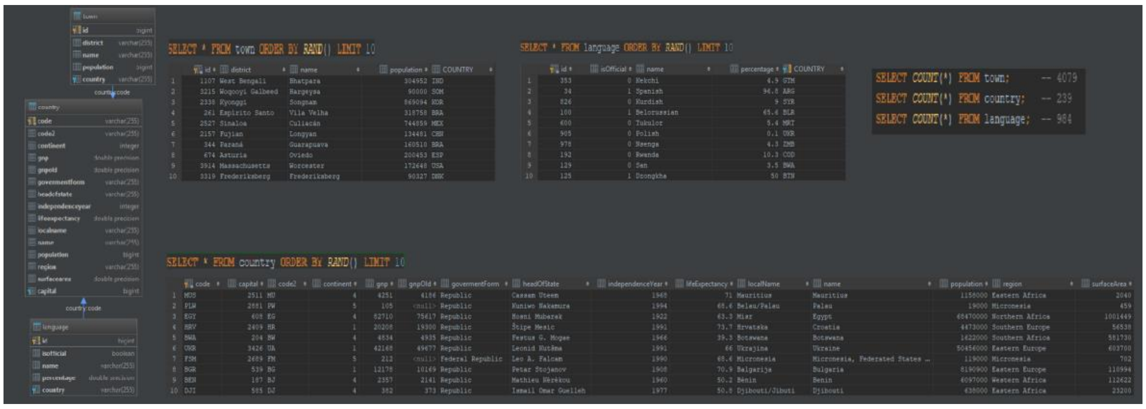
Test report

1. Database schema:



```
SELECT * FROM town ORDER BY RAND() LIMIT 10
```

	id	district	name	population	COUNTRY
1	1107	West Bengali	Bhatpara	304952	IND
2	3215	Woqooyi Galbeed	Hargeysa	90000	SOM
3	2338	Kyonggi	Songnam	869094	KOR
4	261	Espírito Santo	Vila Velha	318758	BRA
5	2527	Sinaloa	Culiacán	744859	MEX
6	2157	Fujian	Longyan	134481	CHN
7	344	Paraná	Guarapuava	160510	BRA
8	674	Asturia	Oviedo	200453	ESP
9	3914	Massachusetts	Worcester	172648	USA
10	3319	Frederiksberg	Frederiksberg	90327	DNK

```
SELECT * FROM language ORDER BY RAND() LIMIT 10
```

	id	isOfficial	name	percentage	COUNTRY
1	353	0	Kekchi	4.9	GTM
2	34	1	Spanish	96.8	ARG
3	826	0	Kurdish	9	SYR
4	100	1	Belorussian	65.6	BLR
5	600	0	Tukulor	5.4	MRT
6	905	0	Polish	0.1	UKR
7	978	0	Nsenga	4.3	ZMB
8	192	0	Rwanda	10.3	COD
9	129	0	San	3.5	BWA
10	125	1	Dzongkha	50	BTN

```
SELECT COUNT(*) FROM town;      -- 4079
SELECT COUNT(*) FROM country;   -- 239
SELECT COUNT(*) FROM language;  -- 984
```

