Banking Database

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Requirement Analysis & Normalization

Requirements Analysis

The BankingDB is the database used for banking systems, where there are customers—who make transactions—and admins—who are also customers but can CRUD (Create, Read, Update, Delete) other customers. Each customer has their own credit points and credit limit, which indicate how trustworthy they are to the bank and whether they are eligible for a mortgage increase or a higher credit limit.

During the lifetime of a user in the bank, they may change their personal details frequently, from their address and phone number to their password or email. To keep track of all these changes, a table will store every modification made throughout their journey in the bank. Additionally, the user's login history will also be recorded for security and auditing purposes.

The Thunder Bay Bank currently only approves internal transactions but has the potential to operate nationally (between different banks). A user in The Thunder Bay Bank can have multiple accounts, whether it is a savings, chequing , investment, or credit account. Each type of account comes with different interest rates, which are competitive with other banks.

Every five years, if an account is not renewed, it will automatically become inactive. There are two types of transactions: Debit (DEB) and Credit (CRE).

- Debit transactions include any deposit into an account, such as transfers from another account, work payments, or returned transactions.
- Credit transactions involve deductions from the account, such as monthly payments, withdrawals, or payments for groceries.

Entities in the Database

- Account
- Account Type
- Bank
- Branch
- City
- Currency
- Login History
- Transaction
- Transaction Type
- User
- User Account Modification
- User Credit Points

Normalization

1NF

As per the following table structure, initial tables are in 1NF

- Each table cell contains a single value.
- Each record is unique.

User Table

UserDid	FirstName	LastName	DOB	Address	City	Province	Country	Username	Password	Email	MobileNumber	SinNumber	CreateDate	UserRole

Branch Table

BranchDid	BranchId	BranchName	Address	City	Province	Country	PhoneNumber	CityDid	Bankdid

Bank Table

Bankdid	Bankid	BankName

Transaction Table

TransactionDid	TransactionDetails	Tran_Status	Transaction Amount	CurrencyDID	TransactionTypeDid	CreatedDate	UserDid	AccountDid

Accout type table

AccountTypeDid	AccountTypeid	Description	InterestRate

Account Table

AccountDid	AccountNumber	PreviousBalance	CurrentBalance	CurrencyCode	OpenDate	EndDate	IsActive	BranchDid	UserDid	AccountTypeDid

User Credit Points Table

UserCreditpPointDId	UserDid	Point	CreditLimit	CurrencyDID

User Account Modification Table

Did	UserDid	UpdatedField	OldValue	NewValue	ModifiedDate

Login History Table

LoginHistoryDid	LoginTime	LogOutTime	UserDid

Transaction Type

TransactionTypeDid	TransactionTypeId	Description

Currency Table

CurrencyDID	CurrencyCode	CurrencyDescription

2NF

As per the following table structure, initial tables are in 2NF

- Tables are in 1NF.
- All non key attributes are fully functional dependent on the primary key.

User Table

UserDid	FirstName	LastName	DOB	Address	City	Province	Country	Username	Password	Email	MobileNumber	SinNumber	CreateDate	UserRole

Branch Table

BranchDid	BranchId	BranchName	Address	City	Province	Country	PhoneNumber	CityDid	Bankdid

Bank Table

Bankdid	Bankid	BankName

Transaction Table

TransactionDid	TransactionDetails	Tran_Status	Transaction Amount	CurrencyDID	TransactionTypeDid	CreatedDate	UserDid	AccountDid

Accout type table

AccountTypeDid	AccountTypeid	Description	InterestRate

Account Table

AccountDid	AccountNumber	PreviousBalance	CurrentBalance	CurrencyCode	OpenDate	EndDate	IsActive	BranchDid	UserDid	AccountTypeDid

User Credit Points Table

UserCreditpPointDId	UserDid	Point	CreditLimit	CurrencyDID

User Account Modification Table

Did	UserDid	UpdatedField	OldValue	NewValue	ModifiedDate

Login History Table

LoginHistoryDid	LoginTime	LogOutTime	UserDid

Transaction Type

TransactionTypeDid	TransactionTypeId	Description

Currency Table

CurrencyDID	CurrencyCode	CurrencyDescription

3NF

As per the following table structure, initial tables are not in 3NF

- Tables are in 2NF.
- However, in the user and branch tables province and country are dependent on the city. Therefore, to make all the table in 3NF, we have created City table with province and country and link User table and branch table using CityDid.

User Table

UserDid	FirstName	LastName	DOB	Address	City	Province	Country	Username	Password	Email	MobileNumber	SinNumber	CreateDate	UserRole

Branch Table

BranchDid	BranchId	BranchName	Address	City	Province	Country	PhoneNumber	CityDid	Bankdid

Bank Table

Bankdid	Bankid	BankName

Transaction Table

TransactionDid	TransactionDetails	Tran_Status	Transaction Amount	CurrencyDID	TransactionTypeDid	CreatedDate	UserDid	AccountDid

Accout type table

AccountTypeDid	AccountTypeid	Description	InterestRate

Account Table

AccountDid	AccountNumber	PreviousBalance	CurrentBalance	CurrencyCode	OpenDate	EndDate	IsActive	BranchDid	UserDid	AccountTypeDid

