



Міністерство освіти і науки України

Національний технічний університет України

“Київський політехнічний інститут імені Ігоря Сікорського”

Факультет інформатики та обчислювальної техніки

Кафедра інформатики та програмної інженерії

Лабораторна робота №1

Обробка надвеликих масивів даних

Тема: Розподілена обробка даних в Apache Hadoop та Apache Hive

Виконав

студент групи ІП-11:

Панченко С. В.

Перевірив:

Смілянець Ф. А.

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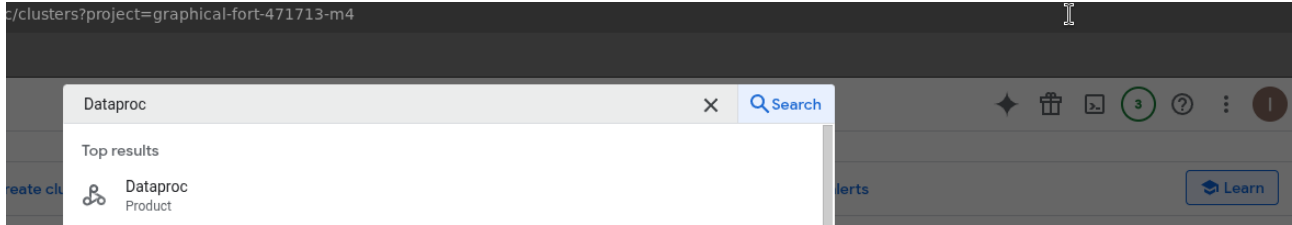
1 META

Відпрацювати повний цикл підготовки Big Data-проєкту: налаштувати компоненти Hadoop/Spark/Hive, реалізувати завантаження даних та ETL-процедури мовами Java/Python/Scala, спроектувати архітектуру бази даних і підготувати короткий аналітичний звіт про результати обробки.

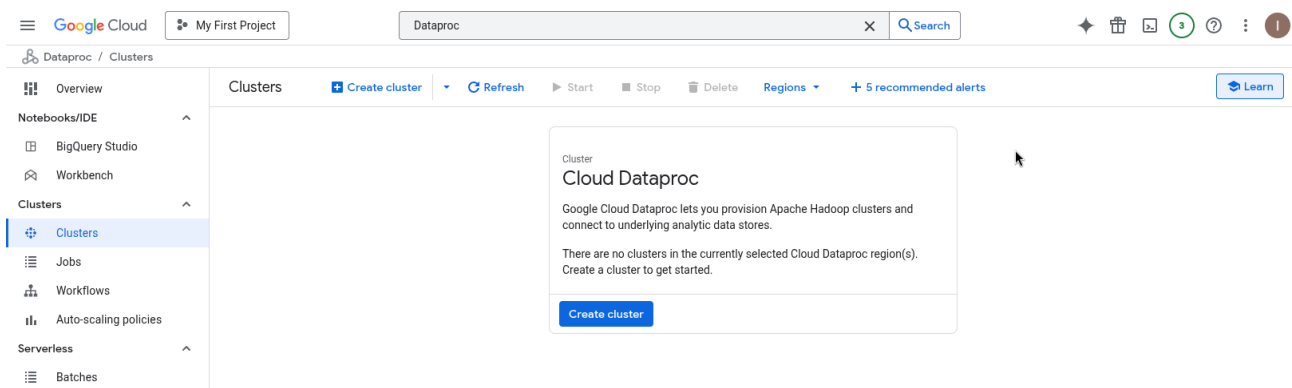
2 ВИКОНАННЯ

2.1 Підготовка даних

Обираю Dataproc.



Обираю вкладку кластери.



Створюю кластер з основною ногою та двома нодами-worker'ами.

Dataproc

ite Engine

Name

Cluster name *
cluster-3f64

Location

Region *
us-central1

Zone *
Any

Cluster type

☒ Standard (1 master, N workers)

☐ Single Node (1 master, 0 workers)
Provides one node that acts as both master and worker. Good for proof-of-concept or small-scale processing

☐ High availability (3 masters, N workers)
Hadoop high availability mode provides uninterrupted YARN and HDFS operations despite single-node failures or reboots

Versioning

Use a custom image to load pre-installed packages. [Learn more](#)

Image type and version

2.2-debian12

Release date

First released on 8 Decemr

[Change](#)

✓ General purpose

Memory-optimised

Machine types for common workloads, optimised for cost and flexibility

Series

N4


▼

Powered by Intel Emerald Rapids CPU platform

Machine type

n4-standard-2 (2 vCPU, 1 core, 8 GB memory)

▼



vCPU

2

Memory

8 GB

✓ CPU platform and GPU

Number of worker nodes *

2

?

Primary disk size *

200

GB

?

Primary disk type *

Hyperdisk Balanced Disk

▼

?

IOPS

IOPS

?

Throughput

MB/s

?

Number of local SSDs *

0

▼

x 375GB

?

Local SSD interface

SCSI

▼

?

Створений кластер.

<input type="checkbox"/>	Name ↑	Status	Region	Zone	Base image version	Total worker nodes	Flexible VMs?	Scheduled deletion	Cloud Storage staging bucket	Created	Labels
<input type="checkbox"/>	cluster-11a7	Running	us-central1	us-central1-a	2.2.64-debian12	2	No	Off	dataproc-staging-us-central1-72670239535-v9tk8dxz	13 Sept 2025, 17:39:44	goog-dataproc... enabled

Відкриваємо SSH.

First Project

dataproc

Search

VM instances

Create instance

Import VM

Refresh

Learn

Instances

Observability

Instance schedules

VM instances

Filter

Enter property name or value

<input type="checkbox"/>	Status	Name ↑	Zone	Recommendations	In use by	Internal IP	External IP	Connect
<input type="checkbox"/>	✓	cluster-11a7-m	us-central1-a			10.128.0.2 (nic0)		SSH
<input type="checkbox"/>	✓	cluster-11a7-w-0	us-central1-a			10.128.0.4 (nic0)		SSH
<input type="checkbox"/>	✓	cluster-11a7-w-1	us-central1-a			10.128.0.3 (nic0)		SSH

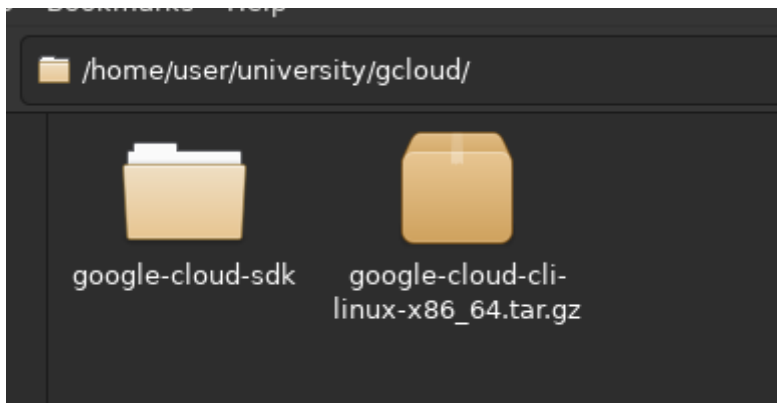
Related actions

Hide

Але для початку встановимо gcloud на мою машину на Archlinux. Завантажимо архів з gcloud.

Platform	Package name	Size	SHA256 Checksum
Linux 64-bit (x86_64)	google-cloud-cli-linux-x86_64.tar.gz	150.2 MB	8ba7e746ca05f225e5a73952bbc03f4086a5f6 5fd94f3717df6f75f212587159

Розпакуємо його.