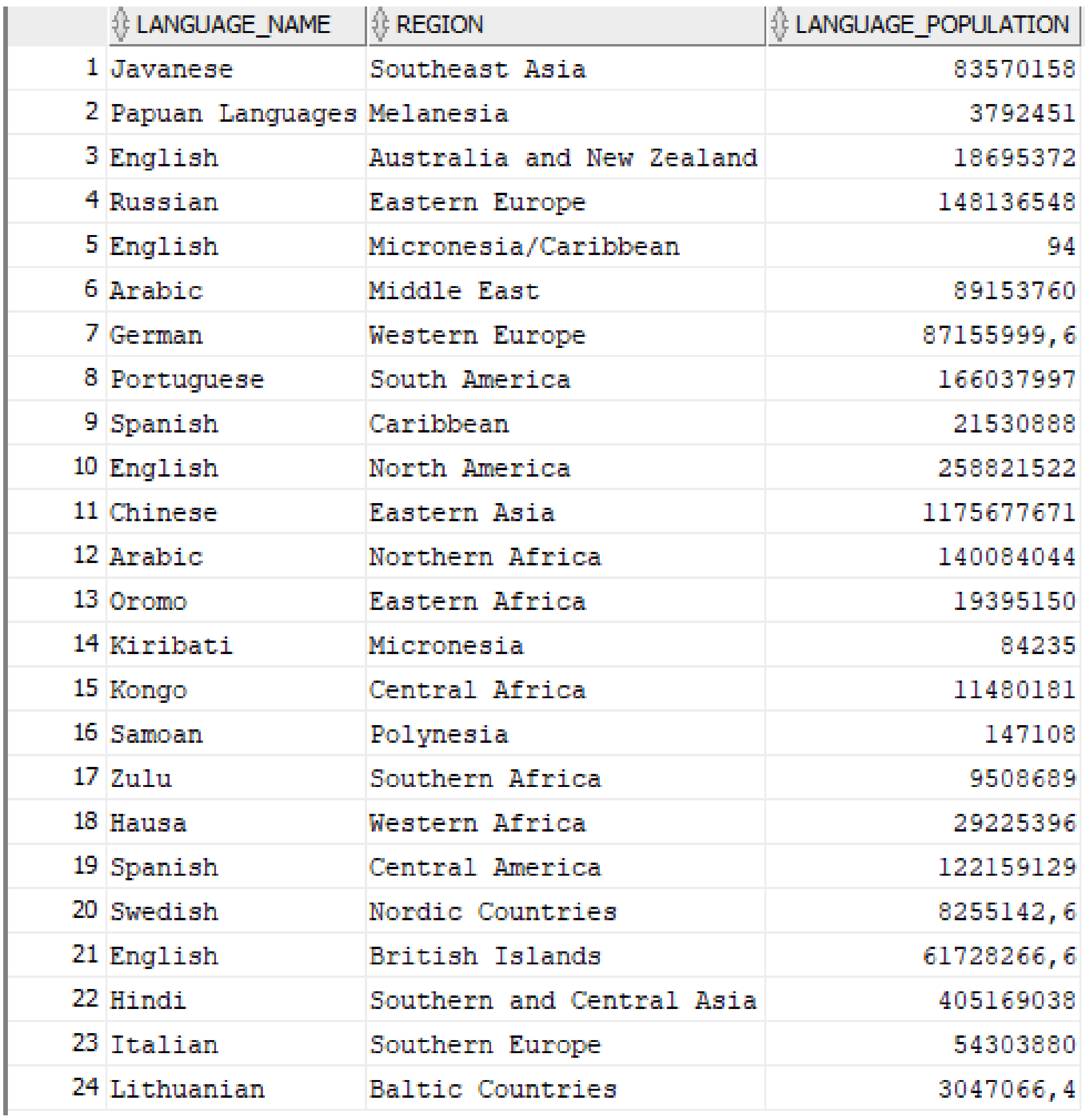
```
SELECT * FROM country ORDER BY RAND() LIMIT 10
```

	code	capital	code2	continent	gnp	gnpOld	governmentForm	headOfState	independenceYear	lifeExpectancy	localName	name	population	region	surfaceArea
1	MUS	2511	MU	4	4251	4186	Republic	Cassam Uteem	1968	71	Mauritius	Mauritius	1158000	Eastern Africa	2040
2	PLW	2881	PW	5	105	<null>	Republic	Kuniwo Nakamura	1994	68.6	Belau/Palau	Palau	19000	Micronesia	459
3	EGY	608	EG	4	82710	75617	Republic	Hosni Mubarak	1922	63.3	Misr	Egypt	68470000	Northern Africa	1001449
4	HRV	2409	HR	1	20208	19300	Republic	Štipe Mesic	1991	73.7	Hrvatska	Croatia	4473000	Southern Europe	56538
5	BWA	204	BW	4	4834	4935	Republic	Festus G. Mogae	1966	39.3	Botswana	Botswana	1622000	Southern Africa	581730
6	UKR	3426	UA	1	42168	49677	Republic	Leonid Kutšma	1991	66	Ukrajina	Ukraine	50456000	Eastern Europe	603700
7	FSM	2689	FM	5	212	<null>	Federal Republic	Leo A. Falcam	1990	68.6	Micronesia	Micronesia, Federated States …	119000	Micronesia	702
8	BGR	539	BG	1	12178	10169	Republic	Petar Stojanov	1908	70.9	Balgarija	Bulgaria	8190900	Eastern Europe	110994
9	BEN	187	BJ	4	2357	2141	Republic	Mathieu Kérékou	1960	50.2	Bénin	Benin	6097000	Western Africa	112622
10	DJI	585	DJ	4	382	373	Republic	Ismail Omar Guelleh	1977	50.8	Djibouti/Jibuti	Djibouti	638000	Eastern Africa	23200

