Tutorial 3

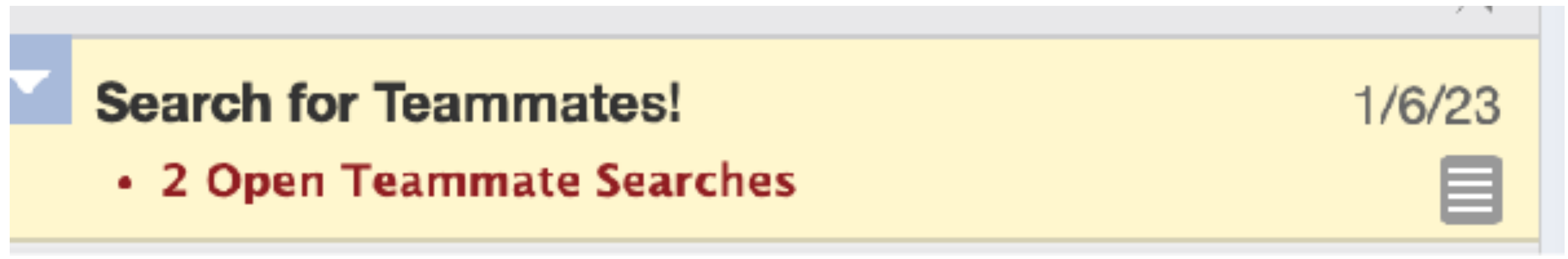
Database System Technology - Indexing

Niv Dayan - 25 Jan, 2023

Groups

Most of you are grouped up.

One new person in the course is looking for a team!



Agenda

More on SSD write-amplification

4 exercises on indexing

Introduce step 2 of the project

Modeling SSD Write-Amp More Precisely

Consider an SSD for which the logical address space size is a fraction of x of the physical capacity.

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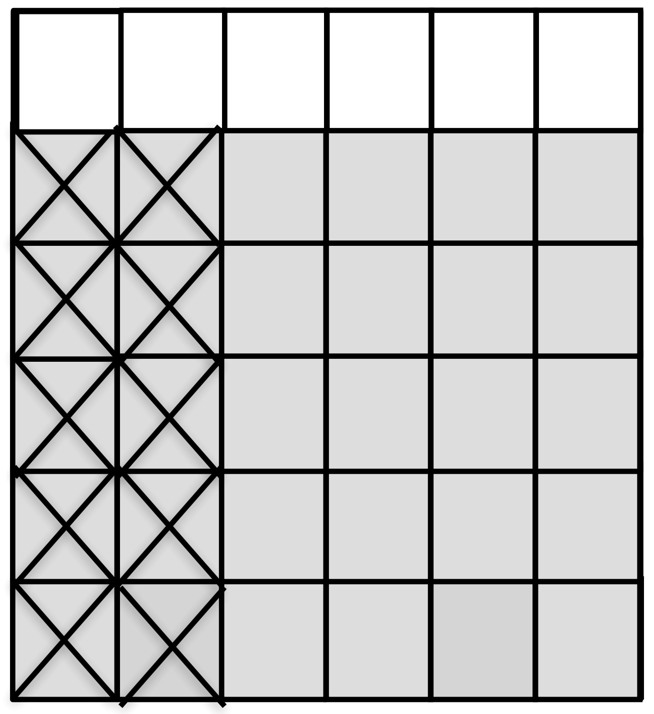
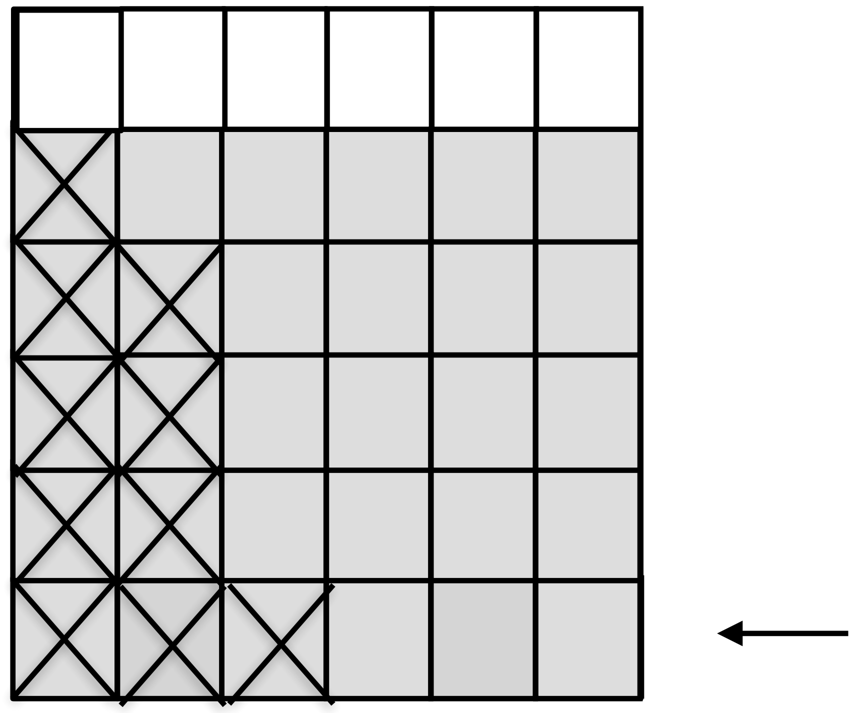
Worst case



Non-Worst Case



Best target

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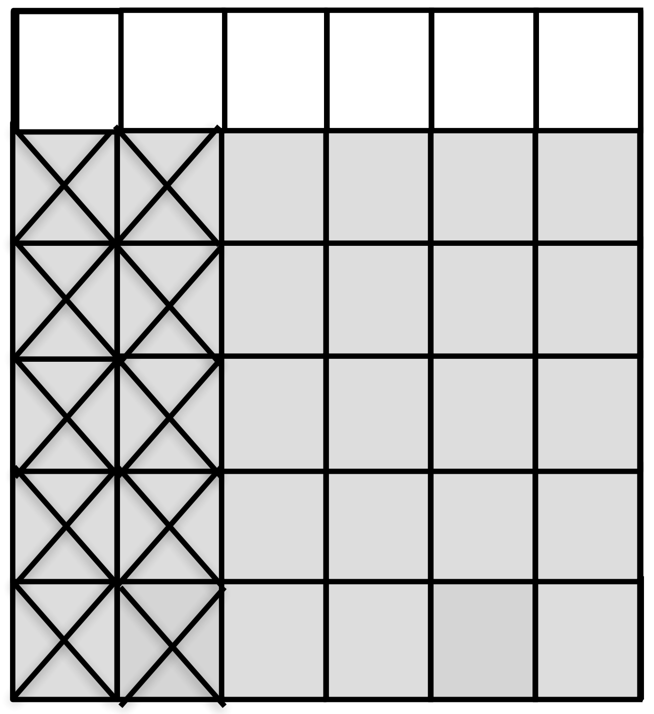

