6.1800 Spring 2024

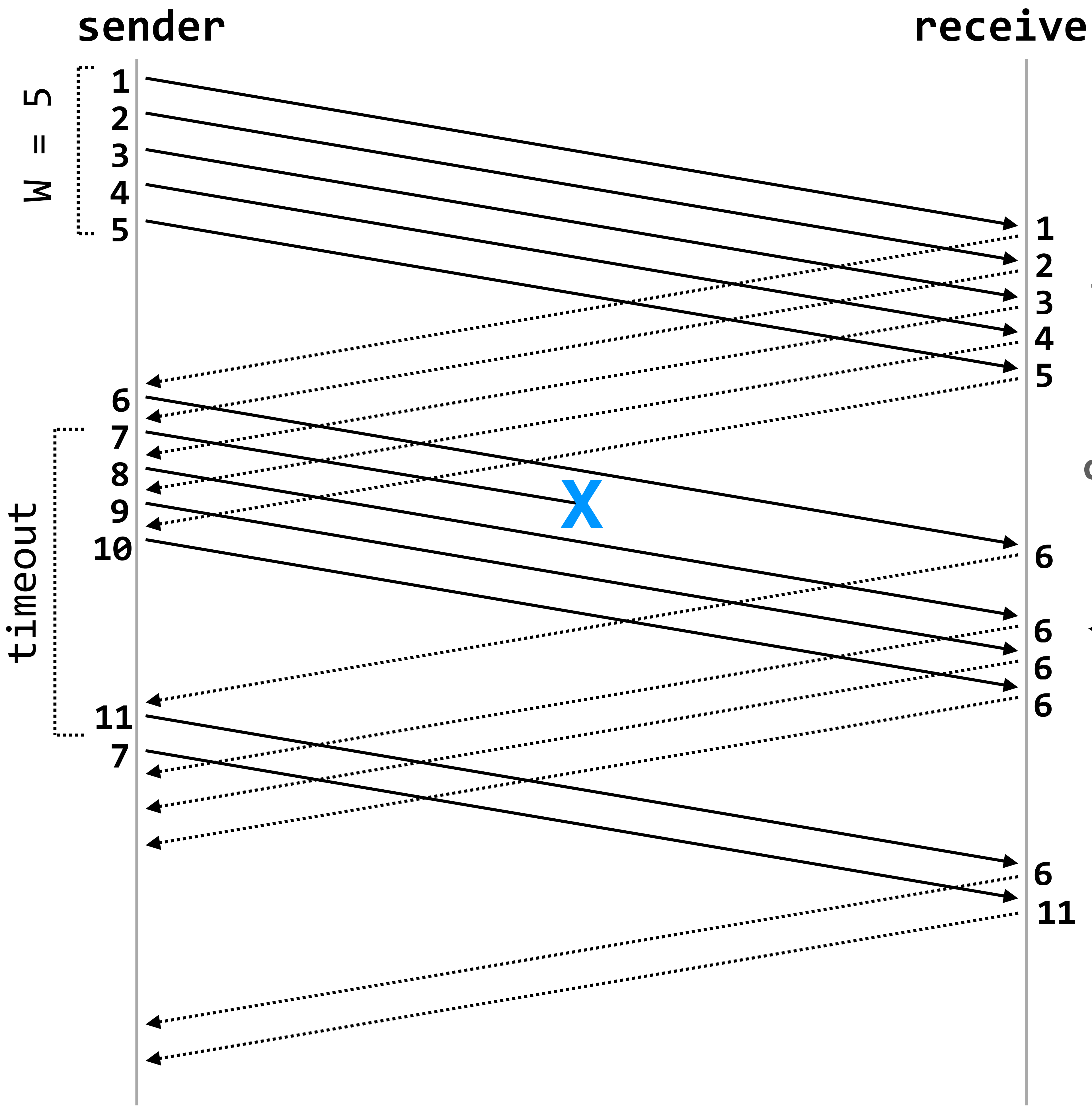
Lecture #12: In-network resource management

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

Katrina LaCurts | lacurts@mit.edu | 6.1800 2024

reliable transport protocols deliver each byte of data **exactly once, in-order**, to the receiving application

the sender is allowed to have W outstanding packets at once, but no more



the receiver will hold onto packets 8-11 until it receives packet 7, and then deliver all of them, in-order, to the application

sequence numbers: used to order the packets

acknowledgments ("ACKs"): used to confirm that a packet has been received

an ACK with sequence number k indicates that the receiver has received **all packets up to and including k**

timeouts: used to retransmit packets

note that the sender could also infer loss because it has received multiple ACKs with sequence number 6, but none with sequence number > 7; we'll come back to that

this is known as a **sliding-window protocol**

the **window** of outstanding (un-ACKed) packets **slides** along the sequence number space

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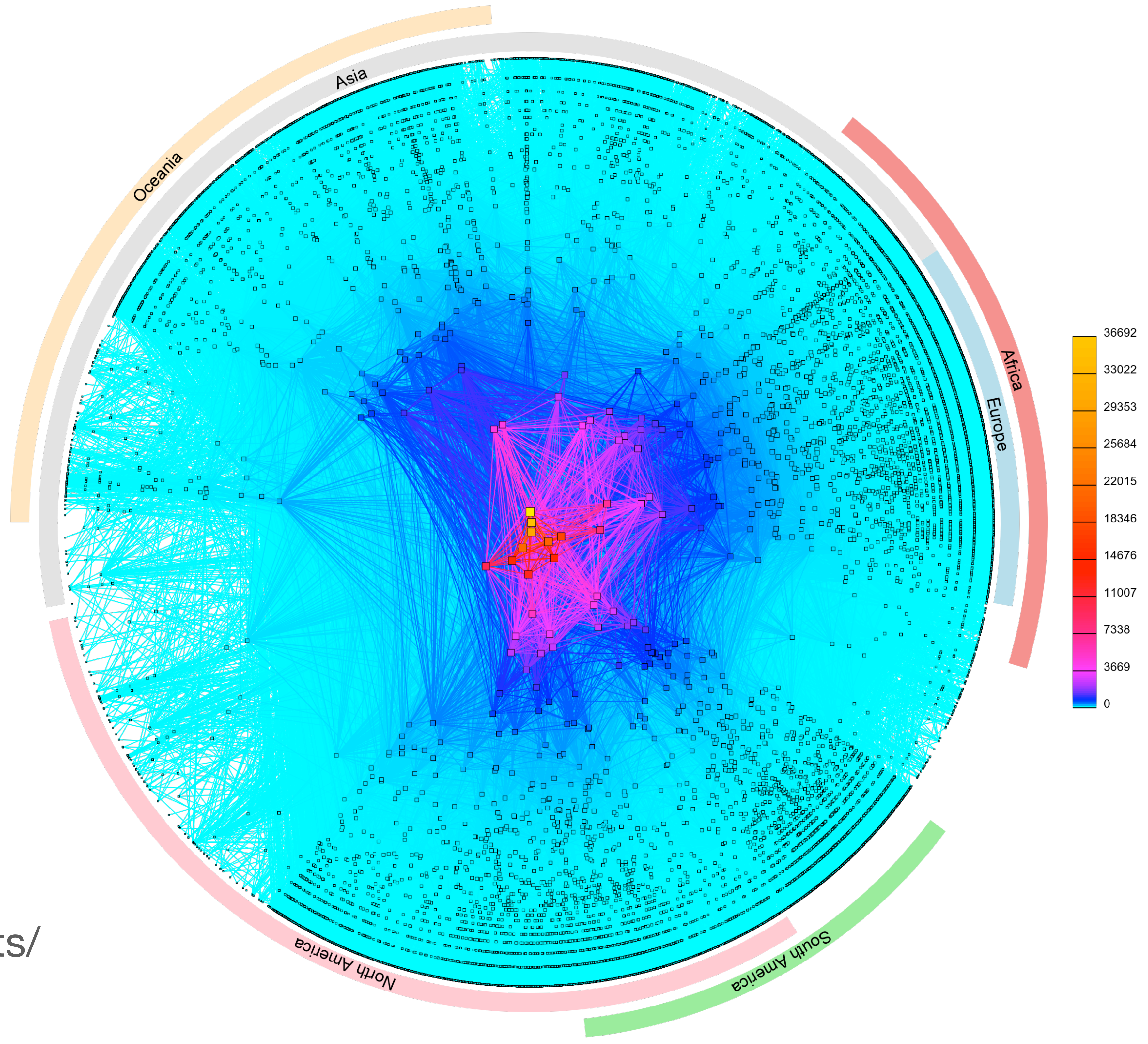
1978: flexibility and layering — distance-vector routing