2. Queries

- **Most popular languages by region**

```
SELECT language.name AS language_name, MAX(language_aggregate.region) AS region,
MAX(language_aggregate.language_population) AS language_population FROM (

  SELECT language_sum.region, MAX(language_sum.language_population) AS
language_population FROM (

    SELECT lang.name, cntr.region, sum((lang.percentage / 100) * cntr.population) AS
language_population

    FROM language lang

    JOIN country cntr

    ON lang.country = cntr.code

    GROUP BY lang.name, cntr.region) language_sum

  GROUP BY language_sum.region) language_aggregate

JOIN country

ON country.region = language_aggregate.region

JOIN language

ON language.country = country.code

GROUP BY language.name, country.region

HAVING SUM((language.percentage / 100) * country.population) =
MAX(language_aggregate.language_population);
```

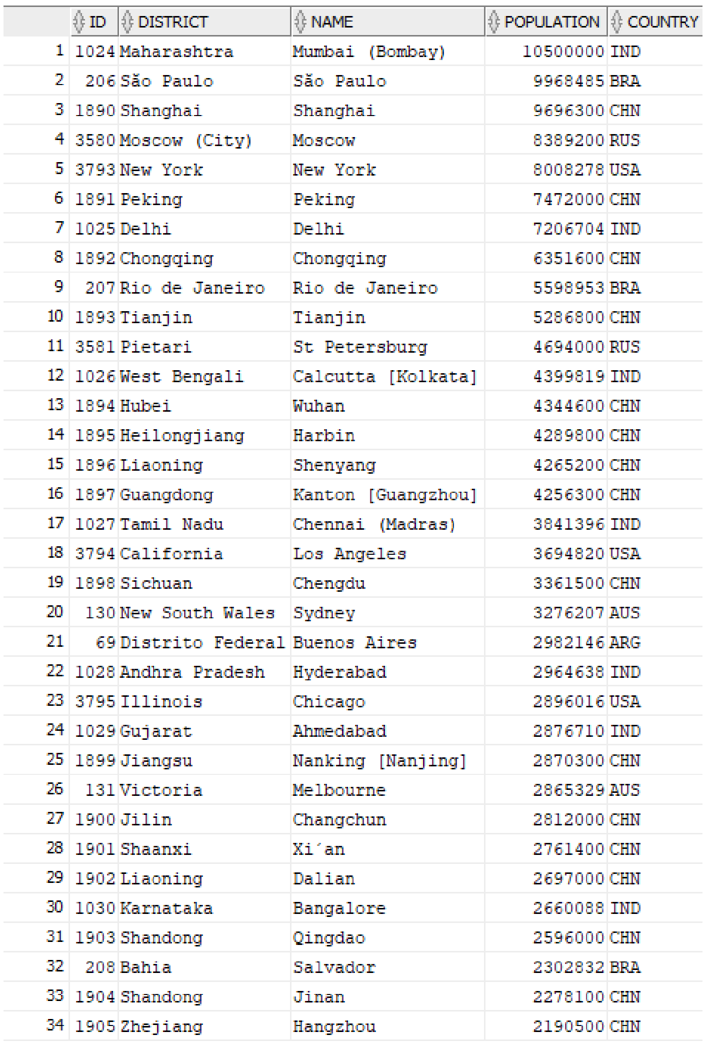


	LANGUAGE_NAME	REGION	LANGUAGE_POPULATION
1	Javanese	Southeast Asia	83570158
2	Papuan Languages	Melanesia	3792451
3	English	Australia and New Zealand	18695372
4	Russian	Eastern Europe	148136548
5	English	Micronesia/Caribbean	94
6	Arabic	Middle East	89153760
7	German	Western Europe	87155999,6
8	Portuguese	South America	166037997
9	Spanish	Caribbean	21530888
10	English	North America	258821522
11	Chinese	Eastern Asia	1175677671
12	Arabic	Northern Africa	140084044
13	Oromo	Eastern Africa	19395150
14	Kiribati	Micronesia	84235
15	Kongo	Central Africa	11480181
16	Samoan	Polynesia	147108
17	Zulu	Southern Africa	9508689
18	Hausa	Western Africa	29225396
19	Spanish	Central America	122159129
20	Swedish	Nordic Countries	8255142,6
21	English	British Islands	61728266,6
22	Hindi	Southern and Central Asia	405169038
23	Italian	Southern Europe	54303880
24	Lithuanian	Baltic Countries	3047066,4

Database	Statistics
POSTGRESQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=70, operationsPerSecond=42.857142857142854)
ORACLE	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=82, operationsPerSecond=36.58536585365854)
MYSQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=151, operationsPerSecond=19.867549668874172)
H2	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=1658, operationsPerSecond=1.8094089264173705)

- **Cities from 10 biggest countries**

```
SELECT town.*
FROM country
JOIN town
ON town.country = country.code
WHERE (
  SELECT COUNT(*)
  FROM country cntr
  WHERE cntr.surfacearea >= country.surfacearea
) <= 10
ORDER BY town.population DESC;
```

