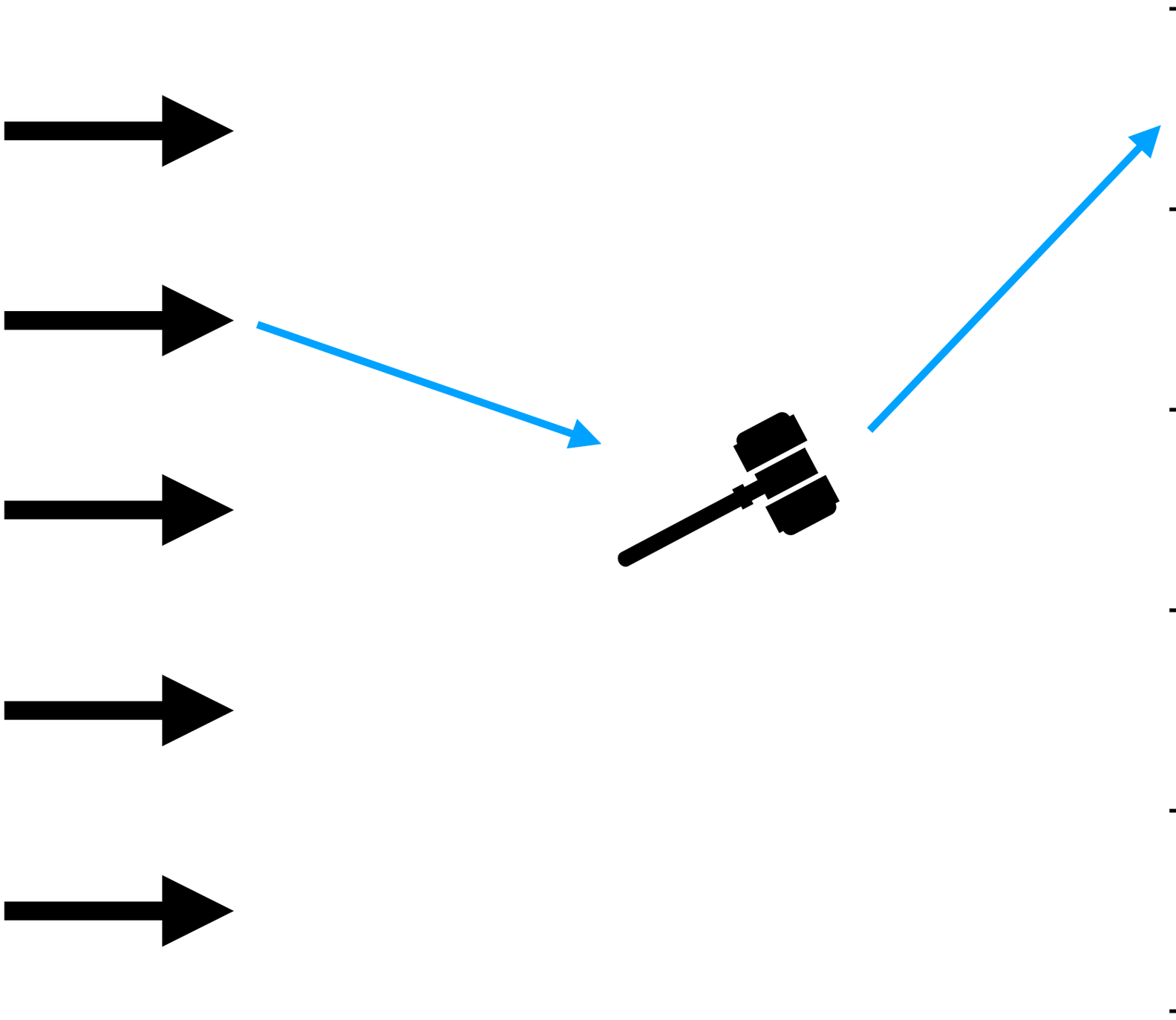

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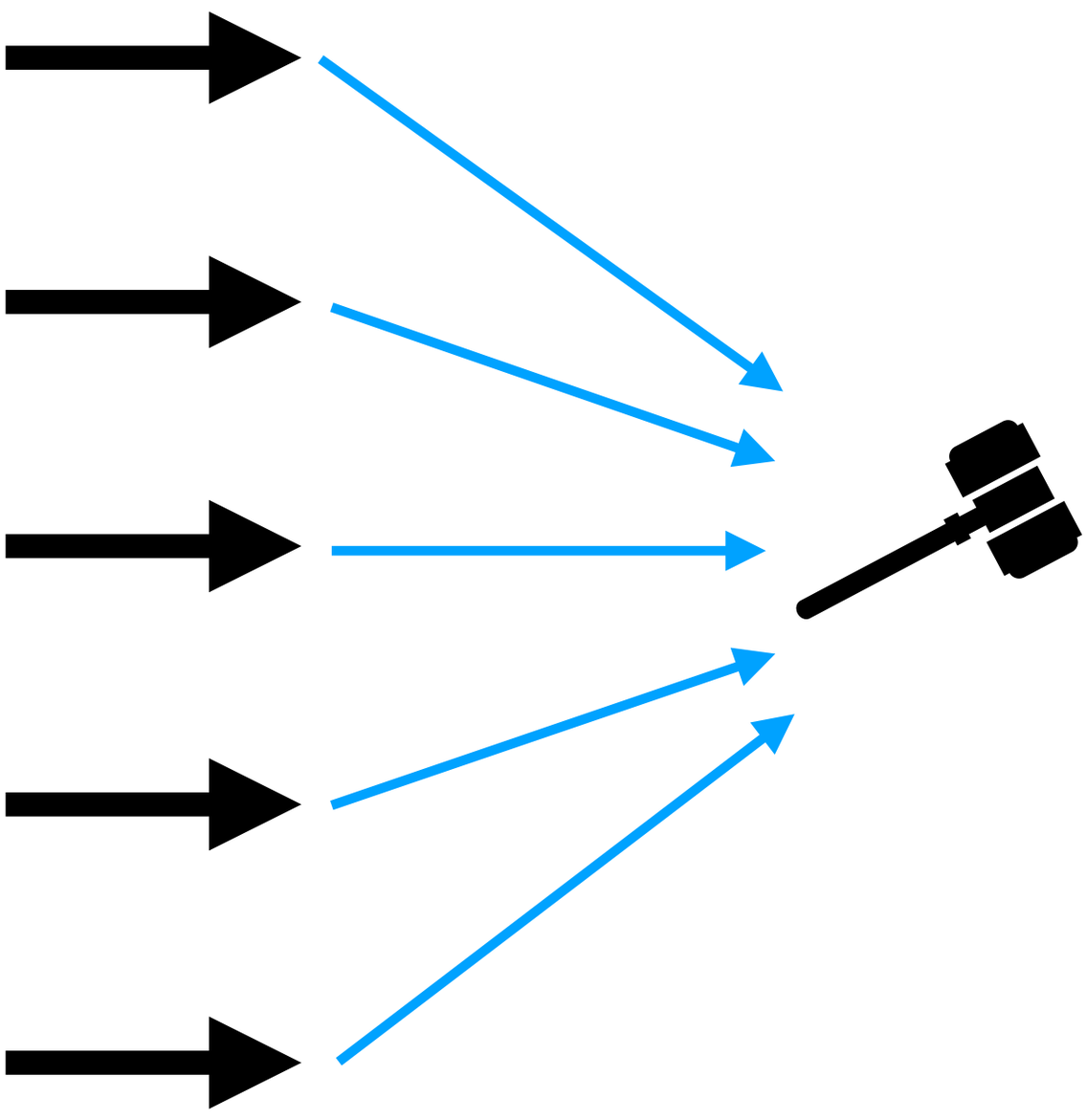

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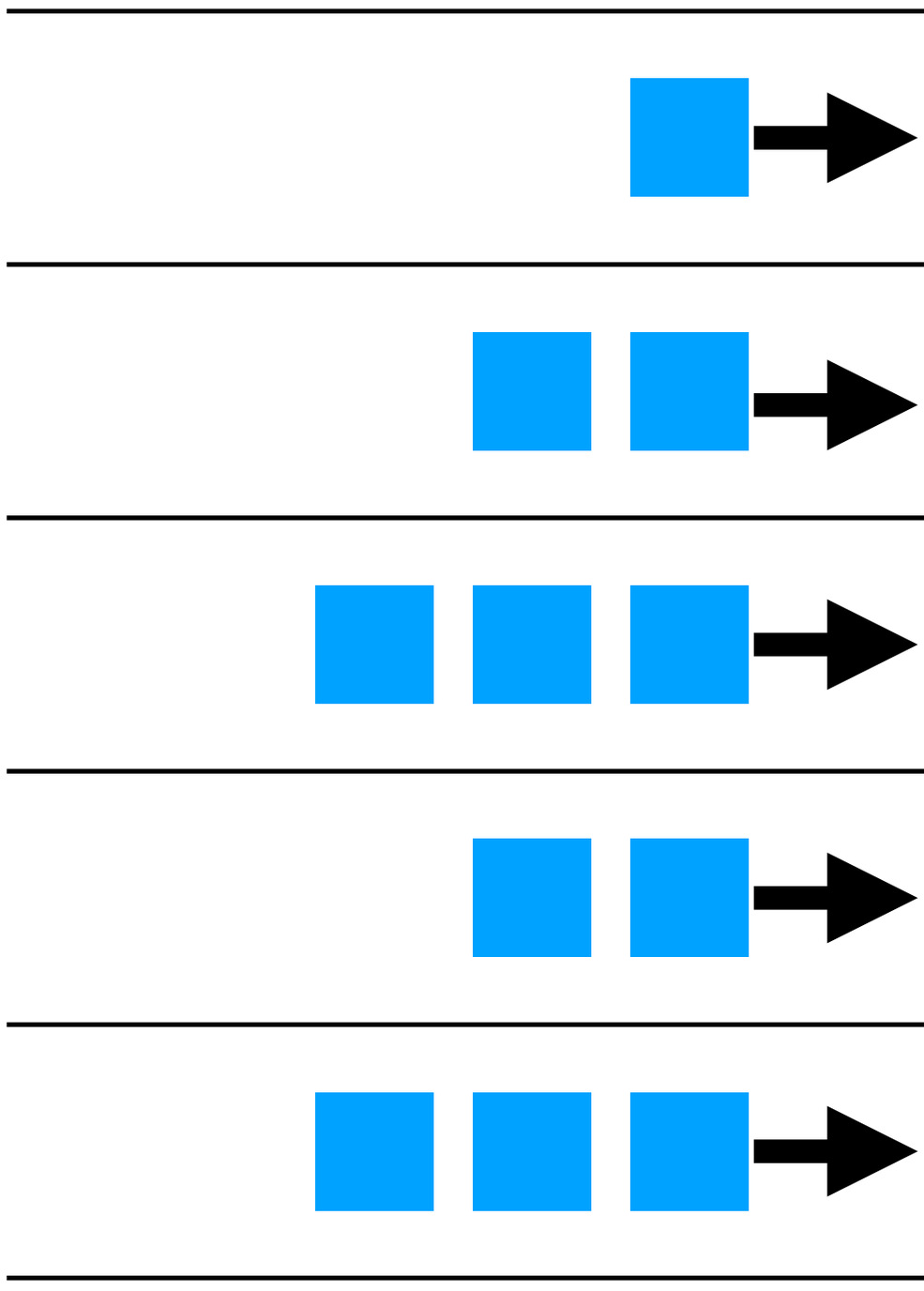