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



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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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transport	sharing the network, reliability (or not) *examples: TCP, UDP*
network	naming, addressing, routing *examples: IP*
link	communication between two directly-connected nodes *examples: ethernet, bluetooth, 802.11 (wifi)*

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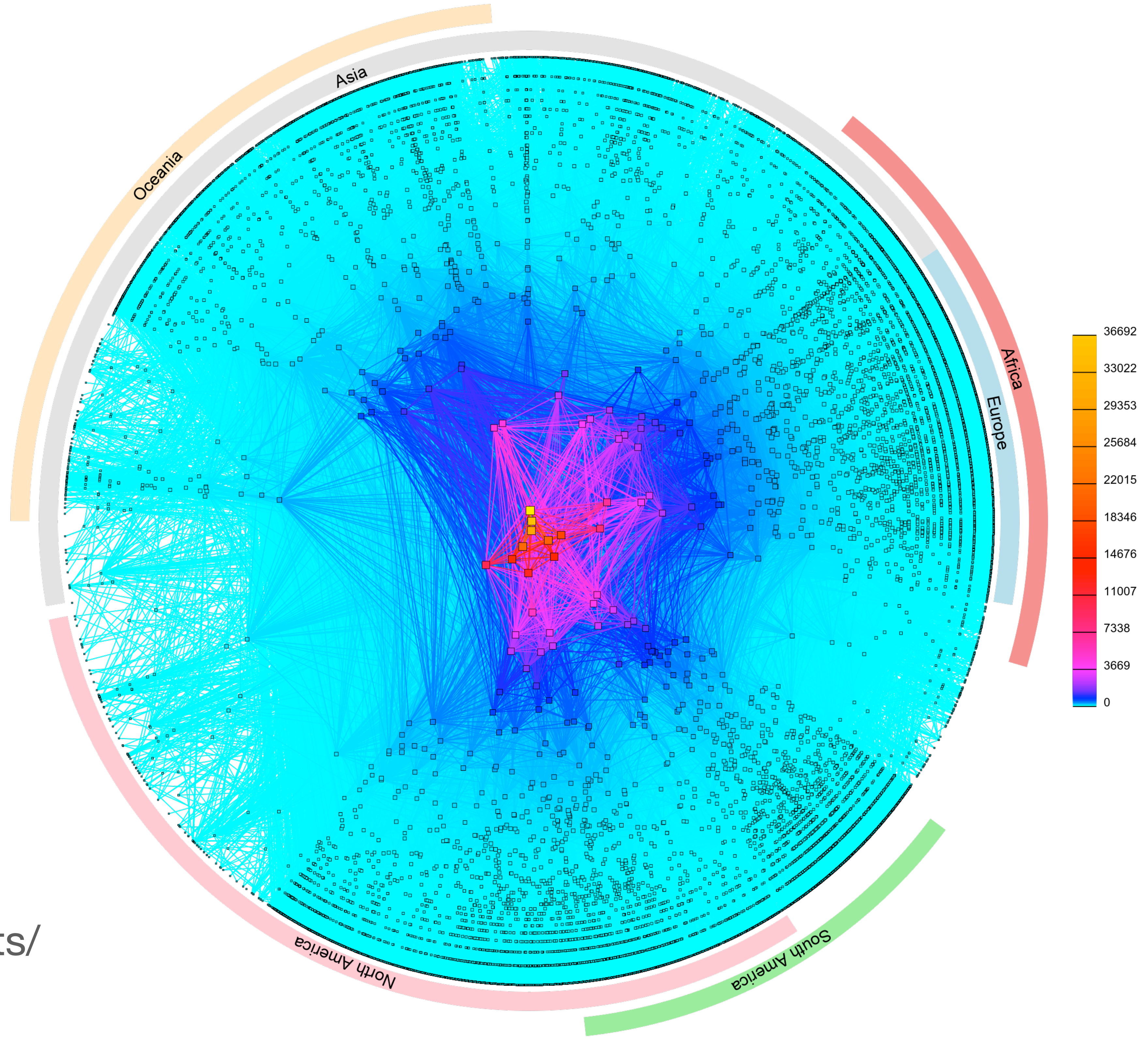

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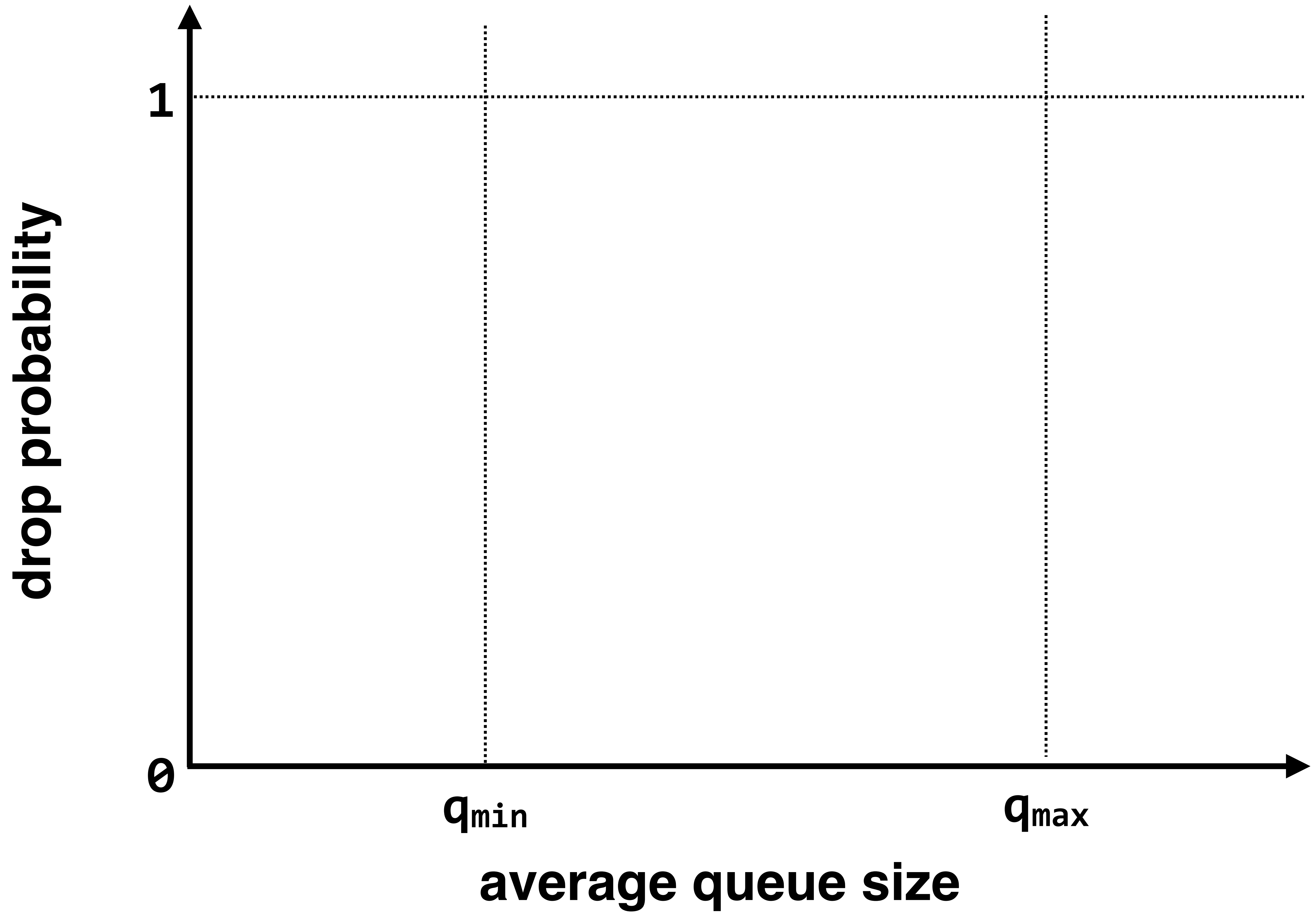