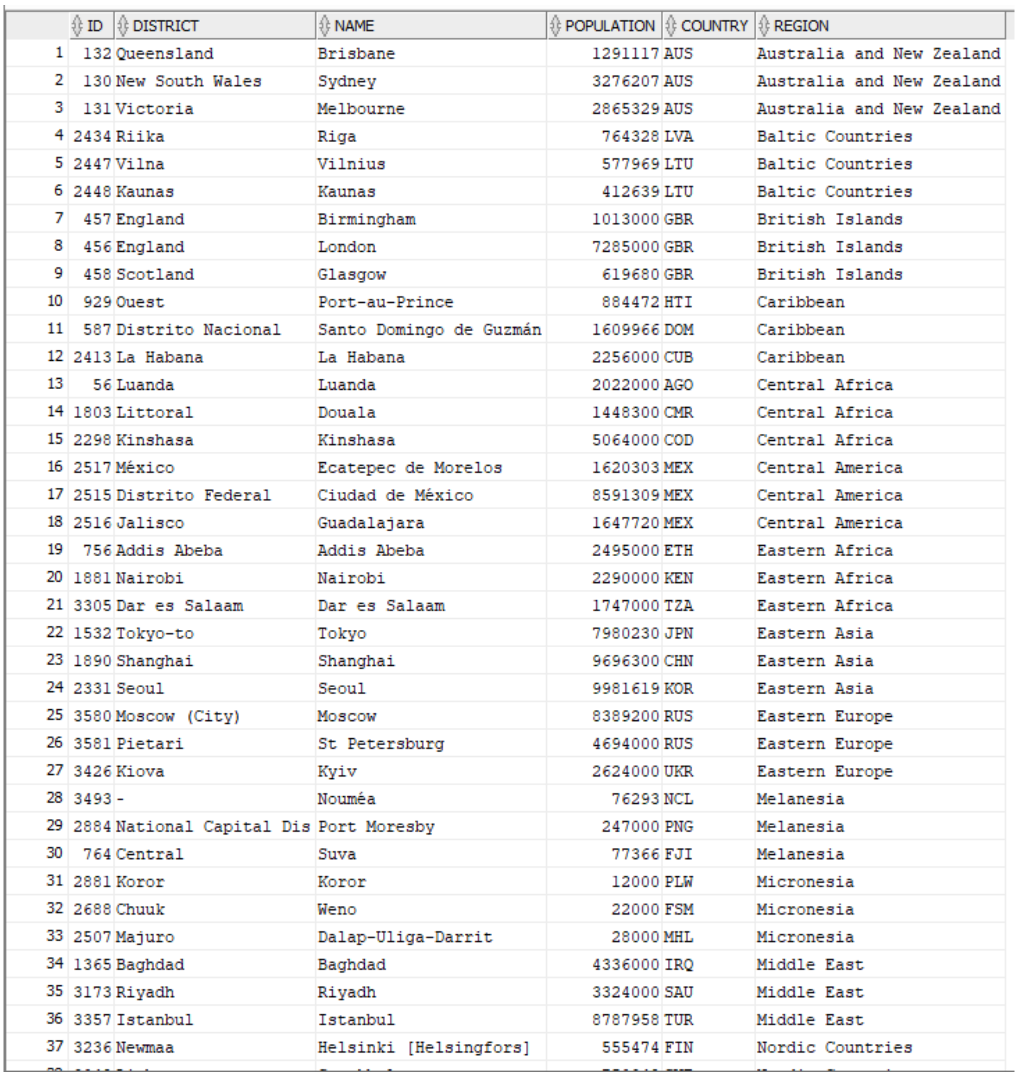


	ID	DISTRICT	NAME	POPULATION	COUNTRY
1	1024	Maharashtra	Mumbai (Bombay)	10500000	IND
2	206	São Paulo	São Paulo	9968485	BRA
3	1890	Shanghai	Shanghai	9696300	CHN
4	3580	Moscow (City)	Moscow	8389200	RUS
5	3793	New York	New York	8008278	USA
6	1891	Peking	Peking	7472000	CHN
7	1025	Delhi	Delhi	7206704	IND
8	1892	Chongqing	Chongqing	6351600	CHN
9	207	Rio de Janeiro	Rio de Janeiro	5598953	BRA
10	1893	Tianjin	Tianjin	5286800	CHN
11	3581	Pietari	St Petersburg	4694000	RUS
12	1026	West Bengali	Calcutta [Kolkata]	4399819	IND
13	1894	Hubei	Wuhan	4344600	CHN
14	1895	Heilongjiang	Harbin	4289800	CHN
15	1896	Liaoning	Shenyang	4265200	CHN
16	1897	Guangdong	Kanton [Guangzhou]	4256300	CHN
17	1027	Tamil Nadu	Chennai (Madras)	3841396	IND
18	3794	California	Los Angeles	3694820	USA
19	1898	Sichuan	Chengdu	3361500	CHN
20	130	New South Wales	Sydney	3276207	AUS
21	69	Distrito Federal	Buenos Aires	2982146	ARG
22	1028	Andhra Pradesh	Hyderabad	2964638	IND
23	3795	Illinois	Chicago	2896016	USA
24	1029	Gujarat	Ahmedabad	2876710	IND
25	1899	Jiangsu	Nanking [Nanjing]	2870300	CHN
26	131	Victoria	Melbourne	2865329	AUS