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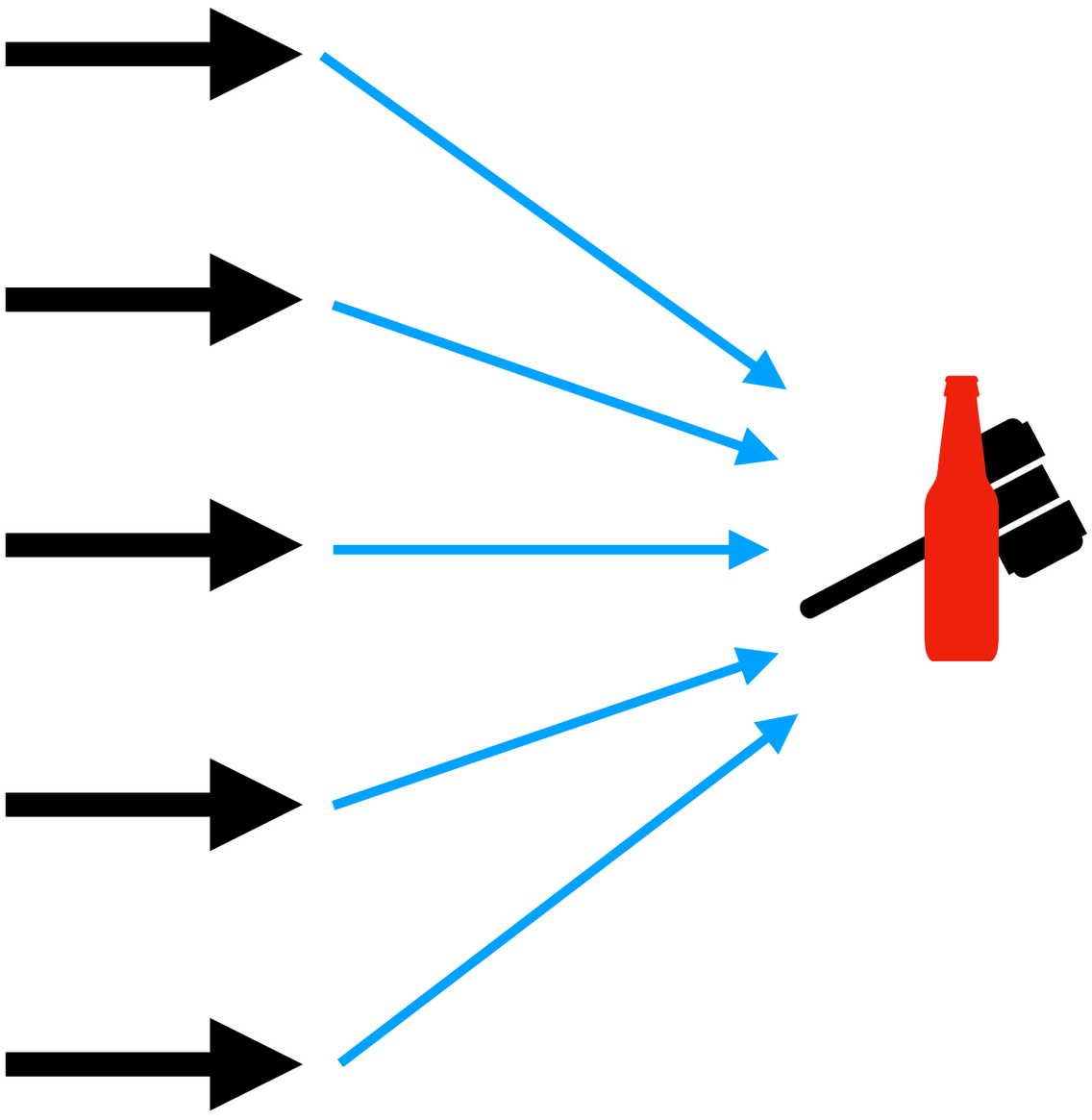

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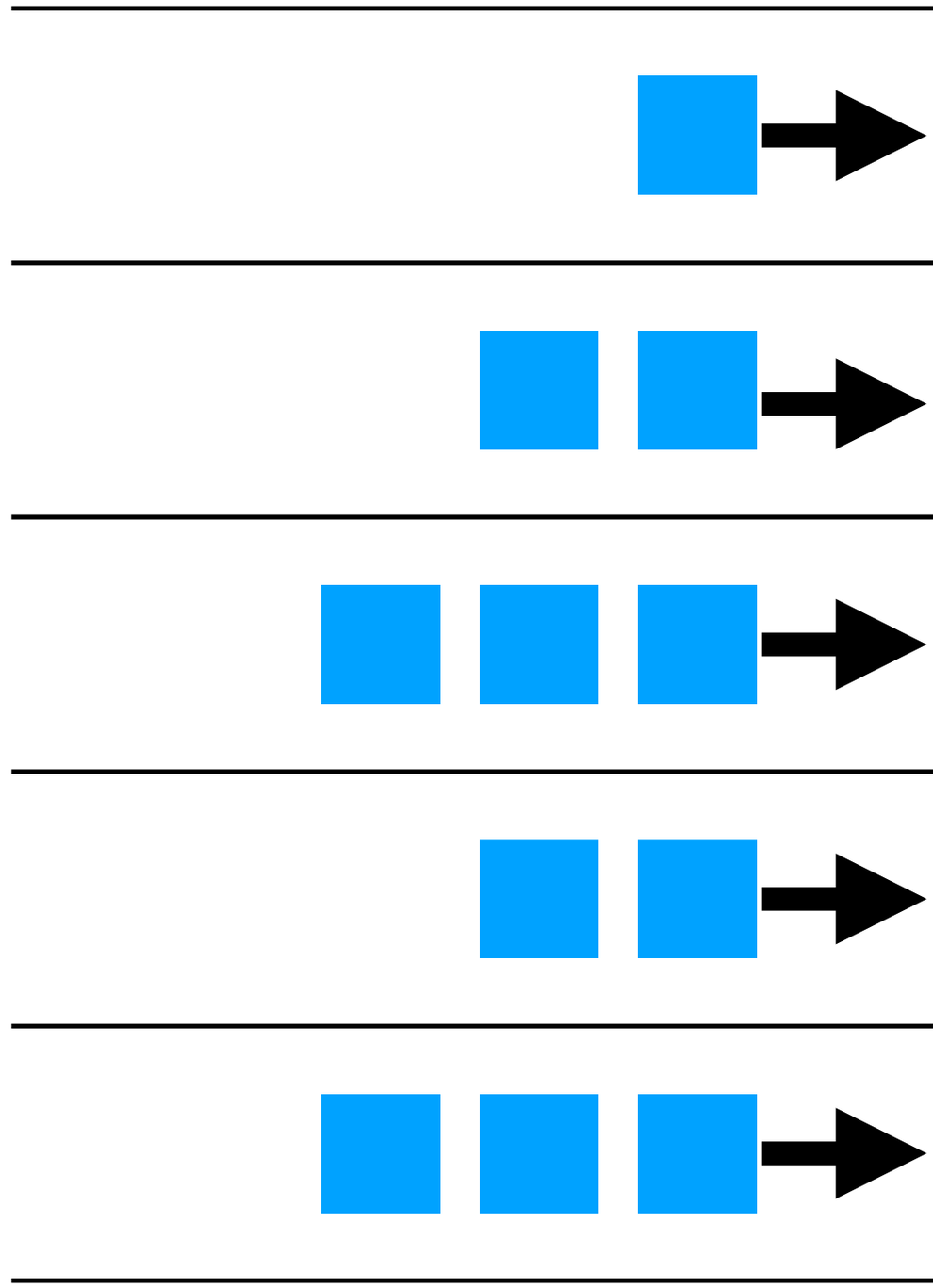

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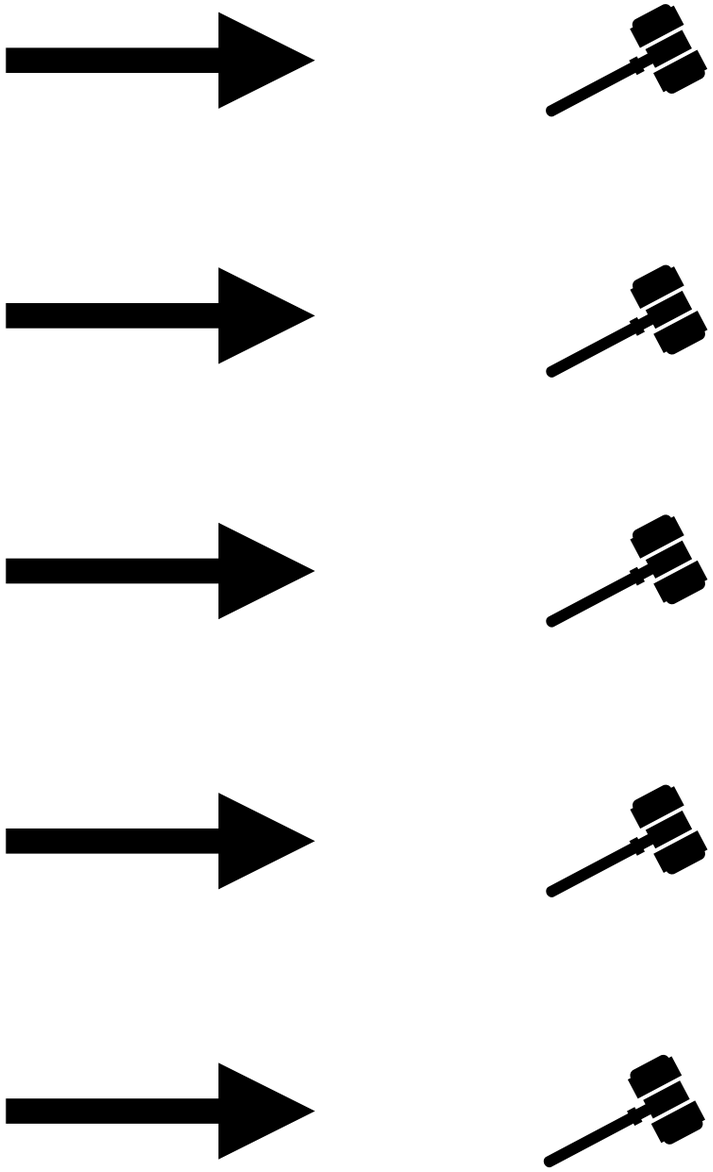

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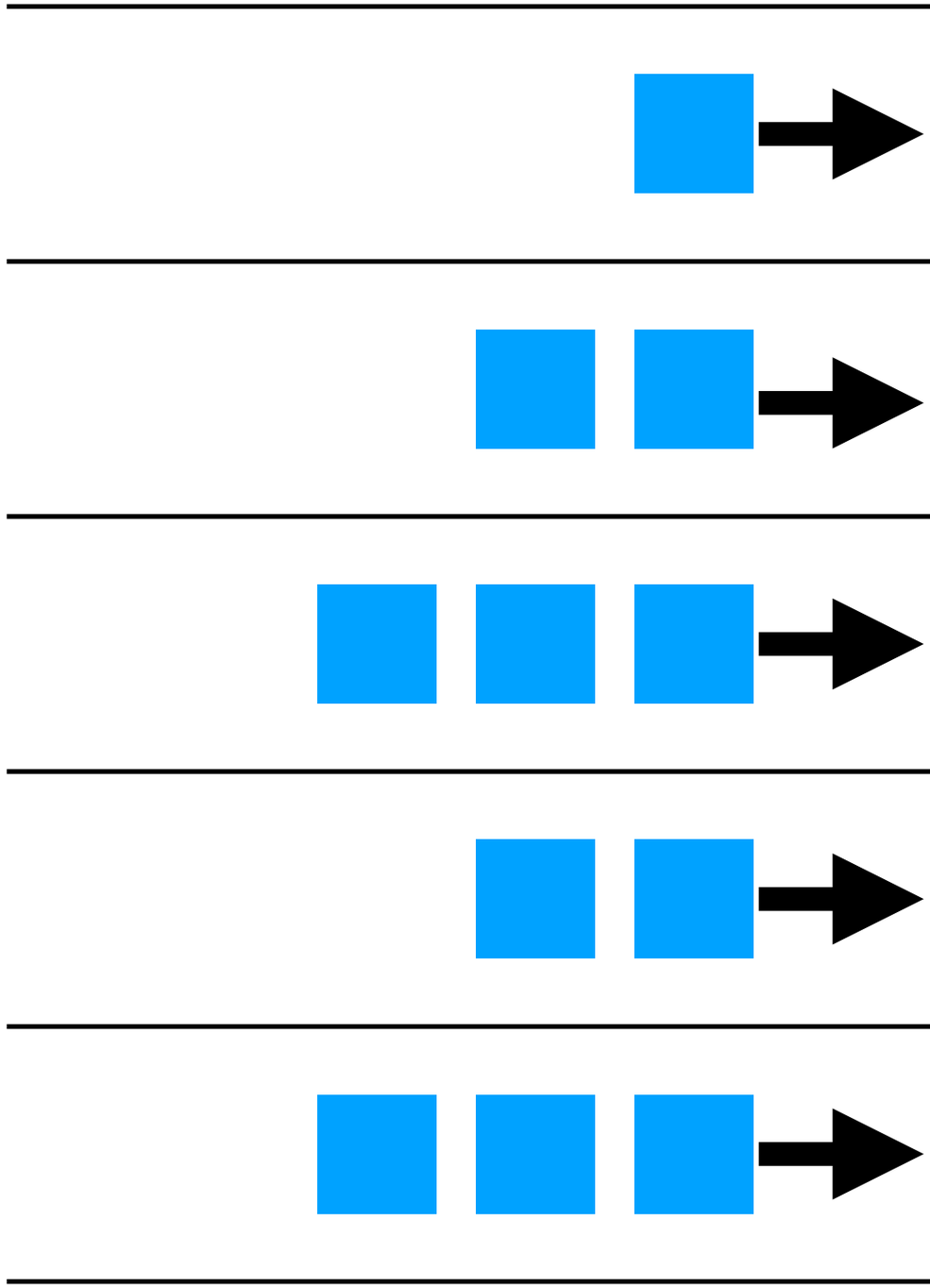