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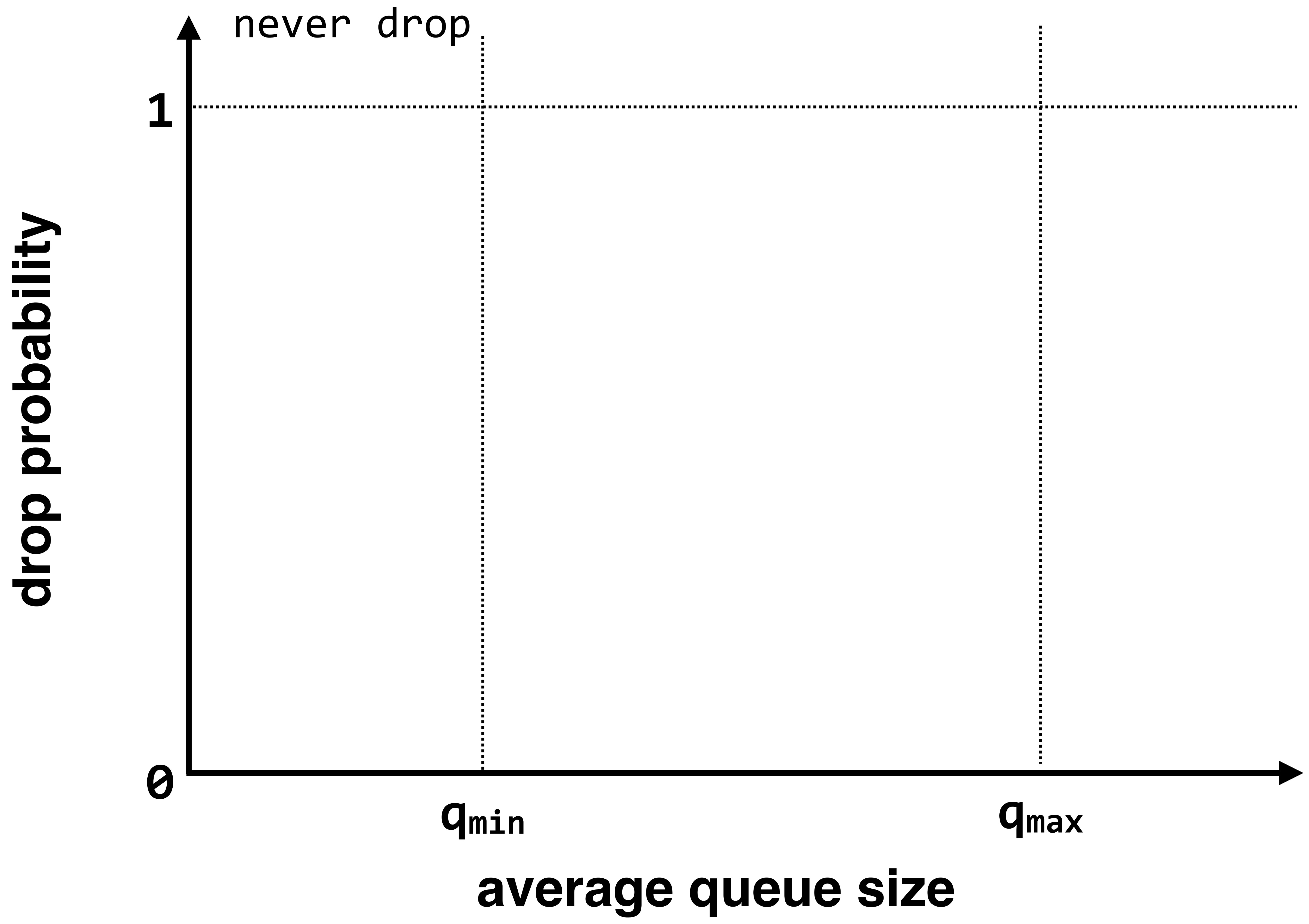

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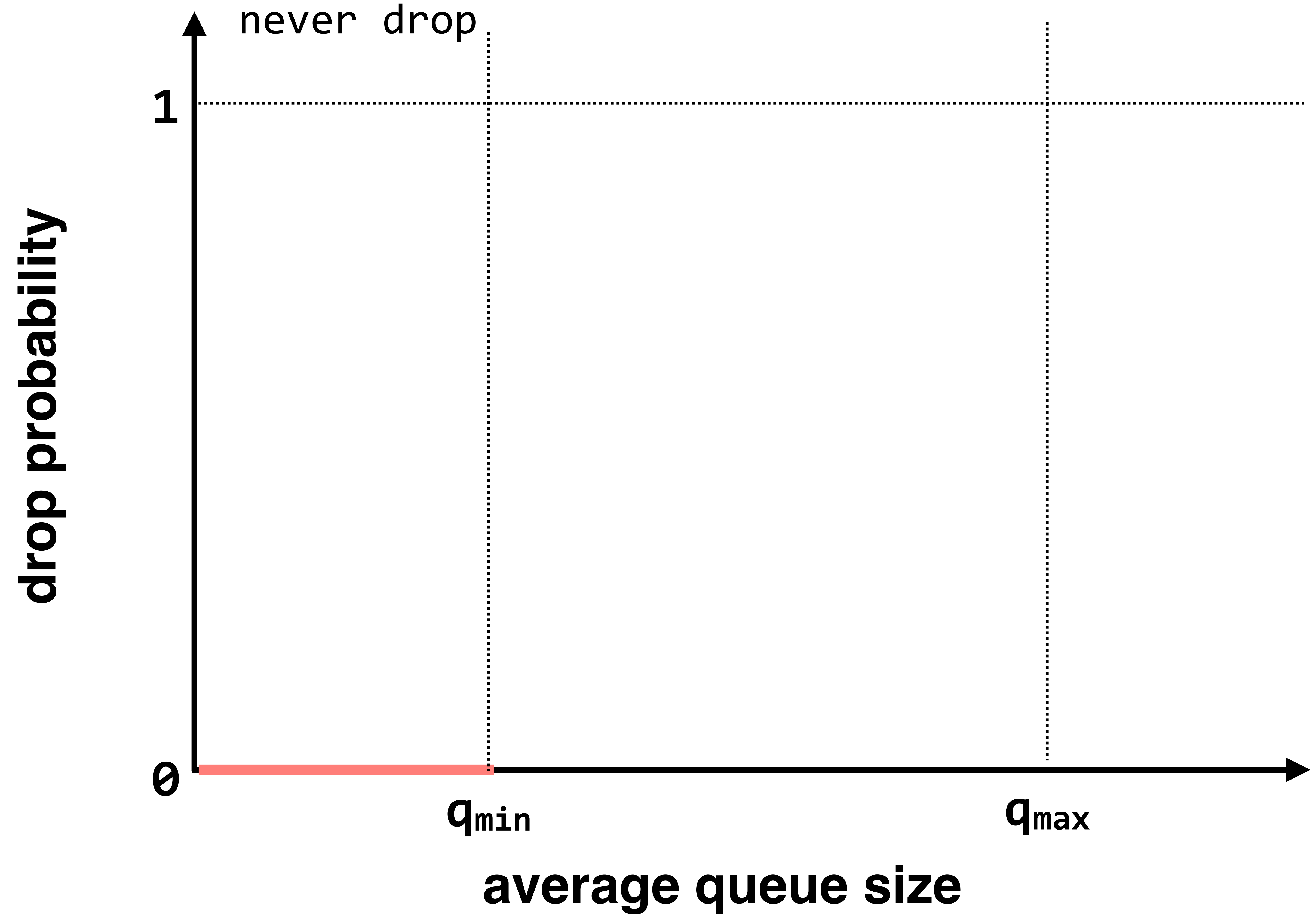

