# 6.1800 Spring 2025

## Lecture #12: In-network resource management

continuing to share a network, this time with help from switches

Katrina LaCurts | lacurts@mit.edu | 6.1800 2025

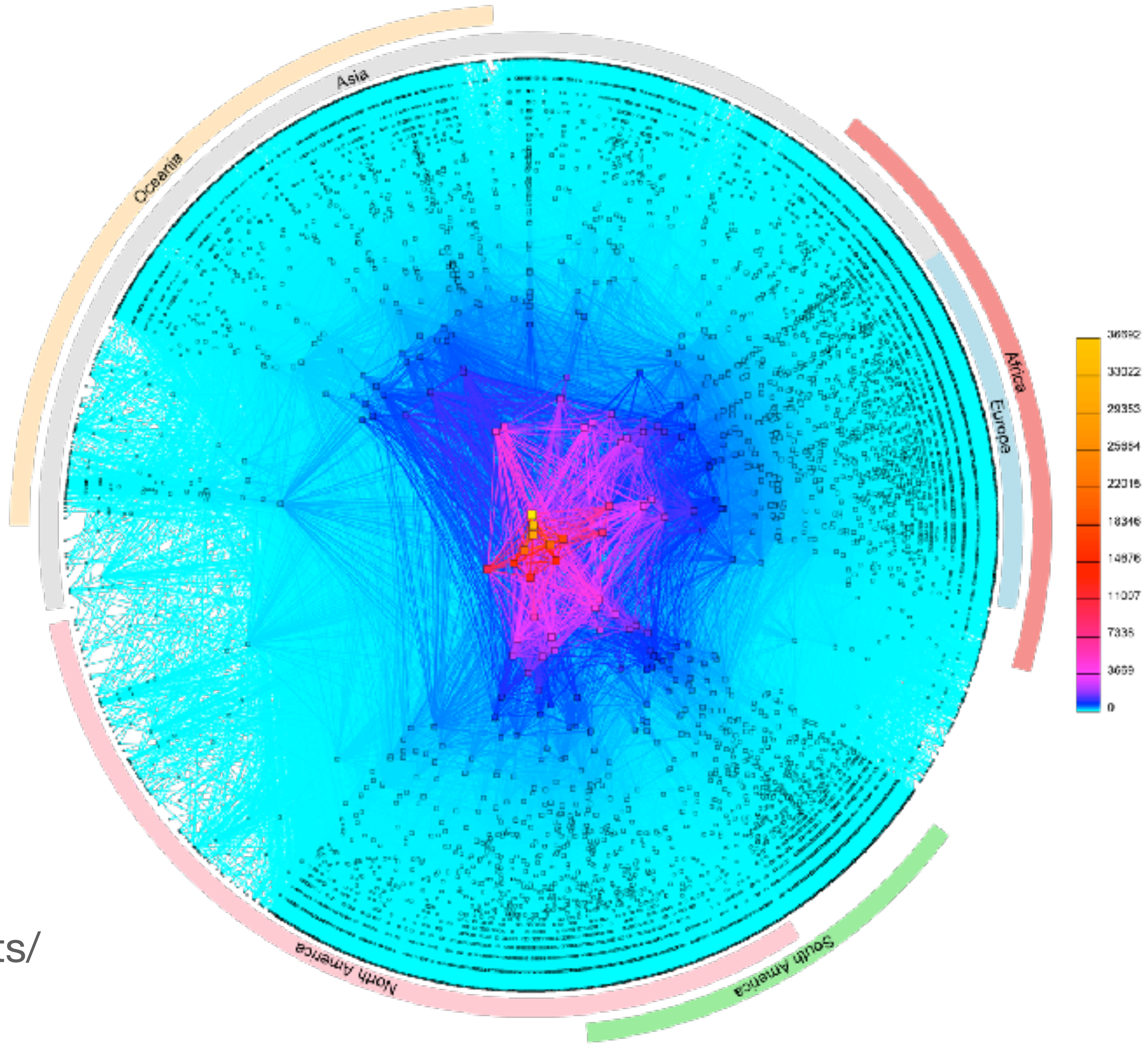
1970s: ARPAnet — hosts.txt

1978: flexibility and layering — distance-vector routing

early 80s: growth → change — **TCP**, UDP; OSPF, EGP, DNS

late 80s: growth → problems — congestion collapse (which led to **congestion control**); policy routing; CIDR

1993: commercialization




CAIDA's IPv4 AS Core, January 2020 (https://www.caida.org/projects/cartography/as-core/2020/)

**question:** TCP congestion control doesn't react to congestion until after it's a problem; could we get senders to react before queues are full?

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| `application` | `the things that actually generate traffic` |
| `transport` | `sharing the network, reliability (or not)` <br> *examples: TCP, UDP* |
| `network` | `naming, addressing, routing` <br> *examples: IP* |
| `link` | `communication between two directly-connected nodes` <br> *examples: ethernet, bluetooth, 802.11 (wifi)* |

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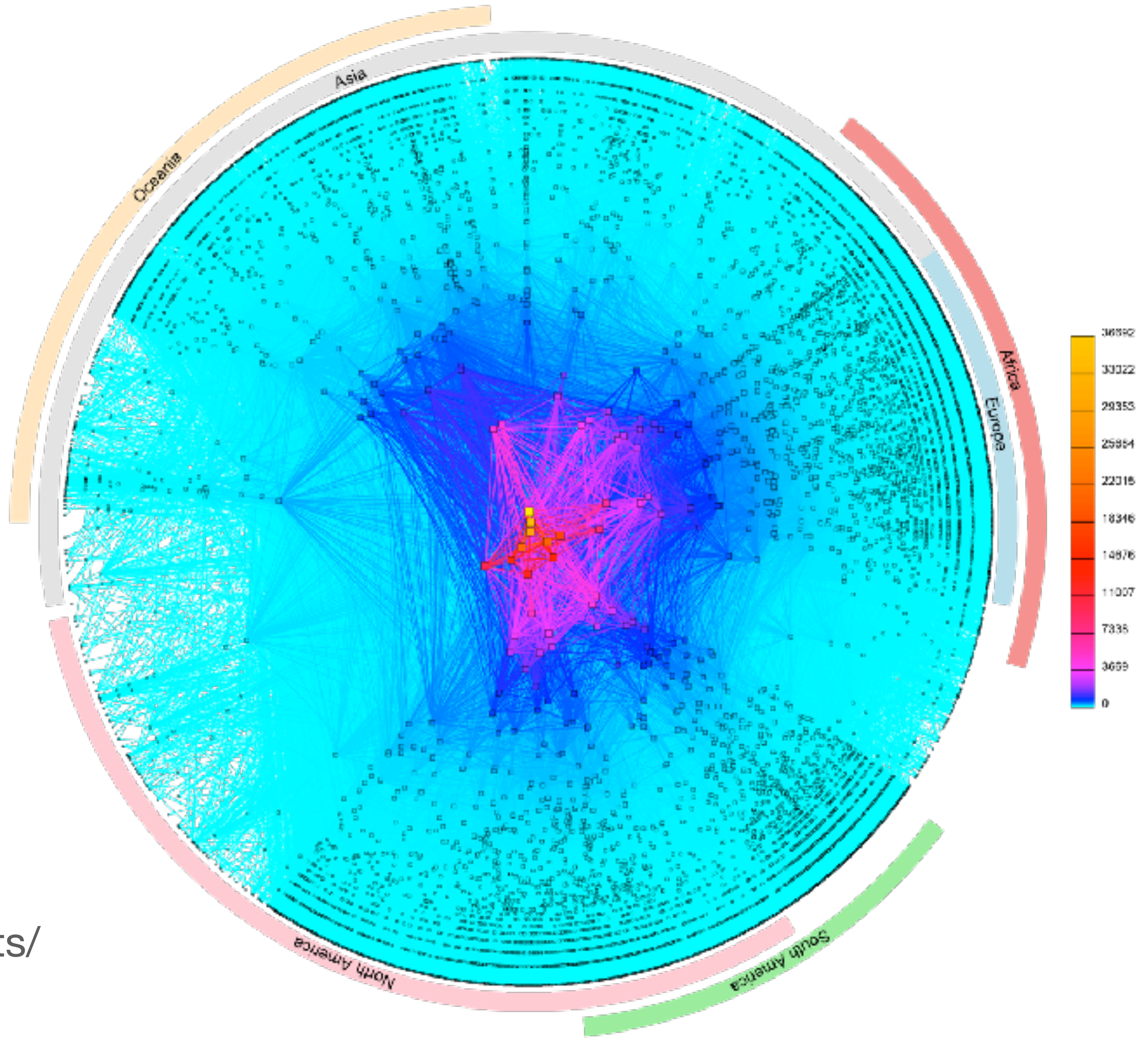