SSD WA Approx. from last week

$$\frac{1}{1-x}$$

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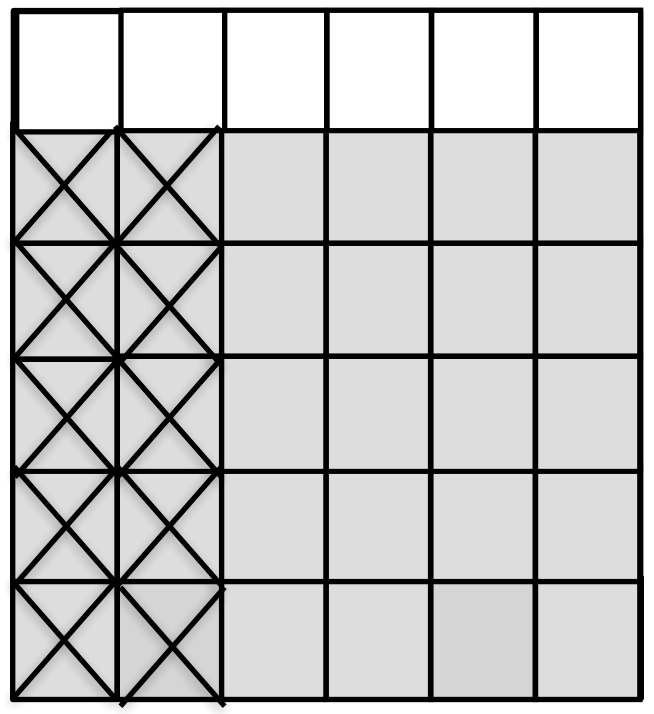

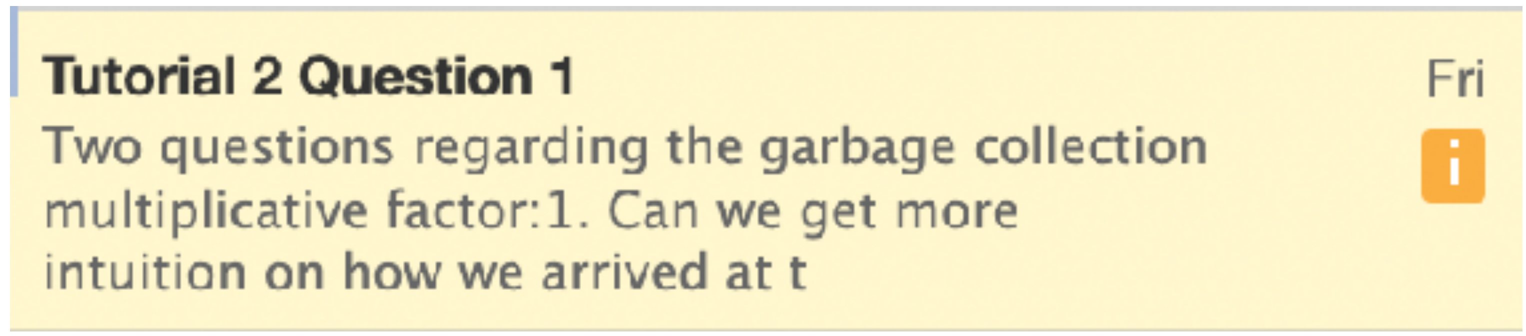

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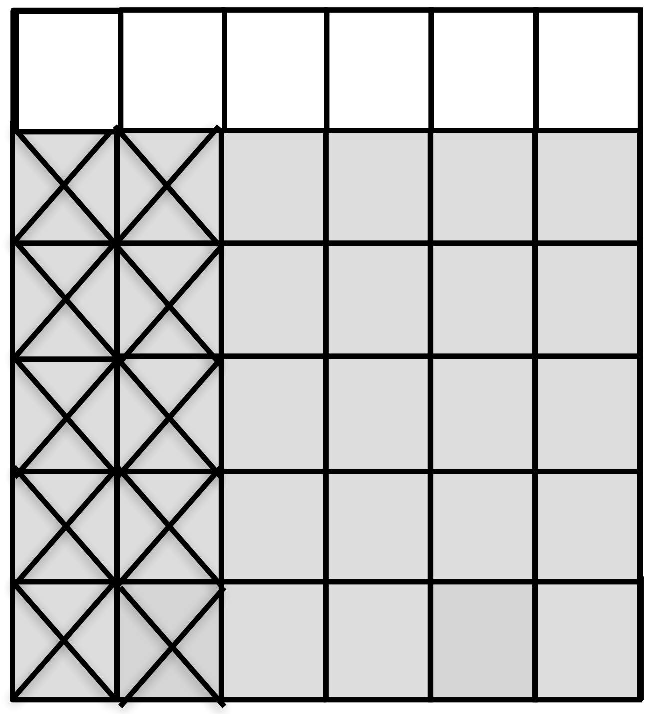

More precise model

$$1 + \frac{x}{1-x}$$

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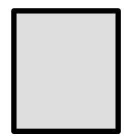

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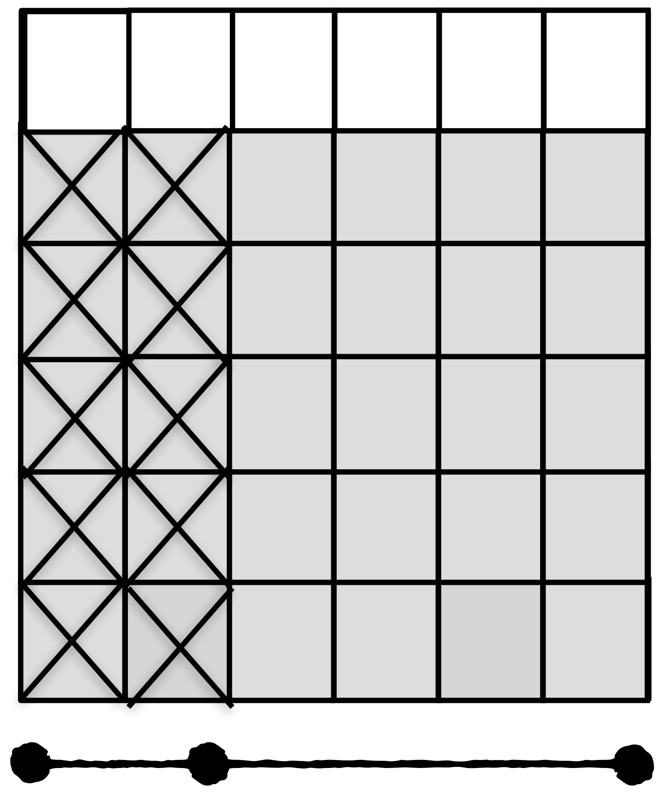