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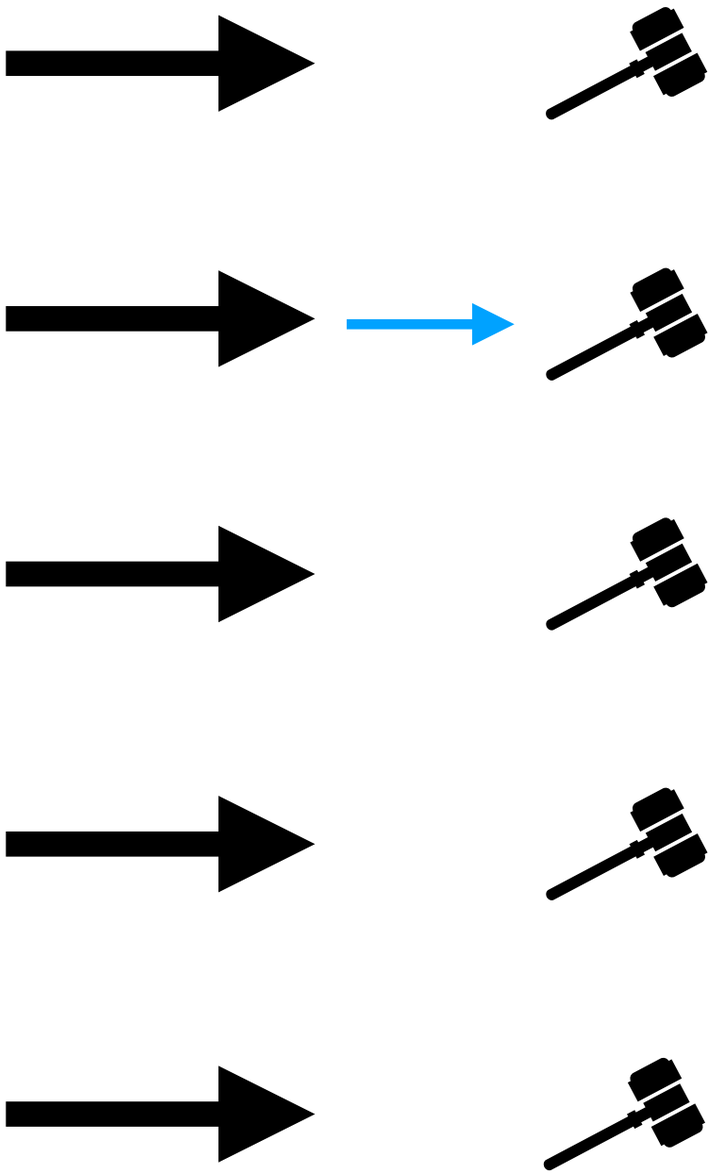

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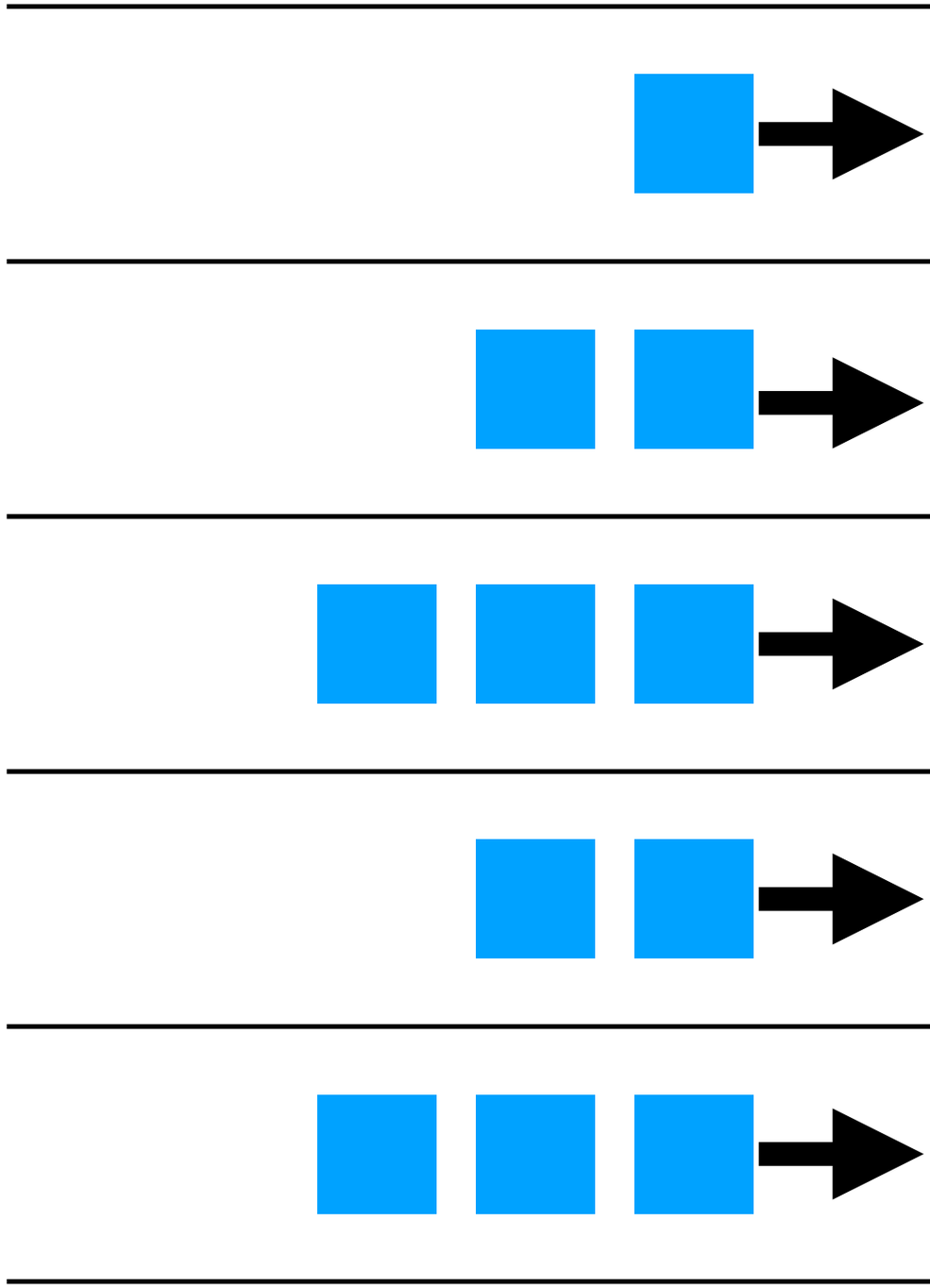

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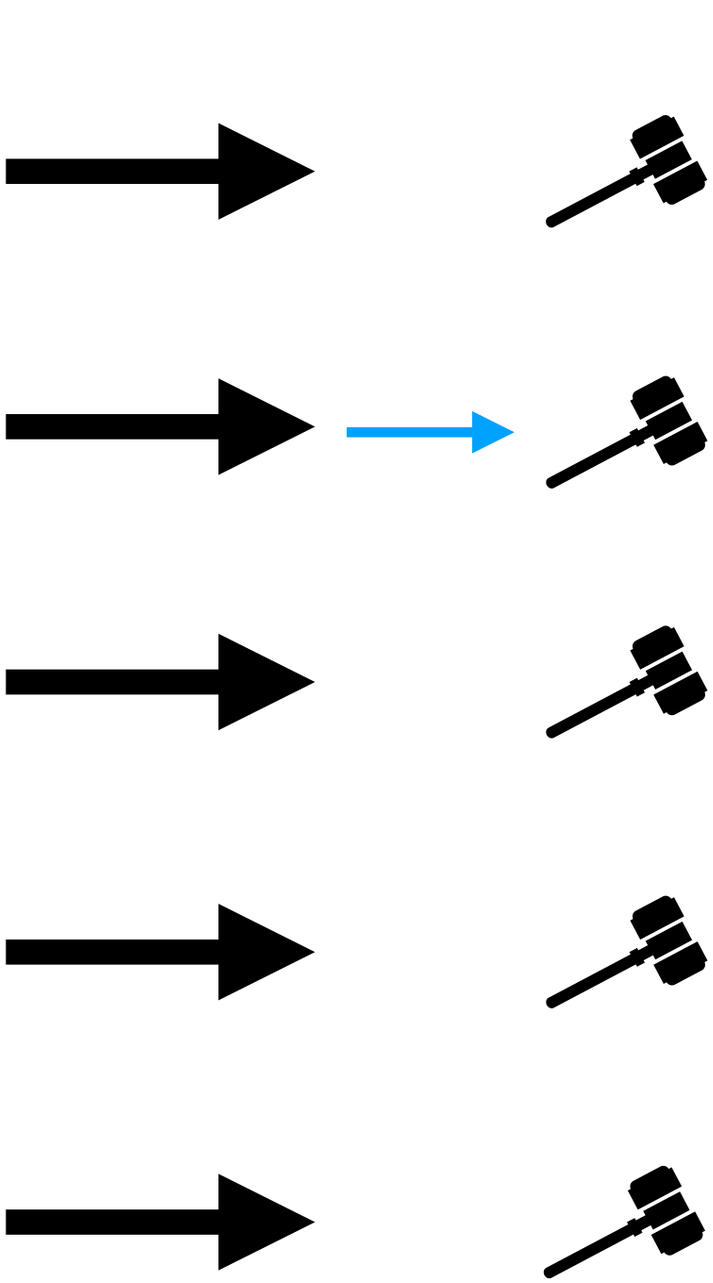