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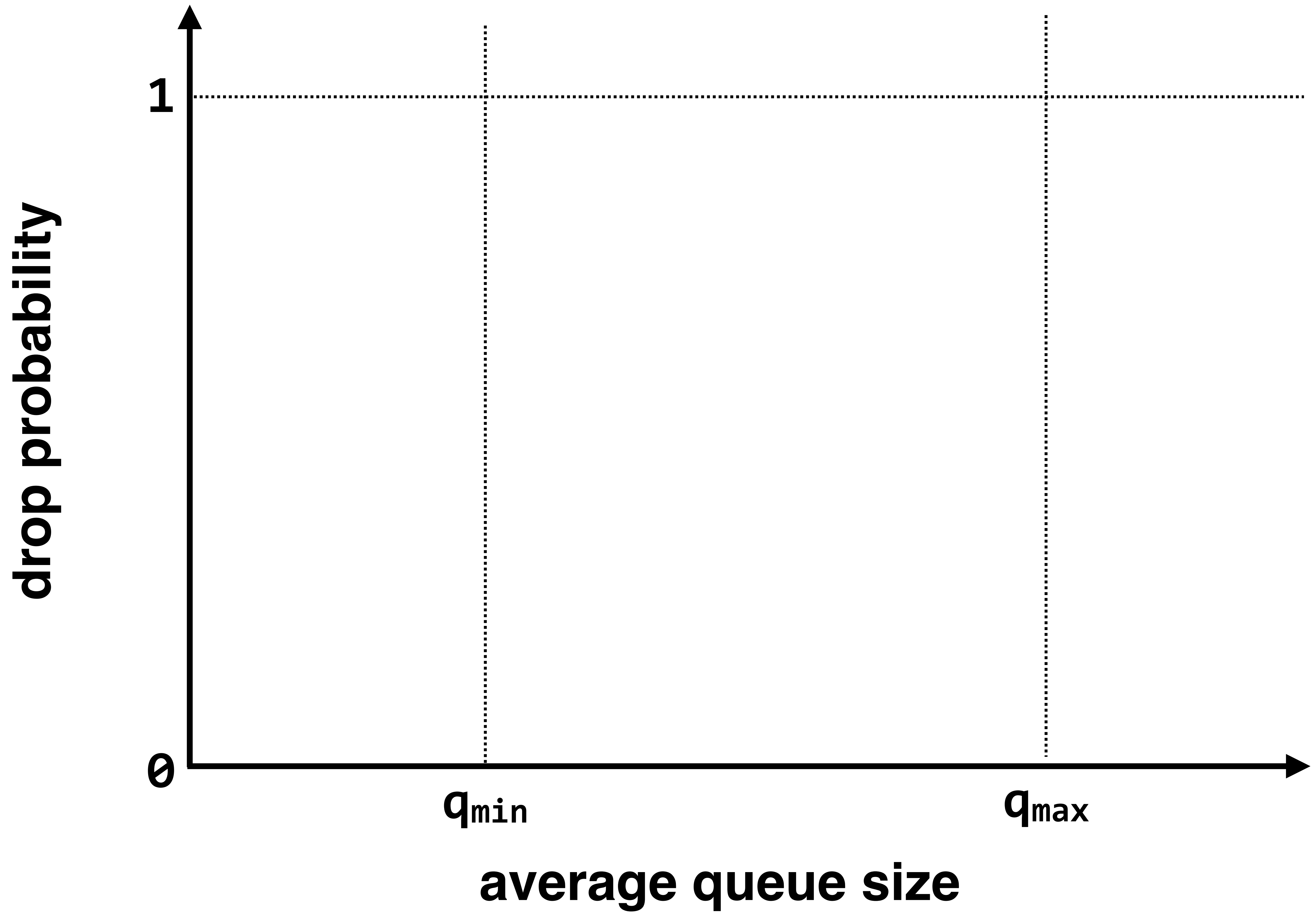

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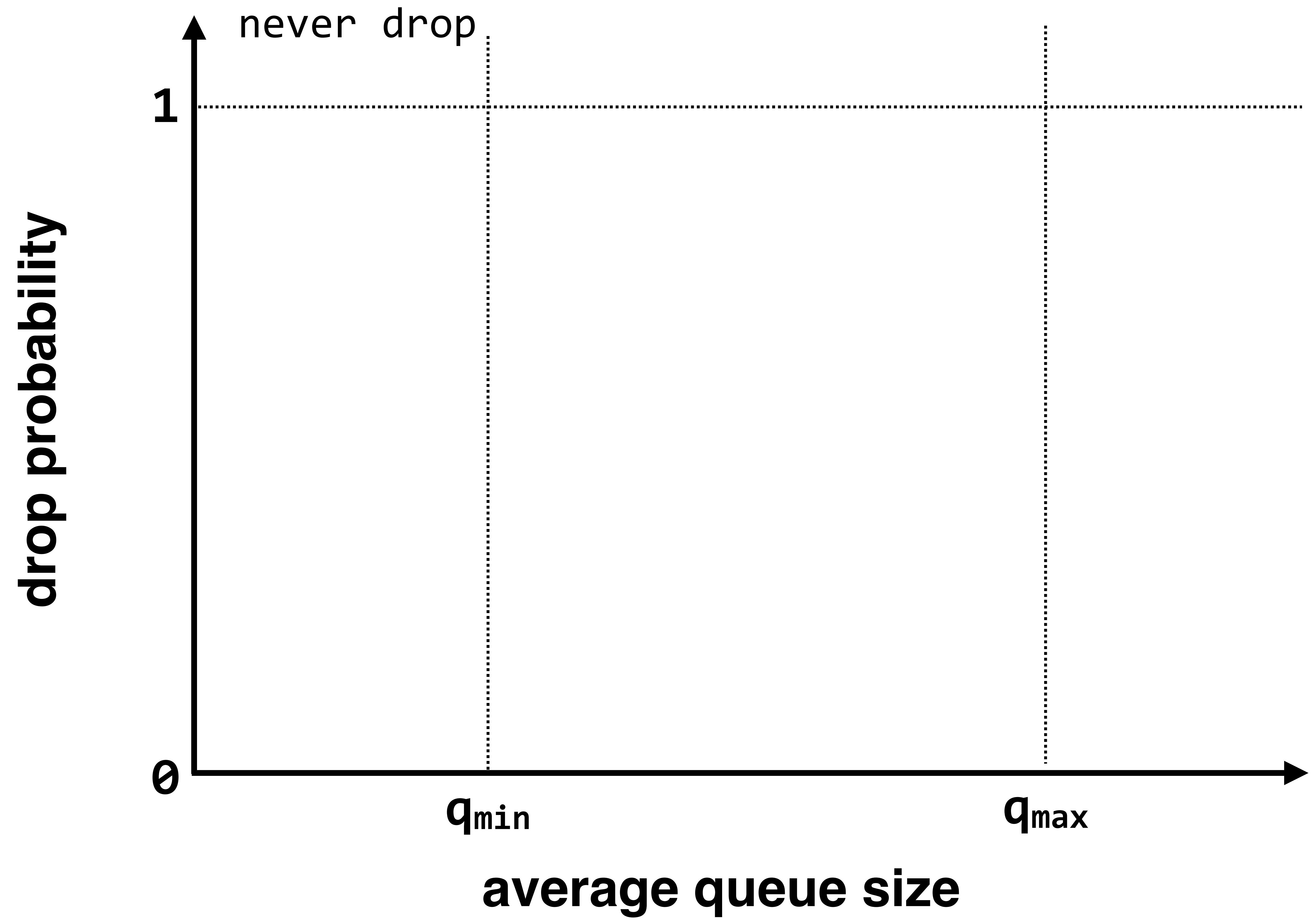