User Credit Points Table

UserCreditpPointDid	UserDid	Point	CreditLimit	CurrencyDID

User Account Modification Table

Did	UserDid	UpdatedField	OldValue	NewValue	ModifiedDate

Login History Table

LoginHistoryDid	LoginTime	LogOutTime	UserDid

Transaction Type

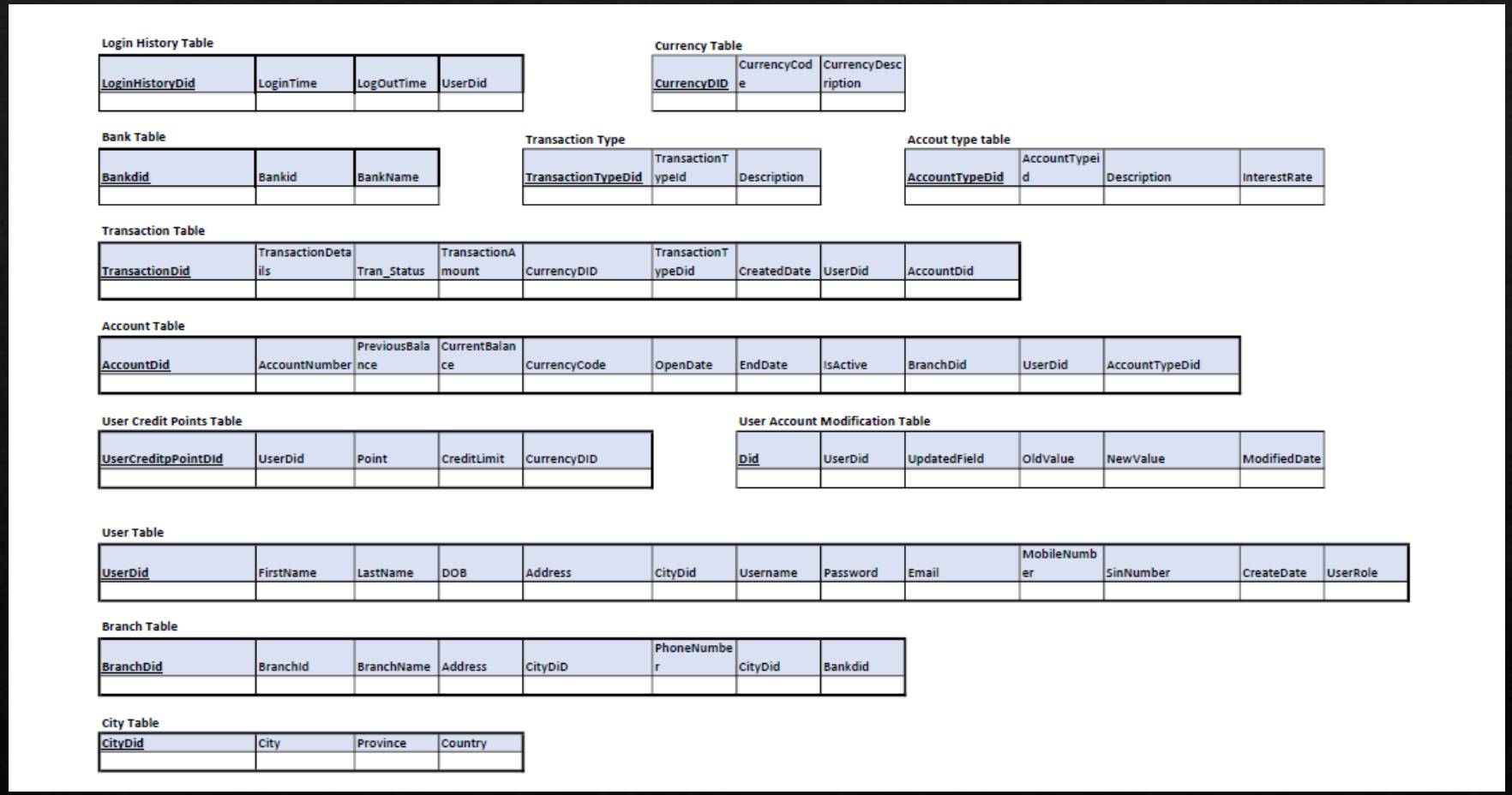
TransactionTypeDid	TransactionTypeId	Description

Currency Table

CurrencyDID	CurrencyCode	CurrencyDescription

3NF Cont.

After the normalization, table are as follows.



Login History Table

LoginHistoryDid	LoginTime	LogOutTime	UserDid

Currency Table

CurrencyDID	CurrencyCode	CurrencyDescription

Bank Table

Bankdid	Bankid	BankName

Transaction Type

TransactionTypeDid	TransactionTypeId	Description

Accout type table

AccountTypeDid	AccountTypeid	Description	InterestRate

Transaction Table

TransactionDid	TransactionDetails	Tran_Status	TransactionAmount	CurrencyDID	TransactionTypeDid	CreatedDate	UserDid	AccountDid

Account Table

AccountDid	AccountNumber	PreviousBalance	CurrentBalance	CurrencyCode	OpenDate	EndDate	IsActive	BranchDid	UserDid	AccountTypeDid

User Credit Points Table

UserCreditpPointDid	UserDid	Point	CreditLimit	CurrencyDID

User Account Modification Table

Did	UserDid	UpdatedField	OldValue	NewValue	ModifiedDate

User Table

UserDid	FirstName	LastName	DOB	Address	CityDid	Username	Password	Email	MobileNumber	SinNumber	CreateDate	UserRole

