

# Lab 2

## Implementation of transaction using JDBC and SP

### 小細節

- **As2BenchTransactionType** 新增一個種類 `UPDATE_PRICE`
- **As2BenchJdbcExecutor & As2BenchStoredProcFactory** 各別新增一個 case 對應 `TxType = UPDATE_PRICE`
- **As2BenchmarkRte** 靜態生成兩種 `TxExecutor`，差別在於分別使用 `As2ReadItemParamGen` 和 `As2UpdatePriceParamGen`。在 `getNextTxType()` 這個函式中，根據 `READ_WRITE_TX_RATE` 這個機率決定此次 `TxType` 為 read or update，然後根據此結果，`getTxExecutor()` 這個函式就會回傳對應的 `TxExecutor`

### JDBC

**As2UpdatePriceParamGen** 會生成需要的參數，內容為 [update 次數, 10 個 update id, 10 個 price raise]。而當要執行 **UpdatePriceJdbcJob** 時，**UpdatePriceProcParamHelper** 會幫忙把上述傳入的參數進行解析，這樣就能知道要更新的次數以及每次操作對應的 id 與價格變化量。接著進行每筆 update 時，利用 `JdbcConnection` 新增 `Statement`，先透過 **executeQuery** 執行sql指令 `SELECT i_name, i_price FROM item WHERE i_id = iid`, 將滿足條件的資料讀取出來，將更新後的價錢設為 `i_price+price raise`, 但若是超過 `As2BenchConstants.MAX_PRICE`, 則新將價錢設為 `As2BenchConstants.MIN_PRICE`，最後在透過 **executeUpdate** 執行sql指令 `UPDATE item SET i_price = newPrice WHERE i_id = iid`, 將更改完的資料寫回資料庫中。

### Stored Procedure

**UpdatePriceProcParamHelper** 用來記錄哪些item的price被update以及把 parameter generator產生的參數根據功能分別存在array中。呼叫 **UpdatePriceProc** 中的 method **executesql()** 時，從 **UpdatePriceProcParamHelper** 中的 getter 把需要update的 item id、需要提升多少 price 取出，接著透過 `StoredProcedureHelper` 的 method **executeQuery()** 執行跟 JDBC 一樣的sql query `SELECT i_name, i_price FROM item WHERE i_id = iid`。接著執行 `StoredProcedureHelper` 的 method **executeUpdate()** 執行跟JDBC一樣的sql query `UPDATE item SET i_price = newPrice WHERE i_id = iid`。最後將更新過的item 的 price、name 用 **UpdatePriceProcParamHelper** 的 setter 將新的值存回 array 中

### Experiment

with screenshot of CSV produced by `StatisticMgr`

### Environment 1

CPU	RAM	Disk	OS
Intel Core i3-12100 3.3GHz	16GB	512GB SSD	Ubuntu 22.04

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75/25

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	4046	2.352	1.072	16.825	1.809	2.339	2.496
10	4260	2.306	1.067	16.676	1.811	2.387	2.486
15	4197	2.361	1.057	26.479	1.810	2.387	2.483
20	4310	2.315	1.050	15.568	1.810	1.331	2.425
25	4336	2.294	1.062	12.178	1.806	2.109	2.339
30	4386	1.911	1.070	14.431	1.809	2.444	
35	3622	2.048	1.077	212.003	1.804	2.144	2.437
40	4339	2.304	1.060	24.038	1.794	2.113	2.384
45	4336	2.369	1.072	17.811	1.801	2.175	2.488
50	4092	2.079	1.065	37.389	1.813	2.180	2.432
55	4310	2.319	1.068	21.125	1.822	2.140	2.469

0/100

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	22864	0.260	0.077	0.270	0.400	0.247	0.279
10	22961	0.201	0.138	0.153	0.153	0.167	0.408
15	22634	0.260	0.139	0.136	0.161	0.164	0.407
20	22993	0.410	0.138	0.145	0.153	0.174	0.407
25	24648	0.400	0.139	10.272	0.164	0.171	0.407
30	22933	0.260	0.142	0.161	0.161	0.165	0.381
35	24078	0.410	0.139	86.102	0.165	0.174	0.408
40	22931	0.260	0.138	1.893	0.153	0.170	0.404
45	24911	0.400	0.139	10.180	0.163	0.169	0.408
50	22353	0.400	0.140	96.931	0.165	0.179	0.408
55	24613	0.401	0.138	10.719	0.163	0.168	0.404
60	22373	0.260	0.138	16.466	0.161	0.163	0.404