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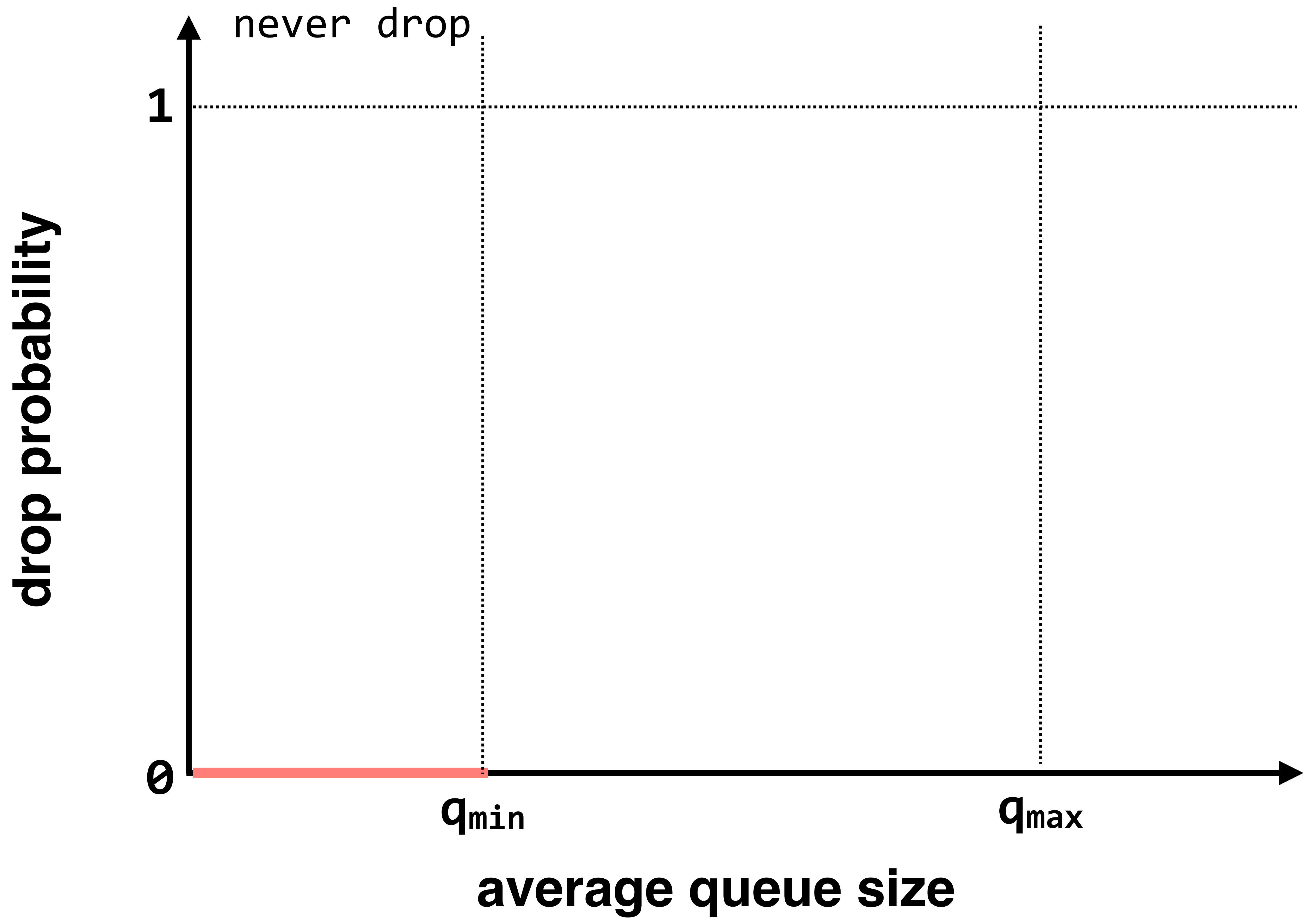

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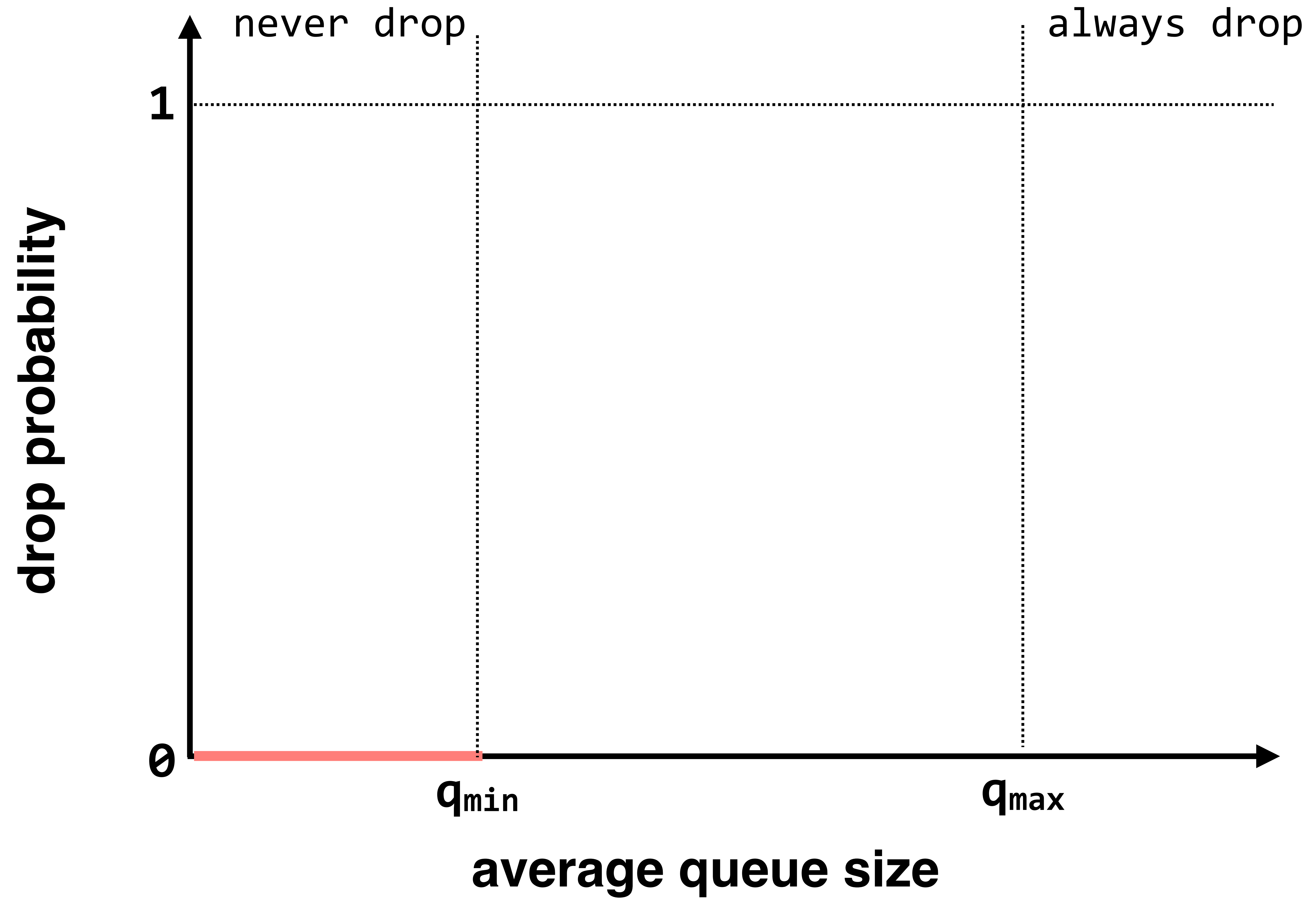