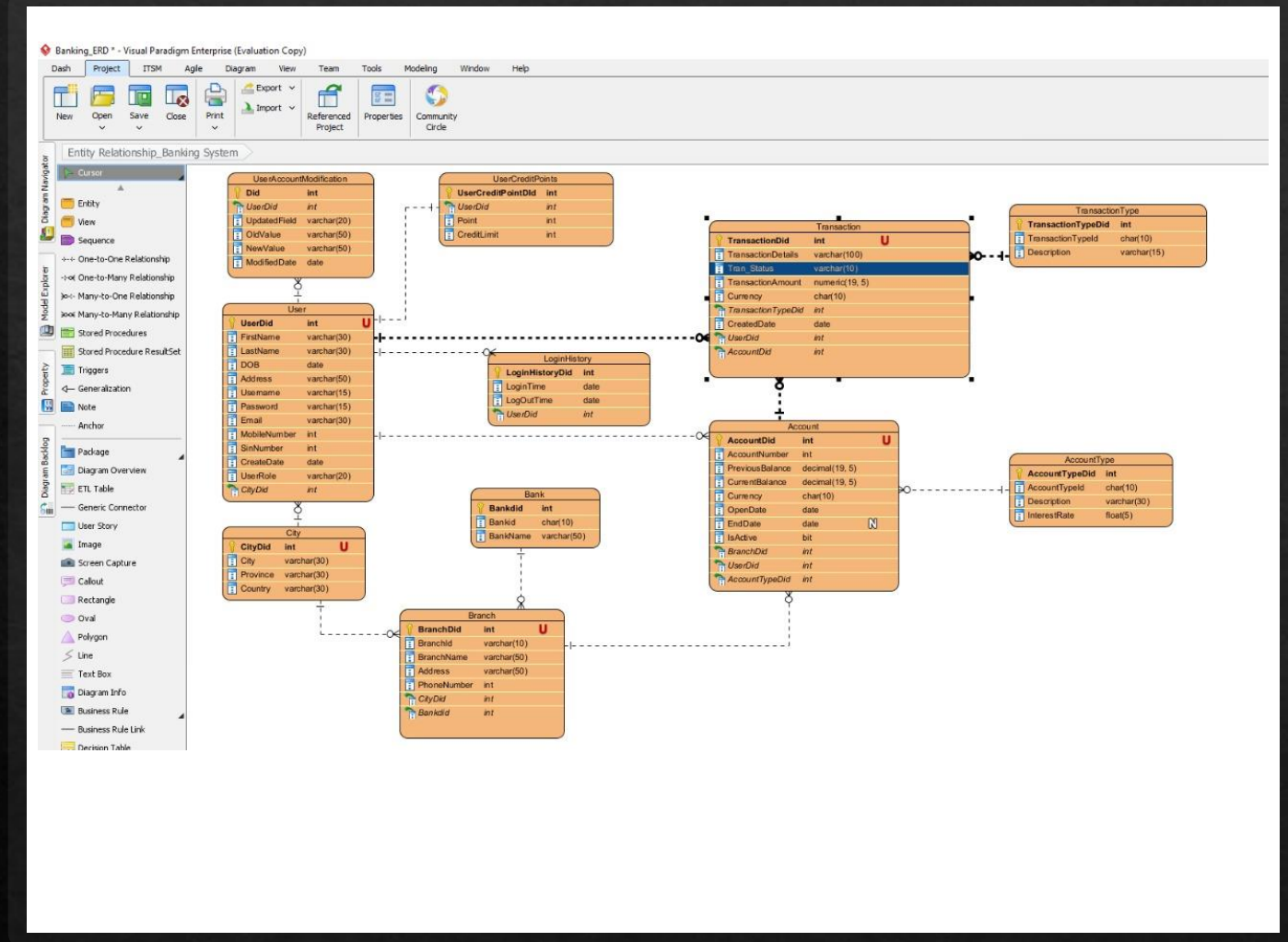
Branch Table

BranchDid	BranchId	BranchName	Address	CityDiD	PhoneNumber	CityDid	Bankdid

City Table

CityDid	City	Province	Country

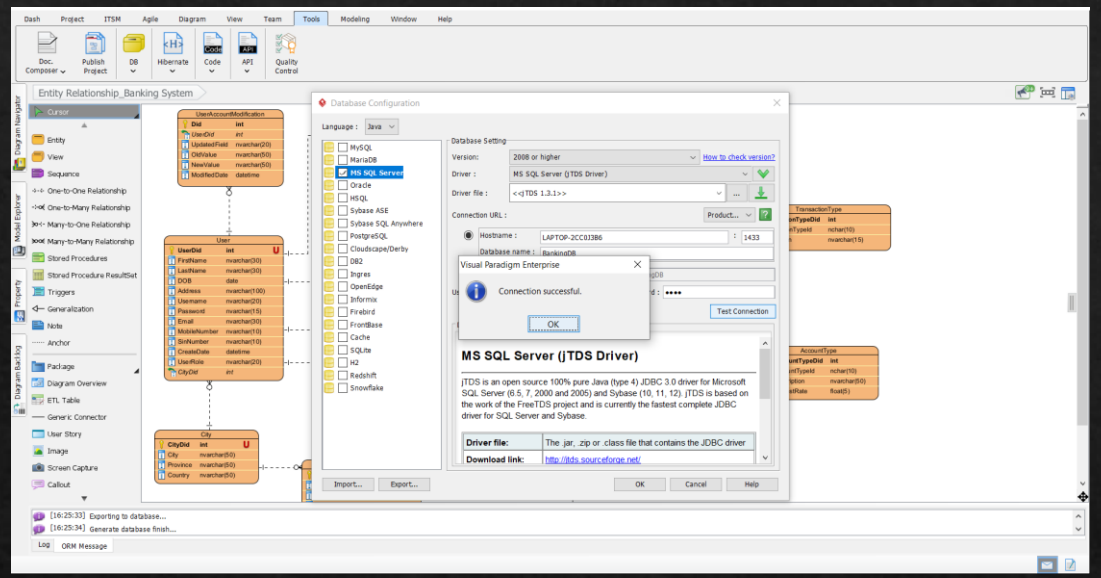
ERD and Database Conversion

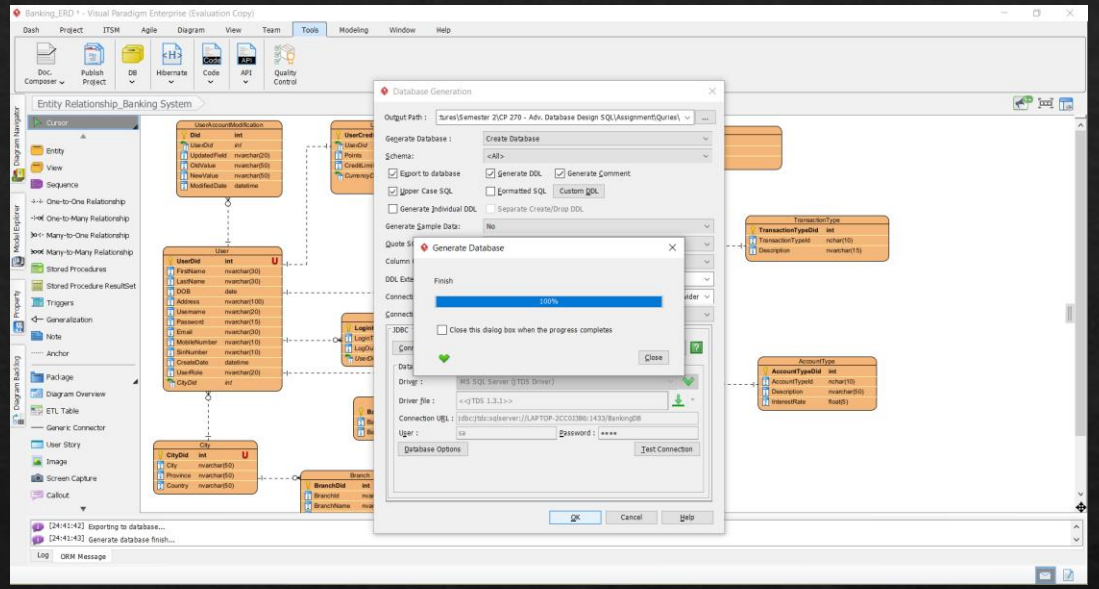


ERD

The finalized ERD after the normalization.