Встановимо gcloud.

```
user@archlinux:~/university/gcloud/google-cloud-sdk$ bash install.sh
Welcome to the Google Cloud CLI!

To help improve the quality of this product, we collect anonymized usage data
and anonymized stacktraces when crashes are encountered; additional information
is available at <https://cloud.google.com/sdk/usage-statistics>. This data is
handled in accordance with our privacy policy
<https://cloud.google.com/terms/cloud-privacy-notice>. You may choose to opt in this
collection now (by choosing 'Y' at the below prompt), or at any time in the
future by running the following command:

    gcloud config set disable_usage_reporting false

Do you want to help improve the Google Cloud CLI (y/N)? y

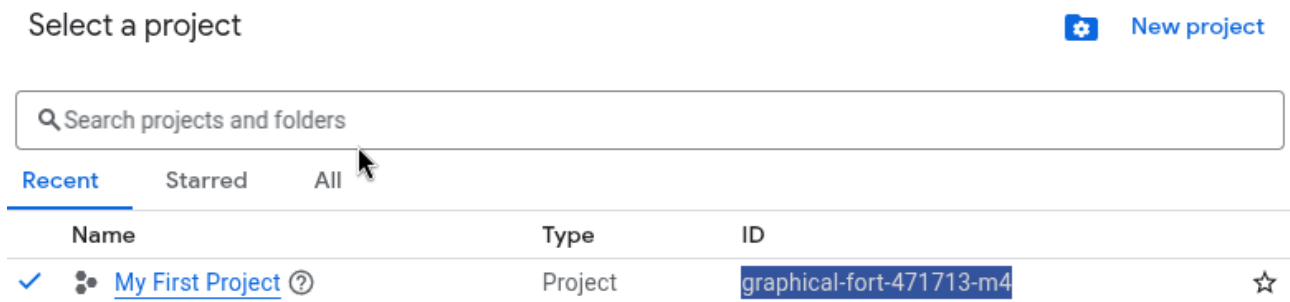
Your current Google Cloud CLI version is: 538.0.0
The latest available version is: 538.0.0
```

Components			
Status	Name	ID	Size
Not Installed	App Engine Go Extensions	app-engine-go	4.7 MiB
Not Installed	Artifact Registry Go Module Package Helper	package-go-module	< 1 MiB
Not Installed	Cloud Bigtable Command Line Tool	cbt	20.5 MiB
Not Installed	Cloud Bigtable Emulator	bigtable	8.5 MiB
Not Installed	Cloud Datastore Emulator	cloud-datastore-emulator	36.2 MiB
Not Installed	Cloud Firestore Emulator	cloud-firestore-emulator	53.6 MiB
Not Installed	Cloud Pub/Sub Emulator	pubsub-emulator	49.8 MiB
Not Installed	Cloud Run Proxy	cloud-run-proxy	13.3 MiB
Not Installed	Cloud SQL Proxy v2	cloud-sql-proxy	15.7 MiB
Not Installed	Cloud Spanner Emulator	cloud-spanner-emulator	37.7 MiB
Not Installed	Google Container Registry's Docker credential helper	docker-credential-gcr	1.8 MiB
Not Installed	Kustomize	kustomize	4.3 MiB

Залогінімося в gcloud.

```
user@archlinux:~/university/gcloud/google-cloud-sdk$ gcloud auth login
Your browser has been opened to visit:
```

Визначимо ID поточного проєкту та збережемо його в конфігу gcloud.



```
user@archlinux:~/university/gcloud/google-cloud-sdk$ gcloud config set project graphical-fort-471713-m4
Updated property [core/project].
```

Перекинемо файли FOP.zip та UO.zip на віртуальну машину.

```
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute scp FOP.zip user@cluster-11a7-m:~/FOP.zip
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
External IP address was not found; defaulting to using IAP tunneling.
WARNING:
To increase the performance of the tunnel, consider installing NumPy. For instructions,
please see https://cloud.google.com/iap/docs/using-tcp-forwarding#increasing_the_tcp_upload_bandwidth
FOP.zip 100% 245MB 4.4MB/s 00:55
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute scp UO.zip user@cluster-11a7-m:~/UO.zip
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
External IP address was not found; defaulting to using IAP tunneling.
WARNING:
To increase the performance of the tunnel, consider installing NumPy. For instructions,
please see https://cloud.google.com/iap/docs/using-tcp-forwarding#increasing_the_tcp_upload_bandwidth
UO.zip 100% 192MB 4.4MB/s 00:43
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$
```

Під'єднаємося до віртуальної машини.

```
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute ssh cluster-11a7-m
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
External IP address was not found; defaulting to using IAP tunneling.
WARNING:
To increase the performance of the tunnel, consider installing NumPy. For instructions,
please see https://cloud.google.com/iap/docs/using-tcp-forwarding#increasing_the_tcp_upload_bandwidth
Linux cluster-11a7-m 6.1.0-38-cloud-amd64 #1 SMP PREEMPT_DYNAMIC Debian 6.1.147-1 (2025-08-02) x86_64
The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Sep 13 15:14:37 2025 from 35.235.241.17
user@cluster-11a7-m:~$
```

Створимо директорії в hadoop.

```
user@cluster-11a7-m:~$ hadoop fs -mkdir /tables_data
hadoop fs -mkdir /tables_data/UO
hadoop fs -mkdir /tables_data/FOP
```

Розпакуємо zip-файли даних та завантажимо їх в hadoop.

```

user@cluster-11a7-m:~$ unzip FOP.zip
Archive:  FOP.zip
  inflating: FOP.csv
user@cluster-11a7-m:~$ unzip UO.zip
Archive:  UO.zip
  inflating: UO.csv
user@cluster-11a7-m:~$ hadoop fs -put ./UO.csv /tables_data/UO/
hadoop fs -put ./FOP.csv /tables_data/FOP/
user@cluster-11a7-m:~$ █

```

Відкриємо Apache Hive.

```

user@cluster-11a7-m:~$ hive
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/usr/lib/tez/lib/slf4j-reload4j-1.7.36.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/usr/lib/hadoop/lib/slf4j-reload4j-1.7.36.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Reload4jLoggerFactory]
SLF4J: Class path contains multiple SLF4J bindings.
SLF4J: Found binding in [jar:file:/usr/lib/tez/lib/slf4j-reload4j-1.7.36.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: Found binding in [jar:file:/usr/lib/hadoop/lib/slf4j-reload4j-1.7.36.jar!/org/slf4j/impl/StaticLoggerBinder.class]
SLF4J: See http://www.slf4j.org/codes.html#multiple_bindings for an explanation.
SLF4J: Actual binding is of type [org.slf4j.impl.Reload4jLoggerFactory]
Hive Session ID = c2e09510-c595-4527-87e0-57a2ae15ca07

Logging initialized using configuration in file:/etc/hive/conf.dist/hive-log4j2.properties Async: true
WARNING: An illegal reflective access operation has occurred
WARNING: Illegal reflective access by org.apache.hadoop.hive.common.StringInternUtils (file:/usr/lib/hive/lib/hive-common-3.1.3.jar) to field java.net.URI.string
WARNING: Please consider reporting this to the maintainers of org.apache.hadoop.hive.common.StringInternUtils
WARNING: Use --illegal-access=warn to enable warnings of further illegal reflective access operations
WARNING: All illegal access operations will be denied in a future release
Hive Session ID = 50fc9d72-ec1f-4ae5-b2b5-2507443454e1
hive> █

```

Створимо таблицю для UO.

```

hive> create external table UOtable(name string,EDRPOU string,ADDRESS string,BOSS string,founders string,fio string,KVED string,stan string) ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.OpenCSVSerde' STORED AS TEXTFILE LOCATION '/tables_data/UO/';
OK
Time taken: 1.205 seconds
hive> █

```

Створимо таблицю для FOP.

```

hive> create external table FOP_table(fio string,address string,kved string,stan string) ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.OpenCSVSerde' STORED AS TEXTFILE LOCATION '/tables_data/FOP/';
OK
Time taken: 0.545 seconds
hive> █

```

Встановимо для віртуальної машини зовнішній ефемерний ір для того щоб мати доступ до репозиторіїв apt та встановити postgresql.

My First Project

datapro

←

Edit cluster-11a7-m instance

default

Subnetwork

default IPv4 (10.128.0.0/20)

?

?

To use IPv6, you need an IPv6 subnet range.

Learn more

Network interface card

gVNIC

gVNIC compatible OS image required. [Learn more](#)

IP stack type

☒ IPv4 (single-stack)
 ☐ IPv4 and IPv6 (dual-stack)
 ☐ IPv6 (single-stack)

Internal IP address

10.128.0.2

Primary internal IPv4 address

Ephemeral

?

Alias IP ranges

+ Add IP range

External IPv4 address

Ephemeral

?