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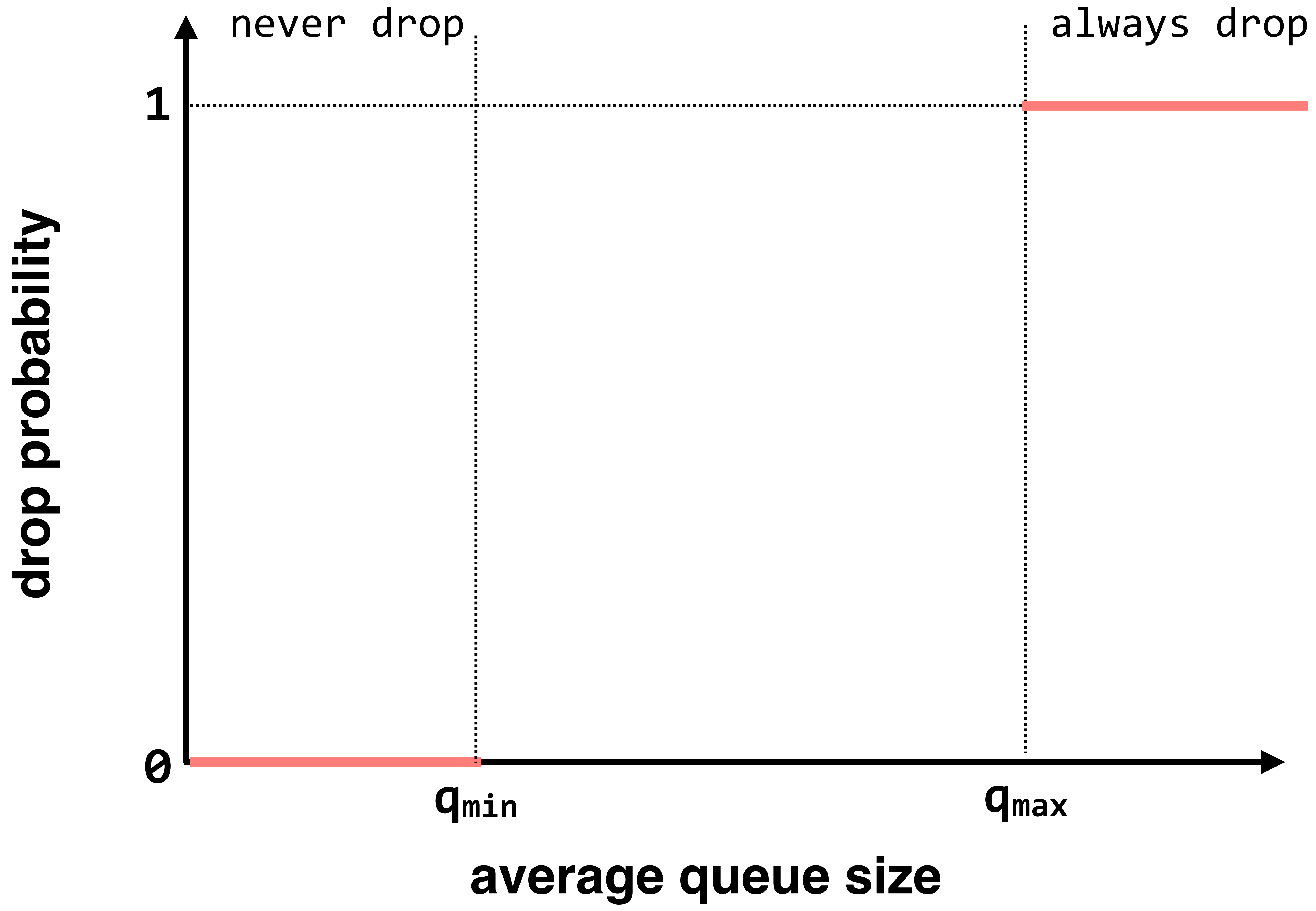

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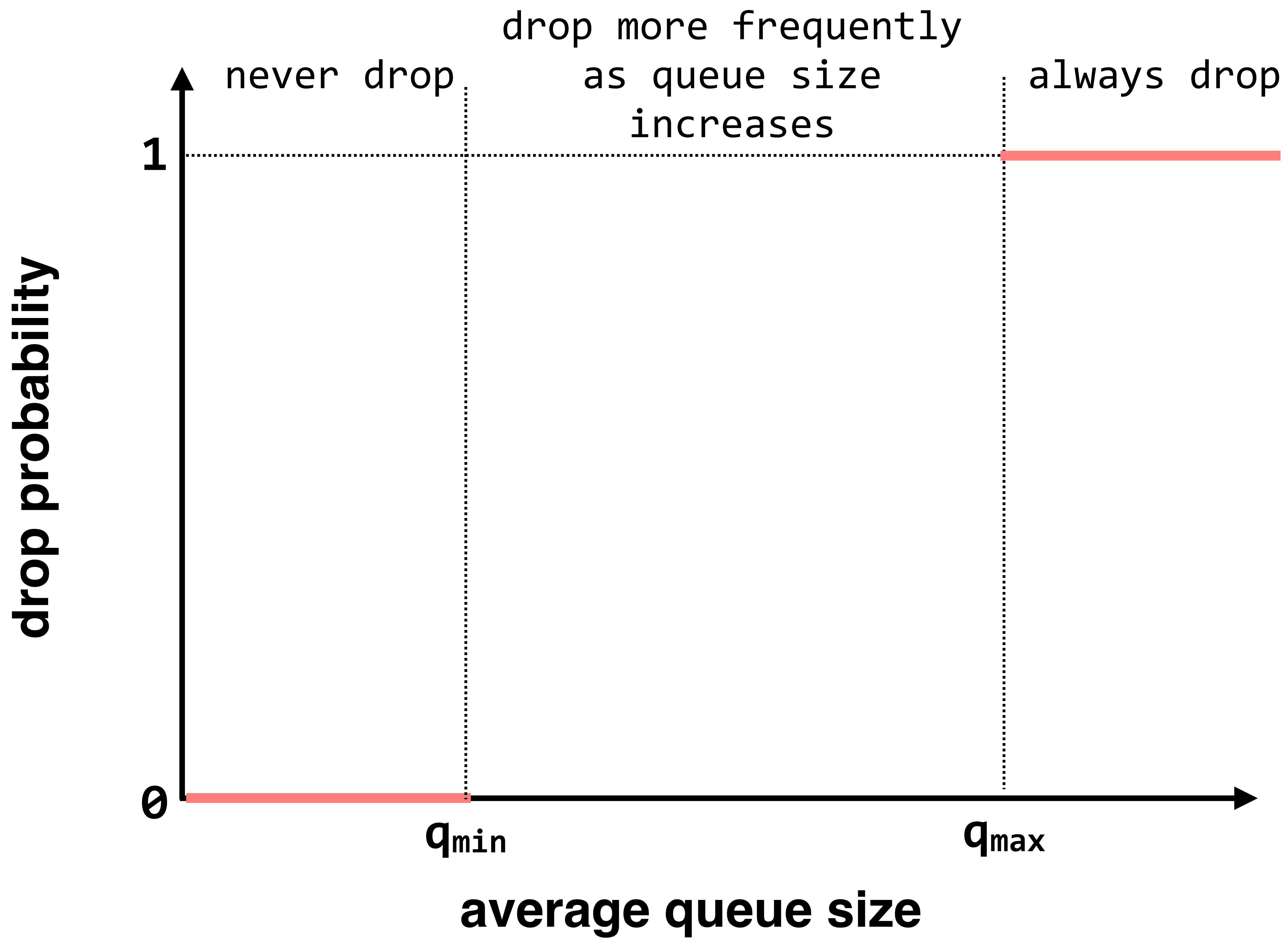