Database Conversion



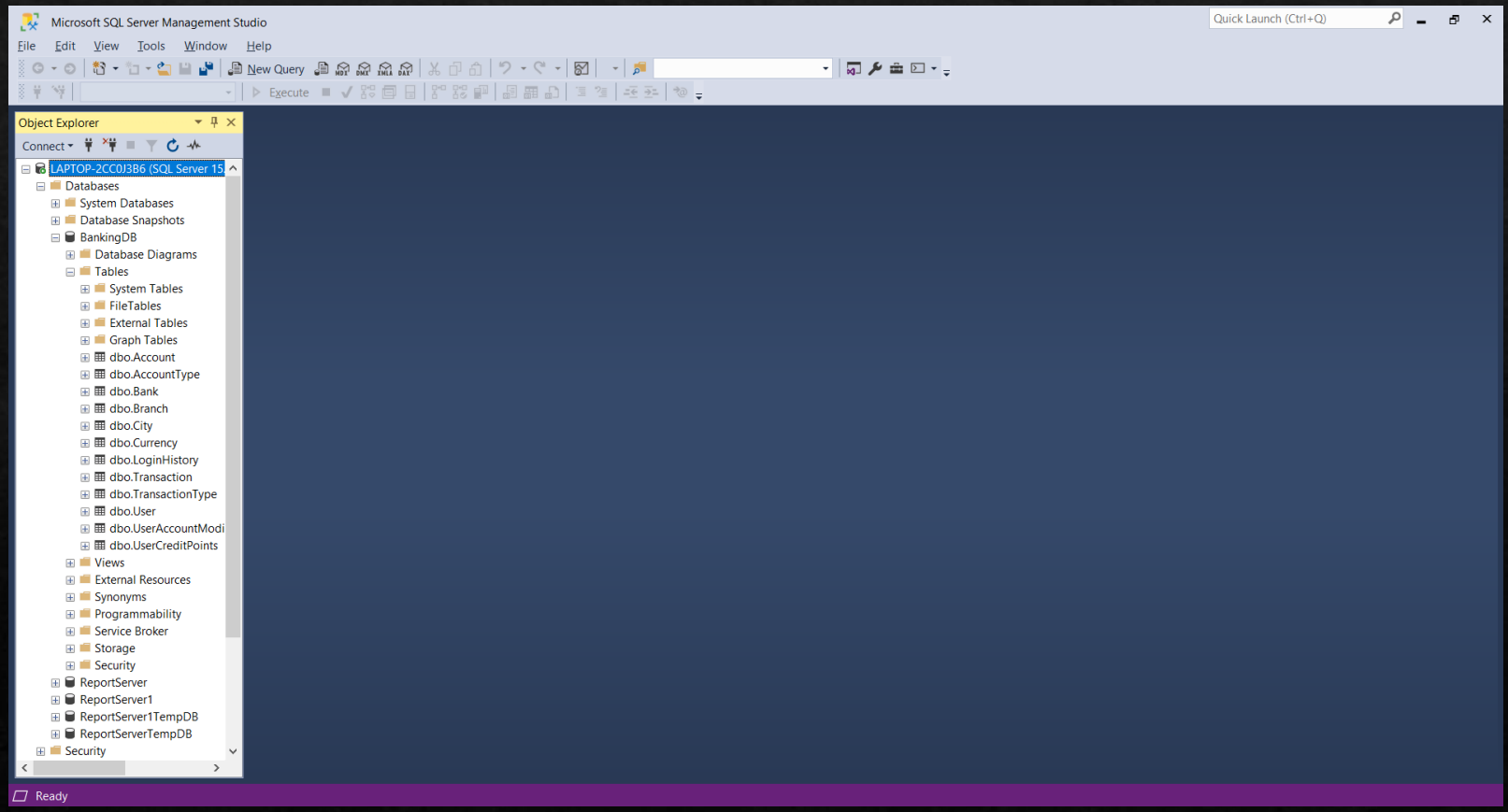


Successful database conversion

Database Creation & Reports

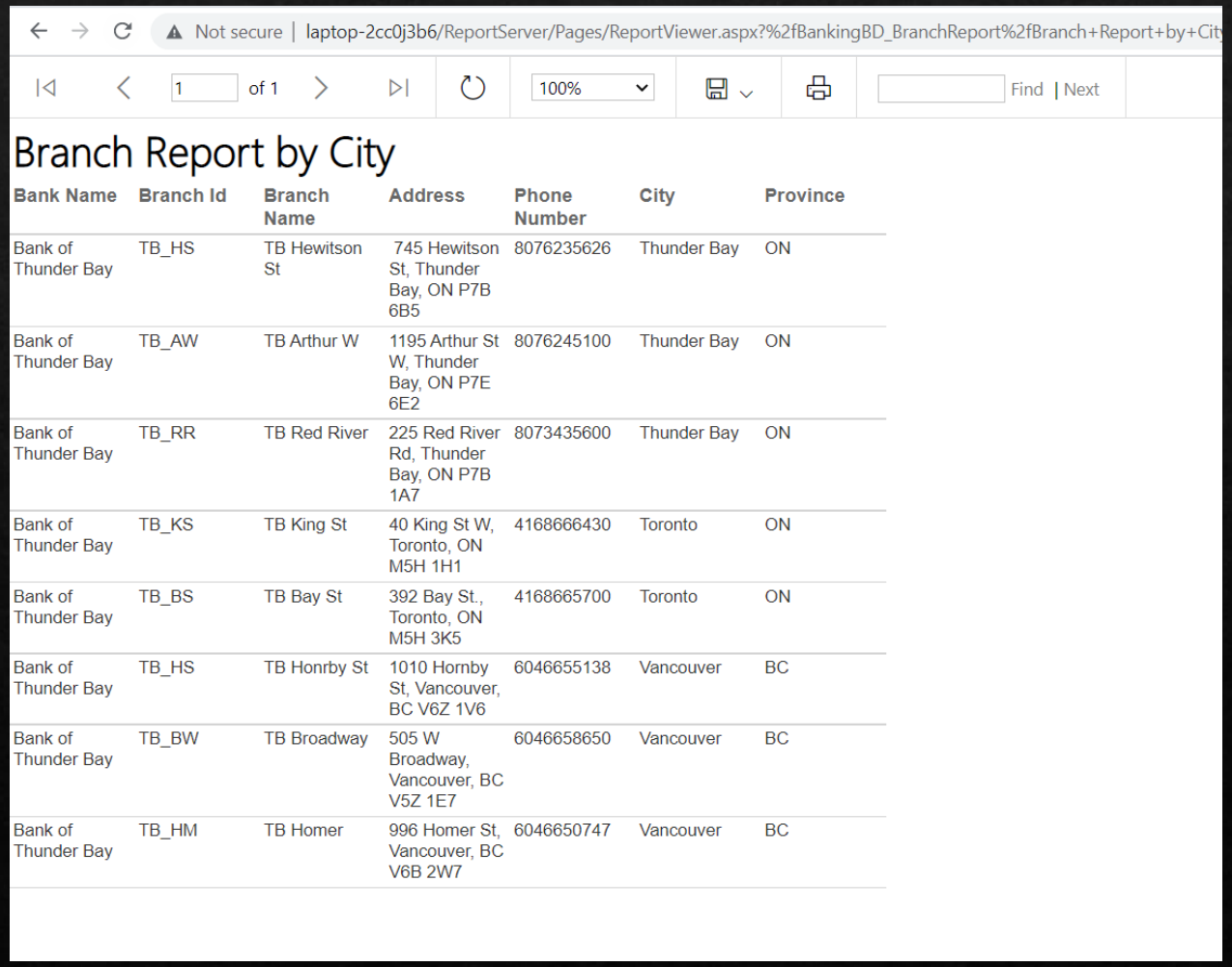
Database Creation

- Table structure in the database



Reports

- Branch report by City

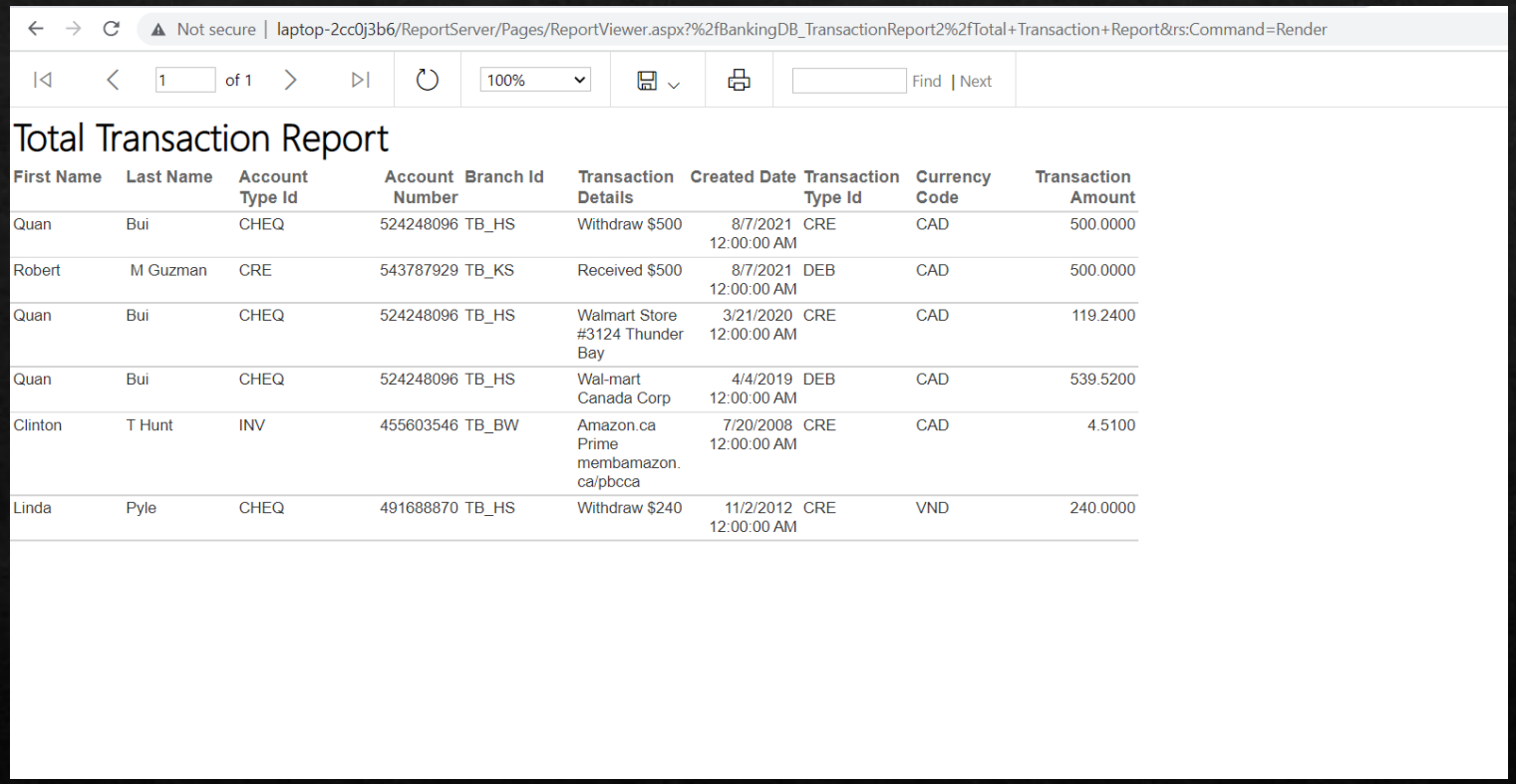


Branch Report by City

Bank Name	Branch Id	Branch Name	Address	Phone Number	City	Province
Bank of Thunder Bay	TB_HS	TB Hewitson St	745 Hewitson St, Thunder Bay, ON P7B 6B5	8076235626	Thunder Bay	ON
Bank of Thunder Bay	TB_AW	TB Arthur W	1195 Arthur St W, Thunder Bay, ON P7E 6E2	8076245100	Thunder Bay	ON
Bank of Thunder Bay	TB_RR	TB Red River	225 Red River Rd, Thunder Bay, ON P7B 1A7	8073435600	Thunder Bay	ON
Bank of Thunder Bay	TB_KS	TB King St	40 King St W, Toronto, ON M5H 1H1	4168666430	Toronto	ON
Bank of Thunder Bay	TB_BS	TB Bay St	392 Bay St., Toronto, ON M5H 3K5	4168665700	Toronto	ON
Bank of Thunder Bay	TB_HS	TB Honrby St	1010 Hornby St, Vancouver, BC V6Z 1V6	6046655138	Vancouver	BC
Bank of Thunder Bay	TB_BW	TB Broadway	505 W Broadway, Vancouver, BC V5Z 1E7	6046658650	Vancouver	BC
Bank of Thunder Bay	TB_HM	TB Homer	996 Homer St, Vancouver, BC V6B 2W7	6046650747	Vancouver	BC

Reports Cont.