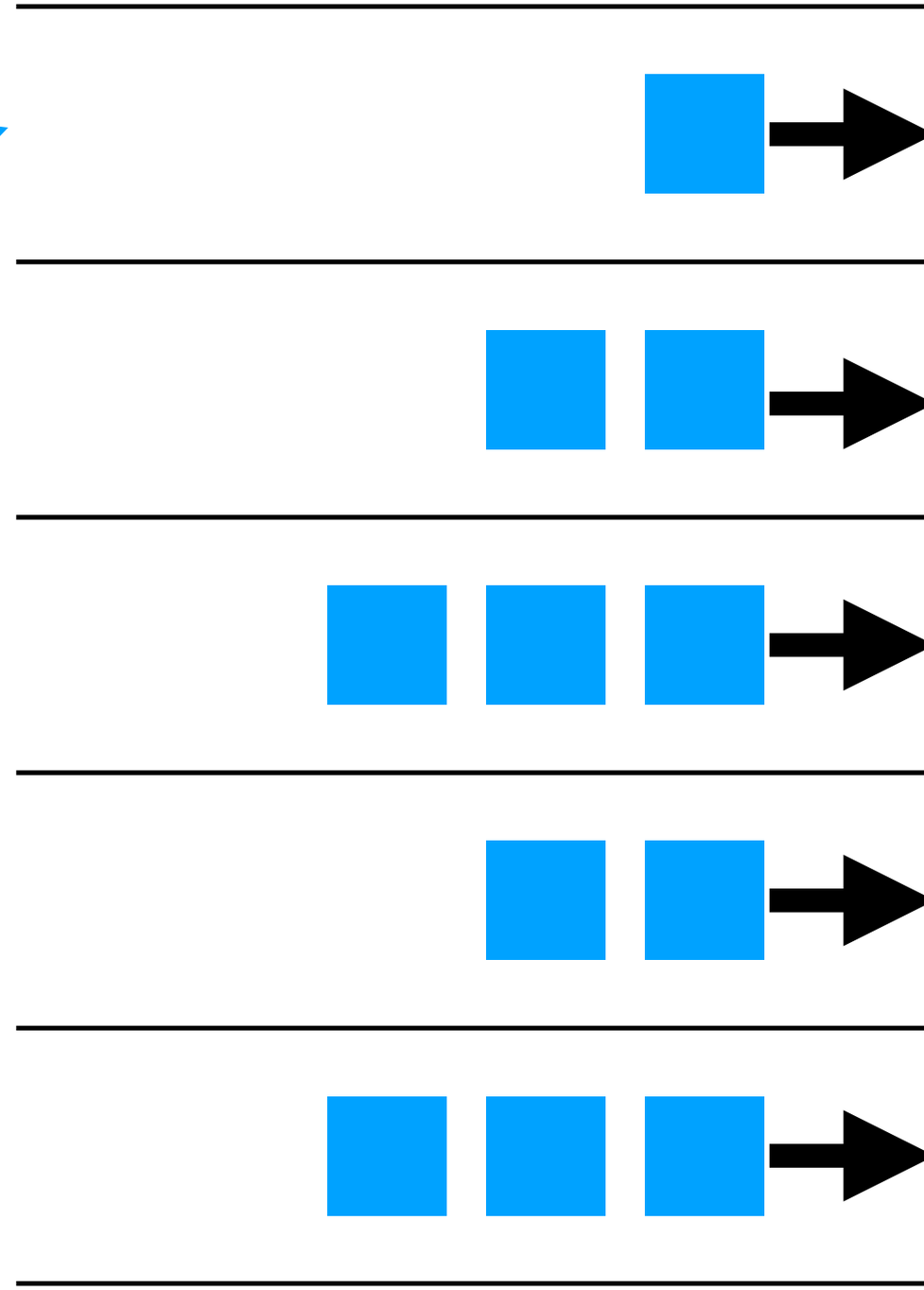

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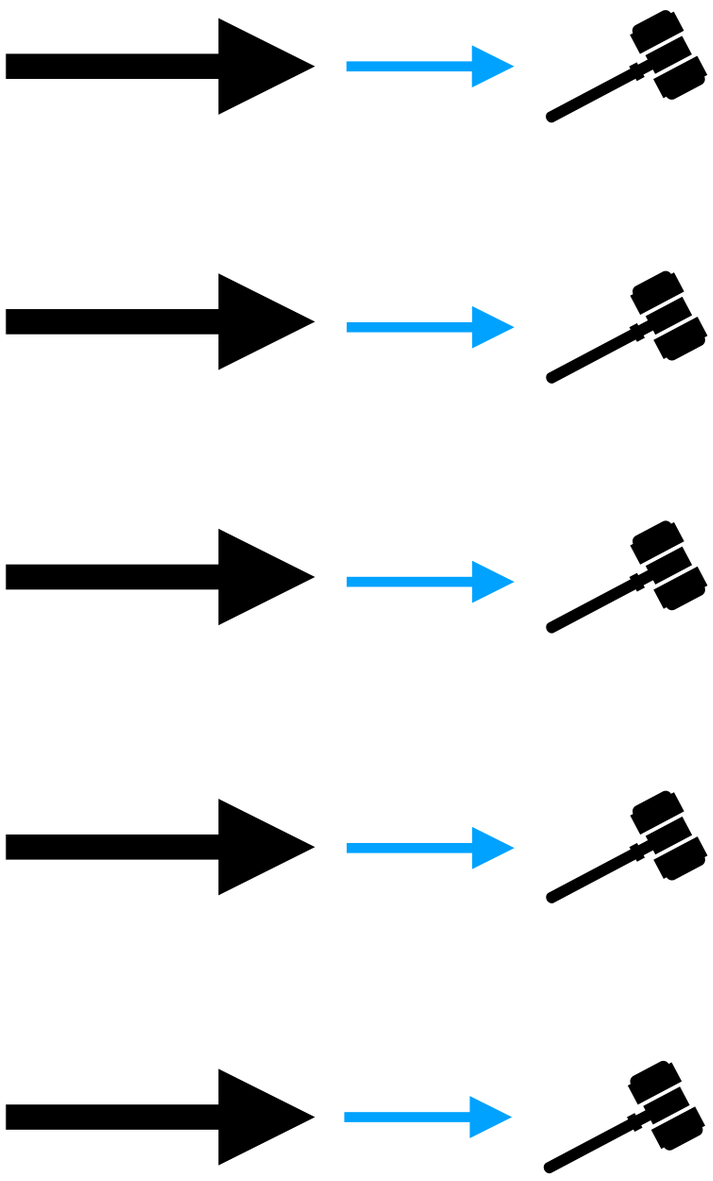
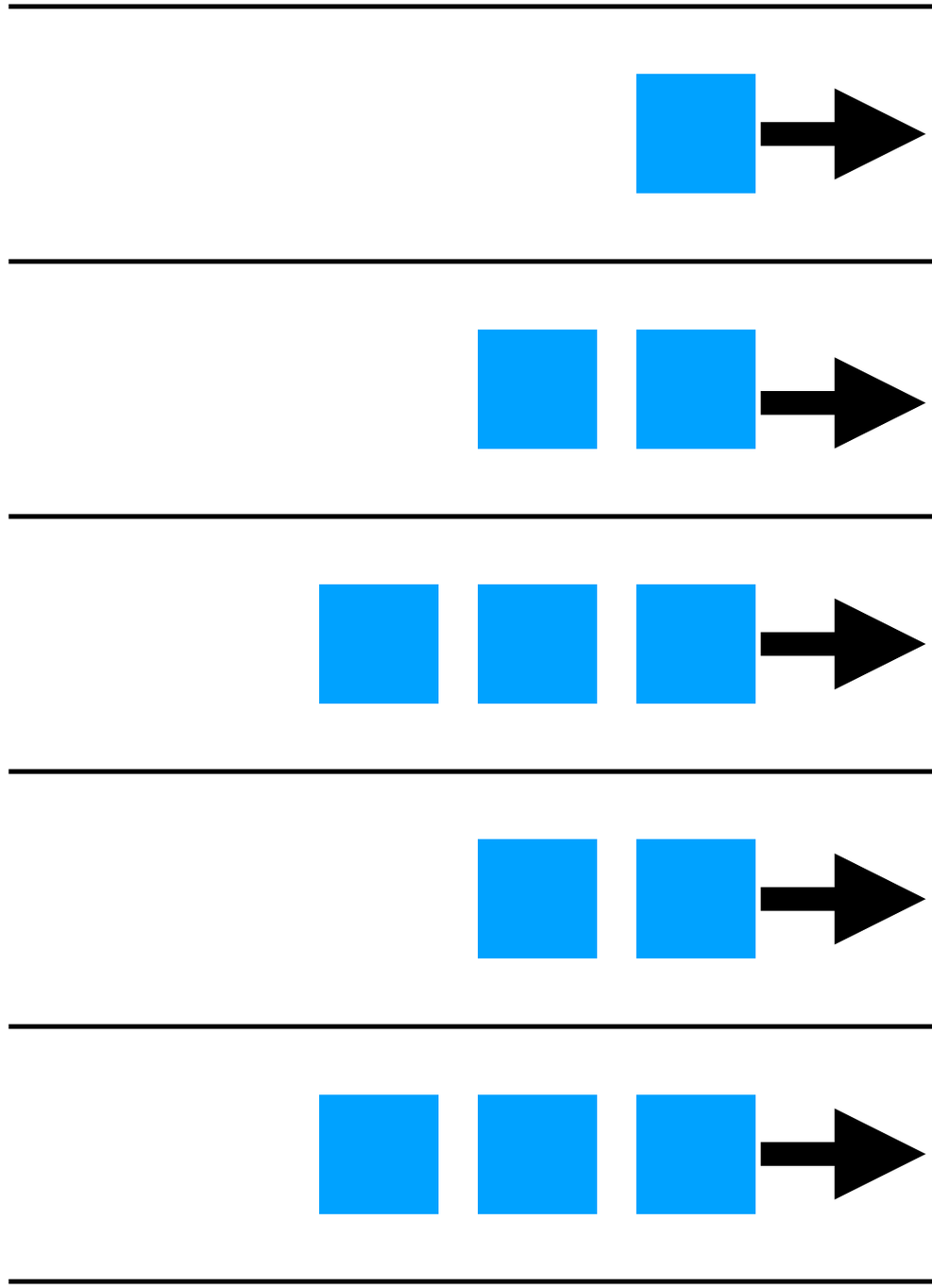


Output ports with queues



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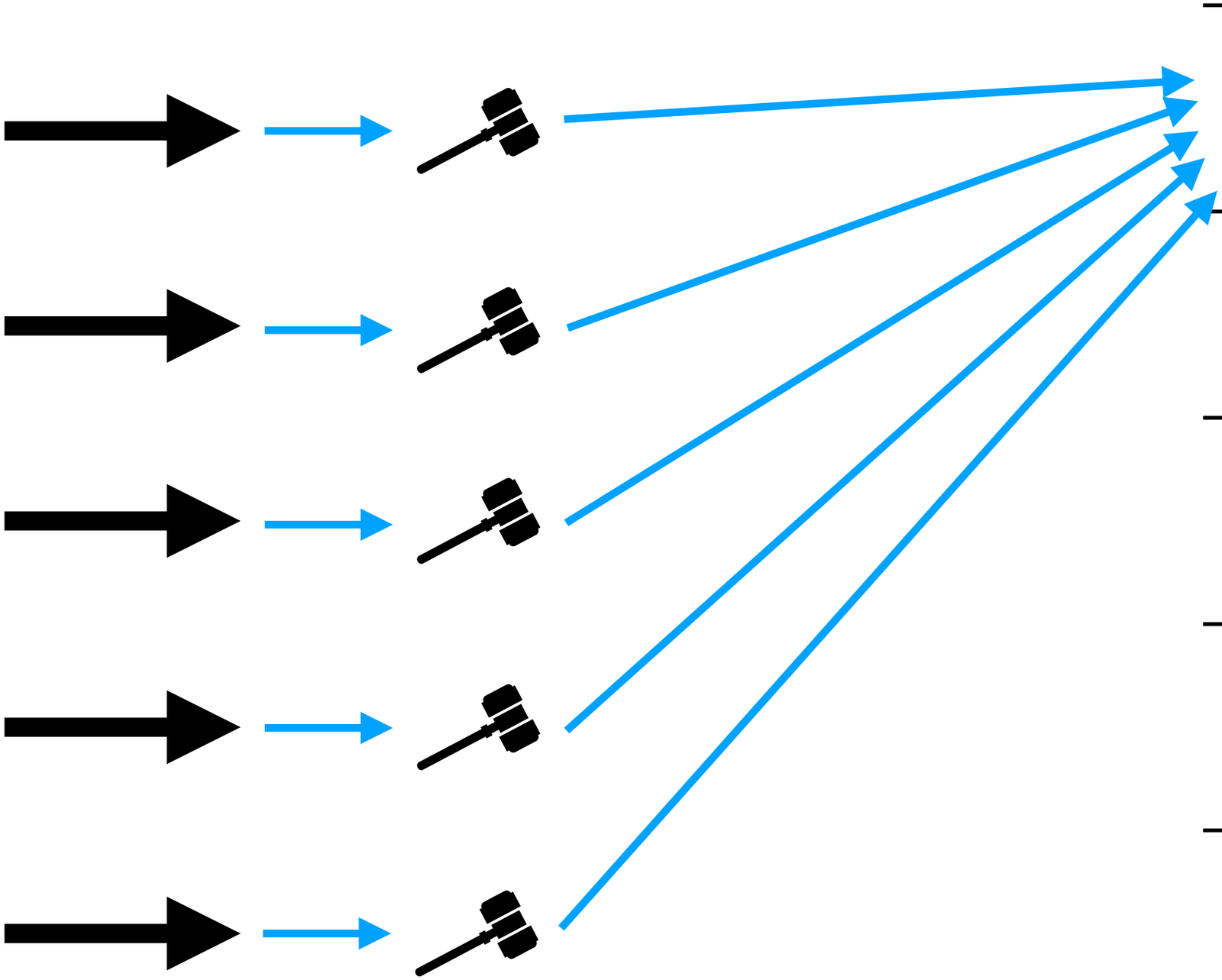