27	1900	Jilin	Changchun	2812000	CHN
28	1901	Shaanxi	Xi´an	2761400	CHN
29	1902	Liaoning	Dalian	2697000	CHN
30	1030	Karnataka	Bangalore	2660088	IND
31	1903	Shandong	Qingdao	2596000	CHN
32	208	Bahia	Salvador	2302832	BRA
33	1904	Shandong	Jinan	2278100	CHN
34	1905	Zhejiang	Hangzhou	2190500	CHN

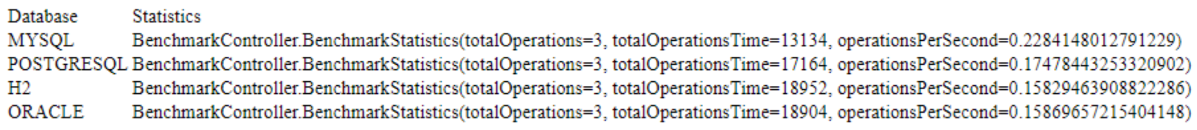
Database	Statistics
MYSQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=255, operationsPerSecond=11.76470588235294)
POSTGRESQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=325, operationsPerSecond=9.23076923076923)
H2	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=1999, operationsPerSecond=1.5007503751875937)
ORACLE	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=115, operationsPerSecond=26.08695652173913)

- **Top 3 cities from every region based on population**

```
SELECT town.*, country.region
FROM town
JOIN country
ON town.country = country.code
WHERE (
  SELECT COUNT(*)
  FROM town twn
  JOIN country cntr
  ON twn.country = cntr.code
  WHERE twn.population >= town.population AND country.region = cntr.region
) <= 3
ORDER BY country.region;
```