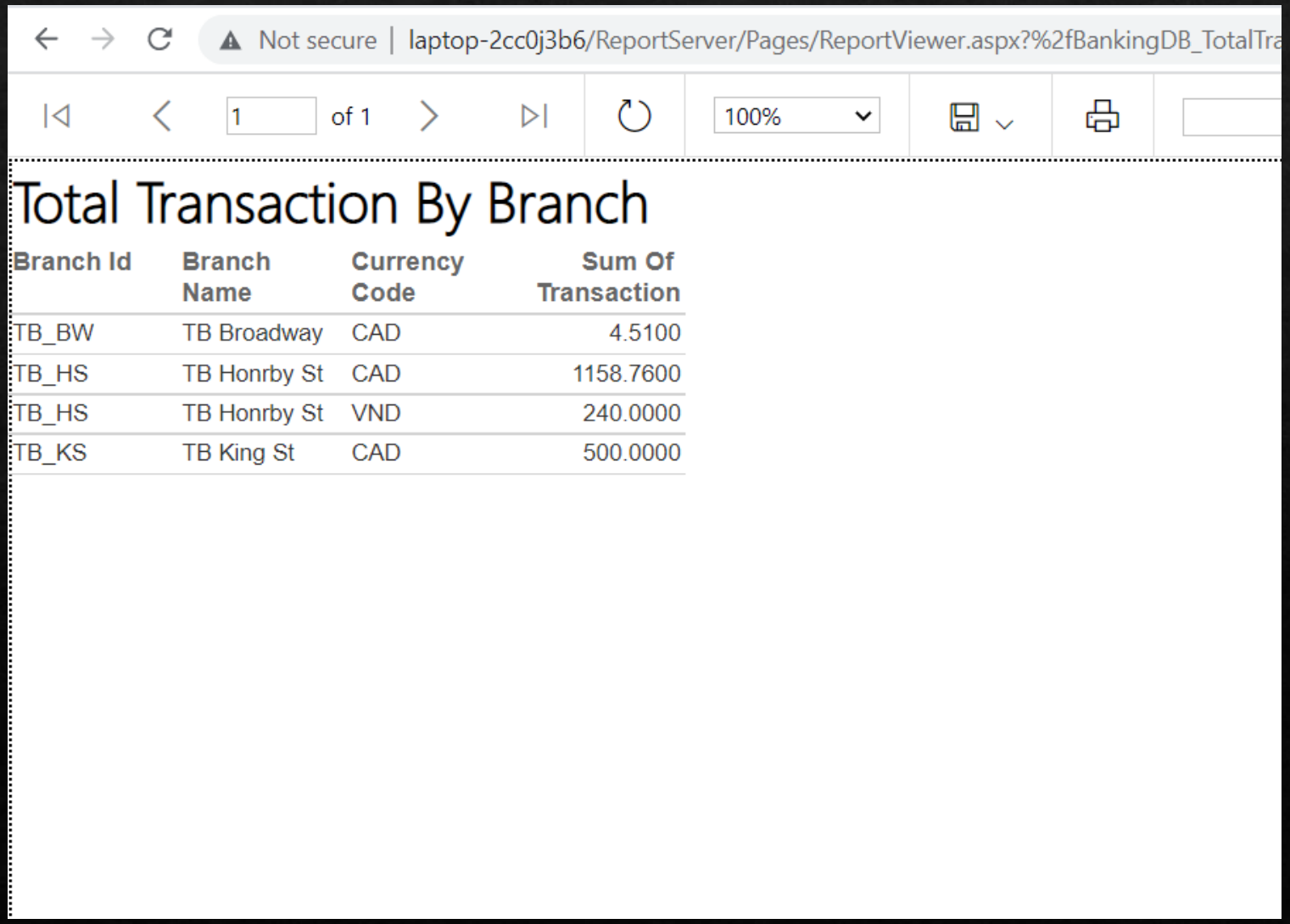
- Total Transaction report



First Name	Last Name	Account Type Id	Account Number	Branch Id	Transaction Details	Created Date	Transaction Type Id	Currency Code	Transaction Amount
Quan	Bui	CHEQ	524248096	TB_HS	Withdraw $500	8/7/2021 12:00:00 AM	CRE	CAD	500.0000
Robert	M Guzman	CRE	543787929	TB_KS	Received $500	8/7/2021 12:00:00 AM	DEB	CAD	500.0000
Quan	Bui	CHEQ	524248096	TB_HS	Walmart Store #3124 Thunder Bay	3/21/2020 12:00:00 AM	CRE	CAD	119.2400
Quan	Bui	CHEQ	524248096	TB_HS	Wal-mart Canada Corp	4/4/2019 12:00:00 AM	DEB	CAD	539.5200
