

Assignment 6

Nikhil Vemula, Atharva Pore, Shreeja Deshpande, Ami Sharma

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Question 10

Observations

1. With no index postgres is performing sequential scan using multiple workers to filter
2. Creating an index on **skill** column reduced the execution time by almost 50%
3. Didn't find any major difference in execution times between btree index and hash index.
4. But hash index took longer time to create on on column with more number of records

size n of relation PersonSkill	No index	With index
10^4	1.007	0.574
10^5	9.066	5.825
10^6	92.875	45.834
10^7	973.207	639.765

Query plans

For 10^4 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on personskill (cost=0.00..163.69 rows=1802 width=4) (actual time=0.012..1.045 rows=1802 loops=1)
  Filter: (skill = 'AI'::text)
  Rows Removed by Filter: 7293
Planning Time: 0.109 ms
Execution Time: 1.191 ms
(5 rows)
```

Btree Index Query Plan

```

QUERY PLAN
-----
Bitmap Heap Scan on personskill  (cost=22.25..94.78 rows=1802 width=4) (actual time=0.067..0.465 rows=1802 loops=1)
  Recheck Cond: (skill = 'AI'::text)
  Heap Blocks: exact=50
  -> Bitmap Index Scan on personskill_skill_idx  (cost=0.00..21.80 rows=1802 width=0) (actual time=0.054..0.054 rows=1802 loops=1)
        Index Cond: (skill = 'AI'::text)
Planning Time: 0.053 ms
Execution Time: 0.620 ms
(7 rows)

```

For 10^5 records

No Index Query Plan

```

QUERY PLAN
-----
Seq Scan on personskill  (cost=0.00..1621.14 rows=18123 width=4) (actual time=0.007..8.684 rows=18172 loops=1)
  Filter: (skill = 'AI'::text)
  Rows Removed by Filter: 72399
Planning Time: 0.061 ms
Execution Time: 9.847 ms
(5 rows)

```

Btree Index Query Plan

```

QUERY PLAN
-----
Bitmap Heap Scan on personskill  (cost=208.75..924.28 rows=18123 width=4) (actual time=0.611..4.082 rows=18172 loops=1)
  Recheck Cond: (skill = 'AI'::text)
  Heap Blocks: exact=489
  -> Bitmap Index Scan on skill_index  (cost=0.00..204.21 rows=18123 width=0) (actual time=0.546..0.546 rows=18172 loops=1)
        Index Cond: (skill = 'AI'::text)
Planning Time: 0.231 ms
Execution Time: 5.322 ms
(7 rows)

```

For 10^6 records

No index Query Plan

```

QUERY PLAN
-----
Seq Scan on personskill  (cost=0.00..16227.24 rows=183887 width=4) (actual time=0.025..81.109 rows=181384 loops=1)
  Filter: (skill = 'AI'::text)
  Rows Removed by Filter: 726355
Planning Time: 0.040 ms
Execution Time: 91.967 ms
(5 rows)

```

Btree index Query Plan

```

QUERY PLAN
-----
Bitmap Heap Scan on personskill  (cost=2031.29..9186.98 rows=181015 width=4) (actual time=6.280..38.996 rows=181384 loops=1)
  Recheck Cond: (skill = 'AI'::text)
  Heap Blocks: exact=4893
  -> Bitmap Index Scan on skill_index  (cost=0.00..1986.04 rows=181015 width=0) (actual time=5.554..5.555 rows=181384 loops=1)
        Index Cond: (skill = 'AI'::text)
Planning Time: 0.238 ms
Execution Time: 50.507 ms
(7 rows)

```

For 10^7 records

No index Query Plan

```
queryplan
-----
Seq Scan on personskill (cost=0.00..162223.31 rows=1834672 width=4) (actual time=0.019..795.445 rows=1811314 loops=1)
  Filter: (skill = 'AI'::text)
  Rows Removed by Filter: 7253413
  Planning Time: 0.113 ms
  Execution Time: 895.138 ms
(5 rows)
```

Btree index Query Plan