Network Service Tier

☒ Premium (current project-level tier, [change](#))
 ☐ Standard (us-central1)

200 GB/mo free in every region

Встановимо postgresql.

```

user@cluster-11a7-m:~$ sudo apt install postgresql
Reading package lists... Done
Building dependency tree... Done
Reading state information... Done
The following additional packages will be installed:
  libc-bin libc-dev-bin libc-devtools libc-l10n libc6 libc6-dbg libc6-dev libllvm14 libpq5 libxslt1.1 locales po
  ssl-cert sysstat
Suggested packages:
  glibc-doc libnss-nis libnss-nisplus postgresql-doc postgresql-doc-15 isag
The following NEW packages will be installed:
  libc-l10n libllvm14 libxslt1.1 locales postgresql postgresql-15 postgresql-client-15 postgresql-client-common
The following packages will be upgraded:
  libc-bin libc-dev-bin libc-devtools libc6 libc6-dbg libc6-dev libpq5
7 upgraded, 11 newly installed, 0 to remove and 77 not upgraded.
Need to get 59.1 MB of archives.
After this operation, 197 MB of additional disk space will be used.
Do you want to continue? [Y/n] Y
Get:1 file:/etc/apt/mirrors/debian.list Mirrorlist [30 B]
Get:2 https://deb.debian.org/debian bookworm/main amd64 libc6-dbg amd64 2.36-9+deb12u13 [7375 kB]
Get:3 https://deb.debian.org/debian bookworm/main amd64 libc-devtools amd64 2.36-9+deb12u13 [55.0 kB]
Get:4 https://deb.debian.org/debian bookworm/main amd64 libc6-dev amd64 2.36-9+deb12u13 [1904 kB]
Get:5 https://deb.debian.org/debian bookworm/main amd64 libc-dev-bin amd64 2.36-9+deb12u13 [47.4 kB]
Get:6 https://deb.debian.org/debian bookworm/main amd64 libc6 amd64 2.36-9+deb12u13 [2758 kB]
Get:7 https://deb.debian.org/debian bookworm/main amd64 libc-bin amd64 2.36-9+deb12u13 [699 kB]

```

Підключимося до postgresql від sudo та створимо користувача user та базу даних.

```
user@cluster-11a7-m:~$ sudo -u postgres psql
psql (15.14 (Debian 15.14-0+deb12u1))
Type "help" for help.

postgres=#
```

```
postgres=# CREATE USER "user" WITH CREATEDB;
CREATE ROLE
postgres=# CREATE DATABASE mydb;
CREATE DATABASE
postgres=#
```

```
postgres=# ALTER USER "user" WITH PASSWORD '1111';
ALTER ROLE
postgres=#
```

Створимо дві таблиці UO_table та FOP_table.

```
mydb=> CREATE TABLE UO_table (
    name TEXT,
    EDRPOU TEXT,
    ADDRESS TEXT,
    BOSS TEXT,
    founders TEXT,
    fio TEXT,
    KVED TEXT,
    stan TEXT
);
CREATE TABLE
mydb=> CREATE TABLE FOP_table (
    fio TEXT,
    address TEXT,
    kved TEXT,
    stan TEXT
);
CREATE TABLE
```

UO.csv має JSON рядки, і в них ліпки не правильно заескейпліні, тому заекспортуємо hive таблицю у csv.

```

hive> INSERT OVERWRITE LOCAL DIRECTORY '/home/user/hive_output'
> ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.OpenCSVSerde'
> WITH SERDEPROPERTIES (
>   "separatorChar" = ",",
>   "quoteChar"     = "\"",
>   "escapeChar"    = "\\"
> )
> STORED AS TEXTFILE
> SELECT * FROM uotable;
Query ID = user_20250913174234_80ce4c61-5d06-41d6-bdff-341d4af34578
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0006)

```

VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	9	9	0	0	0	0

```

VERTICES: 01/01 [=====>>>] 100% ELAPSED TIME: 32.51 s
Moving data to local directory /home/user/hive_output
OK
Time taken: 456.621 seconds

```

```

hive> INSERT OVERWRITE LOCAL DIRECTORY '/home/user/hive_output'
> ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.OpenCSVSerde'
> WITH SERDEPROPERTIES (
>   "separatorChar" = ",",
>   "quoteChar"     = "\"",
>   "escapeChar"    = "\\"
> )
> STORED AS TEXTFILE
> SELECT * FROM uotable;

```

Об'єднаємо результат експорту таблиці в один файл.

```

user@cluster-11a7-m:~$ less hive_output/000001_0
user@cluster-11a7-m:~$ cat hive_output/* > hive_output.csv
user@cluster-11a7-m:~$ less hive_output.csv

```

Далі заімпортуємо цю таблиці в PostgreSQL.

```
mydb=> \copy uo_table (name, edrpou, address, boss, founders, fio, kved, stan)
FROM '/home/user/hive_output.csv'
WITH (
  FORMAT csv,
  DELIMITER ',',
  QUOTE '"',
  ESCAPE '\',
  HEADER false
);
COPY 1659657
```

2.2 Завдання 1.1

Визначимо кількість рядків та підрахуємо час виконання в hive та postgresql.

```
hive> select count(*) from uotable;
Query ID = user_20250913181308_1f69df39-224e-42bf-972d-23fe4f104a77
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0008)
```

	VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	9	9	0	0	0	0	0
Reducer 2	container	SUCCEEDED	1	1	0	0	0	0	0

```
VERTICES: 02/02 [=====>>] 100% ELAPSED TIME: 21.90 s
OK
1659657
Time taken: 25.82 seconds, Fetched: 1 row(s)
hive>
```

```
mydb=> EXPLAIN ANALYZE SELECT COUNT(*) FROM UO_table;
QUERY PLAN
-----
Finalize Aggregate (cost=137470.44..137470.45 rows=1 width=8) (actual time=350.365..355.825 rows=1 loops=1)
-> Gather (cost=137470.23..137470.44 rows=2 width=8) (actual time=350.329..355.792 rows=3 loops=1)
    Workers Planned: 2
    Workers Launched: 2
    -> Partial Aggregate (cost=136470.23..136470.24 rows=1 width=8) (actual time=317.023..317.025 rows=1 loops=3)
        -> Parallel Seq Scan on uo_table (cost=0.00..134740.98 rows=691698 width=0) (actual time=0.031..250.194 rows=553219 loops=3)
Planning Time: 0.058 ms
JIT:
  Functions: 8
  Options: Inlining false, Optimization false, Expressions true, Deforming true
  Timing: Generation 0.615 ms, Inlining 0.000 ms, Optimization 1.112 ms, Emission 13.151 ms, Total 14.877 ms
Execution Time: 356.122 ms
(12 rows)
mydb=>
```

2.3 Завдання 1.2

```
SELECT name, edrpou, address, ROW_NUMBER() OVER
(PARTITION BY address ORDER BY edrpou) AS rn_by_place
FROM uotable LIMIT 20;
```

```
hive> SELECT name, edrpou, address, ROW_NUMBER() OVER (PARTITION BY address ORDER BY edrpou) AS rn_by_place FROM uotable LIMIT 20;
Query ID = user_20250913102033_052cb03-c786-4240-8c99-dedb438e98c8
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0009)
```

VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	9	9	0	0	0	0
Reducer 2	container	SUCCEEDED	49	49	0	0	0	0

VERTICES: 02/02 [=====] 100% ELAPSED TIME: 31.91 s

```
OK
ДІПІРІС ПІДПРИЄМСТВО "ФІРМА"АВЕРС" ВІДКРИТОГО АКЦІОНЕРНОГО ТОВАРИСТВА "ОРІАНА",20550821,77300 Івано-Франківська обл. NULL 1
18 ДЕРЖАВНА ПОЖЕЖНО-РЯТУВАЛЬНА ЧАСТИНА УПРАВЛІННЯ ДЕРЖАВНОЇ СЛУЖБИ УКРАЇНИ З НАДЗВИЧАЙНИХ СИТУАЦІЙ В ІВАНО-ФРАНКІВСЬКІЙ ОБЛАСТІ З ОХОРОНИ ОБ'ЄКТІВ (ПАТ "ДТЕК ЗАХІДЕНЕРГО"),24521666,77111 Івано-Франківська обл. NULL 2
ВІЛЬШАНСЬКА РАЙОННА ОРГАНІЗАЦІЯ ПОЛІТИЧНОЇ ПАРТІЇ ВСЕУКРАЇНСЬКЕ ОБ'ЄДНАННЯ "ГРОМАДА",23904267,Кіровоградська обл. Вільшанський район,NULL,(),NULL,NULL,зареєстровано NULL 3
ПЕРВИННА ПРОСПІЛКОВА ОРГАНІЗАЦІЯ ДП "ШАХТА "НОВА" НЕЗАЛЕЖНОЇ ПРОСПІЛКИ ГІРНИКІВ ДОНБАСУ (НПГД),34150982,85200 Донецька обл. NULL 4
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Time taken: 35.237 seconds, Fetched: 20 row(s)
hive>
```

EXPLAIN ANALYZE SELECT name, edrpou, address,
ROW_NUMBER() OVER (PARTITION BY address ORDER BY edrpou)
AS rn_by_place FROM UO_table LIMIT 20;

```
mydb=> EXPLAIN ANALYZE SELECT name, edrpou, address, ROW_NUMBER() OVER (PARTITION BY address ORDER BY edrpou) AS rn_by_place FROM UO_table LIMIT 20;
QUERY PLAN
```