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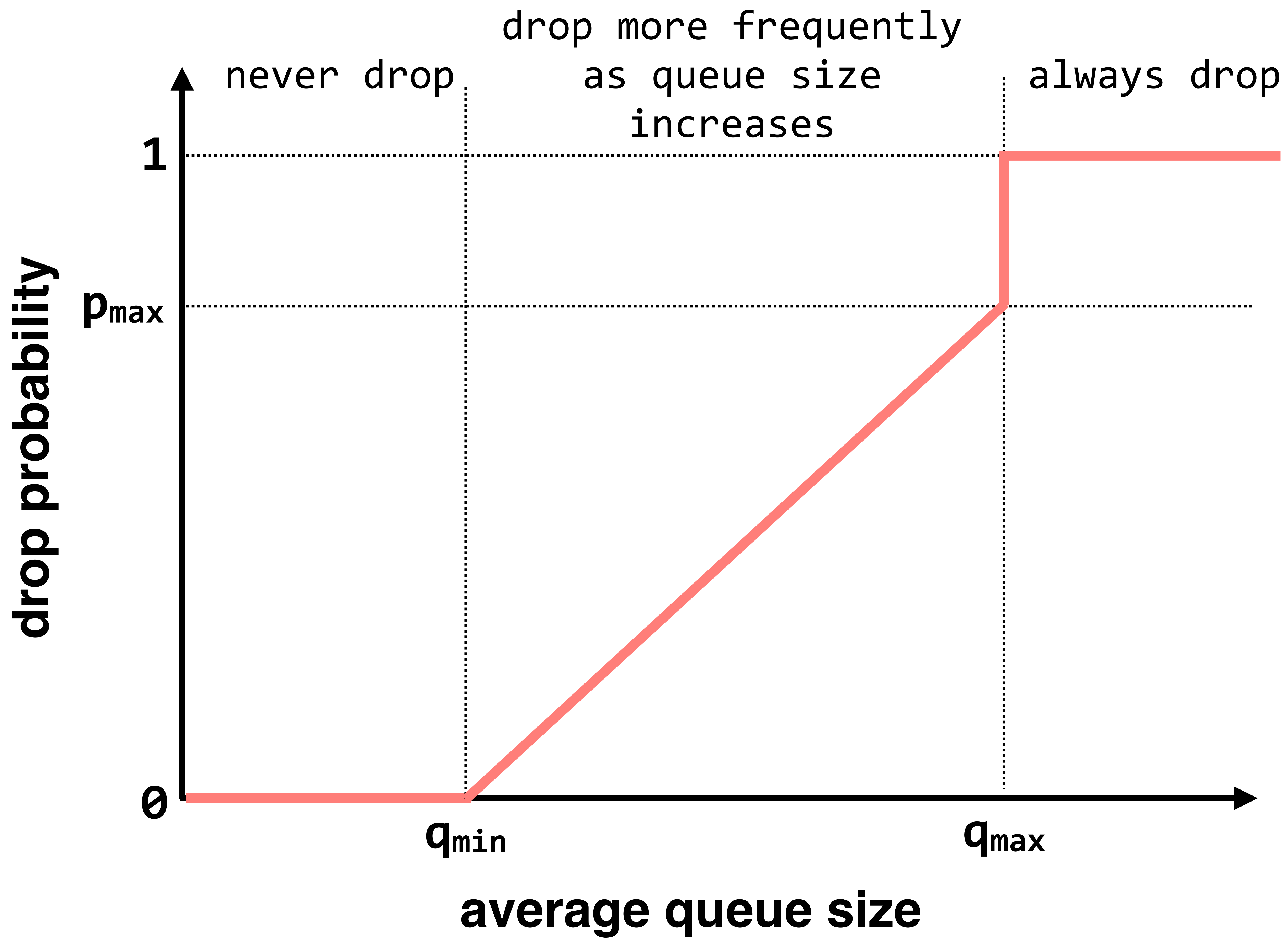

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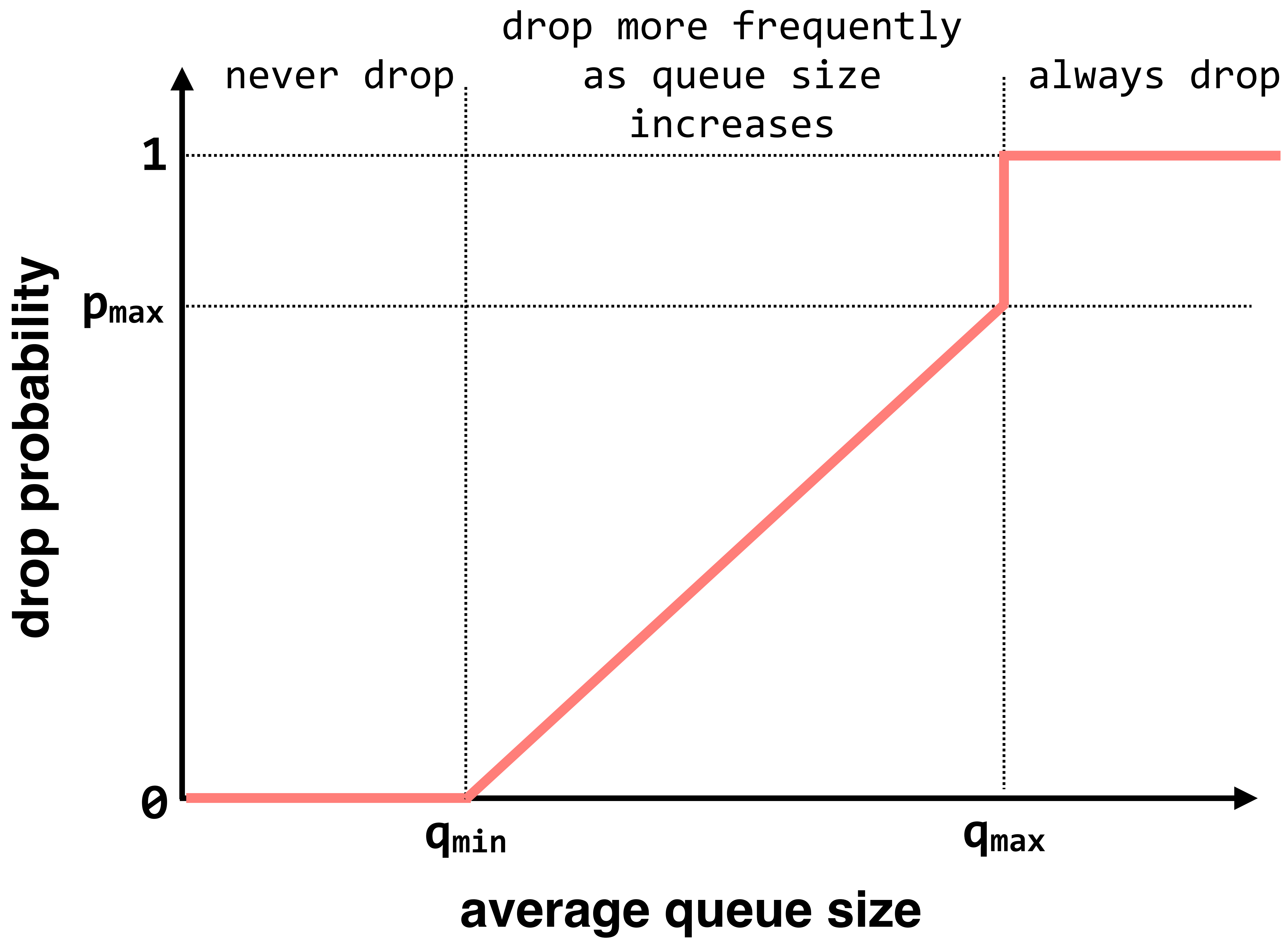