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5	3624	2.746	1.070	15.720	1.807	1.046	2.496
10	3622	2.847	1.067	14.474	1.810	2.461	2.495
15	3509	2.038	1.062	14.529	1.815	2.481	2.490
20	3624	2.660	1.061	26.861	1.810	2.471	2.476
25	3792	2.690	1.060	199.209	1.802	2.480	2.490
30	3553	2.542	1.061	24.100	1.817	2.441	2.473
35	3663	2.613	1.061	39.100	1.806	2.451	2.481
40	3634	2.761	1.061	24.127	1.803	2.443	2.433
45	4112	2.466	1.061	26.457	1.806	2.367	2.437
50	3648	2.602	1.060	36.966	1.811	2.434	2.479
55	2957	2.625	1.060	25.459	1.807	2.447	2.488
60							

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	12284	0.760	0.276	0.321	0.270	0.254	0.487
10	12786	0.760	0.259	11.491	0.258	0.317	0.433
15	12867	0.760	0.262	6.266	0.258	0.316	0.435
20	12864	0.760	0.262	6.266	0.258	0.316	0.435
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50/50

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	1930	2.562	1.066	16.719	1.897	1.481	
10	1866	2.594	1.067	16.676	1.828	2.464	2.423
15	1914	2.517	1.068	14.122	1.897	2.441	2.473
20	1868	2.614	1.061	161.091	1.897	2.486	2.469
25	1934	2.560	1.064	14.236	1.852	2.467	2.484
30	1993	2.663	1.062	14.236	1.852	2.467	2.484
35	1928	2.564	1.063	16.672	1.833	2.465	2.457
40	1951	2.530	1.063	27.157	1.818	2.452	2.461
45	1953	2.607	1.066	16.499	1.875	2.450	2.472
50	1985	2.508	1.074	16.179	1.862	2.453	2.460
55	1983	2.596	1.080	17.418	1.860	2.468	2.459

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	12849	0.760	0.140	0.140	0.129	0.171	1.419
10	12253	0.806	0.143	12.993	0.253	0.738	1.205
15	12786	0.760	0.139	16.306	0.201	0.762	1.243
20	12864	0.760	0.141	16.306	0.400	0.844	1.308
25	12754	0.760	0.141	17.523	0.208	0.714	1.230
30	12857	0.760	0.140	16.306	0.400	0.844	1.308
35	12858	0.760	0.139	16.998	0.202	0.693	1.318
40	12848	0.767	0.140	16.757	0.261	0.828	1.245
45	12719	0.760	0.140	16.421	0.208	0.844	1.298
50	12813	0.769	0.141	16.161	0.206	0.723	1.241
55	12863	0.760	0.140	12.983	0.208	0.687	1.245
60	13657	0.807	0.142	16.209	0.201	0.796	1.288

throughput	avg_latency	min_latency	max_latency	median_latency	75th_latency		
5	101	2.576	1.070	16.719	1.897	1.481	
10	100	17.049	1.061	40.004	1.817	1.674	2.017
15	207	19.714	1.070	51.468	1.810	16.266	2.440
20	407	16.641	1.060	25.496	1.806	1.642	2.064
25	555	17.088	1.058	25.005	1.802	1.624	2.040
30	917	17.008	1.058	40.004	1.803	1.616	2.176
35	626	16.687	1.060	1.206	1.800	1.177	1.651
40	571	17.005	1.057	40.004	1.811	1.611	2.064
45	522	16.385	1.050	40.004	1.811	1.611	2.064
50	564	16.385	1.050	40.004	1.811	1.611	2.064
55	601	16.384	1.050	40.004	1.811	1.611	2.064