Limit	cost=373060.96..373063.64	rows=20	width=265	(actual time=2891.773..2928.666	rows=20	loops=1)
-> WindowAgg	(cost=373060.96..595455.50	rows=1660076	width=265)	(actual time=2887.545..2924.435	rows=20	loops=1)
-> Gather Merge	(cost=373060.96..566404.17	rows=1660076	width=257)	(actual time=2887.501..2924.375	rows=21	loops=1)
Workers Planned: 2						
Workers Launched: 2						
-> Sort	(cost=372060.94..373790.18	rows=691698	width=257)	(actual time=2338.253..2338.316	rows=206	loops=3)
Sort Key: address, edrpou						
Sort Method: external merge	Disk: 148296kB					
Worker 0: Sort Method: external merge	Disk: 145624kB					
Worker 1: Sort Method: external merge	Disk: 146944kB					
-> Parallel Seq Scan on uo_table	(cost=0.00..134740.98	rows=691698	width=257)	(actual time=5.519..313.500	rows=553219	loops=3)

Planning Time: 0.089 ms
JIT:
Functions: 11
Options: Inlining false, Optimization false, Expressions true, Deforming true
Timing: Generation 1.159 ms, Inlining 0.000 ms, Optimization 8.410 ms, Emission 12.298 ms, Total 21.867 ms
Execution Time: 3049.713 ms
(17 rows)

```
mydb=>
```

2.4 Завдання 1.3

EXPLAIN ANALYZE SELECT * FROM UO_table uo join FOP_table
fop on uo.address = fop.address join FOP_table fop1 on
uo.address = fop1.address;

```

mydb=> EXPLAIN ANALYZE SELECT * FROM UO_table uo join FOP_table fop on uo.address = fop.address join FOP_table fop1 on uo.address = fop1.address;
QUERY PLAN
-----
Gather (cost=732420.59..4536304.41 rows=14573054 width=1276) (actual time=65118.282..136066.147 rows=283585188 loops=1)
  Workers Planned: 2
  Workers Launched: 2
  -> Parallel Hash Join (cost=731420.59..3077999.00 rows=6072106 width=1276) (actual time=65054.527..87665.205 rows=94528396 loops=3)
    Hash Cond: (uo.address = fop1.address)
    -> Parallel Hash Join (cost=365710.30..1060597.69 rows=2049406 width=937) (actual time=27895.150..46990.671 rows=529939 loops=3)
      Hash Cond: (uo.address = fop.address)
      -> Parallel Seq Scan on uo_table uo (cost=0.00..134740.98 rows=691698 width=598) (actual time=0.625..8969.723 rows=553219 loops=3)
      -> Parallel Hash (cost=248448.02..248448.02 rows=2042102 width=339) (actual time=18082.463..18082.465 rows=1633268 loops=3)
        Buckets: 32768 Batches: 256 Memory Usage: 7776kB
        -> Parallel Seq Scan on fop_table fop (cost=0.00..248448.02 rows=2042102 width=339) (actual time=88.732..16829.727 rows=1633268 loops=3)
          Buckets: 32768 Batches: 256 Memory Usage: 7776kB
          -> Parallel Seq Scan on fop_table fop1 (cost=0.00..248448.02 rows=2042102 width=339) (actual time=1.056..15486.627 rows=1633268 loops=3)
    Planning Time: 15.516 ms
  JIT:
    Functions: 51
    Options: Inlining true, Optimization true, Expressions true, Deforming true
    Timing: Generation 6.293 ms, Inlining 389.395 ms, Optimization 734.230 ms, Emission 431.705 ms, Total 1561.623 ms
  Execution Time: 151065.981 ms
(20 rows)
mydb=>

```

PostgreSQL запит виконався лише з 8-го разу, після того як почистив оперативу та повідключав сторонні сервіси на VM.

На hive запит зайняв багато часу більше 1000 секунд.

```

hive> SELECT * FROM uotable uo join fop_table fop on uo.address = fop.address join fop_table fop1 on uo.address = fop1.address;
No Stats for default@uotable, Columns: edrpou, address, boss, name, kved, stan, founders, fio
No Stats for default@fop_table, Columns: address, kved, stan, fio
No Stats for default@fop_table, Columns: address, kved, stan, fio
Query ID = user_20250913185314_b5b496d7-e50b-4616-a473-f0106fd64180
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0010)

-----
VERTICES    MODE      STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
-----
Map 1 ..... container  SUCCEEDED    6         6         0         0         0         0
Map 4 ..... container  SUCCEEDED    9         9         0         0         0         0
Reducer 2 ..... container  SUCCEEDED  137       137         0         0         0         0
Reducer 3 ..  container  RUNNING      137        54         2        81         3         0
-----
VERTICES: 03/04 [=====>-----] 71%  ELAPSED TIME: 1007.99 s
-----
Status: Submitted
Interrupting... Be patient, this might take some time.
Press Ctrl+C again to kill JVM
Trying to shutdown DAG
Exiting the JVM
Trying to shutdown DAG
user@cluster-11a7-m:~$

```

Спробуємо виконати запит без останнього джоїна.

```
EXPLAIN ANALYZE SELECT * FROM uotable uo join fop_table
fop on uo.address = fop.address;
```

```
hive> EXPLAIN ANALYZE SELECT * FROM uotable uo join fop.table fop on uo.address = fop.address;
Query ID = user_20250913194036_99708c5e-1f42-464b-ab03-81f7c35284d8
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0013)
```

	VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	9	9	0	0	0	0	0
Map 3	container	SUCCEEDED	6	6	0	0	0	0	0
Reducer 2	container	SUCCEEDED	114	114	0	0	0	0	0

```
VERTICES: 03/03 [=====>>>] 100% ELAPSED TIME: 94.28 s
OK
OK
Plan optimized by CBO.

Vertex dependency in root stage
Reducer 2 <- Map 1 (SIMPLE_EDGE), Map 3 (SIMPLE_EDGE)

Stage-0
Fetch Operator
  limit:-1
Stage-1
  Reducer 2
  File Output Operator [FS_10]
    Merge Join Operator [MERGEJOIN_15] (rows=31344672/1589816 width=584)
      Conds:RS_18._col2=RS_21._col1(Inner),Output:["_col0","_col1","_col2","_col3","_col4","_col5","_col6","_col7","_col8","_col9","_col10","_col11"]
    <-Map 1 [SIMPLE_EDGE] vectorized
    SHUFFLE [RS_18]
      PartitionCols:_col2
      Select Operator [SEL_17] (rows=12585021/1659617 width=984)
        Output:["_col0","_col1","_col2","_col3","_col4","_col5","_col6","_col7"]
        Filter Operator [FIL_16] (rows=12585021/1659617 width=984)
          predicate:address is not null
          TableScan [TS_0] (rows=12585021/1659657 width=984)
            default@uotable,uo,Tbl:COMPLETE,Col:NONE,Output:["name","edrpou","address","boss","founders","fio","kved","stan"]
    <-Map 3 [SIMPLE_EDGE] vectorized
    SHUFFLE [RS_21]
      PartitionCols:_col1
      Select Operator [SEL_20] (rows=28495156/4899804 width=584)
        Output:["_col0","_col1","_col2","_col3"]
        Filter Operator [FIL_19] (rows=28495156/4899804 width=584)
          predicate:address is not null
          TableScan [TS_3] (rows=28495156/4899804 width=584)
            default@fop.table,fop,Tbl:COMPLETE,Col:NONE,Output:["fio","address","kved","stan"]

Time taken: 397.997 seconds, Fetched: 32 row(s)
```

2.5 Завдання 1.4

Завантажимо Lending Club Loans_synthetic1.csv на віртуальну машину.

```
gcloud compute scp Lending\ Club\ Loans_synthetic1.csv
user@cluster-11a7-m:~/lending.csv
```

```
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute scp Lending\ Club\ Loans_synthetic1.csv user@cluster-11a7-m:~/lending.csv
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
Lending Club Loans_synthetic1.csv
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute ssh cluster-11a7-m
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
Linux cluster-11a7-m 6.1.0-38-cloud-amd64 #1 SMP PREEMPT_DYNAMIC Debian 6.1.147-1 (2025-08-02) x86_64

5 updates could not be installed automatically. For more details,
see /var/log/unattended-upgrades/unattended-upgrades.log

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.
Last login: Sat Sep 13 16:22:07 2025 from 35.235.241.17
user@cluster-11a7-m:~$ ls
lending.csv
user@cluster-11a7-m:~$
```

Завантажимо дані у hive.

```
hdfs dfs -mkdir -p /data/lending_club
hdfs dfs -put -f "Lending Club Loans_synthetic1.csv"
/data/lending_club/
```

```
user@cluster-11a7-m:~$ hdfs dfs -mkdir -p /data/lending_club
user@cluster-11a7-m:~$ hdfs dfs -put -f lending.csv /data/lending_club/
```