2 4

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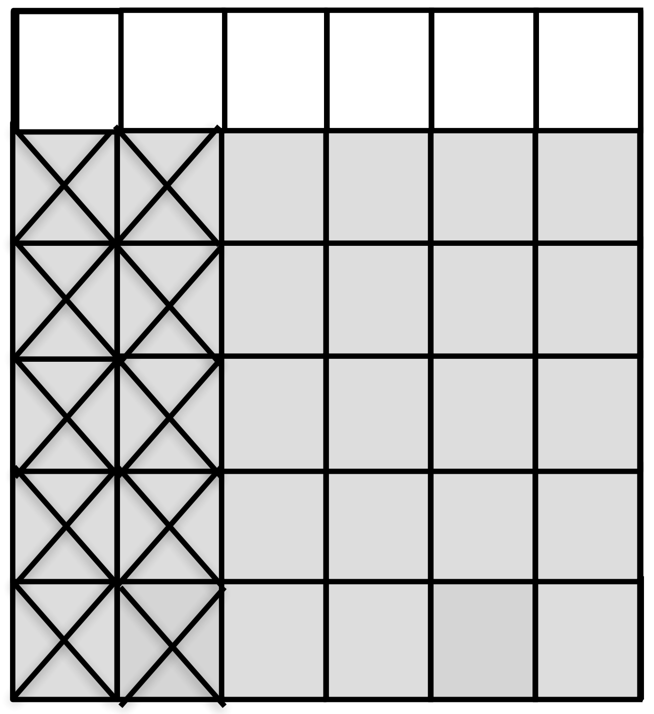