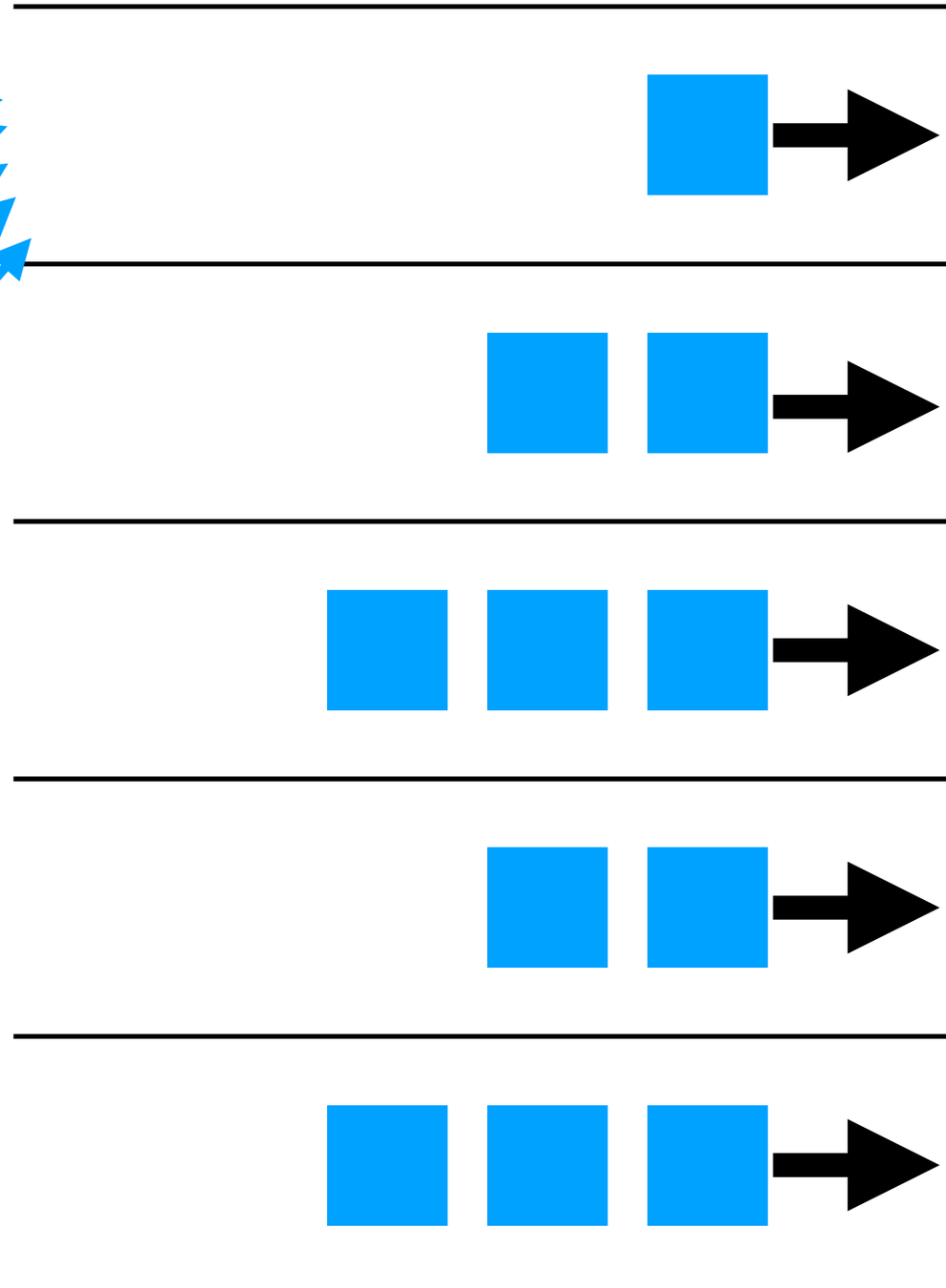

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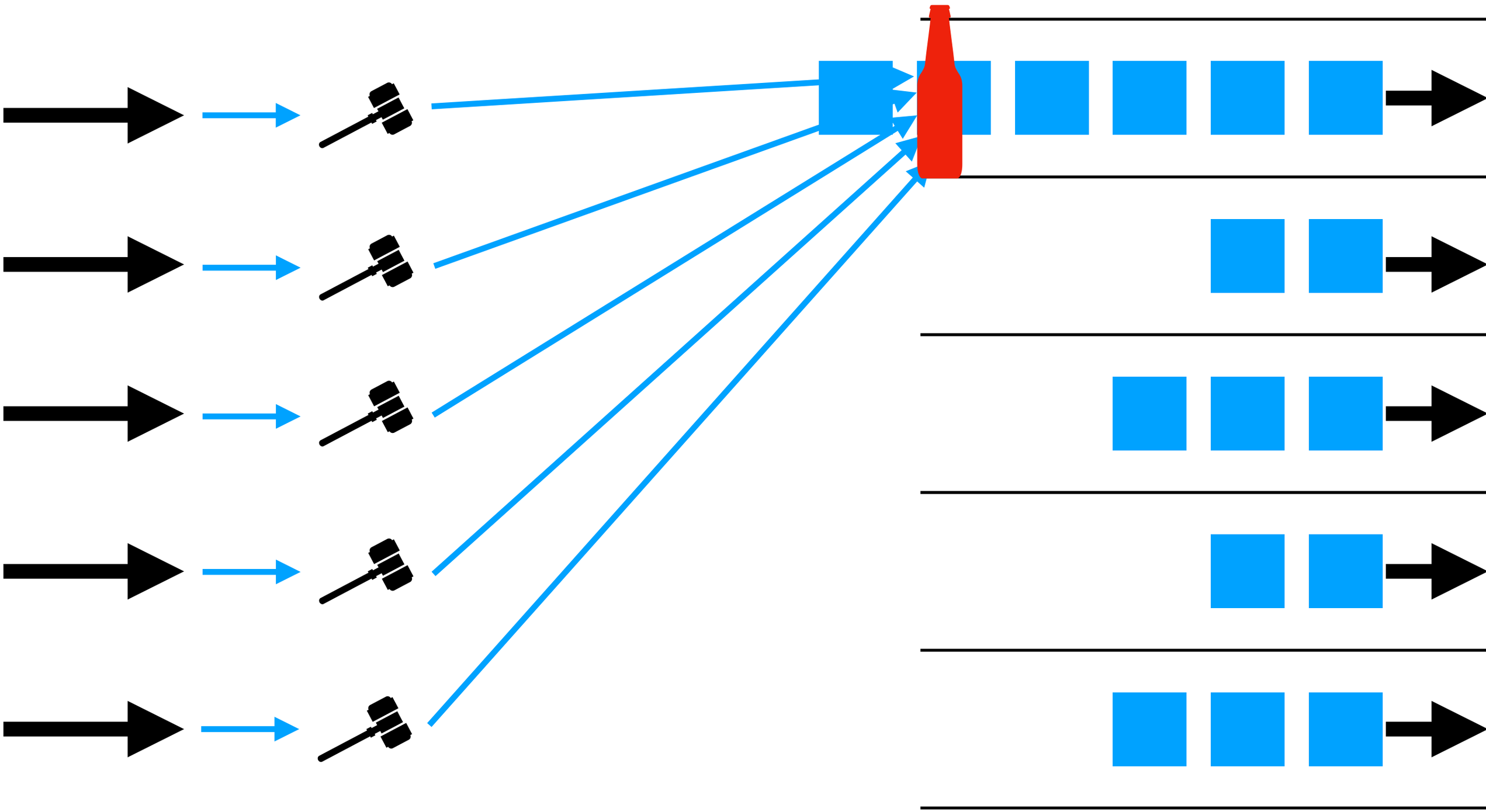
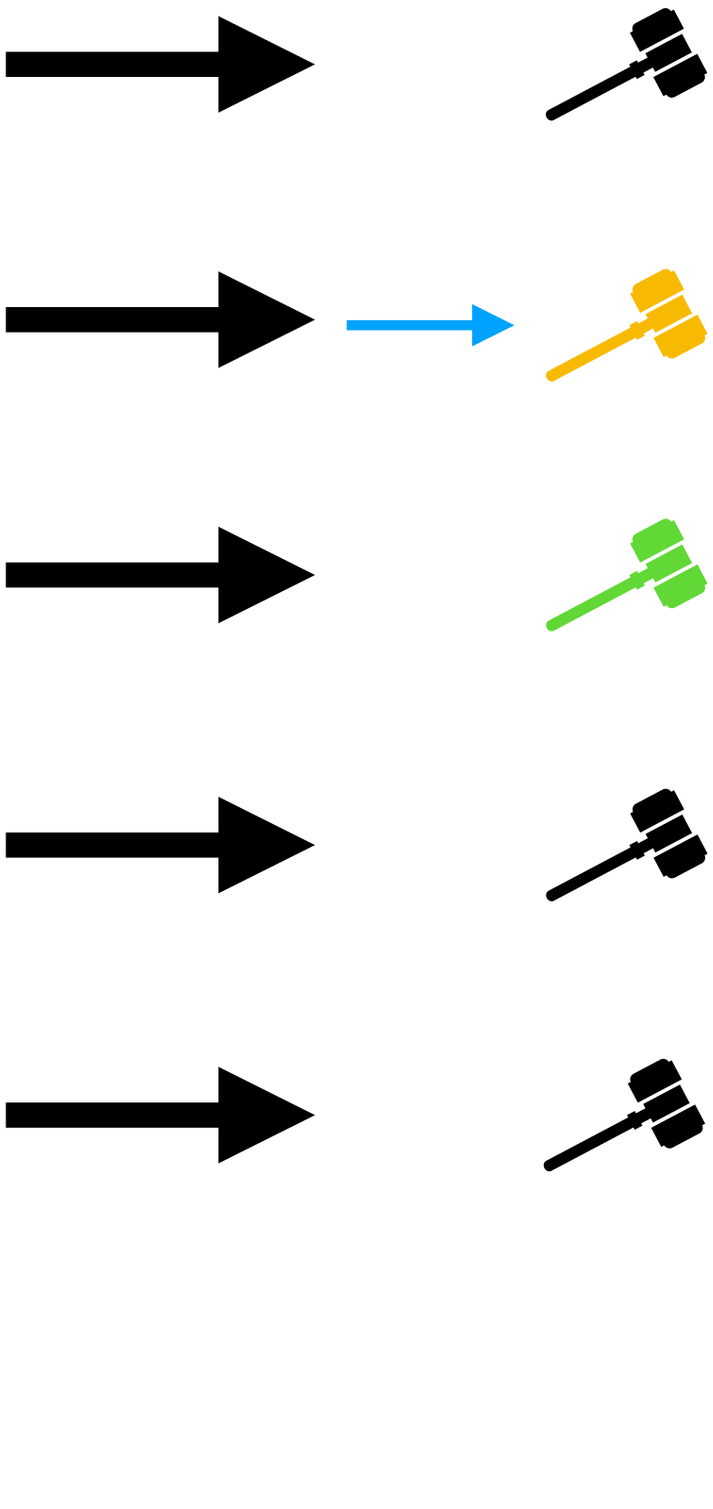


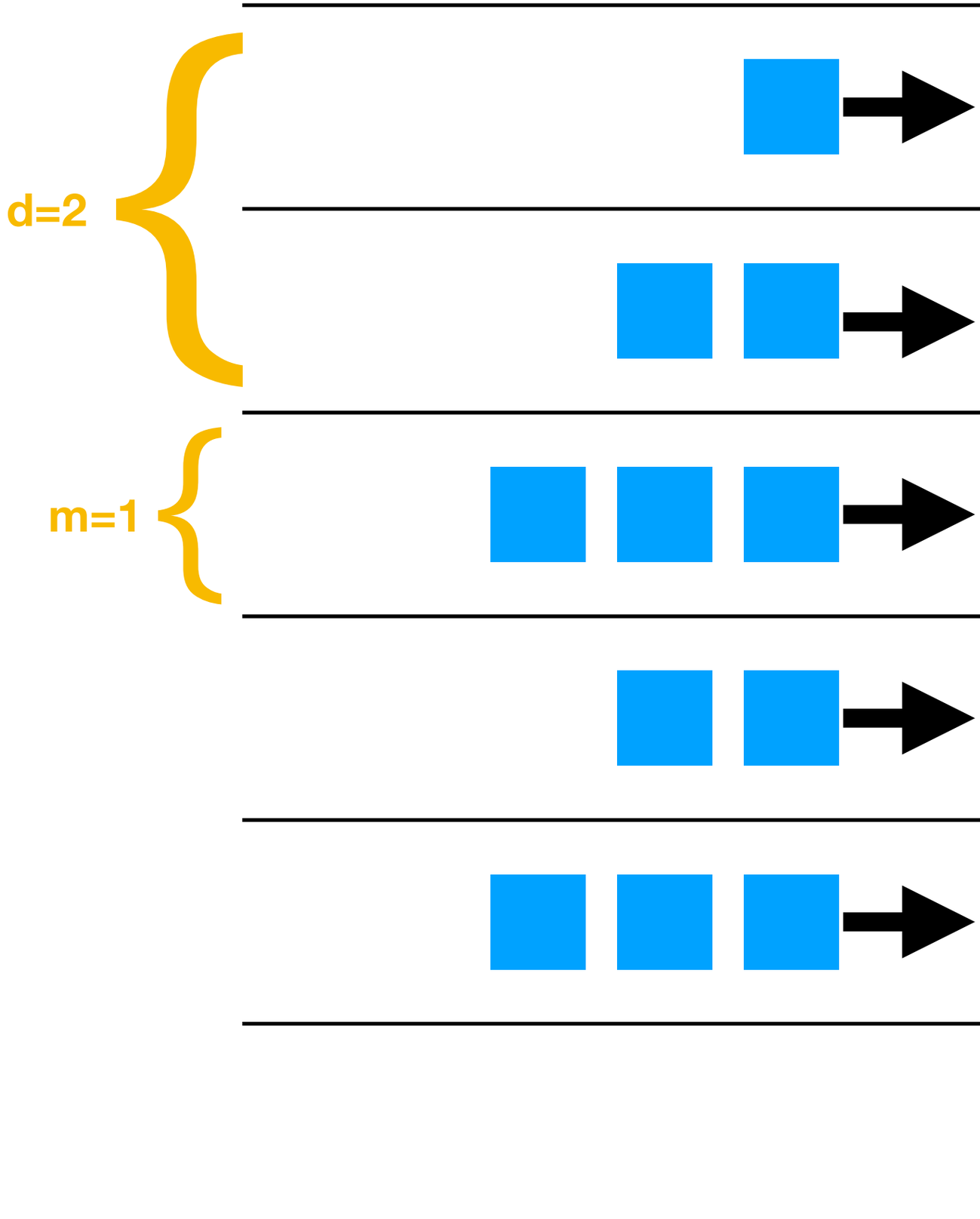
Load-Balancing

- **d** randomly sampled output queues
- **m** of the least-loaded output queues during previous samplings
- Pick minimum
- (d, m) scheduling policy