Створимо зовнішню таблицю для початкового завантаження даних.

```

CREATE EXTERNAL TABLE lending_club_raw (
    loan_amount          INT,
    payments_term        STRING,
    monthly_payment      DOUBLE,
    grade                INT,
    working_years         INT,
    home                 STRING,
    annual_income         DOUBLE,
    verification         STRING,
    purpose              STRING,
    debt_to_income       DOUBLE,
    delinquency          INT,
    inquiries            INT,
    open_credit_lines     INT,
    derogatory_records   INT,
    revolving_balance     INT,
    revolving_rate       DOUBLE,
    total_accounts       INT,
    bankruptcies         INT,
    fico_average         INT,
    loan_risk            STRING
)
ROW FORMAT SERDE
    'org.apache.hadoop.hive.serde2.OpenCSVSerde'
WITH SERDEPROPERTIES (
    "separatorChar" = ";",
    "quoteChar"     = "\"",
    "escapeChar"    = "\\"
)
STORED AS TEXTFILE

```

```
LOCATION '/data/lending_club'
```

```
TBLPROPERTIES ("skip.header.line.count"="1");
```

```
hive> CREATE EXTERNAL TABLE lending_club_raw (
>   loan_amount          INT,
>   payments_term        STRING,
>   monthly_payment      DOUBLE,
>   grade                INT,
>   working_years        INT,
>   home                 STRING,
>   annual_income        DOUBLE,
>   verification         STRING,
>   purpose              STRING,
>   debt_to_income       DOUBLE,
>   delinquency          INT,
>   inquiries            INT,
>   open_credit_lines    INT,
>   derogatory_records   INT,
>   revolving_balance     INT,
>   revolving_rate        DOUBLE,
>   total_accounts       INT,
>   bankruptcies         INT,
>   fico_average         INT,
>   loan_risk            STRING
> )
> ROW FORMAT SERDE 'org.apache.hadoop.hive.serde2.OpenCSVSerde'
> WITH SERDEPROPERTIES (
>   "separatorChar" = ";",
>   "quoteChar"     = "\"",
>   "escapeChar"    = "\\"
> )
> STORED AS TEXTFILE
> LOCATION '/data/lending_club'
> TBLPROPERTIES ("skip.header.line.count"="1");
OK
Time taken: 0.575 seconds
```

Створимо partitioned таблицю.

```
SET hive.exec.dynamic.partition=true;
```

```
SET hive.exec.dynamic.partition.mode=nonstrict;
```

```
hive> SET hive.exec.dynamic.partition=true;
hive> SET hive.exec.dynamic.partition.mode=nonstrict;
```

```
CREATE TABLE lending_club (
    loan_amount          INT,
    payments_term        STRING,
```

```
    monthly_payment    DOUBLE,  
    grade              INT,  
    working_years      INT,  
    home               STRING,  
    annual_income      DOUBLE,  
    purpose            STRING,  
    debt_to_income     DOUBLE,  
    delinquency        INT,  
    inquiries          INT,  
    open_credit_lines  INT,  
    derogatory_records INT,  
    revolving_balance  INT,  
    revolving_rate     DOUBLE,  
    total_accounts     INT,  
    bankruptcies       INT,  
    fico_average       INT,  
    loan_risk          STRING  
)  
PARTITIONED BY (verification STRING)  
STORED AS ORC;
```

```

hive> CREATE TABLE lending_club (
>   loan_amount          INT,
>   payments_term        STRING,
>   monthly_payment      DOUBLE,
>   grade                INT,
>   working_years        INT,
>   home                 STRING,
>   annual_income        DOUBLE,
>   purpose              STRING,
>   debt_to_income       DOUBLE,
>   delinquency          INT,
>   inquiries            INT,
>   open_credit_lines     INT,
>   derogatory_records   INT,
>   revolving_balance     INT,
>   revolving_rate        DOUBLE,
>   total_accounts       INT,
>   bankruptcies         INT,
>   fico_average         INT,
>   loan_risk            STRING
> )
> PARTITIONED BY (verification STRING)
> STORED AS ORC;
OK
Time taken: 0.094 seconds
hive> █

```

INSERT OVERWRITE TABLE lending_club PARTITION
(verification)

SELECT

```

    loan_amount,
    payments_term,
    monthly_payment,
    grade,
    working_years,
    home,
    annual_income,
    purpose,
    debt_to_income,
    delinquency,
    inquiries,
    open_credit_lines,
    derogatory_records,

```

```

    revolving_balance,
    revolving_rate,
    total_accounts,
    bankruptcies,
    fico_average,
    loan_risk,
    verification

```

```

FROM lending_club_raw;

```

```

hive> INSERT OVERWRITE TABLE lending_club PARTITION (verification)

```

```

> SELECT
>   loan_amount,
>   payments_term,
>   monthly_payment,
>   grade,
>   working_years,
>   home,
>   annual_income,
>   purpose,
>   debt_to_income,
>   delinquency,
>   inquiries,
>   open_credit_lines,
>   derogatory_records,
>   revolving_balance,
>   revolving_rate,
>   total_accounts,
>   bankruptcies,
>   fico_average,
>   loan_risk,
>   verification
> FROM lending_club_raw;

```

```

Query ID = user_20250914074243_c0a0af2e-4929-4254-87ce-a2e22da3130d

```

```

Total jobs = 1

```

```

Launching Job 1 out of 1

```

```

Tez session was closed. Reopening...

```

```

Session re-established.

```

```

Session re-established.

```

```

Status: Running (Executing on YARN cluster with App id application_1757774494954_0028)

```

	VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	1	1	0	0	0	0	0
Reducer 2	container	SUCCEEDED	7	7	0	0	0	0	0

```

VERTICES: 02/02 [=====>>>] 100% ELAPSED TIME: 28.35 s

```

```

Loading data to table default.lending_club partition (verification=null)

```

```

Loaded : 3/3 partitions.

```

```

    Time taken to load dynamic partitions: 0.336 seconds

```

```

    Time taken for adding to write entity : 0.002 seconds

```

```

OK

```

```

Time taken: 37.857 seconds

```

```

hive>

```

Покажемо partitions.

```
SHOW PARTITIONS lending_club;
```

```
hive> SHOW PARTITIONS lending_club;
OK
verification=Not Verified
verification=Source Verified
verification=Verified
Time taken: 0.163 seconds, Fetched: 3 row(s)
hive> █
```

Виміряємо час для кожного partition.

```
SELECT COUNT(*) FROM lending_club WHERE
```

```
verification='Verified';
```

```
SELECT COUNT(*) FROM lending_club WHERE verification='Not
Verified';
```

```
SELECT COUNT(*) FROM lending_club WHERE
```

```
verification='Source Verified';
```

```
SELECT COUNT(*) FROM lending_club;
```

```
hive> SELECT COUNT(*) FROM lending_club WHERE verification='Verified';
OK
336338
Time taken: 0.605 seconds, Fetched: 1 row(s)
hive> SELECT COUNT(*) FROM lending_club WHERE verification='Not Verified';
OK
443762
Time taken: 0.15 seconds, Fetched: 1 row(s)
hive> SELECT COUNT(*) FROM lending_club WHERE verification='Source Verified';
OK
258798
Time taken: 0.166 seconds, Fetched: 1 row(s)
hive> SELECT COUNT(*) FROM lending_club;
OK
1038898
Time taken: 0.14 seconds, Fetched: 1 row(s)
hive> █
```

2.6 Завдання 1.5

Встановимо параметри.

```
SET hive.exec.dynamic.partition=true;
```

```
SET hive.exec.dynamic.partition.mode=nonstrict;  
SET hive.enforce.bucketing=true;  
SET hive.enforce.sorting=true;
```

```
hive> SET hive.exec.dynamic.partition=true;  
hive> SET hive.exec.dynamic.partition.mode=nonstrict;  
hive> SET hive.enforce.bucketing=true;  
hive> SET hive.enforce.sorting=true;
```