Clinton	T Hunt	INV	455603546	TB_BW	Amazon.ca Prime membamazon. ca/pbcca	7/20/2008 12:00:00 AM	CRE	CAD	4.5100
Linda	Pyle	CHEQ	491688870	TB_HS	Withdraw $240	11/2/2012 12:00:00 AM	CRE	VND	240.0000

Reports Cont.

- Total Transaction By Branch

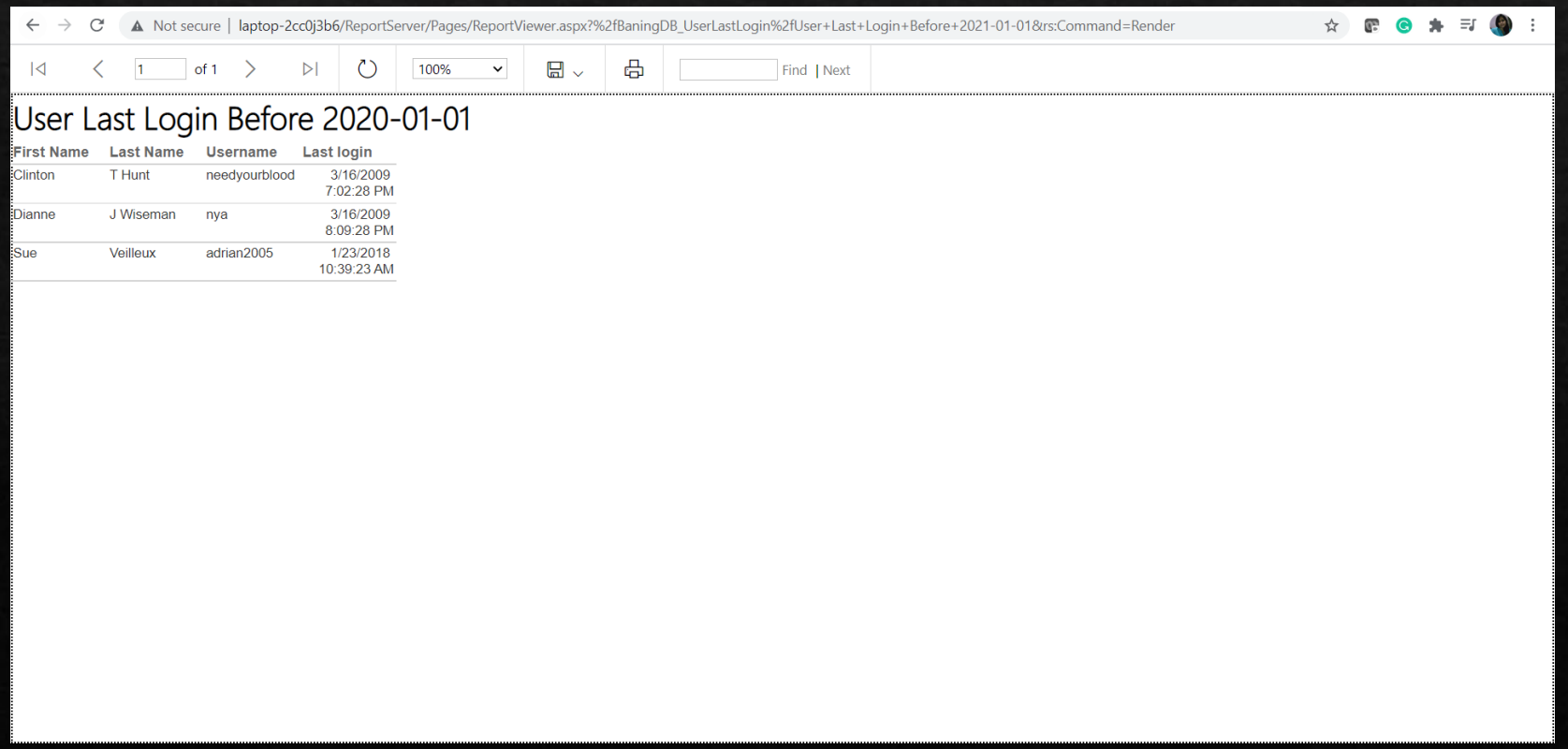


Total Transaction By Branch

Branch Id	Branch Name	Currency Code	Sum Of Transaction
TB_BW	TB Broadway	CAD	4.5100
TB_HS	TB Honrby St	CAD	1158.7600
TB_HS	TB Honrby St	VND	240.0000
TB_KS	TB King St	CAD	500.0000