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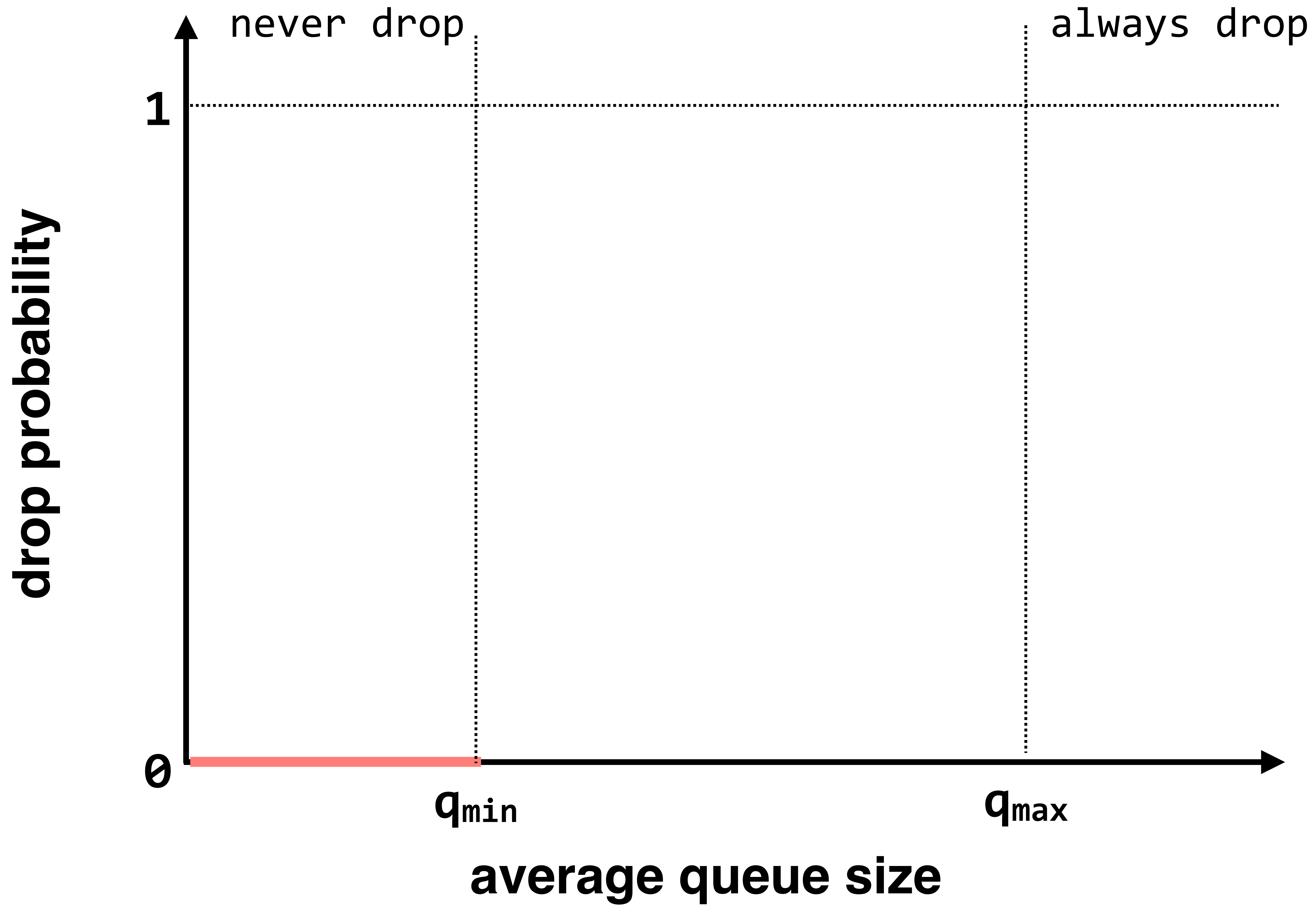

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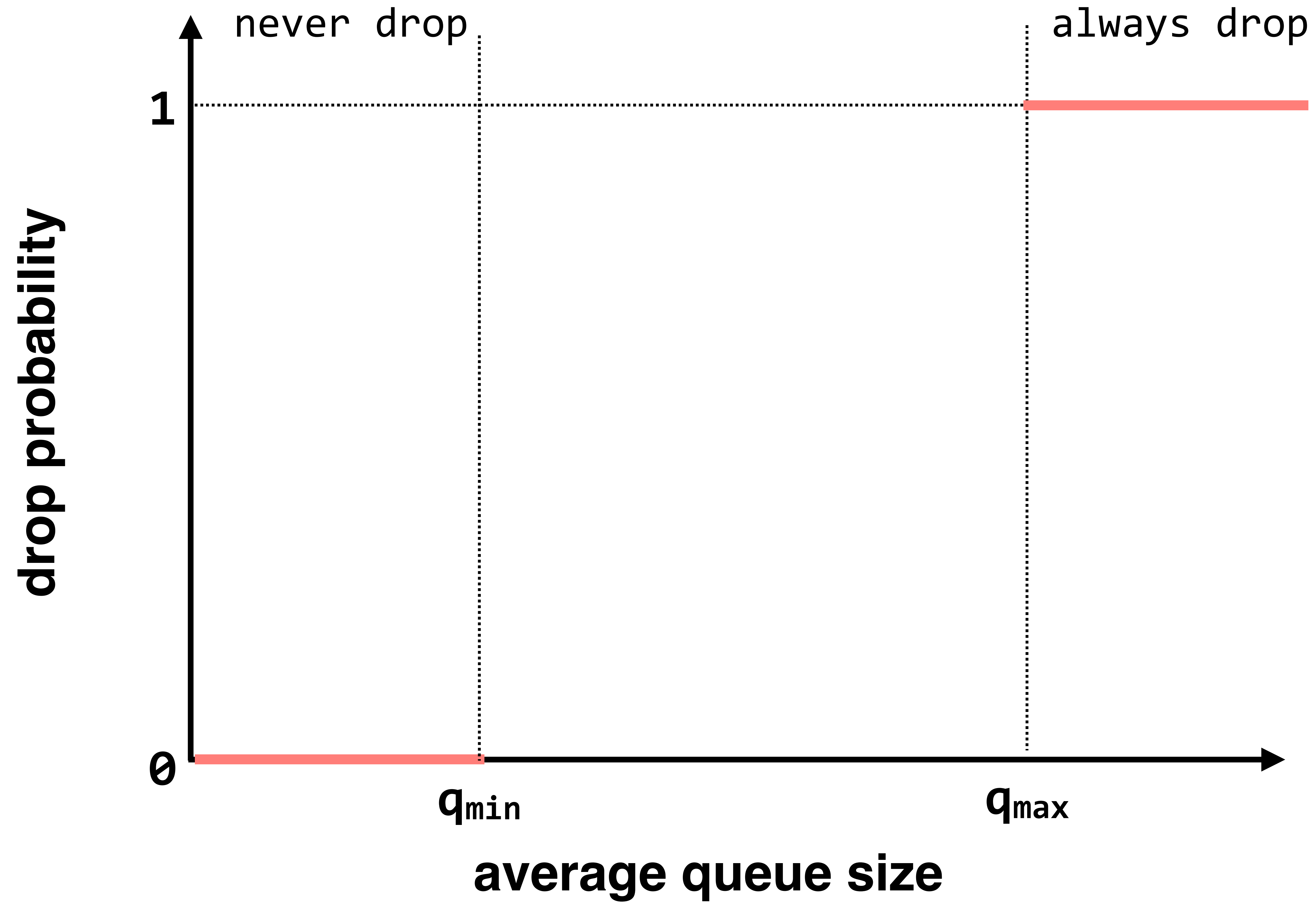