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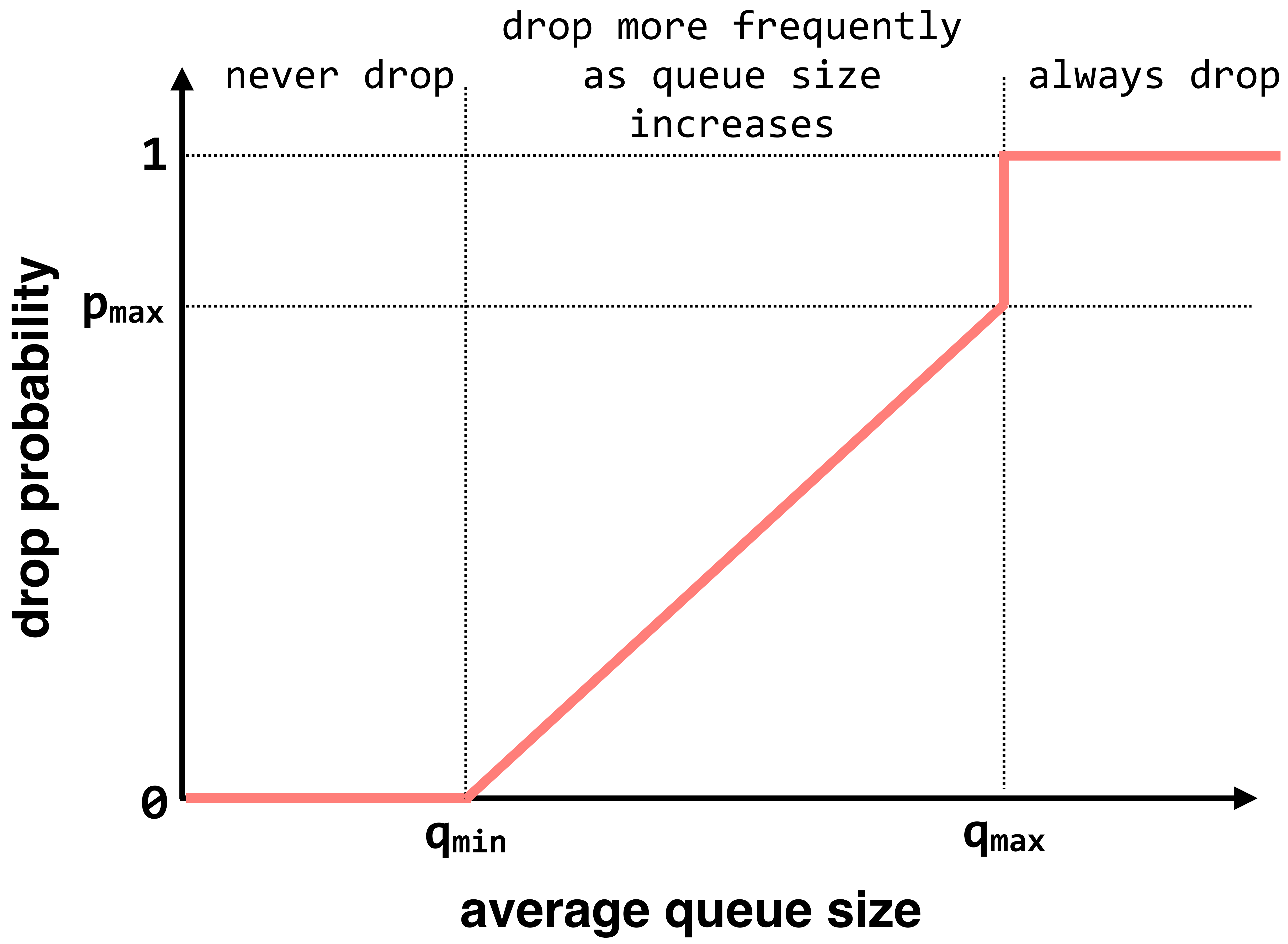

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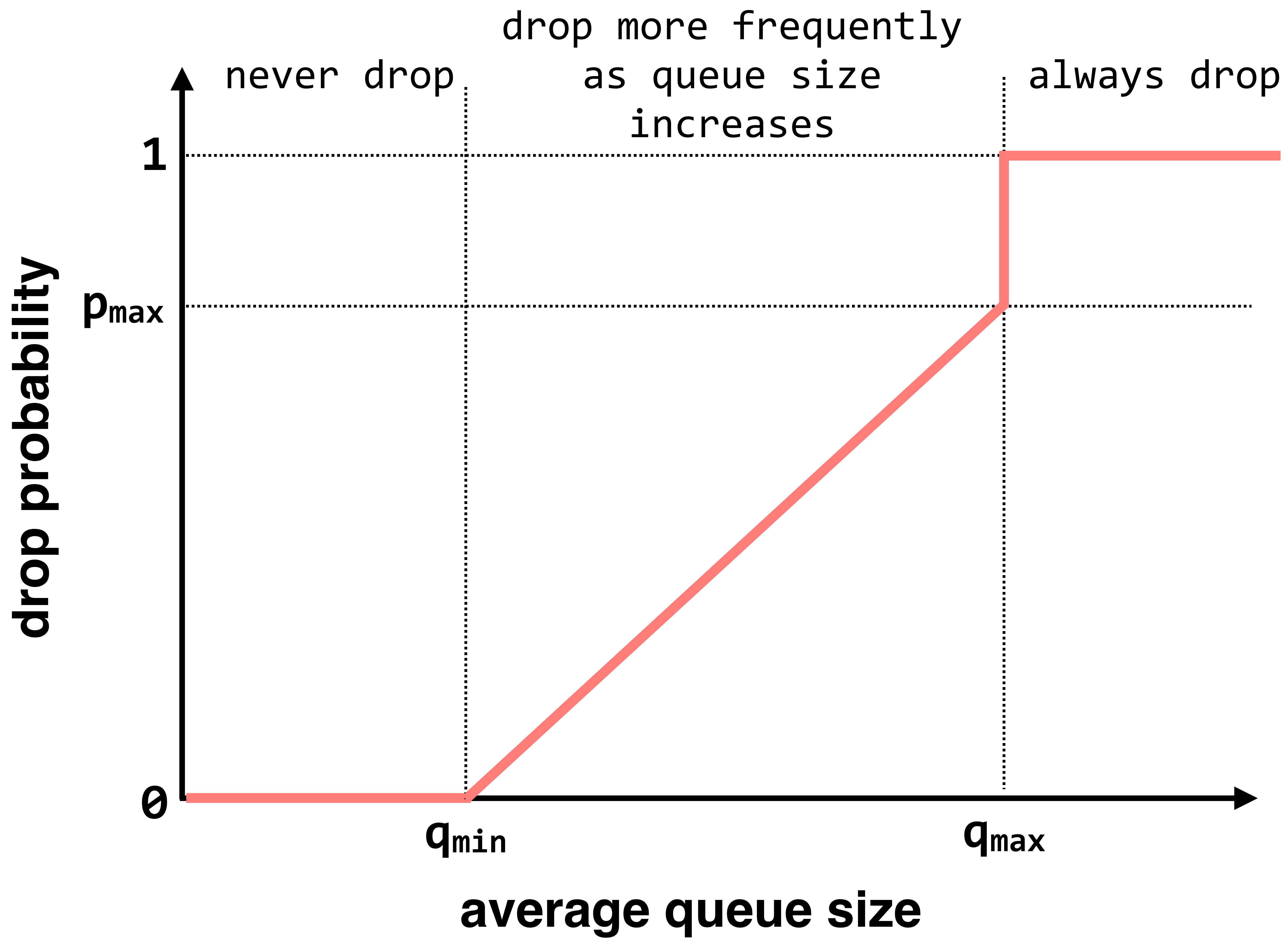