```
queryplan
-----
Bitmap Heap Scan on personskill (cost=20527.37..92377.13 rows=1834701 width=4) (actual time=77.331..499.683 rows=1811314 loops=1)
  Recheck Cond: (skill = 'AI'::text)
  Heap Blocks: exact=48916
  -> Bitmap Index Scan on skill_index (cost=0.00..20068.69 rows=1834701 width=0) (actual time=68.578..68.578 rows=1811314 loops=1)
    Index Cond: (skill = 'AI'::text)
  Planning Time: 0.286 ms
  Execution Time: 603.233 ms
(7 rows)
```

Question 11

Observations

1. If the stats for a range are high then postgres is performing a sequential scan though index is available

Small Range

size n of relation PersonSkill	No index	With index
10^4	0.961	0.020
10^5	8.45	0.021
10^6	37.561	0.022
10^7	279.965	

Medium Range

size n of relation PersonSkill	No index	With index
10^4	1.726	1.552
10^5	24.065	23.626
10^6	216.149	203.814
10^7	1970.034	

Large Range

size n of relation PersonSkill	No index	With index
10^4	2.565	2.409
10^5	20.516	21.637
10^6	196.60	205.833
10^7	1807.410	

Query Plans

Small Range

For 10^4 records

No Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..205.00 rows=1 width=4) (actual time=0.009..0.964 rows=1 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 10000))
  Rows Removed by Filter: 9999
Planning Time: 0.148 ms
Execution Time: 0.976 ms
(5 rows)

```

With Index Query Plan

```

QUERY PLAN
-----
Index Scan using worksfor_salary_idx on worksfor (cost=0.29..8.32 rows=2 width=4) (actual time=0.007..0.008 rows=1 loops=1)
  Index Cond: ((salary >= 10000) AND (salary <= 10000))
Planning Time: 0.128 ms
Execution Time: 0.019 ms
(4 rows)

```

For 10^5 records

No Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..2041.00 rows=1 width=4) (actual time=0.008..8.500 rows=3 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 10000))
  Rows Removed by Filter: 99997
Planning Time: 0.071 ms
Execution Time: 8.513 ms
(5 rows)

```

With Index Query Plan

```

QUERY PLAN
-----
Index Scan using worksfor_salary_idx on worksfor (cost=0.29..8.33 rows=2 width=4) (actual time=0.007..0.008 rows=3 loops=1)
  Index Cond: ((salary >= 10000) AND (salary <= 10000))
Planning Time: 0.453 ms
Execution Time: 0.021 ms
(4 rows)

```

For 10⁶ records

No Index Query Plan

```
QUERY PLAN
-----
Gather  (cost=1000.00..13620.10 rows=1 width=8) (actual time=0.135..37.094 rows=4 loops=1)
  Workers Planned: 2
  Workers Launched: 2
  -> Parallel Seq Scan on worksfor  (cost=0.00..12620.00 rows=1 width=8) (actual time=19.437..31.110 rows=1 loops=3)
        Filter: ((100 <= salary) AND (salary <= 100))
        Rows Removed by Filter: 333332
  Planning Time: 0.075 ms
  Execution Time: 37.107 ms
(8 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Index Scan using worksfor_salary_idx on worksfor  (cost=0.42..8.46 rows=2 width=8) (actual time=0.014..0.016 rows=4 loops=1)
  Index Cond: ((salary >= 100) AND (salary <= 100))
  Planning Time: 0.291 ms
  Execution Time: 0.027 ms
(4 rows)
```

For 10⁷ records

No Index Query Plan

```
QUERY PLAN
-----
Gather  (cost=1000.00..127195.82 rows=1 width=8) (actual time=0.173..282.248 rows=1 loops=1)
  Workers Planned: 2
  Workers Launched: 2
  -> Parallel Seq Scan on worksfor  (cost=0.00..126195.72 rows=1 width=8) (actual time=182.311..275.322 rows=0 loops=3)
        Filter: ((100 <= salary) AND (salary <= 100))
        Rows Removed by Filter: 3333333
  Planning Time: 0.130 ms
  Execution Time: 282.266 ms
(8 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Index Scan using worksfor_salary_idx on worksfor  (cost=0.43..8.50 rows=3 width=8) (actual time=0.014..0.015 rows=1 loops=1)
  Index Cond: ((salary >= 100) AND (salary <= 100))
  Planning Time: 0.501 ms
  Execution Time: 0.027 ms
(4 rows)
```

Medium Range

For 10⁴ records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor  (cost=0.00..205.00 rows=4961 width=4) (actual time=0.014..1.688 rows=4955 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 50186992))
  Rows Removed by Filter: 5045
  Planning Time: 0.073 ms
  Execution Time: 2.182 ms
(5 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Index Scan using worksfor_salary_idx on worksfor  (cost=0.29..186.53 rows=4962 width=4) (actual time=0.018..1.170 rows=4955 loops=1)
  Index Cond: ((salary >= 10000) AND (salary <= 50186992))
  Planning Time: 0.090 ms
  Execution Time: 1.531 ms
(4 rows)
```