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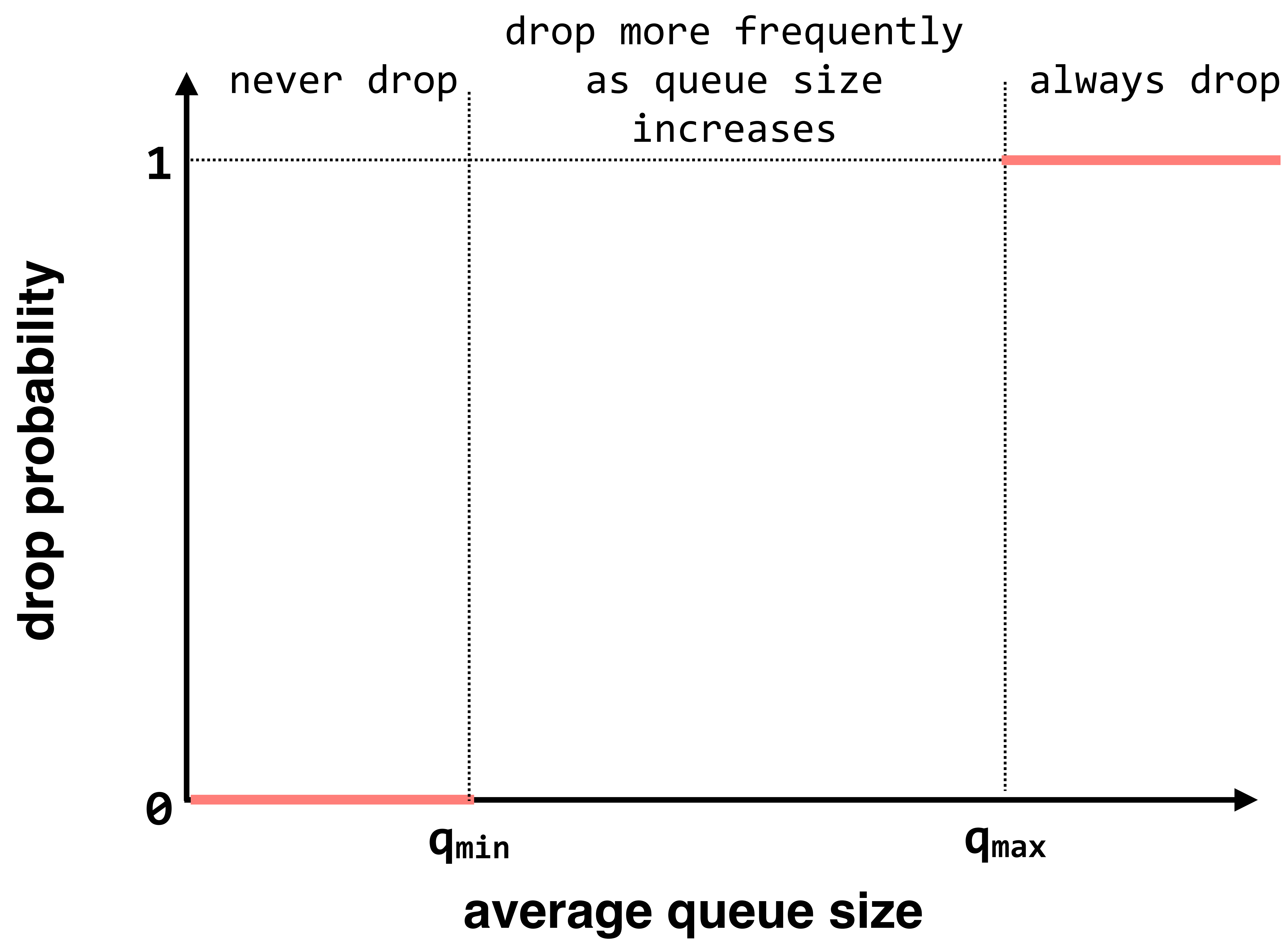

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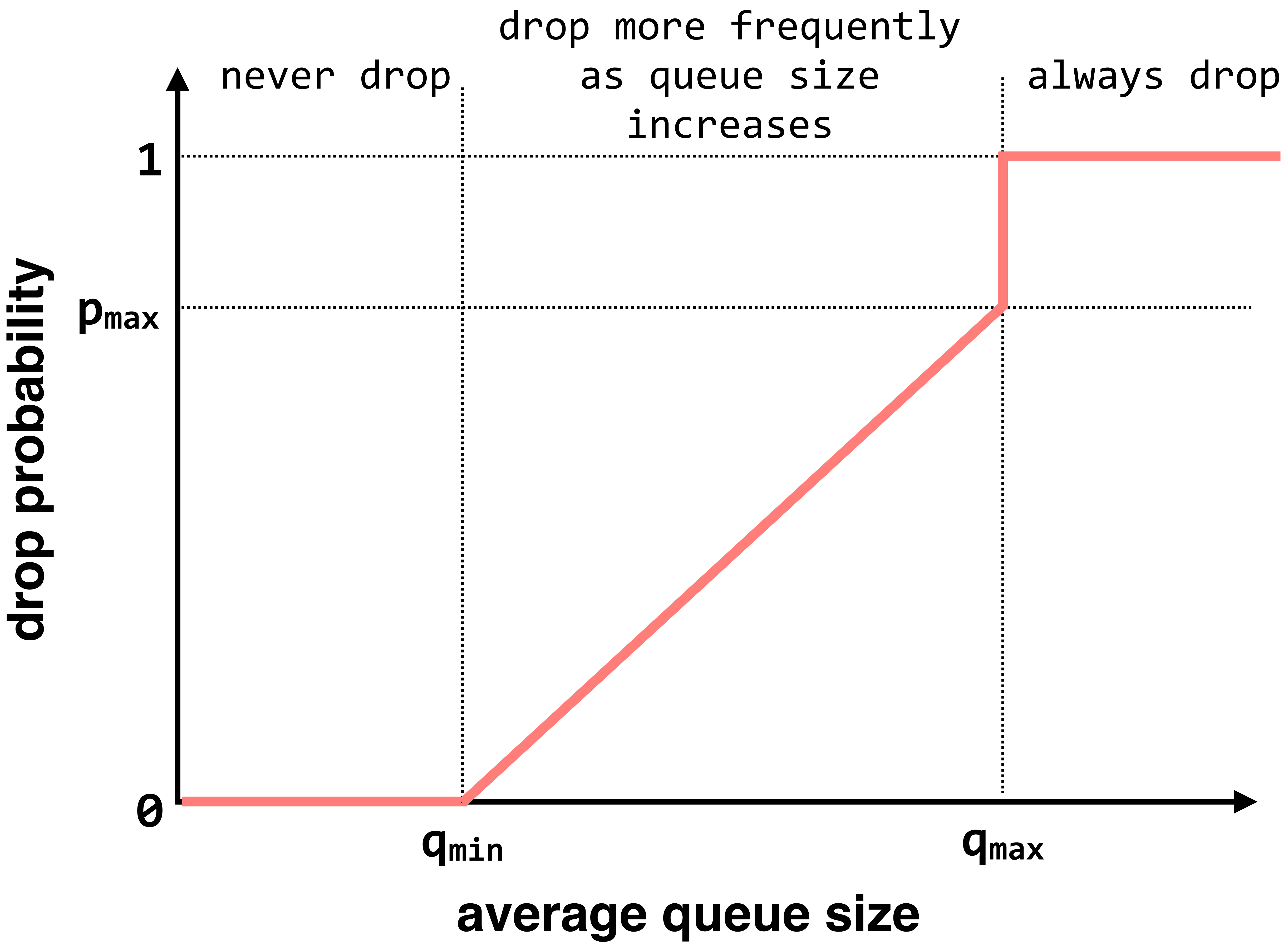

