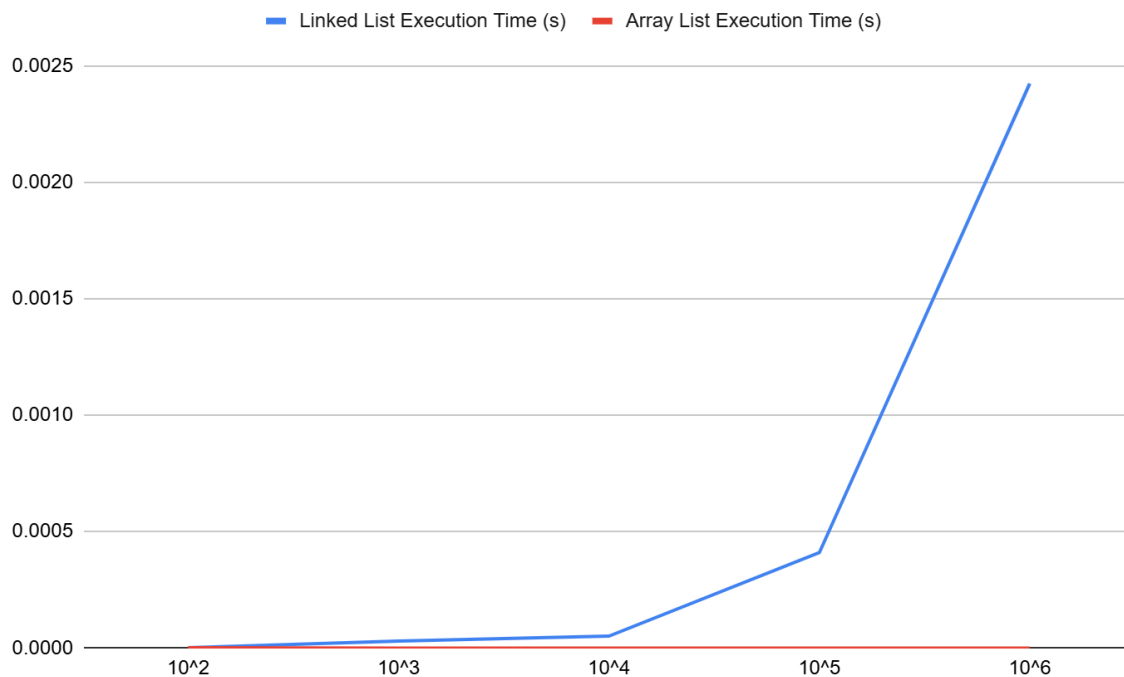


First Name	Breona
Last Name	Pizzuta
Collaborator	Ben Carpenter
Pledge	" I pledge my honor that I have abided by the Stevens Honor System"

1 Task1: Profiling a Linked List and an Array

Please present your experiment record below: either a graph or a chart.

length	Written out length	Linked List Execution Time (s)	Array List Execution Time (s)
10^2	100	0.000001	0.000001
10^3	1000	0.00003	0.000000
10^4	10000	0.000051	0.000000
10^5	100000	0.000410	0.000000
10^6	1000000	0.002423	0.000000



Please explain: why does the two algorithms with both $O(n)$ complexity, have very different performance when n increases? You need to explain in detail from the perspective of locality.

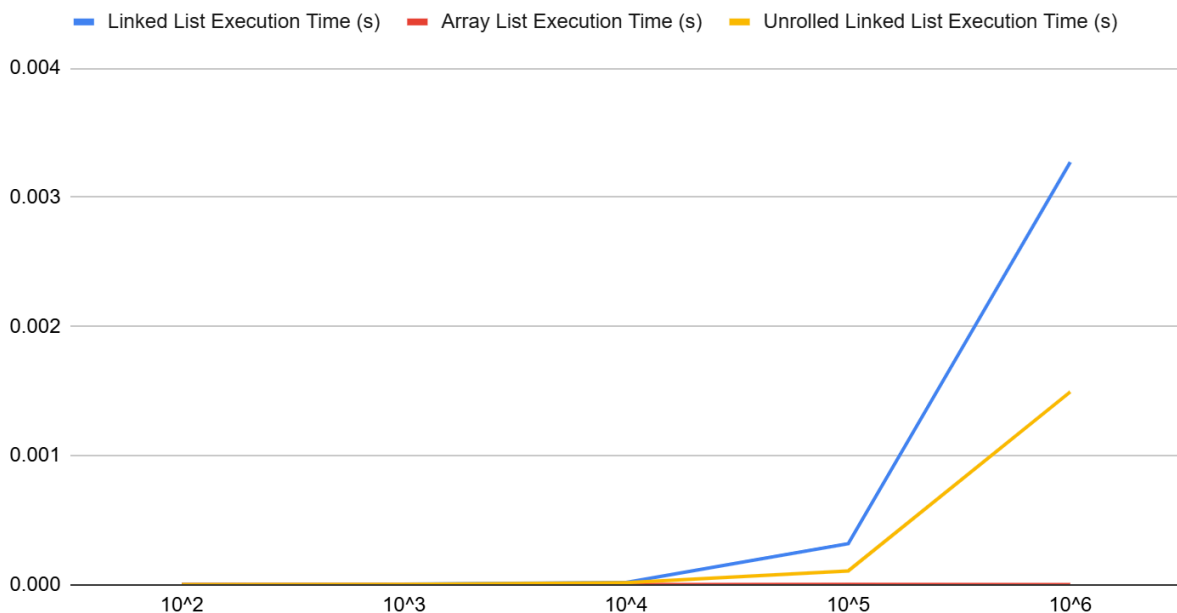
Arrays store memory continuously. Linked lists must create separate nodes and point to those nodes to access data. This is a longer, more scattered path since we must access memory more times. In terms of spatial locality, arrays leverage spatial locality as the CPU cache efficiently loads and processes elements in bulk, resulting in better cache performance. Linked lists suffer from poor spatial locality as each node contains a pointer to the next node, requiring additional memory access, causing higher memory access overhead.

2 Task2: Locality Improved Linked List

Please present your experiment record below: either a graph or a chart.

length	Written out length	Linked List Execution Time (s)	Array List Execution Time (s)	Unrolled Linked List Execution Time (s)
10^2	100	0.000001	0.000000	0.000000
10^3	1000	0.000004	0.000000	0.000001
10^4	10000	0.000017	0.000000	0.000015
10^5	100000	0.000317	0.000001	0.000106
10^6	1000000	0.003272	0.000000	0.001493

Linked List Execution Time (s), Array List Execution Time (s) and Unrolled Linked List Execution Time (s)



Please explain: what is the time complexity of unrolled linked list? How does an unrolled linked list improve the efficiency of traversal in terms of locality?

The time complexity of an unrolled linked list is $\mathcal{O}(n)$. Unrolled linked lists improve the efficiency by putting more elements into each individual node. Therefore the CPU cache will be able to access more elements in memory at a time. This will also enhance the spatial locality of a linked list since it can dramatically increase cache performance, while decreasing the memory overhead associated with storing list data.