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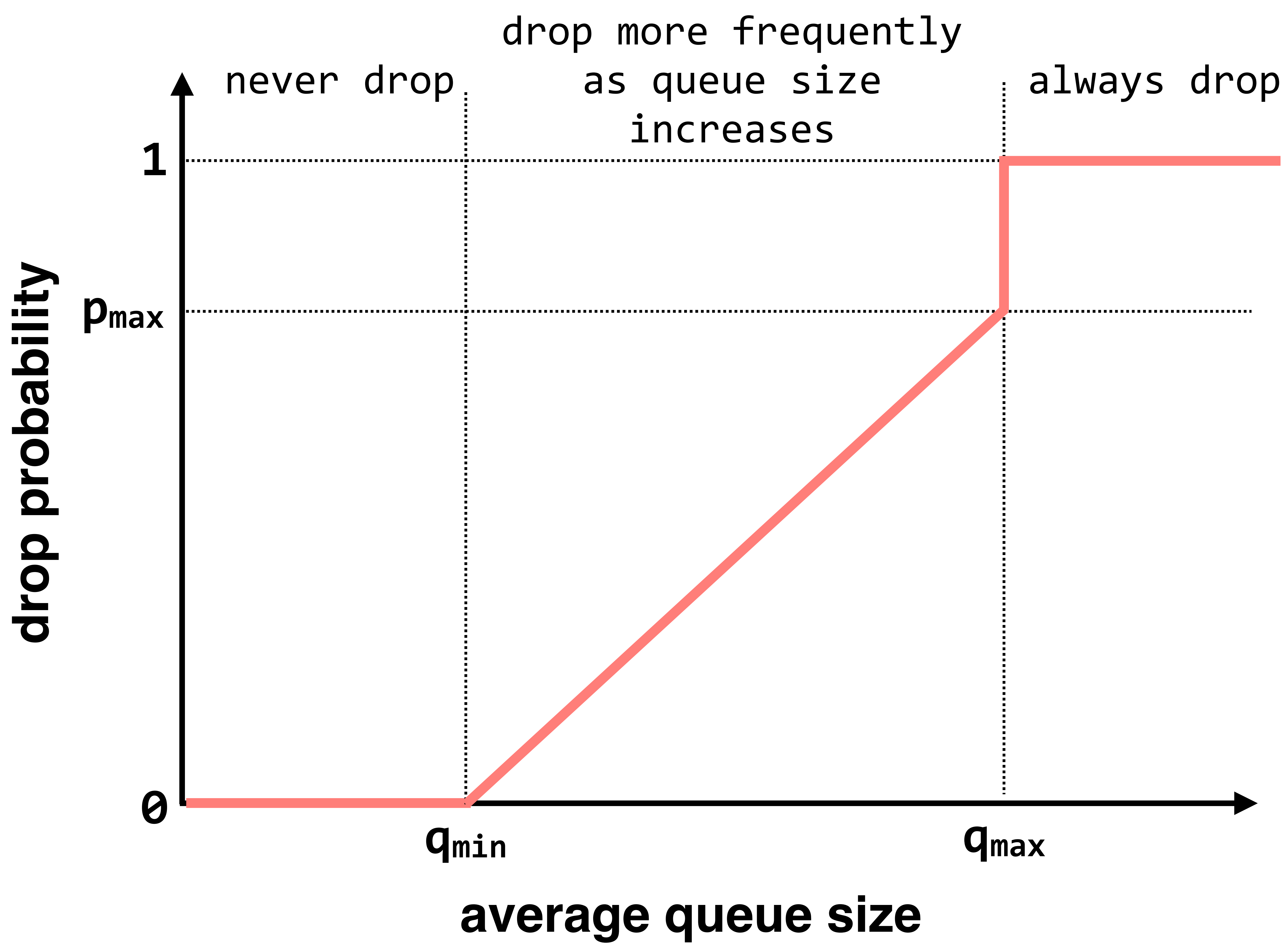

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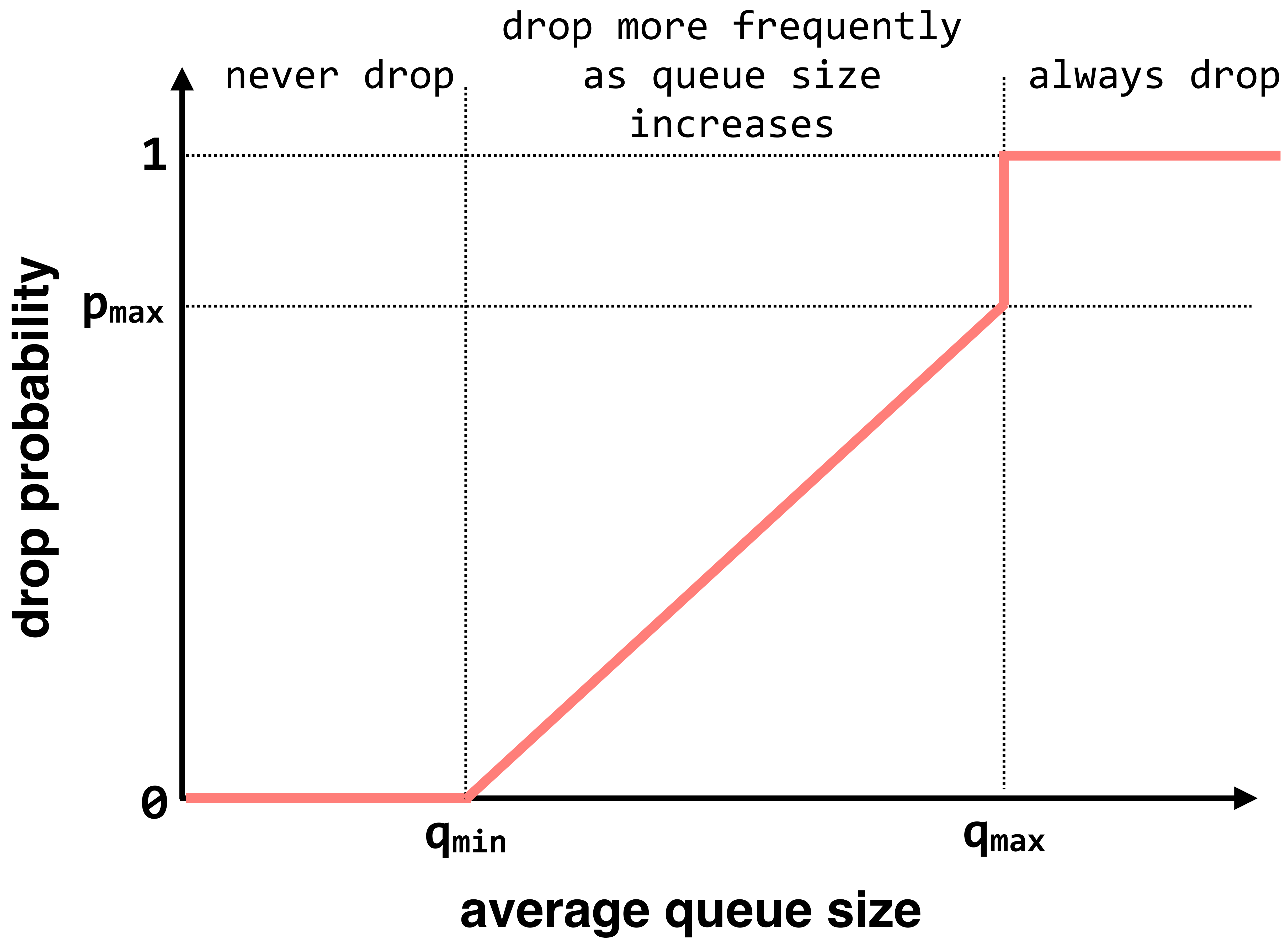