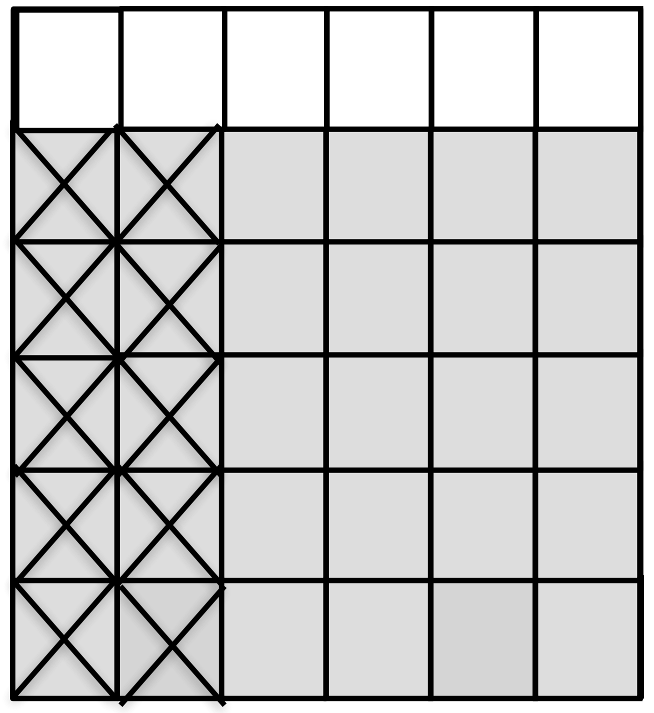
$$1 + \frac{4}{2} = 3$$

More precise model

$$1 + \frac{x}{1 - x}$$

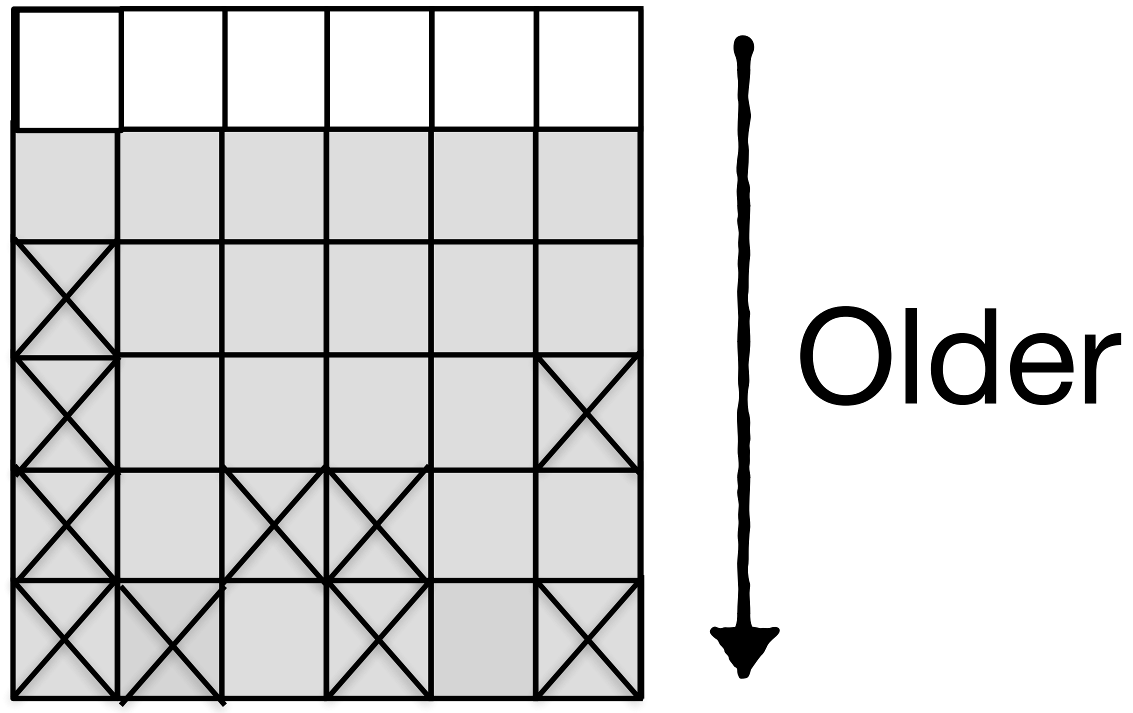
Modeling SSD Write-Amp More Precisely

But the worst-case hardly ever happens in practice



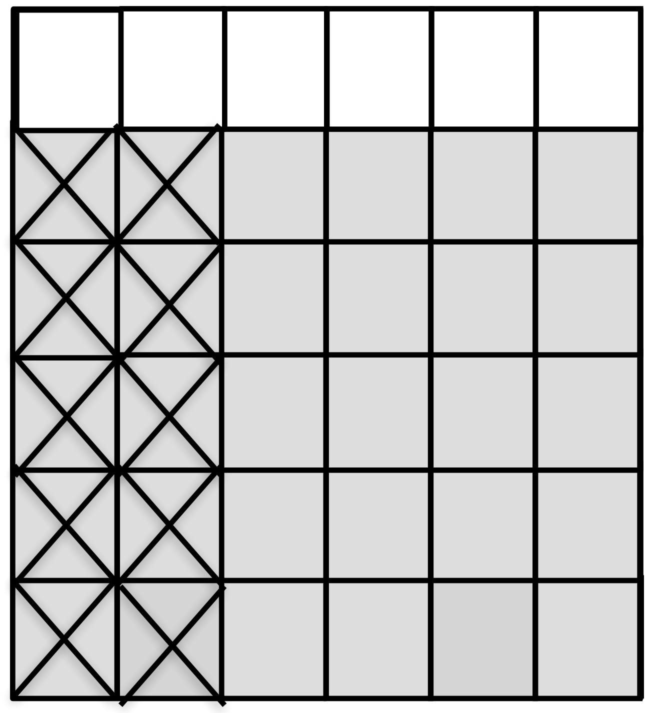
$$1 + \frac{x}{1 - x}$$

In practice, erase units written longer ago have more invalid pages, so GC is cheaper



Modeling SSD Write-Amp More Precisely

Cost model assuming uniformly randomly distributed writes?



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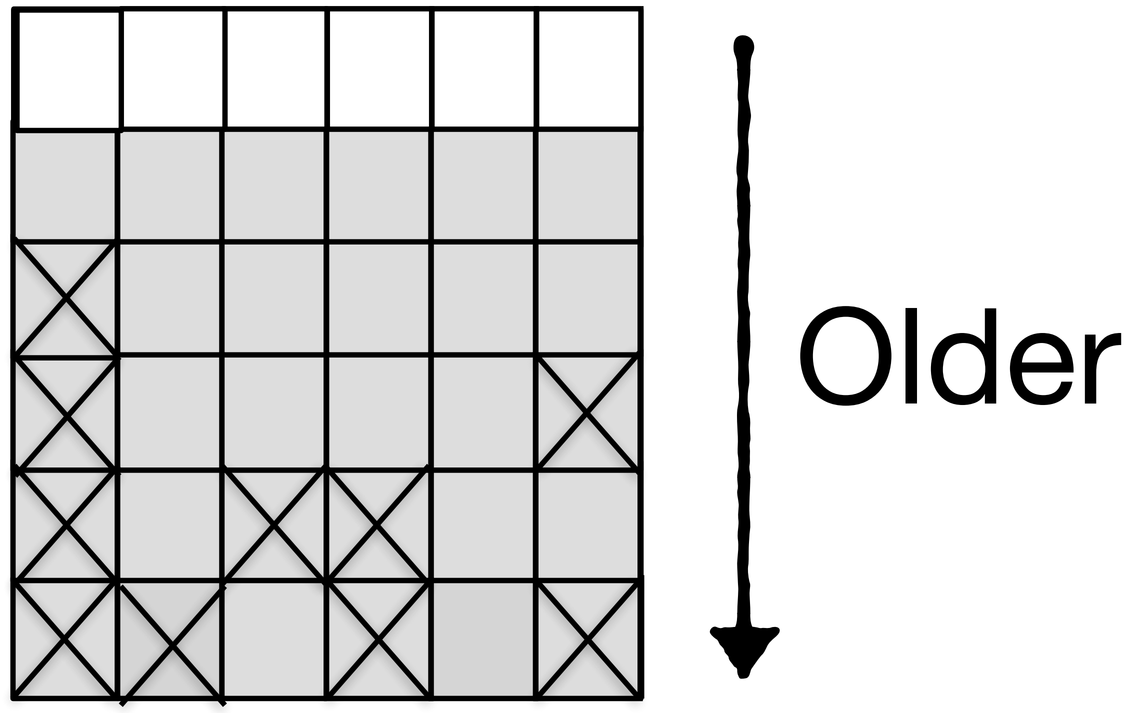

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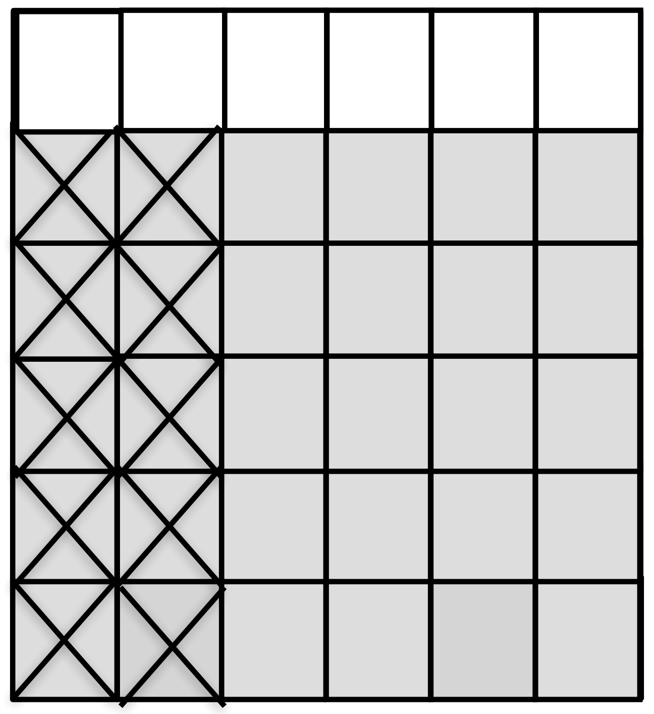
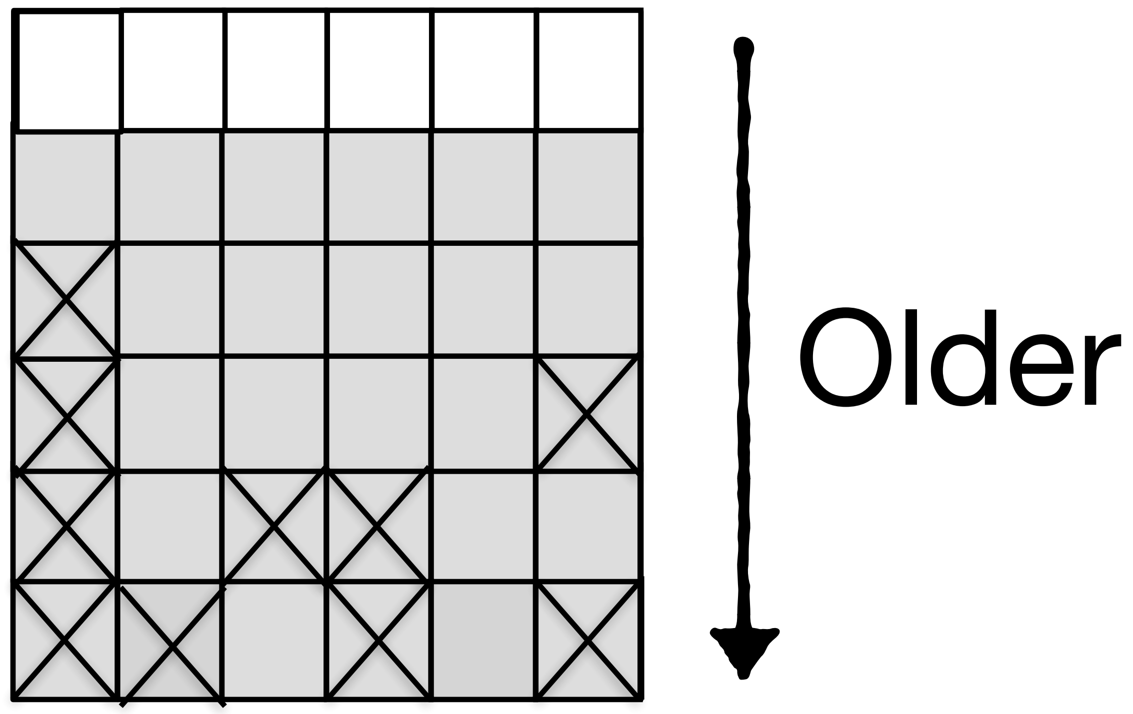