Створимо таблицю.

```
CREATE TABLE lending_club_buckets (  
    loan_amount          INT,  
    payments_term        STRING,  
    monthly_payment      DOUBLE,  
    grade                INT,  
    working_years         INT,  
    home                  STRING,  
    annual_income         DOUBLE,  
    purpose               STRING,  
    debt_to_income        DOUBLE,  
    delinquency           INT,  
    inquiries             INT,  
    open_credit_lines     INT,  
    derogatory_records    INT,  
    revolving_balance     INT,  
    revolving_rate        DOUBLE,  
    total_accounts        INT,  
    bankruptcies          INT,  
    fico_average          INT,  
    loan_risk             STRING  
)  
PARTITIONED BY (verification STRING)  
CLUSTERED BY (working_years) INTO 10 BUCKETS  
STORED AS ORC
```

```
TBLPROPERTIES(  
    "orc.compress"="SNAPPY",  
    "bucketing_version"="2"  
);
```

```
hive> CREATE TABLE lending_club_buckets (  
  >   loan_amount          INT,  
  >   payments_term        STRING,  
  >   monthly_payment      DOUBLE,  
  >   grade                 INT,  
  >   working_years         INT,  
  >   home                  STRING,  
  >   annual_income         DOUBLE,  
  >   purpose               STRING,  
  >   debt_to_income        DOUBLE,  
  >   delinquency           INT,  
  >   inquiries             INT,  
  >   open_credit_lines     INT,  
  >   derogatory_records    INT,  
  >   revolving_balance     INT,  
  >   revolving_rate        DOUBLE,  
  >   total_accounts        INT,  
  >   bankruptcies          INT,  
  >   fico_average          INT,  
  >   loan_risk              STRING  
  > )  
  > PARTITIONED BY (verification STRING)  
  > CLUSTERED BY (working_years) INTO 10 BUCKETS  
  > STORED AS ORC  
  > TBLPROPERTIES(  
  >   "orc.compress"="SNAPPY",  
  >   "bucketing_version"="2"  
  > );  
OK  
Time taken: 0.067 seconds  
hive> 
```

Завантажимо дані.

```
INSERT OVERWRITE TABLE lending_club_buckets PARTITION  
(verification)  
SELECT  
    loan_amount,  
    payments_term,  
    monthly_payment,  
    grade,  
    working_years,
```

```
home,  
annual_income,  
purpose,  
debt_to_income,  
delinquency,  
inquiries,  
open_credit_lines,  
derogatory_records,  
revolving_balance,  
revolving_rate,  
total_accounts,  
bankruptcies,  
fico_average,  
loan_risk,  
verification
```

```
FROM lending_club_raw;
```

```
hive> INSERT OVERWRITE TABLE lending_club_buckets PARTITION (verification)
> SELECT
>   loan_amount,
>   payments_term,
>   monthly_payment,
>   grade,
>   working_years,
>   home,
>   annual_income,
>   purpose,
>   debt_to_income,
>   delinquency,
>   inquiries,
>   open_credit_lines,
>   derogatory_records,
>   revolving_balance,
>   revolving_rate,
>   total_accounts,
>   bankruptcies,
>   fico_average,
>   loan_risk,
>   verification
> FROM lending_club_raw;
Query ID = user_20250914081251_4b7f8731-d229-4997-b459-dccf514989cd
Total jobs = 1
Launching Job 1 out of 1
Tez session was closed. Reopening...
Session re-established.
Session re-established.
Status: Running (Executing on YARN cluster with App id application_1757774494954_0029)
```

	VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	1	1	0	0	0	0	0
Reducer 2	container	SUCCEEDED	10	10	0	0	0	0	0
Reducer 3	container	SUCCEEDED	7	7	0	0	0	0	0

```
VERTICES: 03/03 [=====] 100% ELAPSED TIME: 32.51 s
Loading data to table default.lending_club_buckets partition (verification=null)
Loaded : 3/3 partitions.
Time taken to load dynamic partitions: 0.185 seconds
Time taken for adding to write entity : 0.001 seconds
OK
Time taken: 41.493 seconds
hive>
```

Переглянемо partitions.

```
SHOW PARTITIONS lending_club_buckets;
```

```
hive> SHOW PARTITIONS lending_club_buckets;
OK
verification=Not Verified
verification=Source Verified
verification=Verified
Time taken: 0.075 seconds, Fetched: 3 row(s)
hive>
```

Переглянемо де зберігаються bucket-файли.

```
DESCRIBE FORMATTED lending_club_buckets;
```

```

hive> DESCRIBE FORMATTED lending_club_buckets;
OK
# col_name          data_type          comment
loan_amount         int
payments_term       string
monthly_payment     double
grade               int
working_years       int
home                string
annual_income       double
purpose             string
debt_to_income      double
delinquency         int
inquiries           int
open_credit_lines   int
derogatory_records  int
revolving_balance   int
revolving_rate      double
total_accounts      int
bankruptcies        int
fico_average        int
loan_risk           string

# Partition Information
# col_name          data_type          comment
verification        string

# Detailed Table Information
Database:            default
OwnerType:          USER
Owner:              user
CreateTime:         Sun Sep 14 08:09:18 UTC 2025
LastAccessTime:     UNKNOWN
Retention:          0
Location:           hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets
Table Type:         MANAGED_TABLE
Table Parameters:
    COLUMN_STATS_ACCURATE  {"BASIC_STATS\":"true\"}
    bucketing_version      2
    numFiles               18
    numPartitions          3
    numRows               1038898
    orc.compress           SNAPPY
    rawDataSize            466270274
    totalSize             14605125
    transient_lastDdlTime  1757837358

# Storage Information
SerDe Library:      org.apache.hadoop.hive.ql.io.orc.OrcSerde
InputFormat:        org.apache.hadoop.hive.ql.io.orc.OrcInputFormat
OutputFormat:       org.apache.hadoop.hive.ql.io.orc.OrcOutputFormat
Compressed:         No
Num Buckets:        10
Bucket Columns:     [working_years]
Sort Columns:       []
Storage Desc Params:
    serialization.format  1
Time taken: 0.107 seconds, Fetched: 55 row(s)
hive>

```

Бачимо рядок Location:

Location: hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets

Переглянемо файли за цим шляхом.

```
hdfs dfs -ls
```

```
hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets/
```

```
user@cluster-11a7-m:~$ hdfs dfs -ls hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets/
Found 3 items
drwxr-xr-x - user hadoop      0 2025-09-14 08:13 hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets/verification=Not Verified
drwxr-xr-x - user hadoop      0 2025-09-14 08:13 hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets/verification=Source Verified
drwxr-xr-x - user hadoop      0 2025-09-14 08:13 hdfs://cluster-11a7-m/user/hive/warehouse/lending_club_buckets/verification=Verified
user@cluster-11a7-m:~$
```

Виміряємо час для різних значень.

```
SELECT * FROM lending_club_buckets WHERE working_years = 0;
```

```
Hive> EXPLAIN ANALYZE SELECT * FROM lending_club_buckets WHERE working_years = 0;
OK
OK
Plan optimized by CBO.

Stage-0
Fetch Operator
  Limit:1
  Select Operator [SEL_2]
    Output: ["_col0", "_col1", "_col2", "_col3", "_col4", "_col5", "_col6", "_col7", "_col8", "_col9", "_col10", "_col11", "_col12", "_col13", "_col14", "_col15", "_col16", "_col17", "_col18", "_col19"]
    Filter Operator [FIL_4]
      predicate:(working_years = 0)
      TableScan [TS_0]
        Output: ["loan_amount", "payments_term", "monthly_payment", "grade", "working_years", "home", "annual_income", "purpose", "debt_to_income", "delinquency", "inquiries", "open_credit_lines", "derogatory_records", "revolving_balance", "revolving_rate", "total_accounts", "bankruptcies", "fico_average", "loan_risk"]
Time taken: 3.698 seconds, Fetched: 12 row(s)
Hive>
```

```
SELECT * FROM lending_club_buckets WHERE working_years = 1;
```

```
Hive> EXPLAIN ANALYZE SELECT * FROM lending_club_buckets WHERE working_years = 1;
OK
OK
Plan optimized by CBO.

Stage-0
Fetch Operator
  Limit:1
  Select Operator [SEL_2]
    Output: ["_col0", "_col1", "_col2", "_col3", "_col4", "_col5", "_col6", "_col7", "_col8", "_col9", "_col10", "_col11", "_col12", "_col13", "_col14", "_col15", "_col16", "_col17", "_col18", "_col19"]
    Filter Operator [FIL_4]
      predicate:(working_years = 1)
      TableScan [TS_0]
        Output: ["loan_amount", "payments_term", "monthly_payment", "grade", "working_years", "home", "annual_income", "purpose", "debt_to_income", "delinquency", "inquiries", "open_credit_lines", "derogatory_records", "revolving_balance", "revolving_rate", "total_accounts", "bankruptcies", "fico_average", "loan_risk"]
Time taken: 3.697 seconds, Fetched: 12 row(s)
Hive>
```

```
SELECT * FROM lending_club_buckets WHERE working_years = 10;
```

```
Hive> EXPLAIN ANALYZE SELECT * FROM lending_club_buckets WHERE working_years = 10;
OK
OK
Plan optimized by CBO.

Stage-0
Fetch Operator
  Limit:1
  Select Operator [SEL_2]
    Output: ["_col0", "_col1", "_col2", "_col3", "_col4", "_col5", "_col6", "_col7", "_col8", "_col9", "_col10", "_col11", "_col12", "_col13", "_col14", "_col15", "_col16", "_col17", "_col18", "_col19"]
    Filter Operator [FIL_4]
      predicate:(working_years = 10)
      TableScan [TS_0]
        Output: ["loan_amount", "payments_term", "monthly_payment", "grade", "working_years", "home", "annual_income", "purpose", "debt_to_income", "delinquency", "inquiries", "open_credit_lines", "derogatory_records", "revolving_balance", "revolving_rate", "total_accounts", "bankruptcies", "fico_average", "loan_risk"]
Time taken: 1.914 seconds, Fetched: 12 row(s)
Hive>
```