Input ports

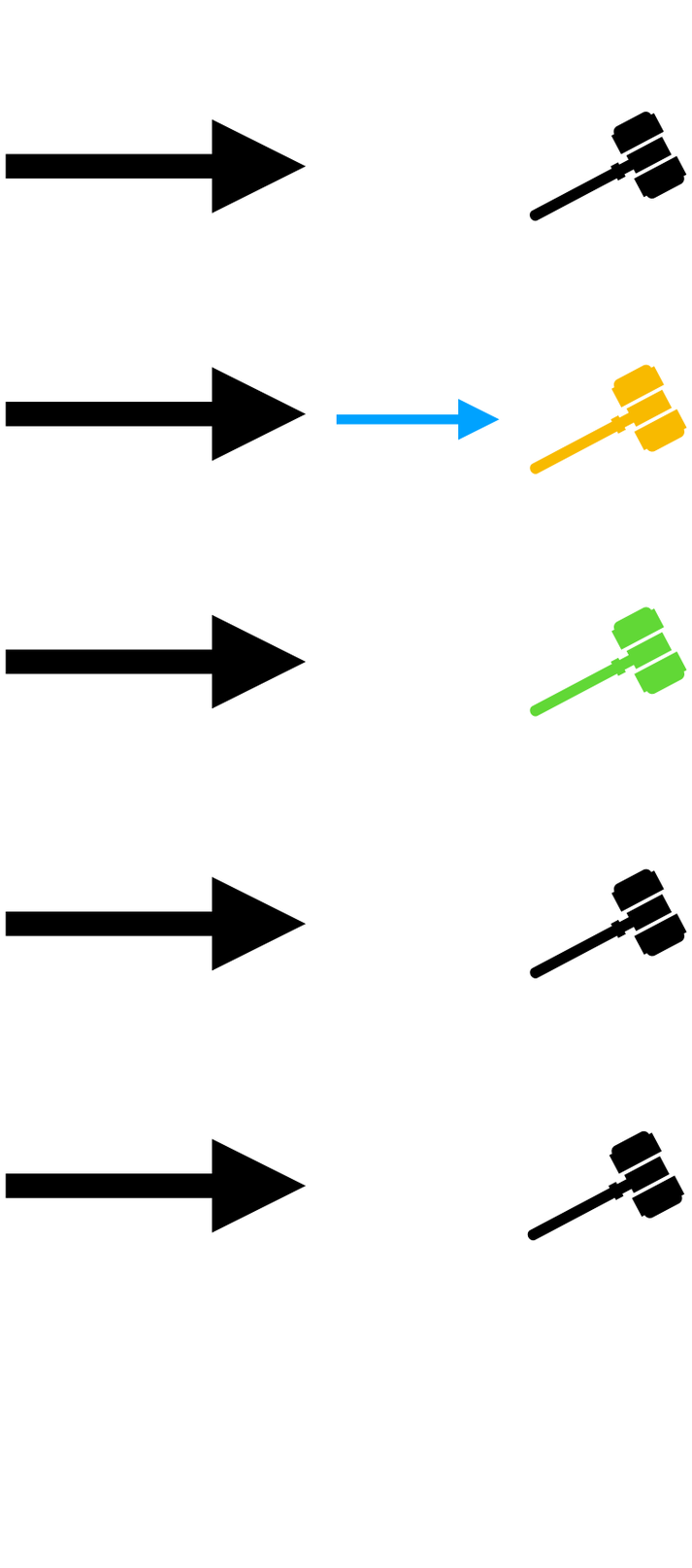
Output ports with queues

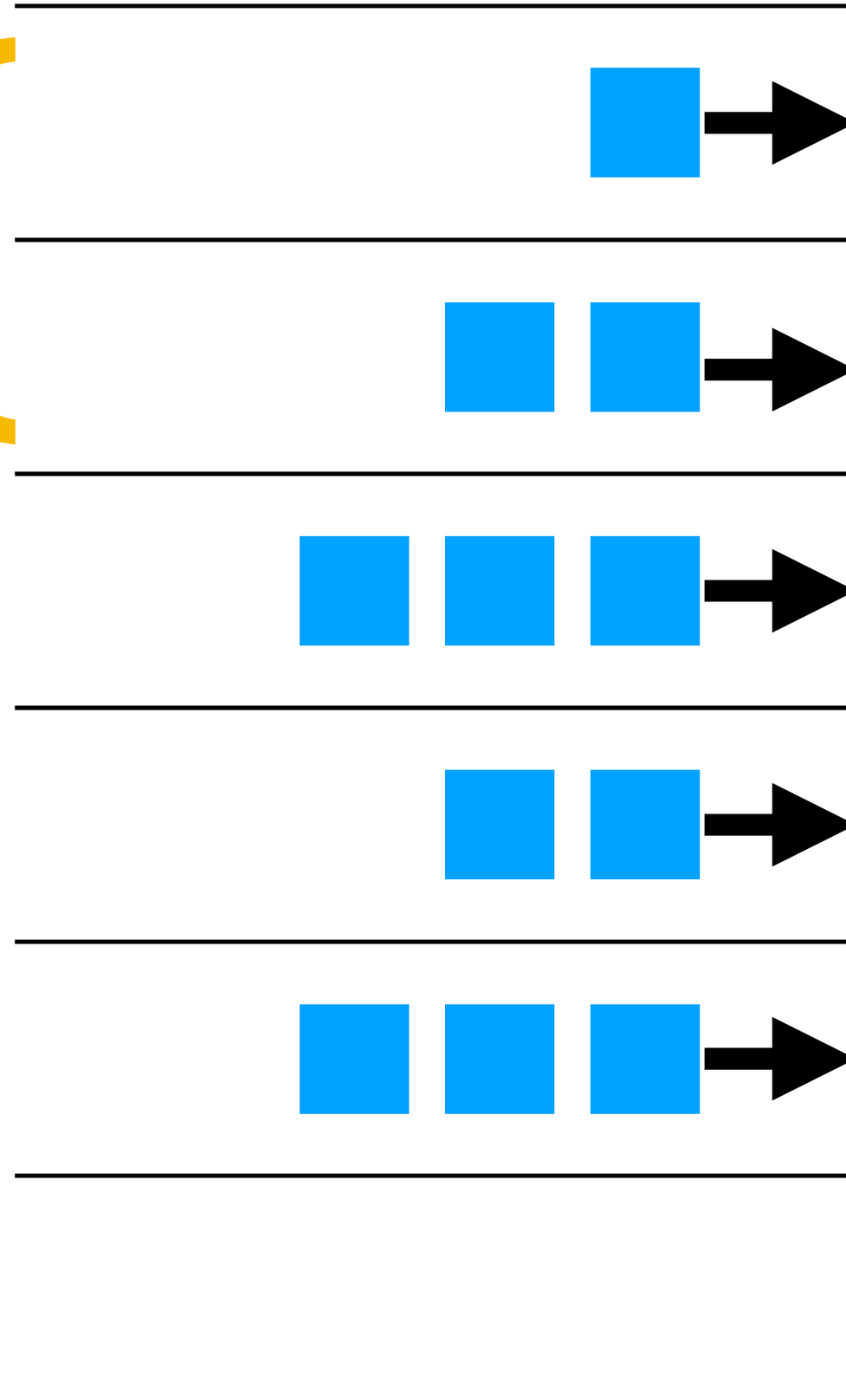




Input ports

Output ports with queues





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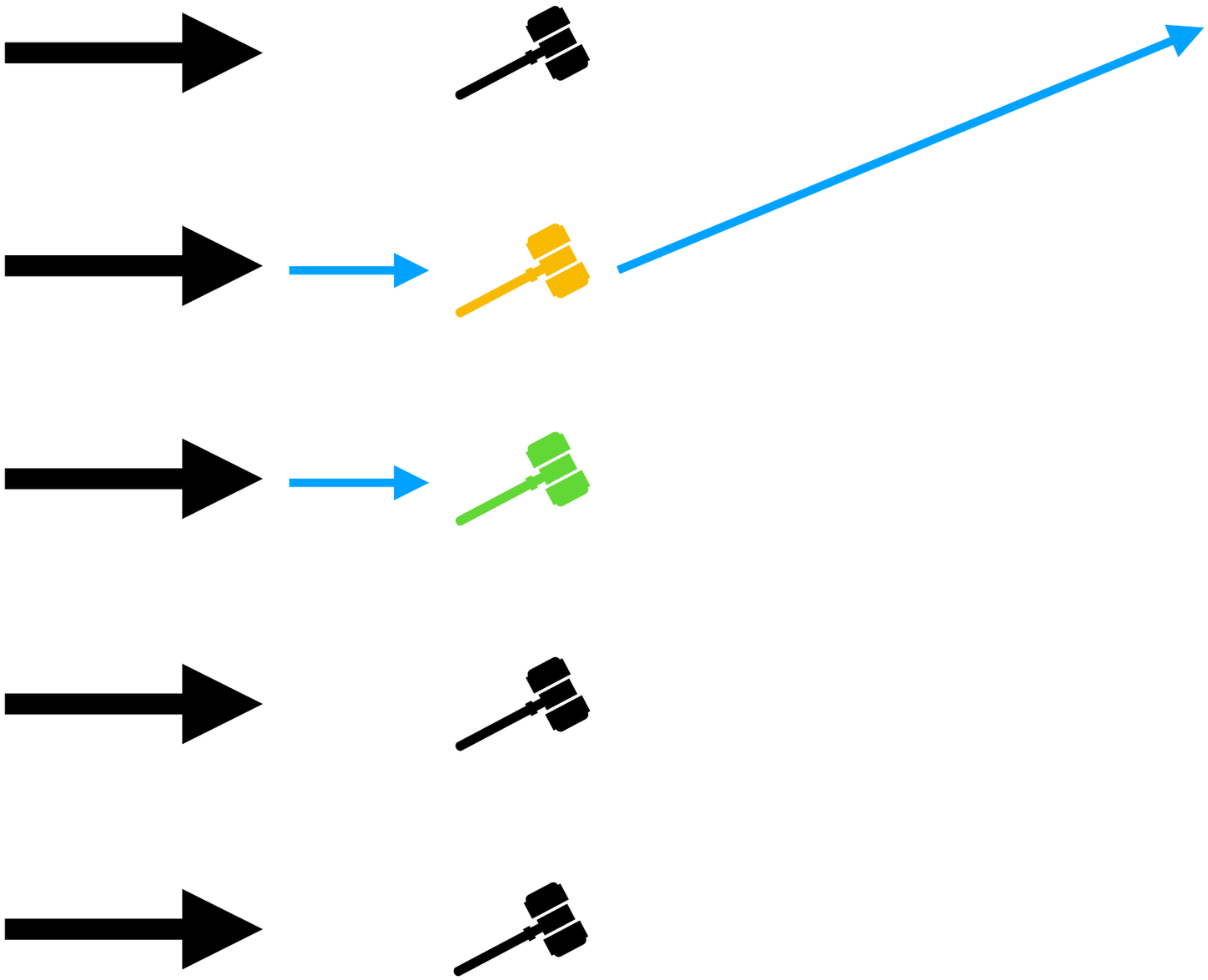