$$1 + \frac{x}{1 - x}$$

$$1 + \frac{1}{2} \cdot \frac{x}{1 - x}$$



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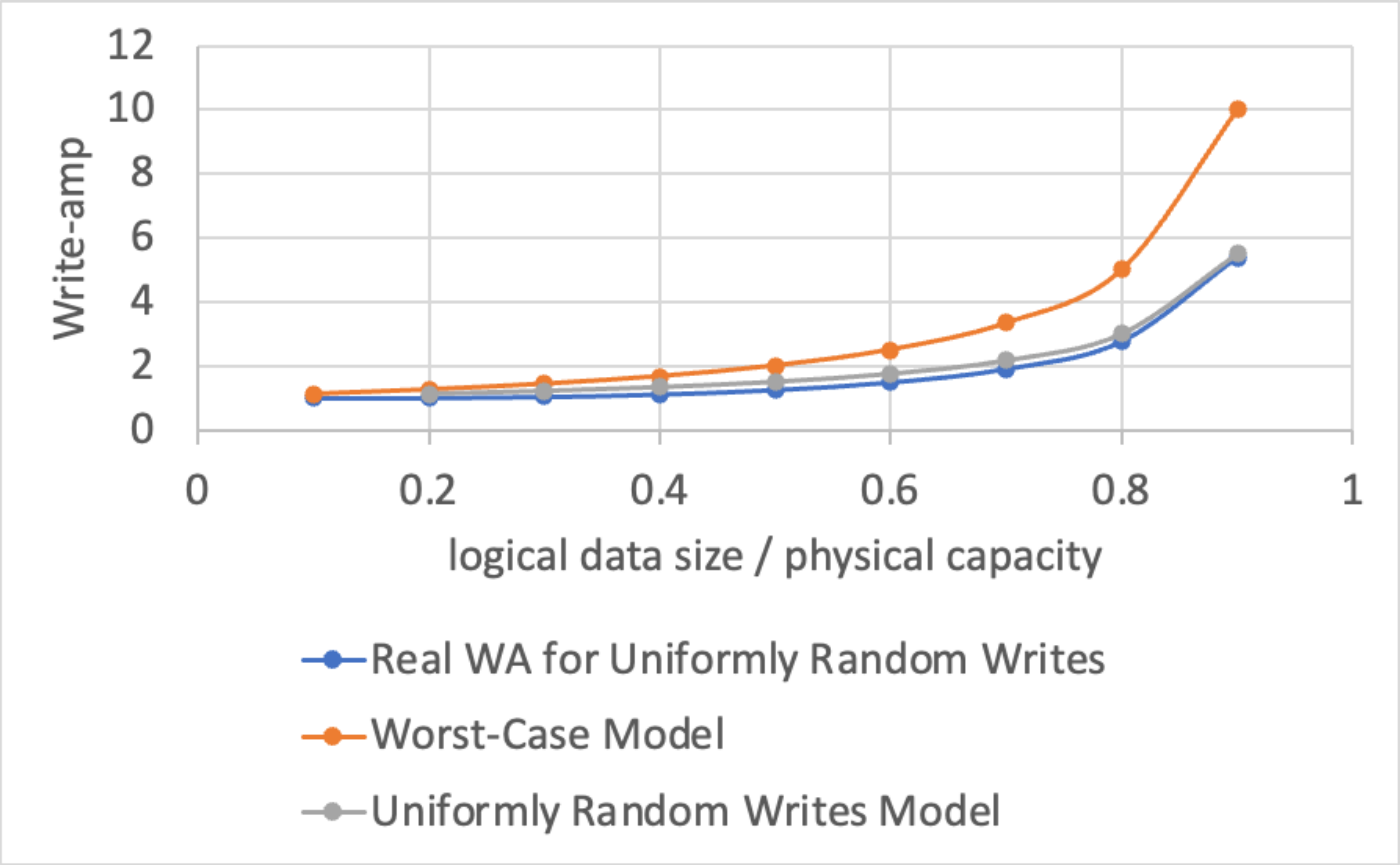
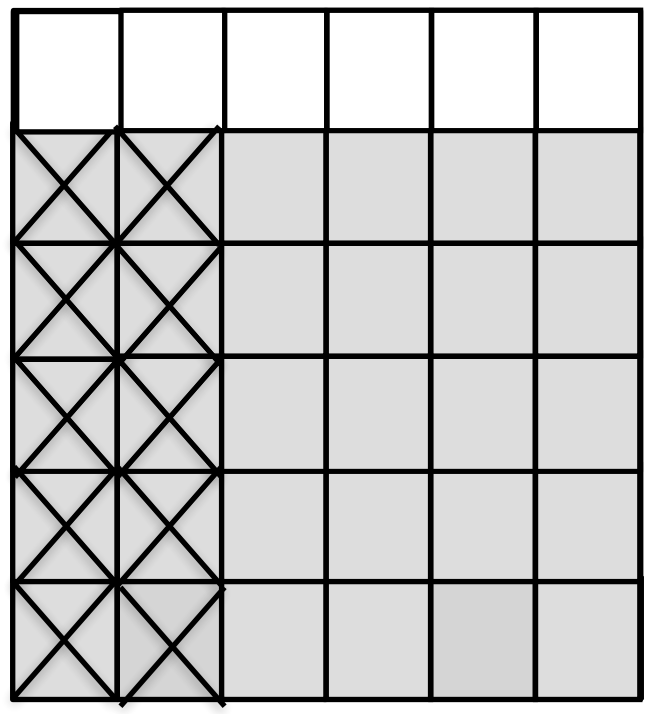