	ID	DISTRICT	NAME	POPULATION	COUNTRY	REGION
1	132	Queensland	Brisbane	1291117	AUS	Australia and New Zealand
2	130	New South Wales	Sydney	3276207	AUS	Australia and New Zealand
3	131	Victoria	Melbourne	2865329	AUS	Australia and New Zealand
4	2434	Riika	Riga	764328	LVA	Baltic Countries
5	2447	Vilna	Vilnius	577969	LTU	Baltic Countries
6	2448	Kaunas	Kaunas	412639	LTU	Baltic Countries
7	457	England	Birmingham	1013000	GBR	British Islands
8	456	England	London	7285000	GBR	British Islands
9	458	Scotland	Glasgow	619680	GBR	British Islands
10	929	Ouest	Port-au-Prince	884472	HTI	Caribbean
11	587	Distrito Nacional	Santo Domingo de Guzmán	1609966	DOM	Caribbean
12	2413	La Habana	La Habana	2256000	CUB	Caribbean
13	56	Luanda	Luanda	2022000	AGO	Central Africa
14	1803	Littoral	Douala	1448300	CMR	Central Africa
15	2298	Kinshasa	Kinshasa	5064000	COD	Central Africa
16	2517	México	Ecatepec de Morelos	1620303	MEX	Central America
17	2515	Distrito Federal	Ciudad de México	8591309	MEX	Central America
18	2516	Jalisco	Guadalajara	1647720	MEX	Central America
19	756	Addis Abeba	Addis Abeba	2495000	ETH	Eastern Africa
20	1881	Nairobi	Nairobi	2290000	KEN	Eastern Africa
21	3305	Dar es Salaam	Dar es Salaam	1747000	TZA	Eastern Africa
22	1532	Tokyo-to	Tokyo	7980230	JPN	Eastern Asia
23	1890	Shanghai	Shanghai	9696300	CHN	Eastern Asia
24	2331	Seoul	Seoul	9981619	KOR	Eastern Asia
25	3580	Moscow (City)	Moscow	8389200	RUS	Eastern Europe
26	3581	Pietari	St Petersburg	4694000	RUS	Eastern Europe
27	3426	Kiova	Kyiv	2624000	UKR	Eastern Europe
28	3493	-	Nouméa	76293	NCL	Melanesia
29	2884	National Capital Dis	Port Moresby	247000	PNG	Melanesia
30	764	Central	Suva	77366	FJI	Melanesia
31	2881	Koror	Koror	12000	PLW	Micronesia
32	2688	Chuuk	Weno	22000	FSM	Micronesia
33	2507	Majuro	Dalap-Uliga-Darrit	28000	MHL	Micronesia
34	1365	Baghdad	Baghdad	4336000	IRQ	Middle East
35	3173	Riyadh	Riyadh	3324000	SAU	Middle East
36	3357	Istanbul	Istanbul	8787958	TUR	Middle East
37	3236	Newmaa	Helsinki [Helsingfors]	555474	FIN	Nordic Countries



Database	Statistics
MYSQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=13134, operationsPerSecond=0.2284148012791229)
POSTGRESQL	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=17164, operationsPerSecond=0.17478443253320902)
H2	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=18952, operationsPerSecond=0.15829463908822286)
ORACLE	BenchmarkController.BenchmarkStatistics(totalOperations=3, totalOperationsTime=18904, operationsPerSecond=0.15869657215404148)

3. Conclusions

Three of the testes databases can be used in production environment, Oracle, MySQL, PostgreSQL. H2 is here only for contrast. As you can see H2 have worst execution times for every query, in first case H2 was about 20 times worst than other databases.

Let’s then focus on these three databases mentioned before, in each case different database won, but in general, Oracle had the most stable results, it of course depends on many factors, for example all of these engines works simultaneously on my local machine, which of course is not the best testing environment.

Another case are indexes, in each queries there was some subqueries, this means at least square complexity, indexes on COUNTRY.POPULATION, COUNTRY.SURFACEAREA and TOWN.POPULATION would for sure speed up a bit all the queries, there can be more indexes of course, but I think, these on mentioned numeric values, are most valuable, as I often searched using these values. Additionally, it is difficult to find two same values for mentioned columns, and that’s good from index point of view.