For 10^5 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor  (cost=0.00..2291.00 rows=33330 width=4) (actual time=0.008..19.839 rows=50095 loops=1)
  Filter: ((10000 <= salary) AND ((salary)::numeric <= 499212216.5))
  Rows Removed by Filter: 49905
  Planning Time: 0.038 ms
  Execution Time: 23.056 ms
(5 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor  (cost=0.00..2291.00 rows=33333 width=4) (actual time=0.010..20.457 rows=50095 loops=1)
  Filter: ((10000 <= salary) AND ((salary)::numeric <= 499212216.5))
  Rows Removed by Filter: 49905
  Planning Time: 0.083 ms
  Execution Time: 23.758 ms
(5 rows)
```

For 10^6 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor  (cost=0.00..23870.00 rows=333300 width=8) (actual time=0.010..179.810 rows=500077 loops=1)
  Filter: ((100 <= salary) AND ((salary)::numeric <= 49956718.44850))
  Rows Removed by Filter: 499923
  Planning Time: 0.048 ms
  Execution Time: 209.021 ms
(5 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor  (cost=0.00..23870.00 rows=333333 width=8) (actual time=0.013..211.058 rows=500077 loops=1)
  Filter: ((100 <= salary) AND ((salary)::numeric <= 49956718.44850))
  Rows Removed by Filter: 499923
  Planning Time: 0.116 ms
  Execution Time: 240.352 ms
(5 rows)
```

For 10^7 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..238697.01 rows=3333038 width=8) (actual time=0.129..1717.734 rows=5000037 loops=1)
  Filter: ((100 <= salary) AND ((salary)::numeric <= 500082613.5282))
  Rows Removed by Filter: 4999963
  Planning Time: 0.072 ms
  Execution Time: 1985.666 ms
(5 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..238695.00 rows=3333333 width=8) (actual time=0.010..1737.548 rows=5000037 loops=1)
  Filter: ((100 <= salary) AND ((salary)::numeric <= 500082613.5282))
  Rows Removed by Filter: 4999963
  Planning Time: 0.081 ms
  Execution Time: 2017.289 ms
(5 rows)
```

Large Range

For 10^4 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..205.00 rows=9998 width=4) (actual time=0.010..1.891 rows=10000 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 99980000))
  Planning Time: 0.052 ms
  Execution Time: 2.656 ms
(4 rows)
```

With Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..205.00 rows=10000 width=4) (actual time=0.013..1.734 rows=10000 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 99980000))
  Planning Time: 0.211 ms
  Execution Time: 2.500 ms
(4 rows)
```

For 10^5 records

No Index Query Plan

```
QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..2041.00 rows=99980 width=4) (actual time=0.010..14.724 rows=100000 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 1000000000))
  Planning Time: 0.143 ms
  Execution Time: 21.192 ms
(4 rows)
```

With Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..2041.00 rows=100000 width=4) (actual time=0.011..14.475 rows=100000 loops=1)
  Filter: ((10000 <= salary) AND (salary <= 10000000000))
  Planning Time: 0.227 ms
  Execution Time: 20.928 ms
(4 rows)

```

For 10^6 records

No Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..21370.00 rows=999800 width=8) (actual time=0.024..136.545 rows=1000000 loops=1)
  Filter: ((100 <= salary) AND (salary <= 1000000000))
  Planning Time: 0.129 ms
  Execution Time: 194.728 ms
(4 rows)

```

With Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..21370.00 rows=1000000 width=8) (actual time=0.009..135.051 rows=1000000 loops=1)
  Filter: ((100 <= salary) AND (salary <= 1000000000))
  Planning Time: 0.213 ms
  Execution Time: 192.895 ms
(4 rows)

```

For 10^7 records

No Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..213696.73 rows=9998115 width=8) (actual time=0.030..1298.063 rows=10000000 loops=1)
  Filter: ((100 <= salary) AND (salary <= 10000000000))
  Planning Time: 0.064 ms
  Execution Time: 1837.039 ms
(4 rows)

```

With Index Query Plan

```

QUERY PLAN
-----
Seq Scan on worksfor (cost=0.00..213695.00 rows=10000000 width=8) (actual time=0.010..1345.495 rows=10000000 loops=1)
  Filter: ((100 <= salary) AND (salary <= 10000000000))
  Planning Time: 0.811 ms
  Execution Time: 1898.255 ms
(4 rows)

```