$$1 + \frac{x}{1-x}$$

$$1 + \frac{1}{2} \cdot \frac{x}{1-x}$$

How does this model change assuming there are B entries per page, and each update modifies B entries?

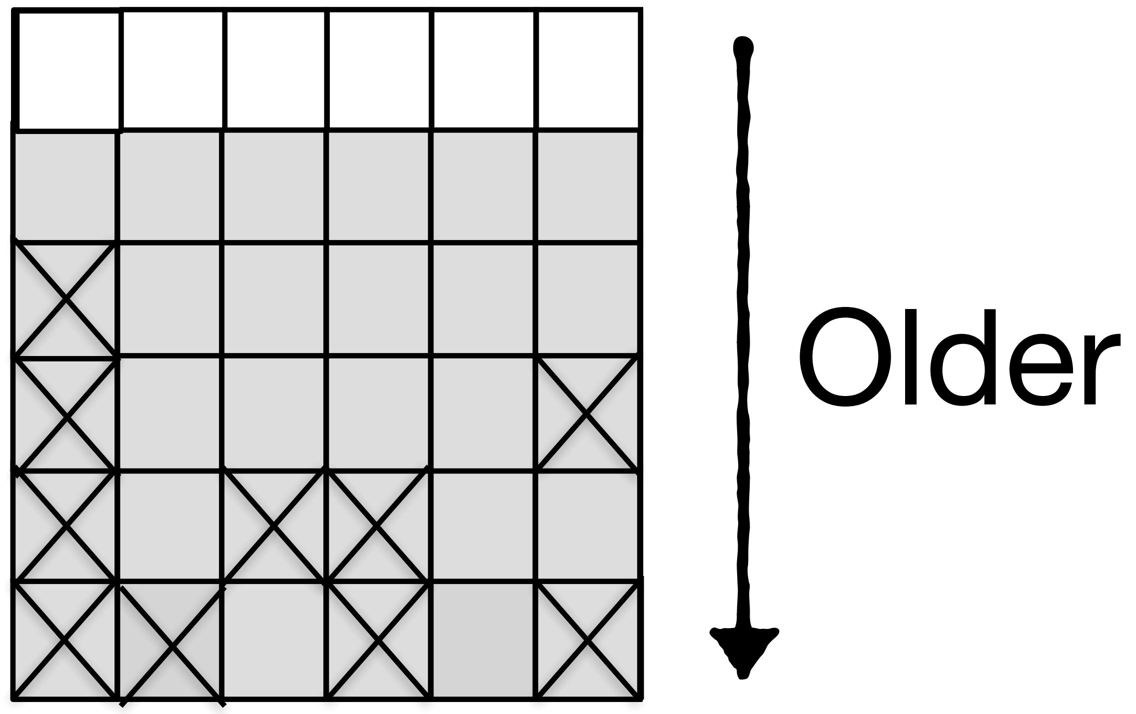
Worst-case



$$1 + \frac{x}{1 - x}$$

Uniformly Random Case

$$1 + \frac{1}{2} \cdot \frac{x}{1 - x}$$



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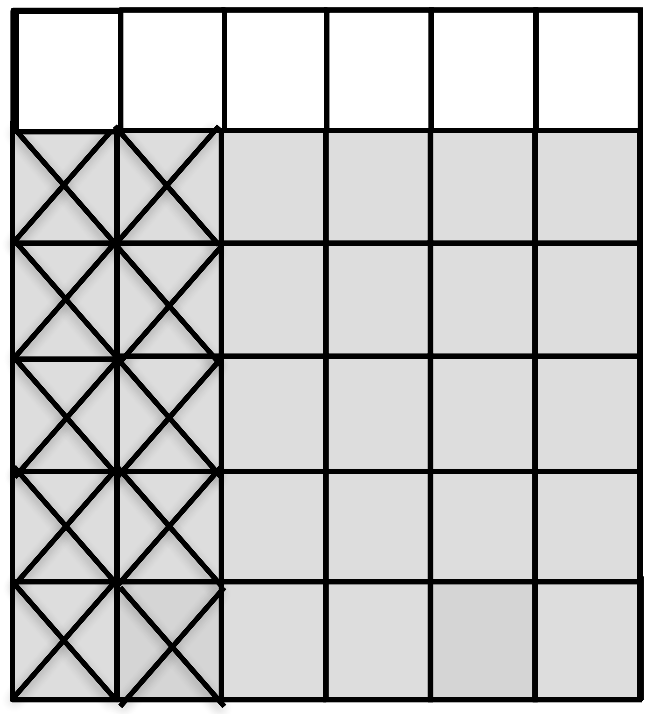