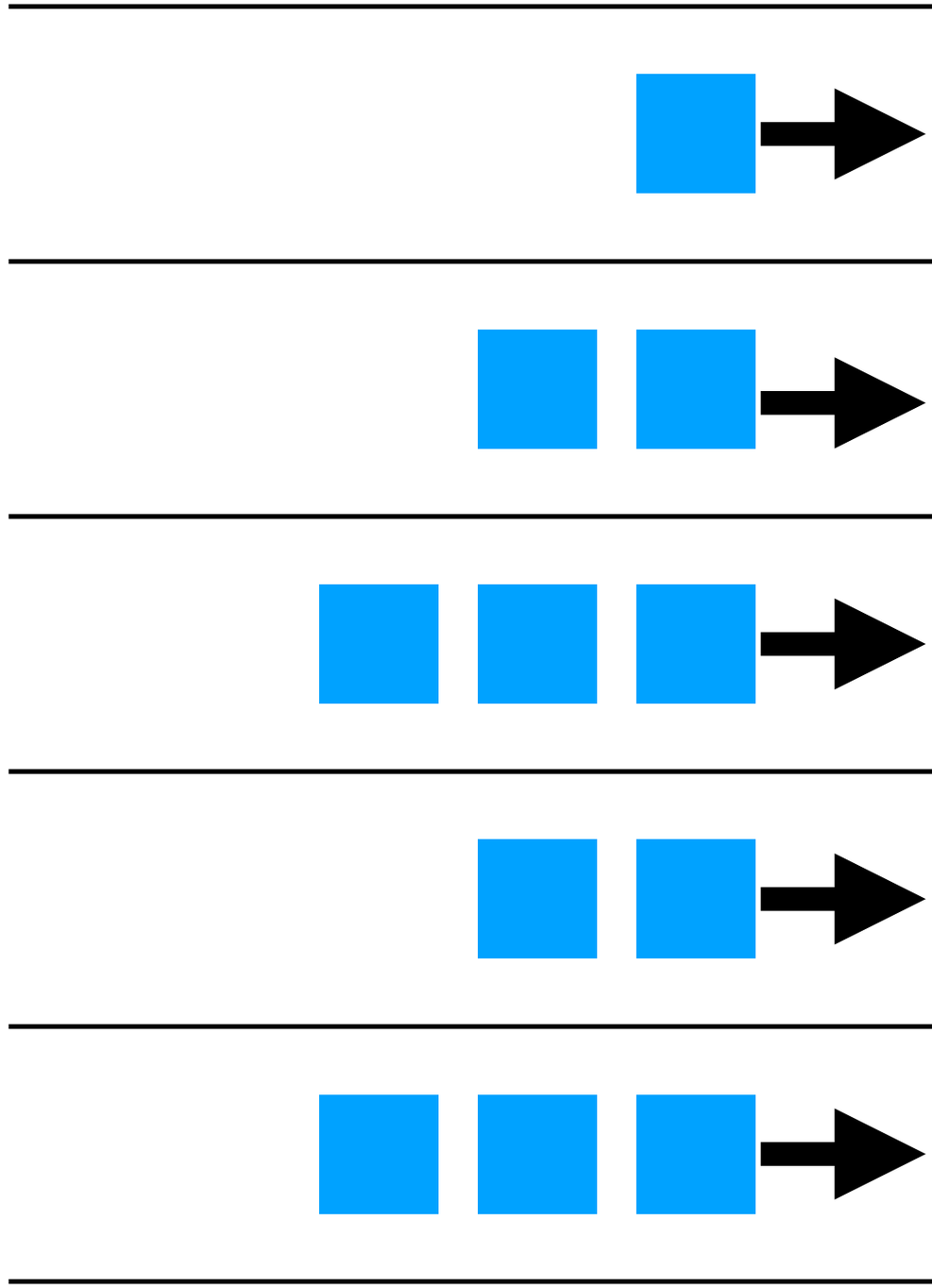

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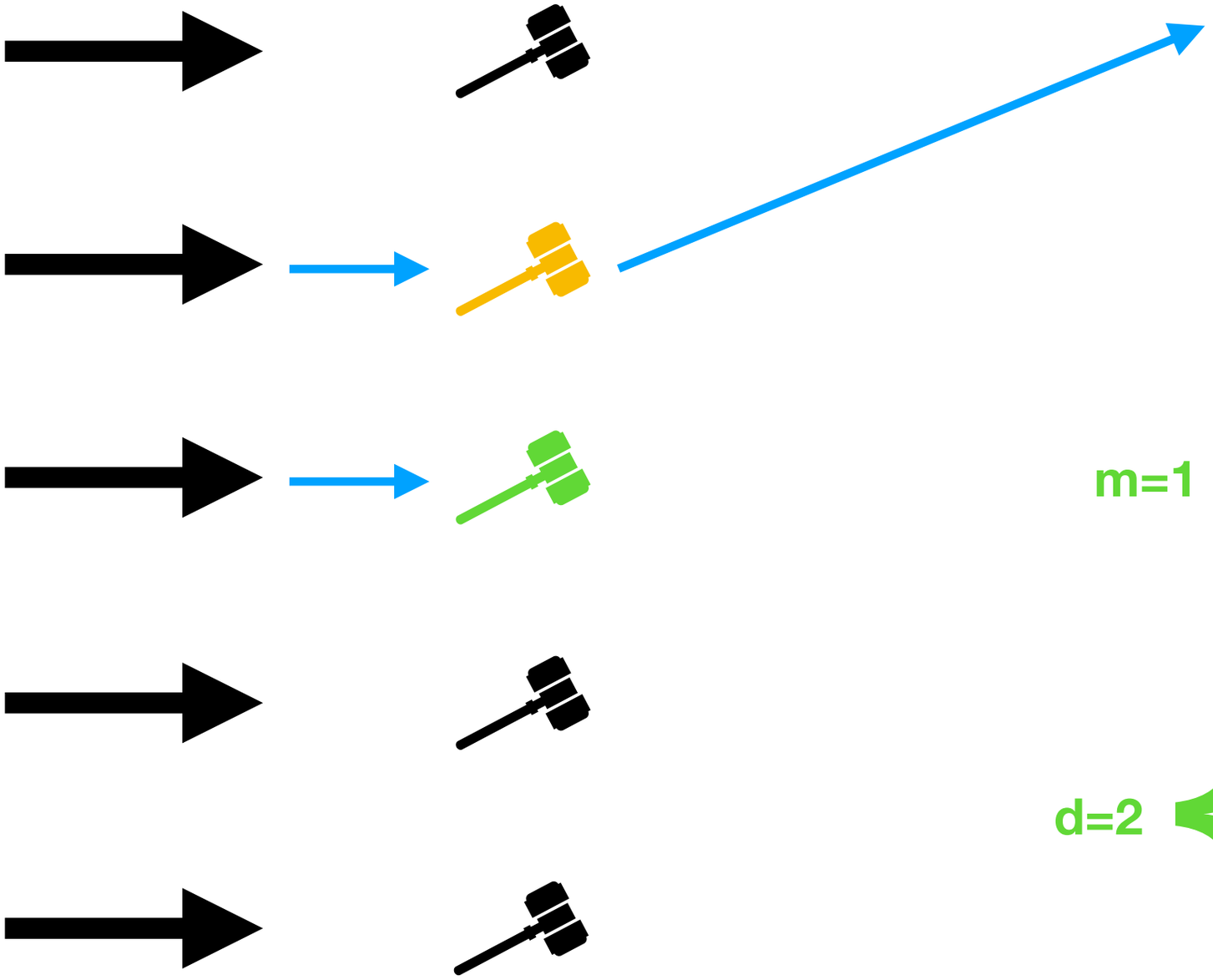
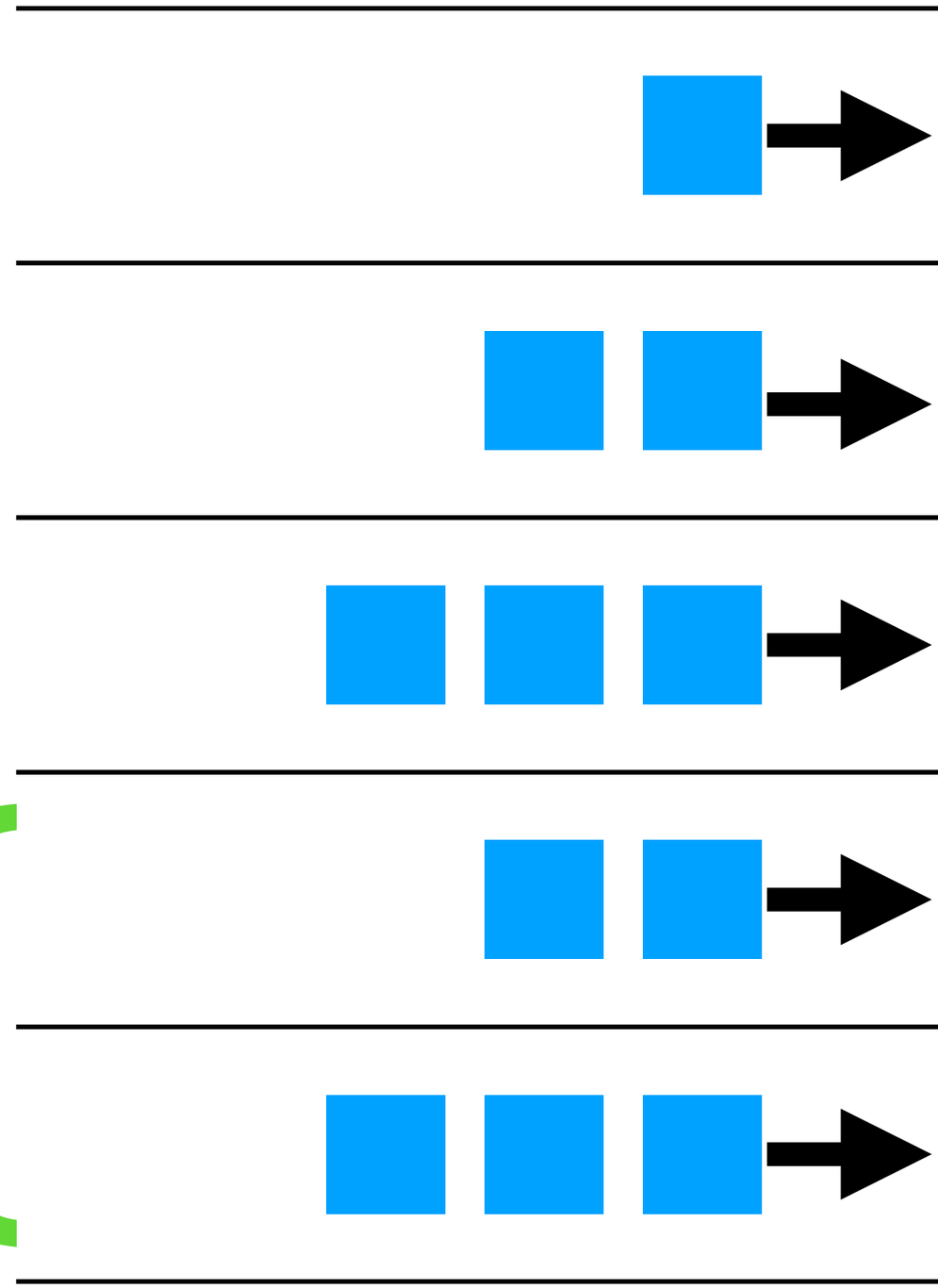