2.7 Завдання 1.6

Створюємо зовнішню таблицю за базовою директорією для експорту.

```
SET hive.exec.dynamic.partition=true;
SET hive.exec.dynamic.partition.mode=nonstrict;
CREATE EXTERNAL TABLE lending_club_export_by_years (
    loan_amount          INT,
    payments_term        STRING,
    monthly_payment      DOUBLE,
    grade                INT,
    home                 STRING,
    annual_income        DOUBLE,
    verification         STRING,
    purpose              STRING,
    debt_to_income       DOUBLE,
    delinquency          INT,
    inquiries            INT,
    open_credit_lines    INT,
    derogatory_records   INT,
    revolving_balance    INT,
    revolving_rate        DOUBLE,
    total_accounts       INT,
    bankruptcies         INT,
    fico_average         INT,
    loan_risk            STRING
)
PARTITIONED BY (working_years INT)
ROW FORMAT DELIMITED
    FIELDS TERMINATED BY ';'
STORED AS TEXTFILE
LOCATION
'hdbs://cluster-11a7-m/user/hive/warehouse/exports/lendin
```

g_club_by_working_years';

```
> CREATE EXTERNAL TABLE lending_club_export_by_years (  
>   loan_amount          INT,  
>   payments_term        STRING,  
>   monthly_payment      DOUBLE,  
>   grade                INT,  
>   home                  STRING,  
>   annual_income        DOUBLE,  
>   verification         STRING,  
>   purpose               STRING,  
>   debt_to_income       DOUBLE,  
>   delinquency          INT,  
>   inquiries            INT,  
>   open_credit_lines    INT,  
>   derogatory_records   INT,  
>   revolving_balance     INT,  
>   revolving_rate        DOUBLE,  
>   total_accounts       INT,  
>   bankruptcies         INT,  
>   fico_average         INT,  
>   loan_risk            STRING  
> )  
> PARTITIONED BY (working_years INT)  
> ROW FORMAT DELIMITED  
>   FIELDS TERMINATED BY ';'   
> STORED AS TEXTFILE  
> LOCATION 'hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years';  
OK  
Time taken: 0.118 seconds
```

INSERT OVERWRITE TABLE lending_club_export_by_years

PARTITION (working_years)

SELECT

loan_amount,
 payments_term,
 monthly_payment,
 grade,
 home,
 annual_income,
 verification,
 purpose,
 debt_to_income,

```
delinquency,  
inquiries,  
open_credit_lines,  
derogatory_records,  
revolving_balance,  
revolving_rate,  
total_accounts,  
bankruptcies,  
fico_average,  
loan_risk,  
working_years  
FROM lending_club_buckets;  
SHOW PARTITIONS lending_club_export_by_years;
```

```

hive>
> -- 2) Записати дані з bucket-таблиці, розклавши по партиціях working_years
> INSERT OVERWRITE TABLE lending_club_export_by_years PARTITION (working_years)
> SELECT
>   loan_amount,
>   payments_term,
>   monthly_payment,
>   grade,
>   home,
>   annual_income,
>   verification,
>   purpose,
>   debt_to_income,
>   delinquency,
>   inquiries,
>   open_credit_lines,
>   derogatory_records,
>   revolving_balance,
>   revolving_rate,
>   total_accounts,
>   bankruptcies,
>   fico_average,
>   loan_risk,
>   working_years
> FROM lending_club_buckets;
Query ID = user_20250914083335_27248fa1-9767-4282-a7a7-34ce21862e21
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1757774494954_0033)
-----
VERTICES    MODE        STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
-----
Map 1 ..... container  SUCCEEDED    1         1         0         0         0         0
Reducer 2 ..... container  SUCCEEDED    2         2         0         0         0         0
-----
VERTICES: 02/02 [=====>>] 100% ELAPSED TIME: 15.69 s
-----
Loading data to table default.lending_club_export_by_years partition (working_years=null)

Loaded : 11/11 partitions.
    Time taken to load dynamic partitions: 0.669 seconds
    Time taken for adding to write entity : 0.003 seconds
OK
Time taken: 79.901 seconds

```

Переглянемо створені partitions.

```
SHOW PARTITIONS lending_club_export_by_years;
```

```
> SHOW PARTITIONS lending_club_export_by_years;
OK
working_years=0
working_years=1
working_years=10
working_years=2
working_years=3
working_years=4
working_years=5
working_years=6
working_years=7
working_years=8
working_years=9
Time taken: 0.067 seconds, Fetched: 11 row(s)
```

Переглянемо каталоги і файли.

```
hdfs dfs -ls
```

```
hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/
```

```
user@cluster-11a7-m:~$ hdfs dfs -ls hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/
Found 11 items
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=0
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=1
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=10
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=2
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=3
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=4
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=5
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=6
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=7
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=8
drwxr-xr-x - user hadoop 0 2025-09-14 08:34 hdfs://cluster-11a7-m/user/hive/warehouse/exports/lending_club_by_working_years/working_years=9
user@cluster-11a7-m:~$
```

2.8 Завдання 1.7

Завантажимо дані на віртуальну машину.

```
gcloud compute scp articles.csv
```

```
user@cluster-11a7-m:~/articles.csv
```

```
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$ gcloud compute scp articles.csv user@cluster-11a7-m:~/articles.csv
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
articles.csv
user@archlinux:~/university/masters_first_semester_bigdata/lab_1$
```

Завантажимо дані в hdfs.

```
hdfs dfs -mkdir -p /data/wordcount/input
```

```
hdfs dfs -put -f articles.csv /data/wordcount/input/
```

```
user@cluster-11a7-m:~$ hdfs dfs -mkdir -p /data/wordcount/input
user@cluster-11a7-m:~$ hdfs dfs -put -f articles.csv /data/wordcount/input/
user@cluster-11a7-m:~$
```


Завантажимо `hadoop-examples-1.2.1` за посиланням <https://repo1.maven.org/maven2/org/apache/hadoop/hadoop-examples/1.2.1/hadoop-examples-1.2.1.jar> (ПРИМІТКА: Чому я сам маю шукати це посилання в інтернеті? Чому це посилання не вказано у лабораторній?). Завантажимо його на віртуальну машину.

```
gcloud compute scp hadoop-examples-1.2.1.jar
user@cluster-11a7-m:~/hadoop-examples-1.2.1.jar
```

```
user@archlinux:/university/westers_first_semester_bigdata/lab_1$ gcloud compute scp hadoop-examples-1.2.1.jar user@cluster-11a7-m:~/hadoop-examples-1.2.1.jar
No zone specified. Using zone [us-central1-a] for instance: [cluster-11a7-m].
hadoop-examples-1.2.1.jar 100% 139KB 247.5KB/s 00:00
```