$$B \cdot (1 + \frac{x}{1-x})$$

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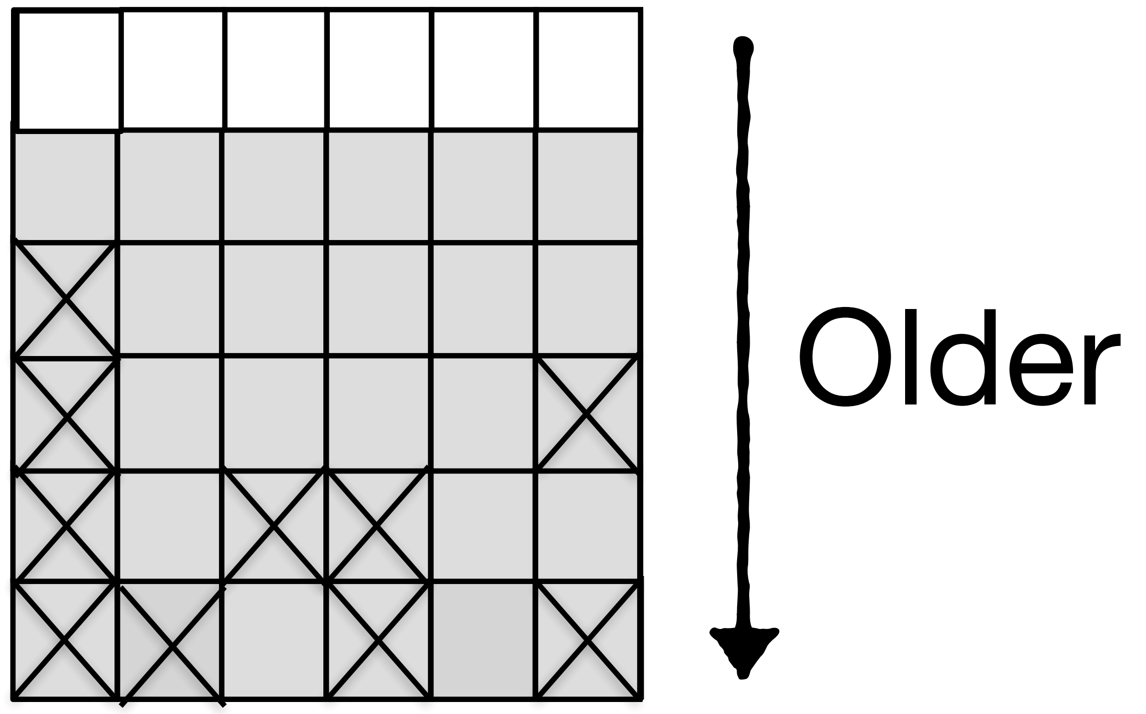


Question 1

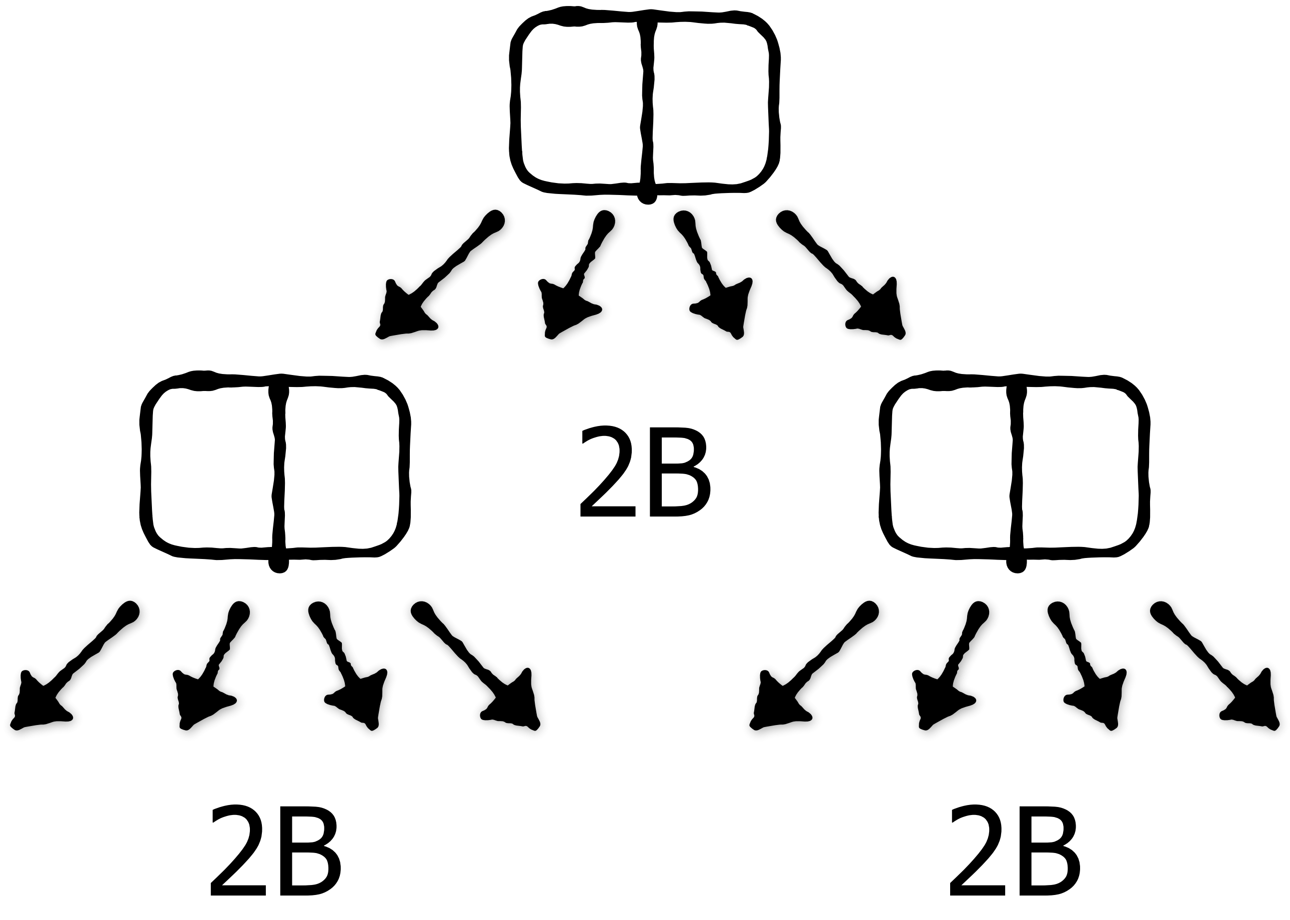
Consider a B-tree subject to uniformly randomly distributed updates. There are 100 entries per page. The b-tree occupies 70% of the SSD, while the rest is empty. What write-amplification would you expect?

Model: $$B \cdot (1 + \frac{1}{2} \cdot \frac{x}{1-x})$$

Under what kind of workload would write-amplification for a B-tree be significantly lower?