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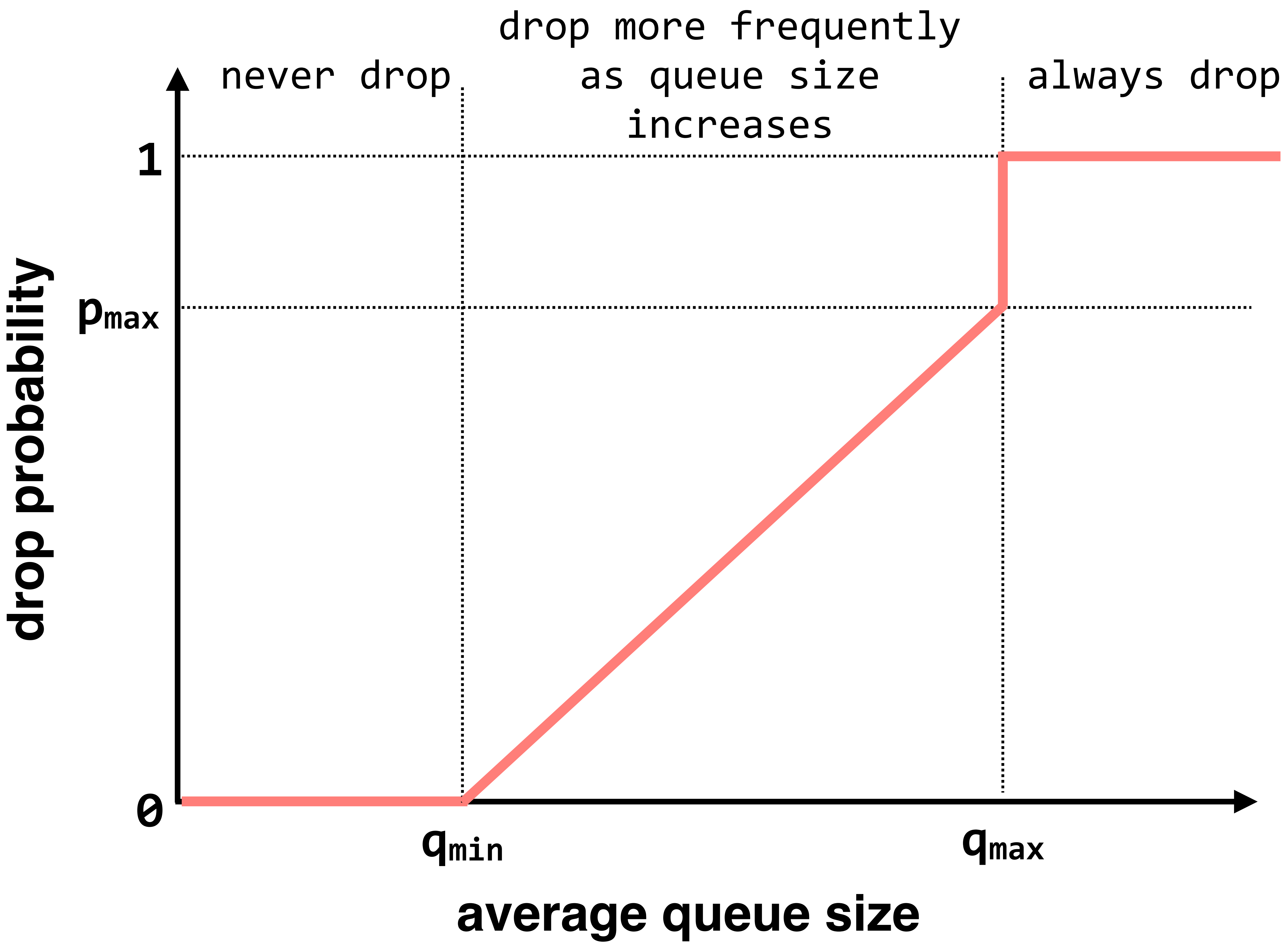

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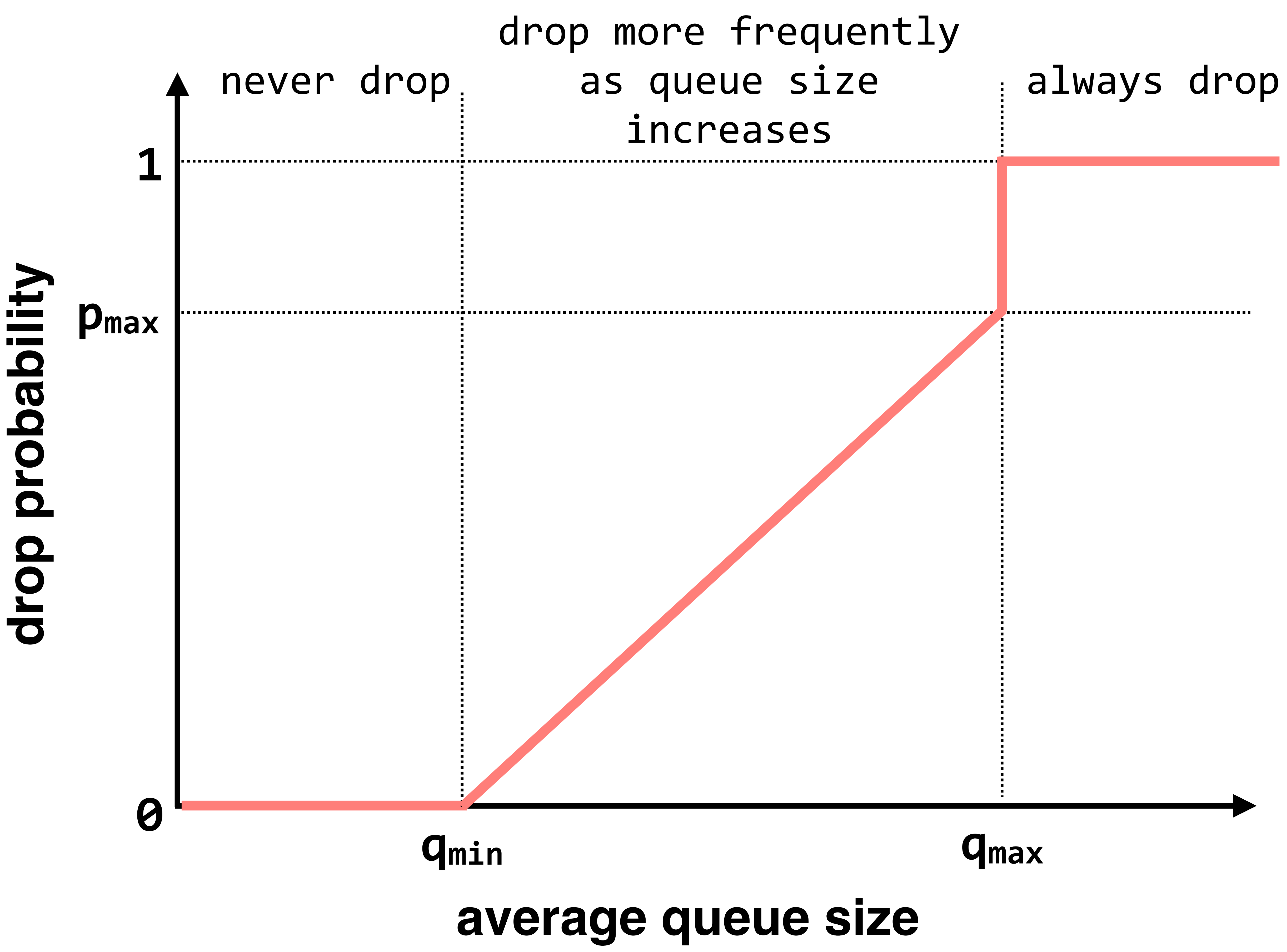