Запустимо wordcount.

```
hdfs dfs -rm -r -f /data/wordcount/output
hadoop jar hadoop-examples-1.2.1.jar wordcount
/data/wordcount/input /data/wordcount/output
```

```
user@cluster-11a7-m:~$ hadoop jar hadoop-examples-1.2.1.jar wordcount /data/wordcount/input /data/wordcount/output
2025-09-14 09:10:56,923 INFO client.DefaultHARMFaloverProxyProvider: Connecting to ResourceManager at cluster-11a7-m.us-central1-a.c.graphical-fort-471713-m4.internal./10.128.0.2:8032
2025-09-14 09:10:57,059 INFO client.AHSProxy: Connecting to Application History server at cluster-11a7-m.us-central1-a.c.graphical-fort-471713-m4.internal./10.128.0.2:10200
2025-09-14 09:10:57,217 INFO mapreduce.JobResourceUploader: Disabling Erasure Coding for path: /tmp/hadoop-yarn/staging/user/.staging/job_1757774494954_0035
2025-09-14 09:10:57,508 INFO input.FileInputFormat: Total input files to process : 1
2025-09-14 09:10:57,554 INFO mapreduce.JobSubmitter: number of splits:1
2025-09-14 09:10:57,796 INFO mapreduce.JobSubmitter: Submitting tokens for job: job_1757774494954_0035
2025-09-14 09:10:57,796 INFO mapreduce.JobSubmitter: Executing with tokens: []
2025-09-14 09:10:57,953 INFO conf.Configuration: resource-types.xml not found
2025-09-14 09:10:57,953 INFO resource.ResourceUtils: Unable to find 'resource-types.xml'.
2025-09-14 09:10:58,092 INFO impl.YarnClientImpl: Submitted application application_1757774494954_0035
2025-09-14 09:10:58,036 INFO mapreduce.Job: The url to track the job: http://cluster-11a7-m.us-central1-a.c.graphical-fort-471713-m4.internal.:8088/proxy/application_1757774494954_0035/
2025-09-14 09:10:58,036 INFO mapreduce.Job: Running job: job_1757774494954_0035
2025-09-14 09:11:09,153 INFO mapreduce.Job: Job job_1757774494954_0035 running in uber mode : false
2025-09-14 09:11:09,154 INFO mapreduce.Job: map 0% reduce 0%
2025-09-14 09:11:21,240 INFO mapreduce.Job: map 100% reduce 0%
2025-09-14 09:11:28,276 INFO mapreduce.Job: map 100% reduce 33%
2025-09-14 09:11:31,290 INFO mapreduce.Job: map 100% reduce 67%
2025-09-14 09:11:32,295 INFO mapreduce.Job: map 100% reduce 100%
2025-09-14 09:11:34,311 INFO mapreduce.Job: Job job_1757774494954_0035 completed successfully
2025-09-14 09:11:34,390 INFO mapreduce.Job: Counters: 55
  File System Counters
    FILE: Number of bytes read=8745166
    FILE: Number of bytes written=10639851
    FILE: Number of read operations=0
    FILE: Number of large read operations=0
    FILE: Number of write operations=0
    HDFS: Number of bytes read=38818151
    HDFS: Number of bytes written=7396184
    HDFS: Number of read operations=18
    HDFS: Number of large read operations=0
    HDFS: Number of write operations=0
    HDFS: Number of bytes read erasure-coded=0
  Job Counters
    Killed reduce tasks=1
    Launched map tasks=1
    Launched reduce tasks=3
    Data-local map tasks=1
    Total time spent by all maps in occupied slots (ms)=30712044
    Total time spent by all reduces in occupied slots (ms)=69125038
    Total time spent by all map tasks (ms)=9372
    Total time spent by all reduce tasks (ms)=21094
    Total vcore-milliseonds taken by all map tasks=9372
    Total vcore-milliseonds taken by all reduce tasks=21094
    Total megabyte-milliseonds taken by all map tasks=30712044
    Total megabyte-milliseonds taken by all reduce tasks=69125038
  Map-Reduce Framework
    Map input records=122437
    Map output records=2827664
    Map output bytes=50127221
    Map output materialized bytes=8745166
    Input split bytes=120
    Combine input records=2827664
    Combine output records=345349
    Reduce input groups=345349
    Reduce shuffle bytes=8745166
    Reduce input records=345349
    Reduce output records=345349
    Spilled Records=690698
    Shuffled Map=3
```

Подивимося результати частоти слів.

```
hdfs dfs -ls /data/wordcount/output
```

```
user@cluster-11a7-m:~$ hdfs dfs -ls /data/wordcount/output
Found 4 items
-rw-r--r--  2 user hadoop      0 2025-09-14 09:11 /data/wordcount/output/_SUCCESS
-rw-r--r--  2 user hadoop 2466624 2025-09-14 09:11 /data/wordcount/output/part-r-00000
-rw-r--r--  2 user hadoop 2468934 2025-09-14 09:11 /data/wordcount/output/part-r-00001
-rw-r--r--  2 user hadoop 2460626 2025-09-14 09:11 /data/wordcount/output/part-r-00002
user@cluster-11a7-m:~$
```

Переглянемо 20 найчастіших слів.

```
hdfs dfs -cat /data/wordcount/output/part-* | sort
-k2,2nr | head -20
```

```
user@cluster-11a7-m:~$ hdfs dfs -cat /data/wordcount/output/part-* | sort -k2,2nr | head -20
в      77626
и      54933
на     40415
что    33981
не     29032
с      23839
по     15781
-      13255
-      12067
В      11732
это    10399
Украины 10307
о      10192
для    9808
из     9621
как    9449
к      8845
-      8503
а      8470
за     8022
user@cluster-11a7-m:~$
```

2.9 Відповіді на запитання

2.9.1 Опис обробки запиту до завдання 1.2

```
SELECT name, edrpou, address, ROW_NUMBER() OVER
(PARTITION BY address ORDER BY edrpou) AS rn_by_place
FROM uotable LIMIT 20;
```

Вивід запиту:

```
hive> SELECT name, edrpou, address, ROW_NUMBER() OVER (PARTITION BY address ORDER BY edrpou) AS rn_by_place FROM
uotable LIMIT 20;
Query ID = user_20250917185201_5cea007b-f5db-439f-ad79-003d61f1a5b2
Total jobs = 1
Launching Job 1 out of 1
Tez session was closed. Reopening...
Session re-established.
Session re-established.
Status: Running (Executing on YARN cluster with App id application_1758134565428_0002)
```

```

-----
      VERTICES      MODE      STATUS  TOTAL  COMPLETED  RUNNING  PENDING  FAILED  KILLED
-----
Map 1 ..... container  SUCCEEDED    9         9         0         0         0         0
Reducer 2 ..... container  SUCCEEDED   49        49         0         0         0         0
-----
VERTICES: 02/02  [=====>>] 100%  ELAPSED TIME: 30.92 s
-----
OK

```

На стороні Map виконується скан uotable по сплітах, тобто читаються лише потрібні колонки (name, edrpou, address). Map тут не рахує ROW_NUMBER(). Він лише розподіляє, тобто PARTITION BY, і забезпечує порядок, тобто ORDER BY.

На стороні Reducer відбувається потокове обчислення віконної функції, тобто для кожної групи address reducer проходить рядки у відсортованому порядку і лічильником виставляє ROW_NUMBER(). Далі виводяться готові рядки, а LIMIT 20 застосовується вже після обчислення.

У колонках TOTAL, COMPLETED, RUNNING, PENDING, FAILED, KILLED виводиться кількість taskів для кожного Map та Reducer. У даному випадку для Map 1 ми маємо 9 завершених завдань, тобто 9 сплітів. Також маємо одну Reducer вершину, тобто 49 taskів, визначений налаштуваннями hive.exec.reducers.bytes.per.reducer.

2.10 Визначення кількості Map та Reducer в залежності від запиту

Розглянемо запит та вивід до нього нижче.

```

EXPLAIN ANALYZE SELECT * FROM UO_table uo join FOP_table
fop on uo.address = fop.address join FOP_table fop1 on
uo.address = fop1.address;

```

```

hive> EXPLAIN ANALYZE SELECT * FROM uotable uo join fop_table fop on uo.address = fop.address join
fop_table fop1 on uo.address = fop1.address;
No Stats for default@uotable, Columns: edrpou, address, boss, name, kved, stan, founders, fio
No Stats for default@fop_table, Columns: address, kved, stan, fio
No Stats for default@fop_table, Columns: address, kved, stan, fio
Query ID = user_20250917184411_49df2f53-e476-4c0b-9387-ee6fbedf166e
Total jobs = 1
Launching Job 1 out of 1
Status: Running (Executing on YARN cluster with App id application_1758134565428_0001)

```

VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	KILLED	6	0	0	6	0	0
Map 4	container	KILLED	9	7	0	2	0	0
Reducer 2	container	KILLED	137	0	0	137	0	0
Reducer 3	container	KILLED	137	0	0	137	0	0
VERTICES: 00/04 [>-----] 2% ELAPSED TIME: 30.38 s								

Виникає питання чому саме створюються лише дві Мар вершини: Мар 1, Мар 4? Чому не одна, не три, не N-на кількість? Аналогічно й для Reducer 2 та Reducer 3.

Map 1 та Map 4 створені для скану різних таблиць — `uotable` та `for_table`.
Reducer 2 та Reducer 3 — створені для двох послідовних джойнів.

Спробуємо заджойнити таблицю саму з собою, тобто виконається два скани таблиці, тобто 2 Map, і один Reducer.

VERTICES	MODE	STATUS	TOTAL	COMPLETED	RUNNING	PENDING	FAILED	KILLED
Map 1	container	SUCCEEDED	9	9	0	0	0	0
Map 3	container	SUCCEEDED	9	9	0	0	0	0
Reducer 2 ..	container	RUNNING	97	37	3	57	0	0
VERTICES: 02/03 [=====>>-----] 47% ELAPSED TIME: 721.31 s								

3 ВИСНОВОК

У підсумку розгорнули та перевірили працездатність середовища, реалізували та запустили ETL-конвеєр на тестових даних, спроектували схему БД і задокументували результати у звіті.