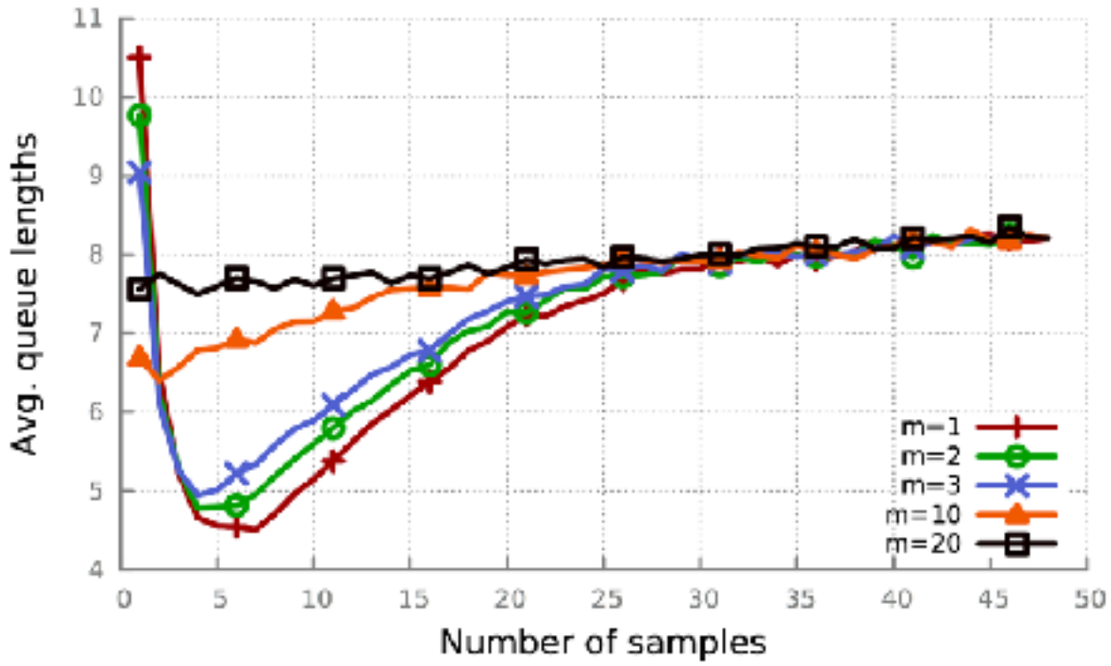
Input ports

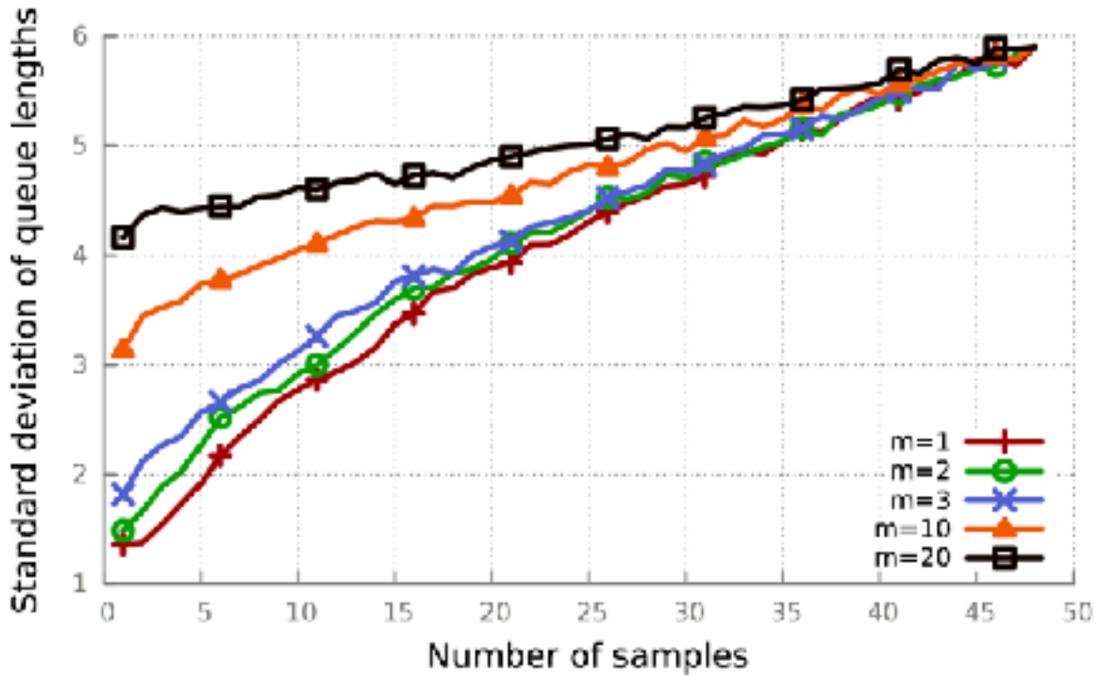
Output ports with queues

m=1

d=2

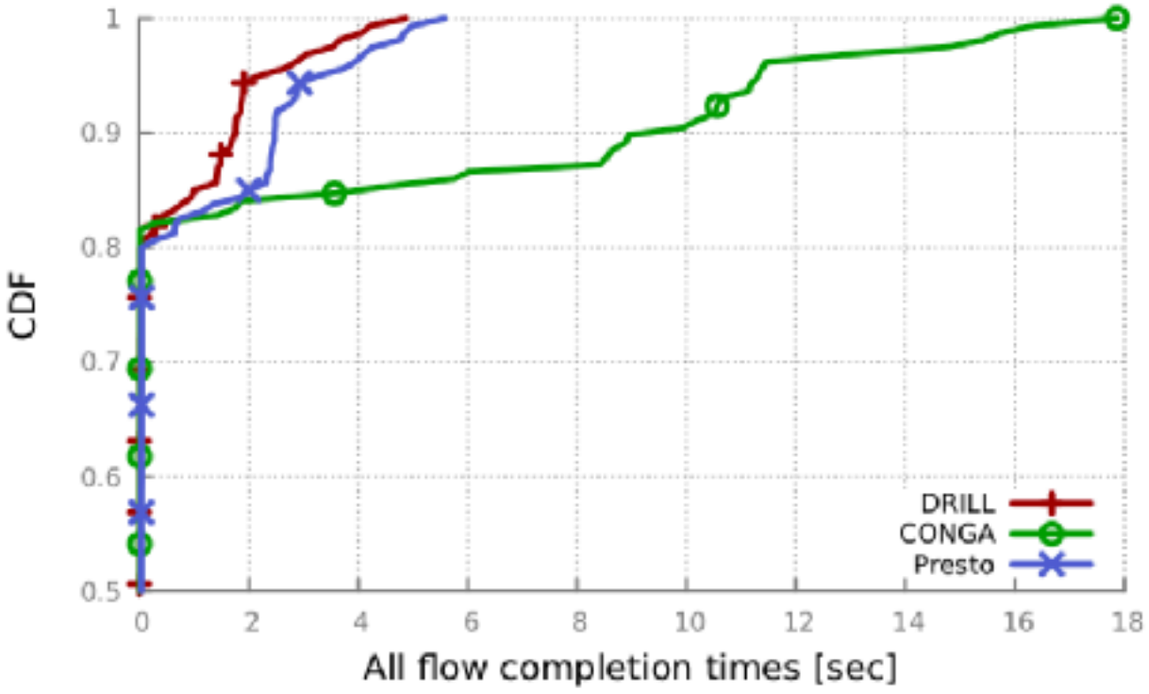
Choosing the right parameters

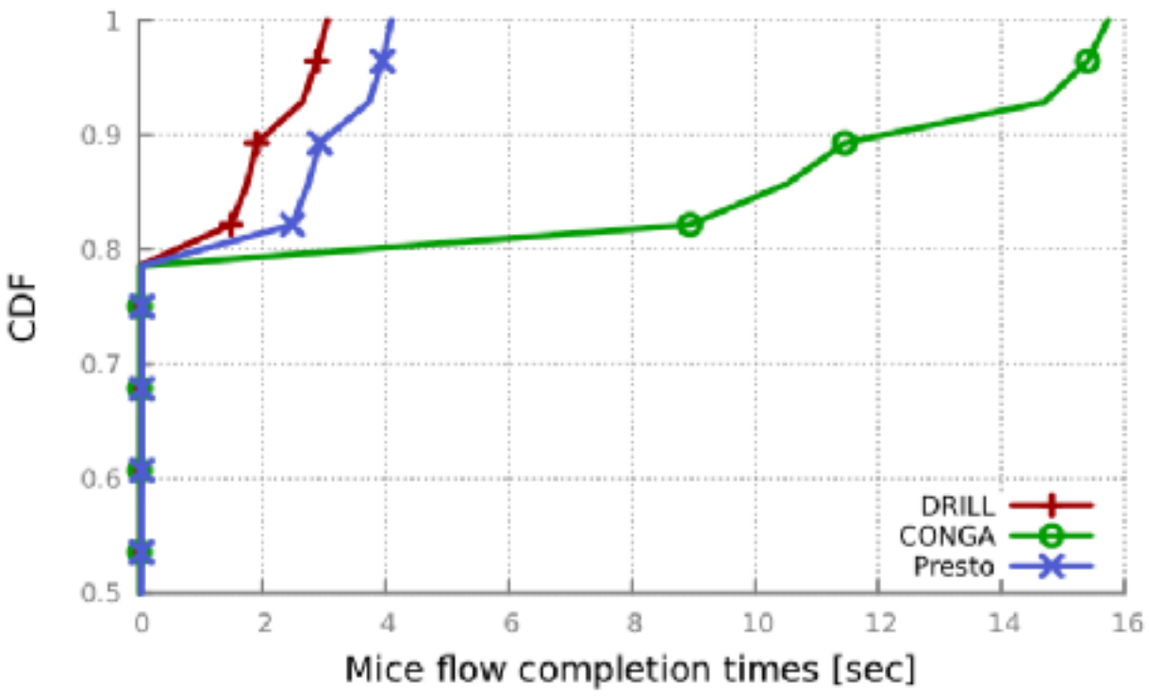




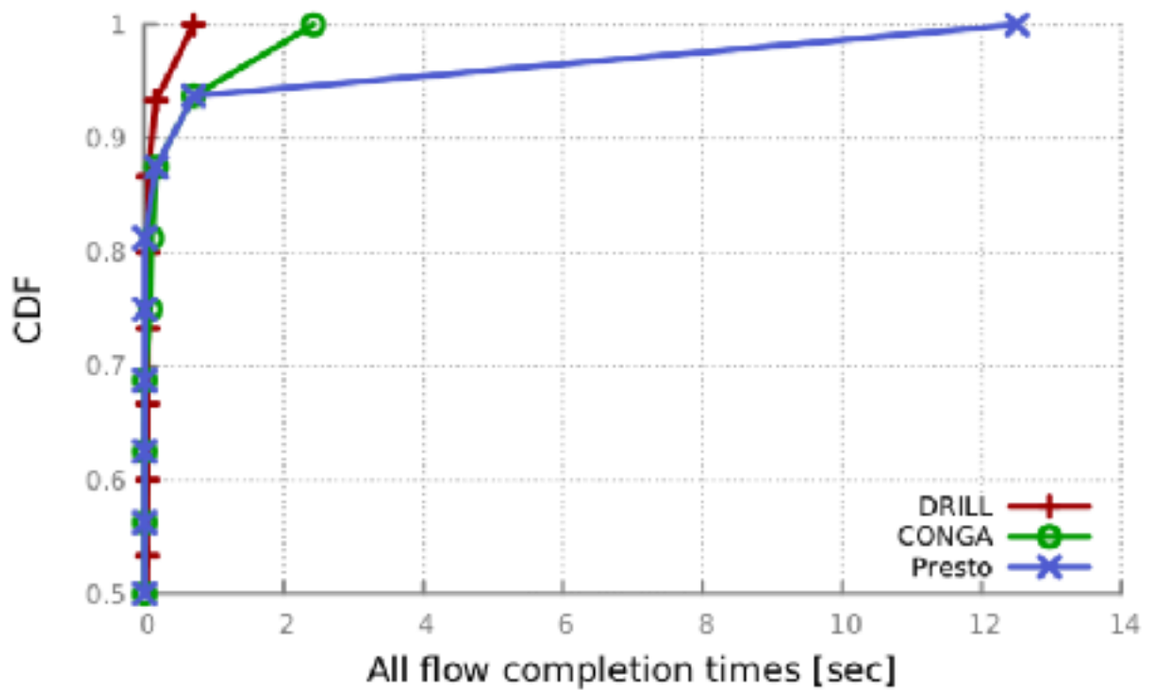
(48-port switch under 100% load)

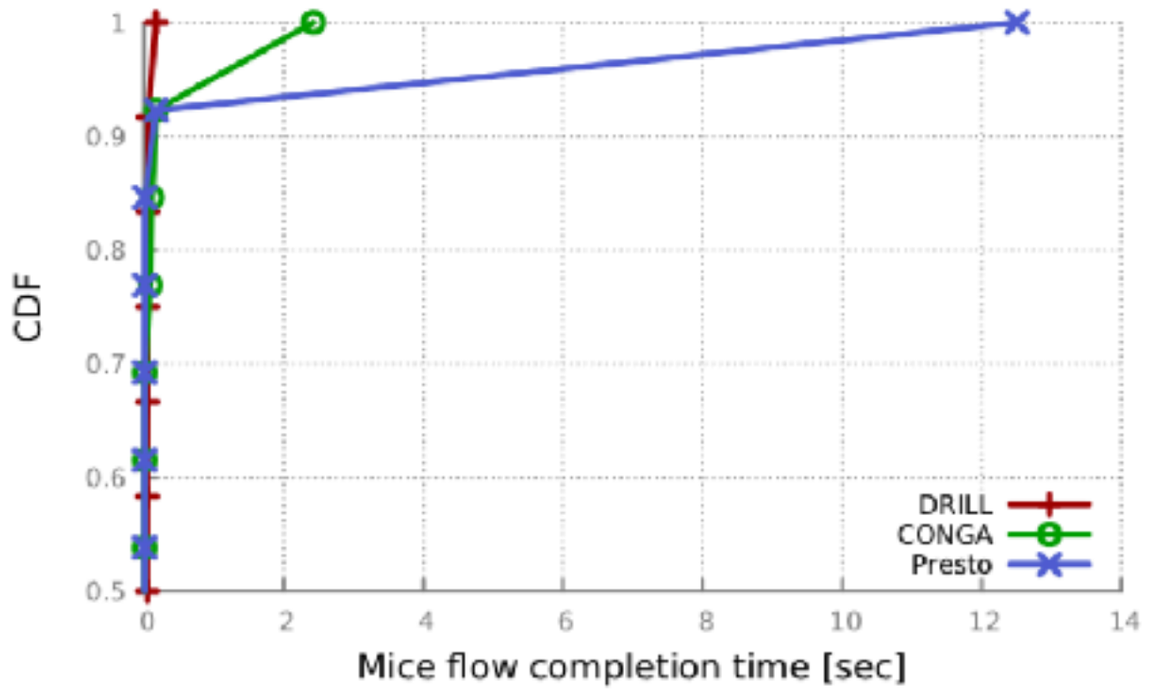
Heavy Load





Incast Scenario



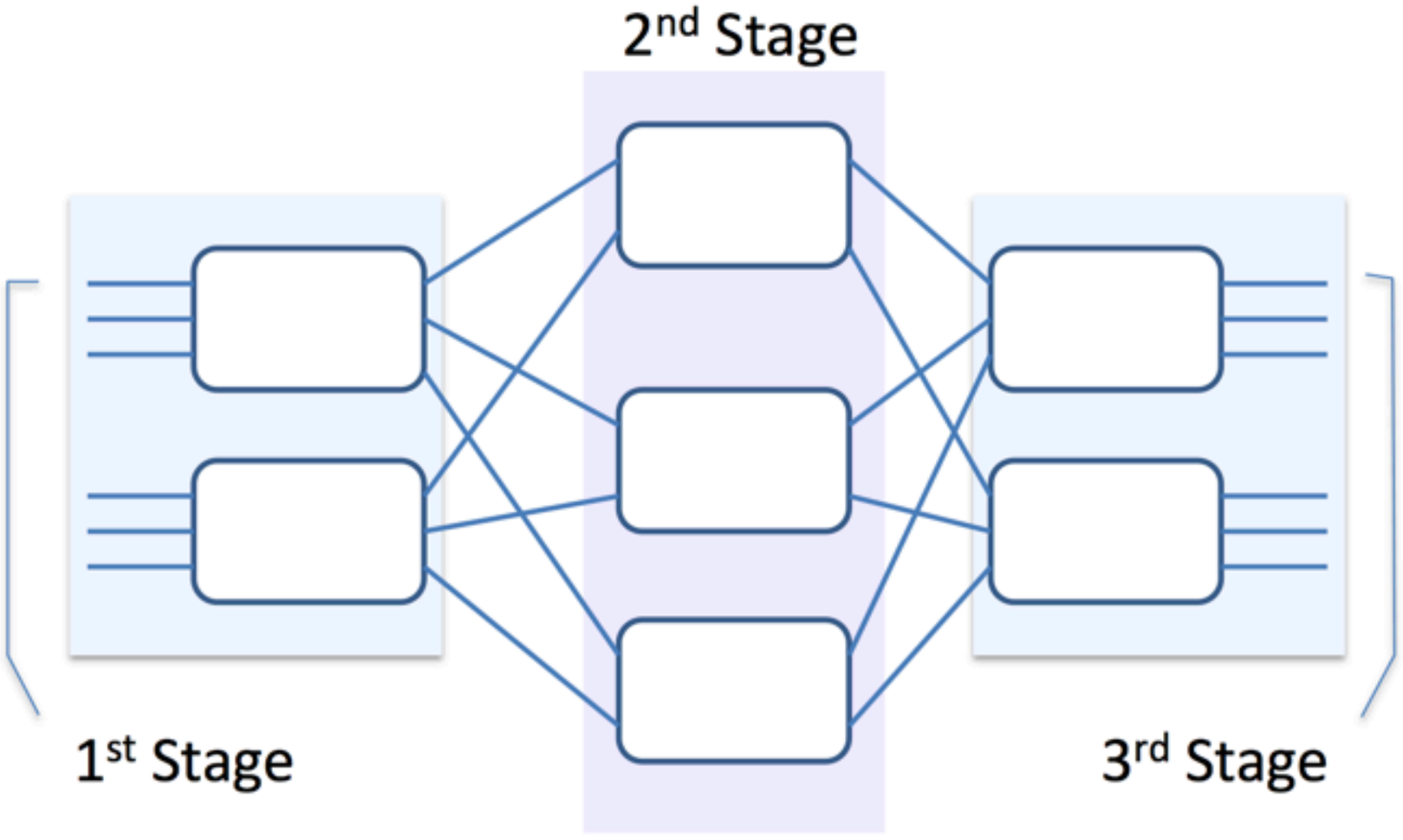


Out of order delivery

- LetFlow taught us that packet-level load balancing causes out of order delivery
- Splitting flows + Latency Variance = Reordering
- DRILL claims that its load balancing is so good that (almost) no reordering happens (no latency difference across different paths); even less than with Presto

Conclusion

- Only simulated evaluation, with synthetic traffic
- Simulated network quite small (4 Leaves, 6 Spines)
- What to do with **m** if network not fully interconnected?
- Asymmetric systems might impose interesting problems: SIGCOMM talk mentions approaches (graph decomposition)


2nd Stage
1st Stage
3rd Stage