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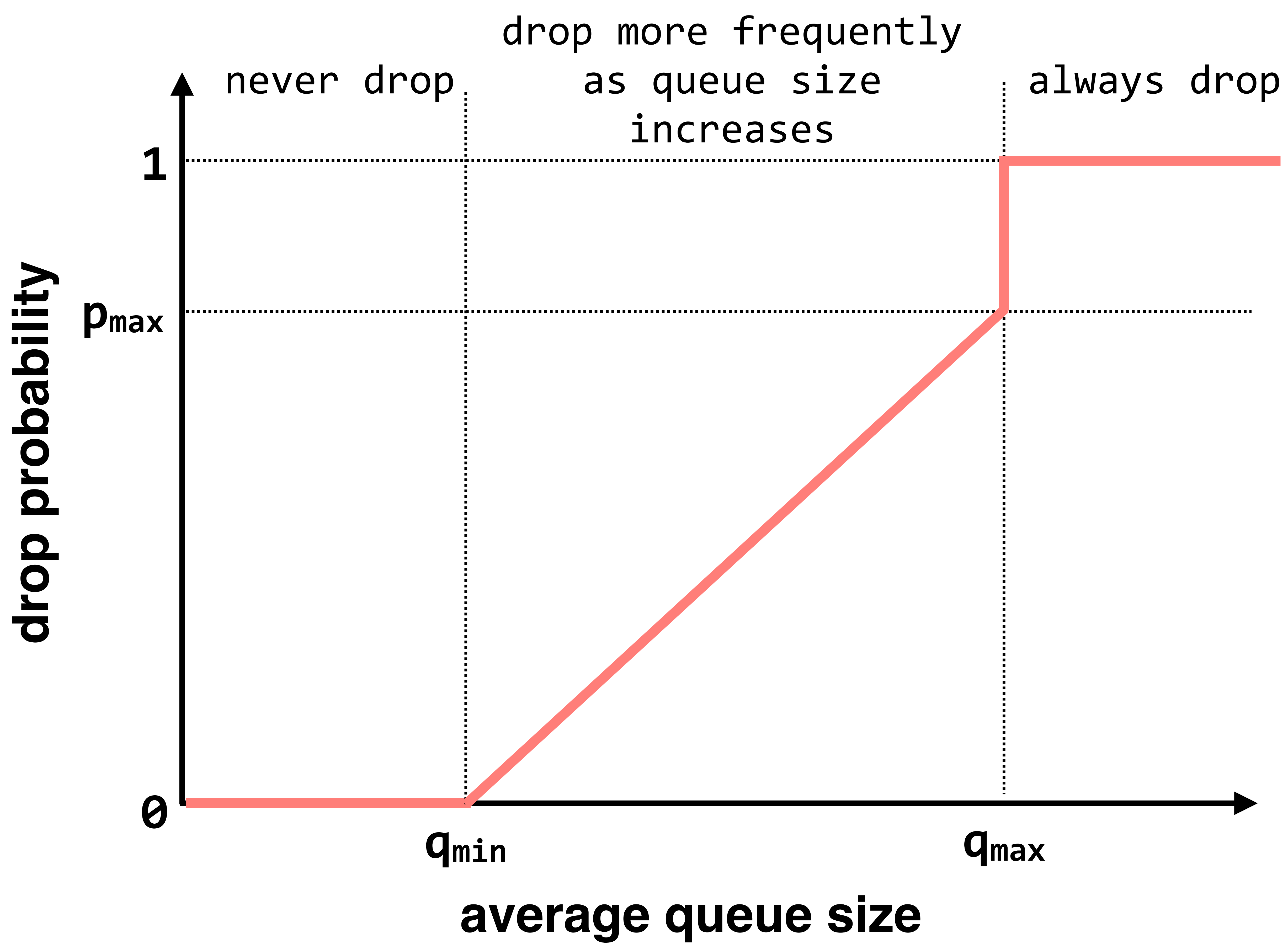

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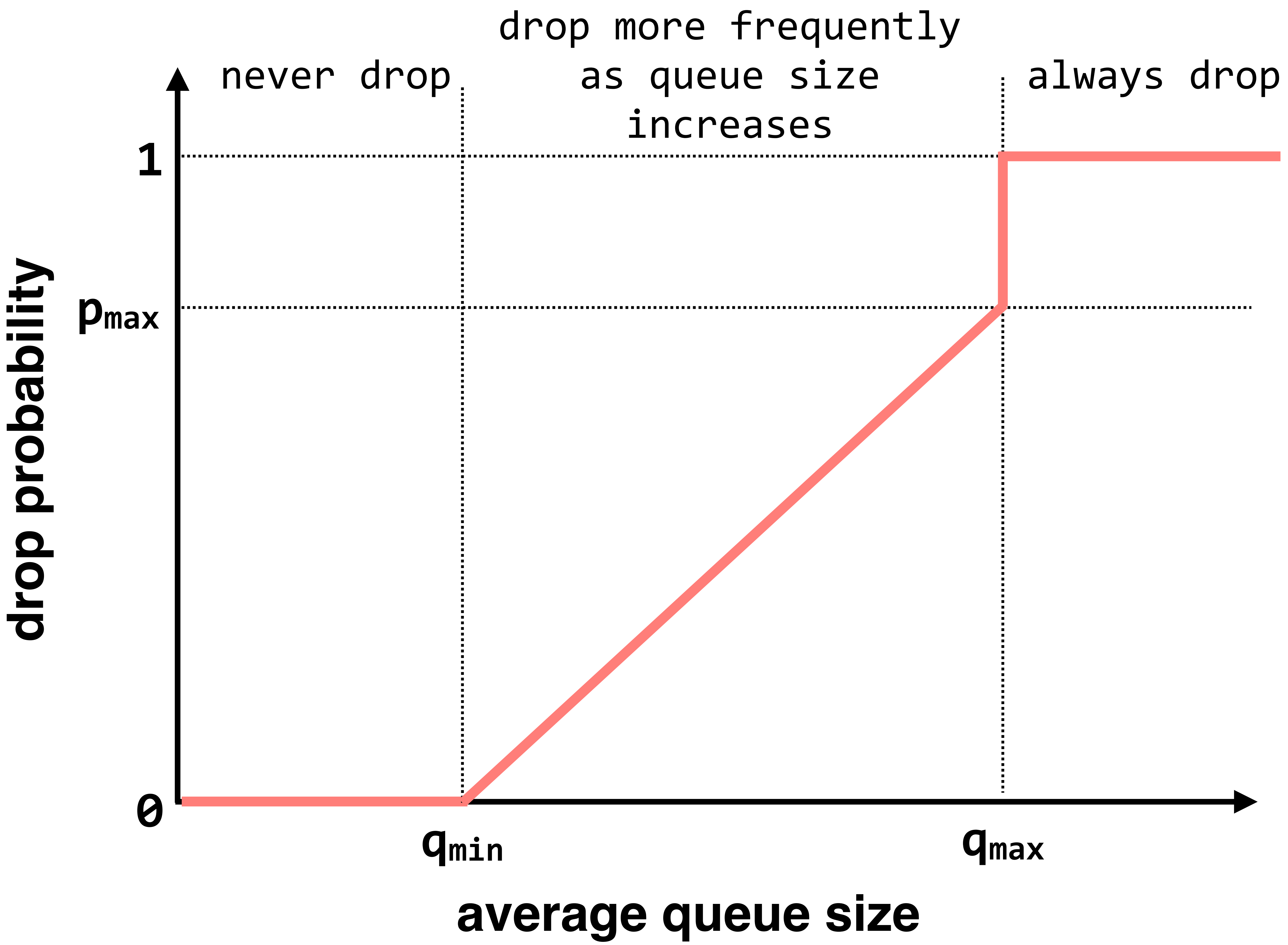