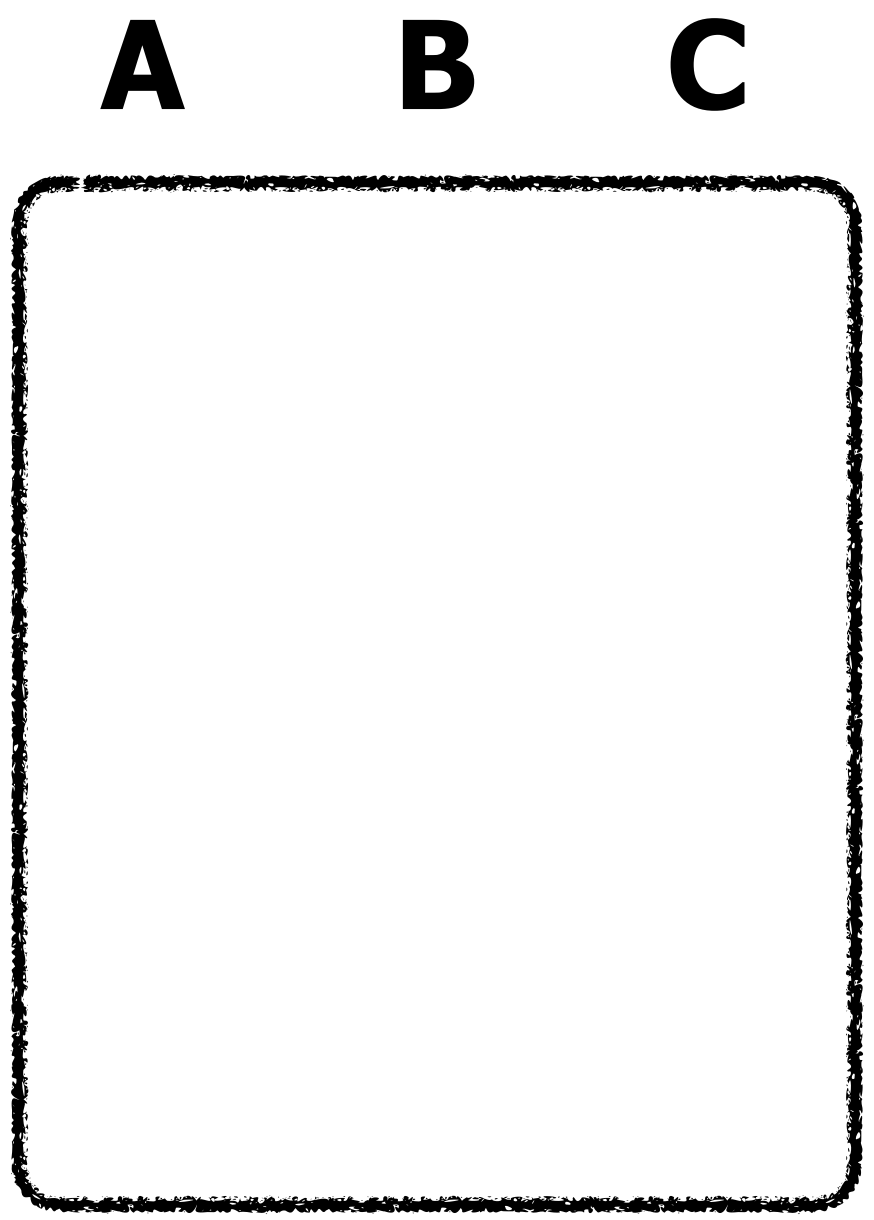
Question 2

Consider the possibility of making each B-tree node take up two rather than just one flash pages (i.e., 8KB rather than 4KB). This can make the tree shallower. Is this a good idea for flash? How about on Disk?



Question 3

Consider a table with columns A, B and C. Suppose we employ buffered inserts at a cost of O(1/B) each.



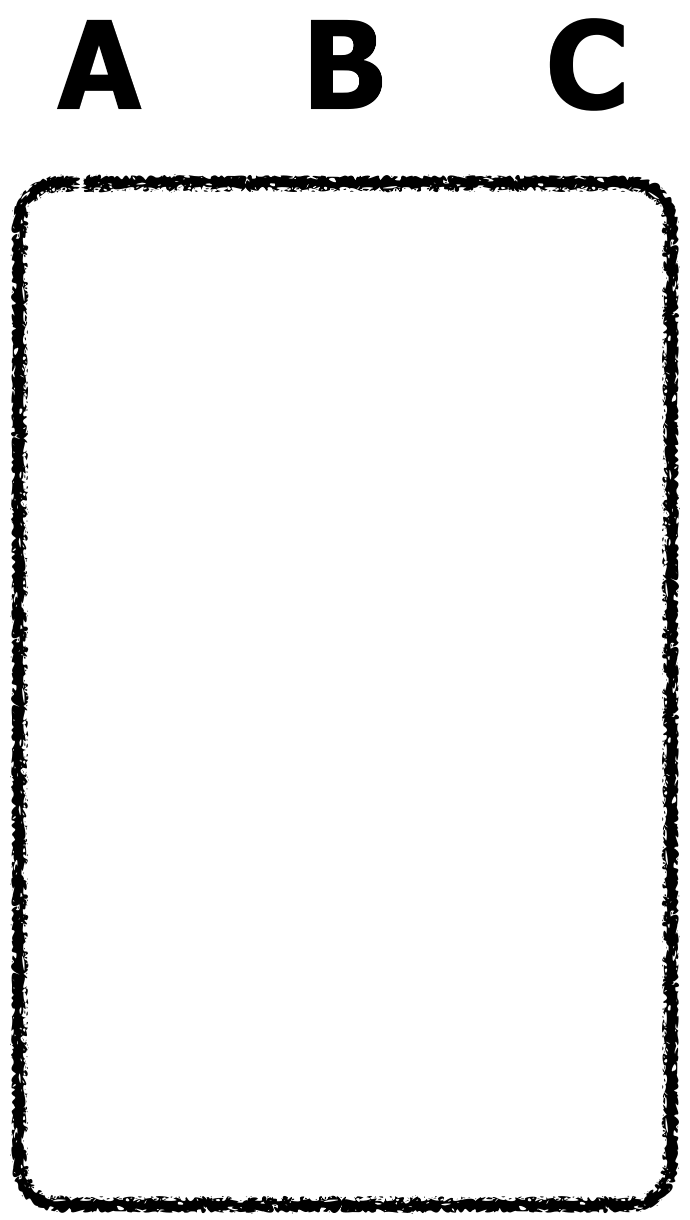
The workload consists of:

50%	Select * from table where A = "…"	Return 1 row each
50%	Insert (, ,)	

Should we employ a B-tree index on any of the columns? Estimate the overall I/O cost of both queries with and without out it.

Question 4

Consider a table with columns A, B and C.



50%	Select A from table where A = "…"	Returns 1 row each
50%	Select * from table where B > x and B < y	Returns avg. S=10 rows

How should we index this table? B-tree or extendible hashing? Clustered vs. unclustered? Estimate worst-case I/O cost with your plan for each query with these indexes assuming $N=2^{40}$ and $B=2^{10}$