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## Environment 2

CPU	RAM	Disk	OS
Intel Core i7-1065G7 1.3GHz	16GB	477GB SSD	Windows 10

Ratio R/W (%)	JDBC	SP	Ratio R/W (%)	JDBC	SP																																																																																																																																																																																																										
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JDBC over SP					SP over JDBC				
throughput	latency	25th	50th	75th	throughput	latency	25th	50th	75th
6.280770625496686	0.22913808098545652	0.10473386488356295	0.19998290123599638	0.3245116107227025	0.159216131208568	4.364180740710098	9.548010102670633	5.000427505649181	3.0815538395466135
16.5803896469392	0.0630111149435015	0.06061595905623331	0.06112656284263664	0.06209271631596902	0.06031221348194333	15.870215927723915	16.497305587003943	16.359499921079905	16.10494852425742
8.816548602114109	0.11388281842154234	0.1087283254673191	0.11530726399428852	0.1205365666469472	0.11342306895015714	8.780955844440513	9.19723536348009	8.67248051301896	8.296237629938556

由上分析可知 SP 在吞吐量大勝 JDBC 約 6~16 倍，在不同平台上平均延遲 (平均、25 分位數、中位數、75 分位數) 也有約 3~16 倍的差距，足見在略過呼叫 JDBC 介面的情況下，Stored Procedure 擁有遠勝於套皮後的 query/update 速度。細究之，以 `executeQuery` 於 JDBC 和 Stored Procedure 的行為來說...

- 後者直接呼叫 `VanillaDb::newPlanner` 取得 planer 後呼叫 `Planner::createQueryPlan`，並然後呼叫 `Plan::open`，連續的呼叫一氣呵成。
- 前者呼叫後會透過介面呼叫 `JdbcStatement::executeQuery`，接著呼叫 `RemoteStatementImpl::executeQuery`，然後建構 `RemoteResultSetImpl` 才呼叫 `VanillaDb::newPlanner` 取得 planer 後呼叫 `Planner::createQueryPlan`，並然後呼叫 `Plan::open`。還沒完，還要包成 `JdbcResultSet` 傳送回去。

對前者的追蹤實際上還跳過一些處理，足見兩者 Function call 負擔的極大差距。

- Performance w.r.t. R/W ratio, based on 100% read

ratio(r)	throughput	latency	25th	50th	75th
100	1.0	1.0	1.0	1.0	1.0
75	0.5924481076716653	1.0168564854552404	1.055936353692201	1.030473900736178	1.0129095796609235
50	0.42896774520198144	0.9760867013627741	1.0049334965505445	1.0488239155200902	0.9657397413156963
25	0.42044098412528513	1.2515237195346256	1.2397767571799392	1.2915078548740748	1.2804365985122443
0	0.37223021648205235	1.3223331547600705	1.2623552781479301	1.3179694413118197	1.377059929599736

基本上吞吐量隨 write 的比率提高逐漸降低，延遲則反之，原因也十分清楚，即 Update 由於比起 Read 多進行了更新，導致執行時間較長。

- Platform

platform	throughput	latency	25th	50th	75th
env1	14297.778787878788	1.571721212121212	1.0693924242424242	1.414223484848485	1.8359416666666664
env2	5868.174242424242	8.316594696969698	6.240559848484848	7.665376515151516	9.908326515151515
env3	9350.731060606062	2.974796212121212	2.7188378787878786	2.9160916666666665	3.1611856060606063

不同平台下結果大相徑庭，Ubuntu server (env1) 遠勝其他兩者的原因可能有以下。

- env2 SSD 空間不足，該 SSD 可能由於空間過少而難以使用 SLC 模擬加速，導致 IO burst 時效率遠低於其他兩者。
- env2 讀寫速度 (R/W 1700/1400 Mb/s) 較其他兩者低 (e.g. env1 R/W 3500/2300 Mb/s)
- Ubuntu Server (env1) 除了啟動 JVM、數個 VSCode 工作空間與相應套件之外，沒有額外的工作，讓系統可以專注服務 CPU/IO，反之 env2 同時進行 IO burst 的其他工作，這使執行時間可用的 IO 資源進一步減少。