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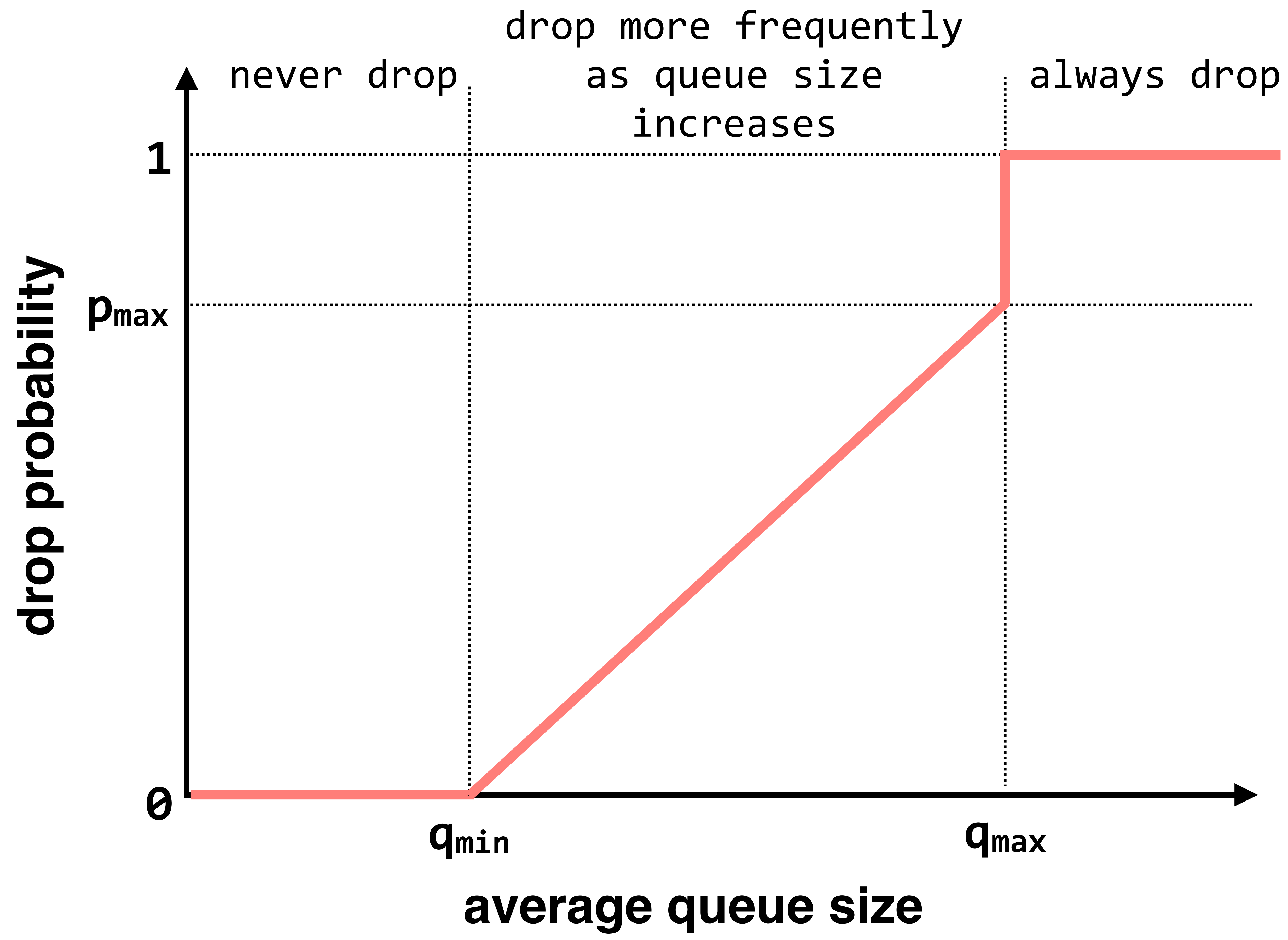

as long as our switches are taking a more active role, let's see what else they can do

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

delay-based scheduling: can we give latency guarantees for some types of traffic?

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question: what could go wrong here?

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    while q.credit >= size of next packet p:
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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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  else:
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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

in-network resource management

type of management	what does this type of management allow a switch to do	example protocols	how the protocol works	pros/cons?
Queue Management	signal congestion, potentially before queues are full	`DropTail`	drop packets when the queue is full	simple, but queues get full (among other problems)
		`RED, ECN`	drop or mark packets before the queue is full	can keep queues from filling up, but complicated
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
		`Weighted Round-robin`	round robin, but incorporate average packet size	average packet size hard to get
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we didn't cover weighted round-robin; this is just to give you a sense that there are algorithms that exist "between" round-robin and deficit round-robin

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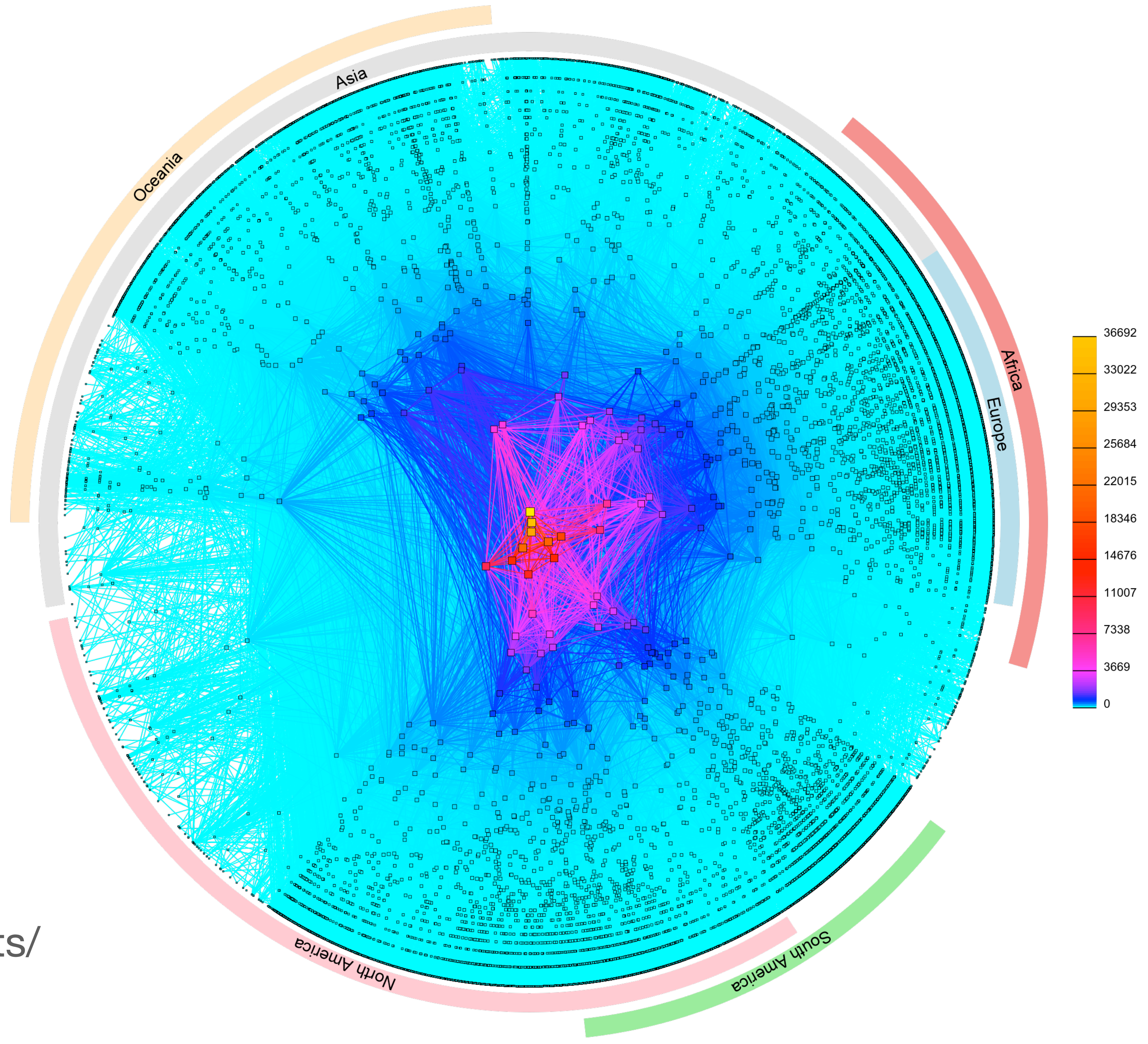

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6.1800 in the news

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