**as long as our switches are taking a more active role, let's see what else they can do**

(we'll return to queue management later in the lecture)

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**question:** what could go wrong here?

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**question:** suppose one of our queues is empty for many rounds. should it accumulate credit while empty?

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**now let's start revisiting some of our previous strategies**

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can solve this problem by doing something similar to bandwidth-based scheduling across the two queues

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| | | `RED (+ECN)` | drop (or mark) packets before the queue is full | gets TCP senders to react early, but complex, not clear how well it controls delay |
| | | `CoDel, PIE` | drop (or mark) packets before the queue is full (but in different ways than RED) | more robust than RED |
| **Delay-based Scheduling** | prioritize latency-sensitive traffic | `Priority Queueing` | serve some queues before others | prioritized queues can starve out the others |
| **Bandwidth-based Scheduling** | enforce (weighted) fairness among different types of traffic | `Round-robin` | try to give each type of traffic an equal share of bandwidth | can't handle variable packet sizes |
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we didn't cover the highlighted protocols; this is just to give you a sense that there are other algorithms out there — in particular, in the case of AQM, there are algorithms that are more robust than RED

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**is in-network resource management a good idea on the Internet?**

# 6.1800 in the news

## *Sally Floyd, Who Helped Things Run Smoothly Online, Dies at 69*

In the early 1990s, Dr. Floyd was one of the inventors of Random Early Detection, which continues to play a vital role in the stability of the internet.

Sally Floyd. "Her work on congestion control," a colleague said, helped keep the internet "working for everyone." Carole Leita

One byproduct of Dr. Floyd's work reflected her passion for keeping things fair to all internet users. "Her work on congestion control was about keeping it working for everyone," Dr. Kohler said. "For people with fast connections, and for people with slow connections."

https://www.nytimes.com/2019/09/04/science/sally-floyd-dead.html

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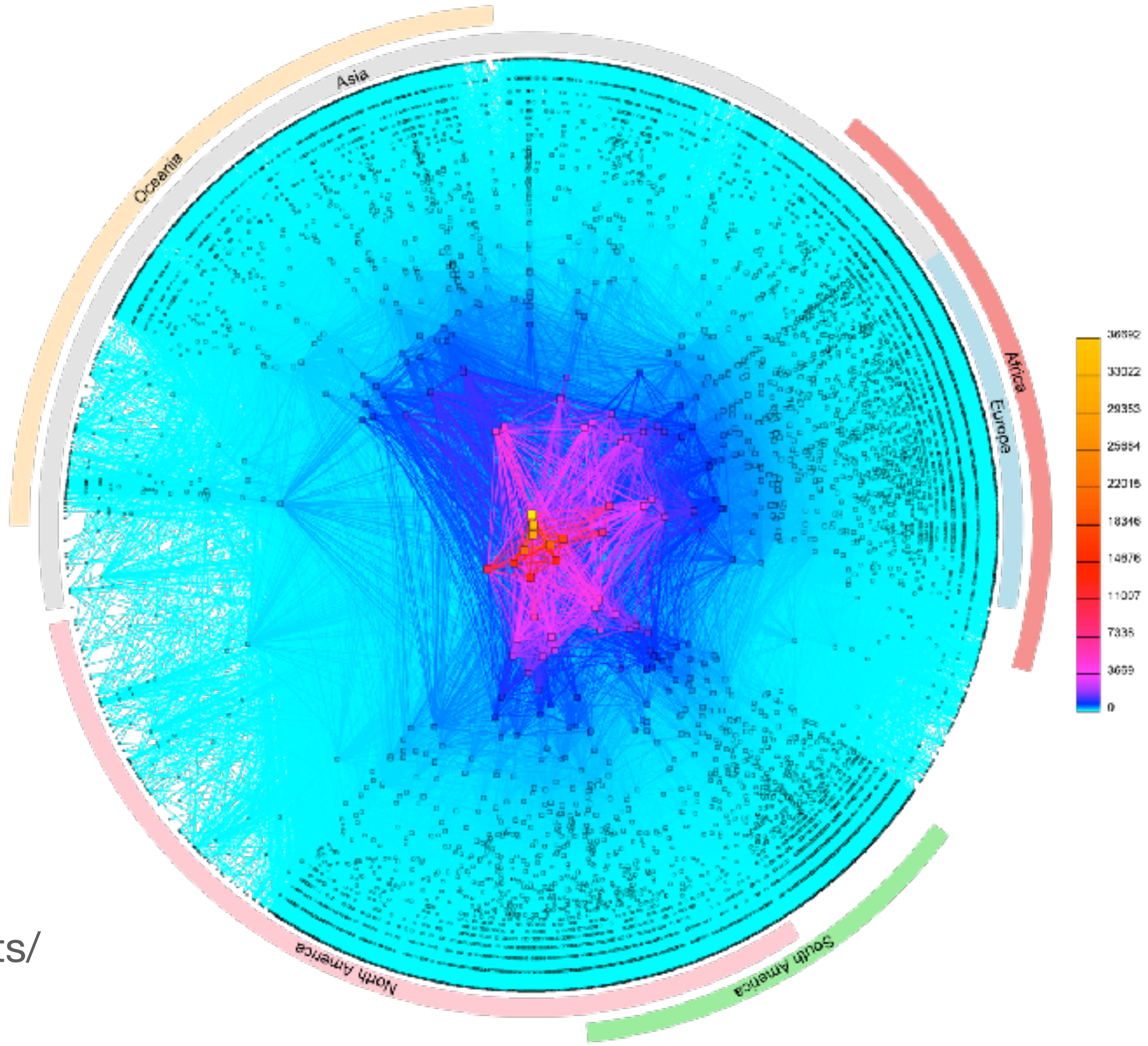


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