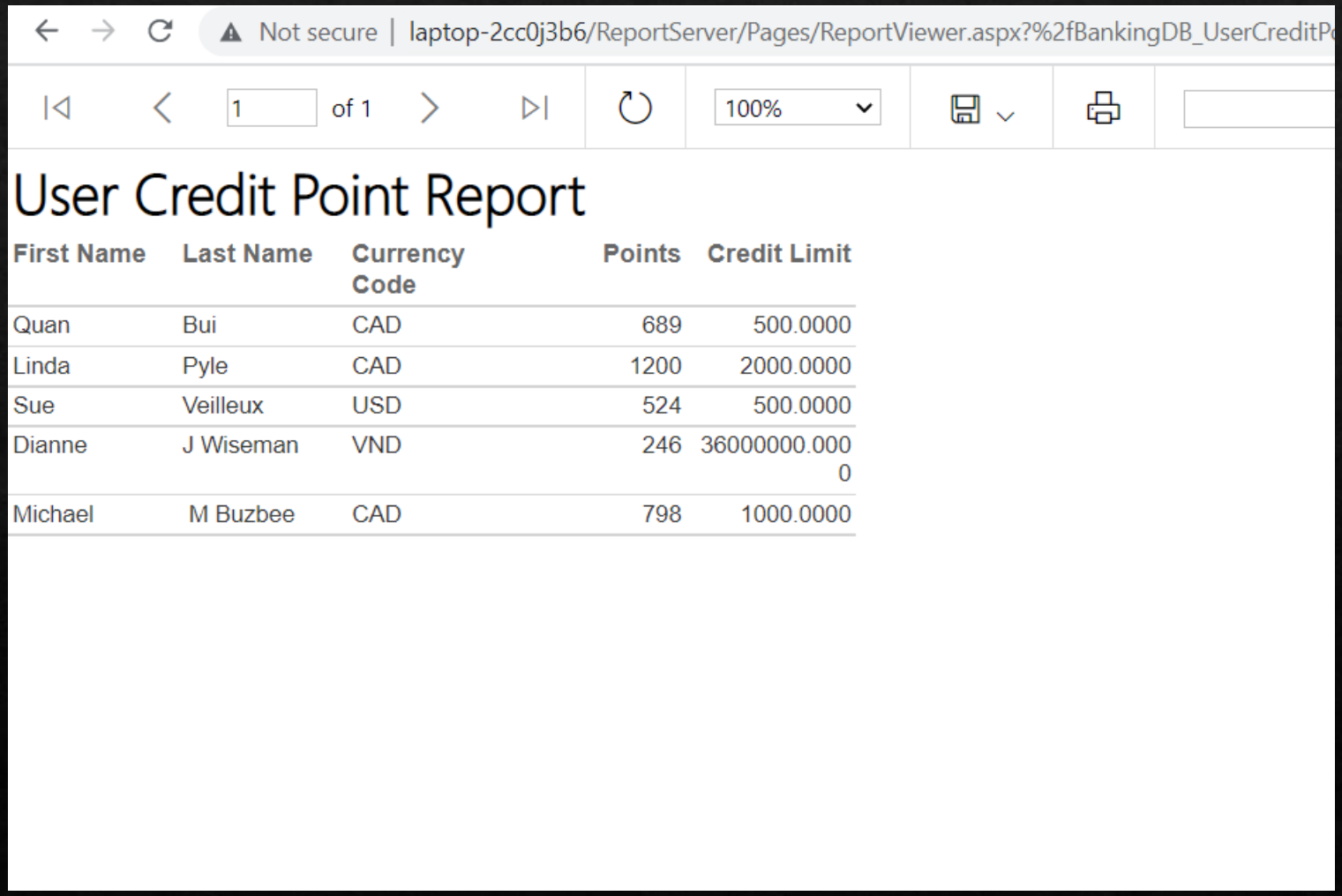
Reports Cont.

- User Last login before 2020-01-01



Reports Cont.

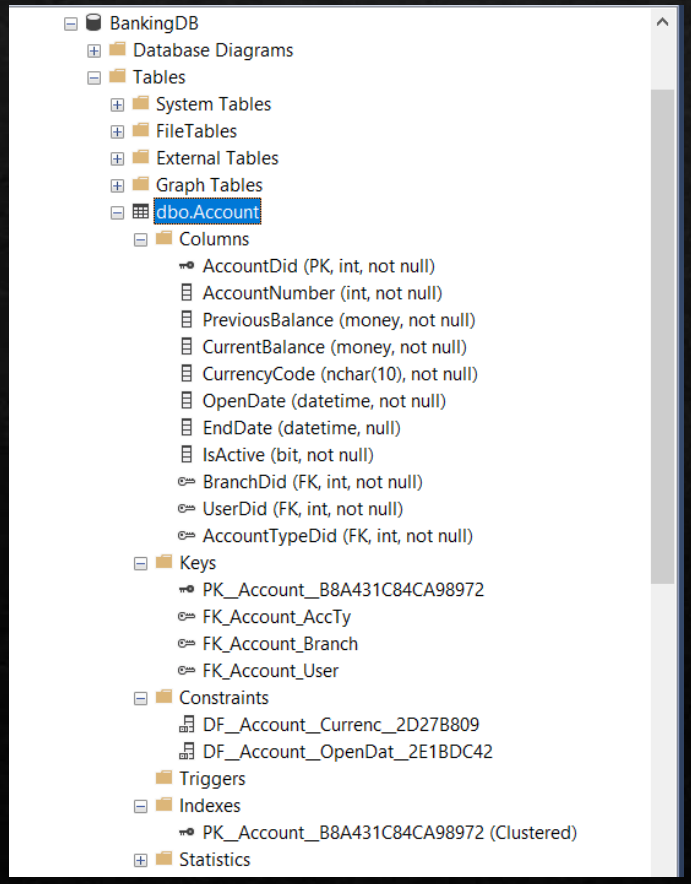
- User Credit Point Report

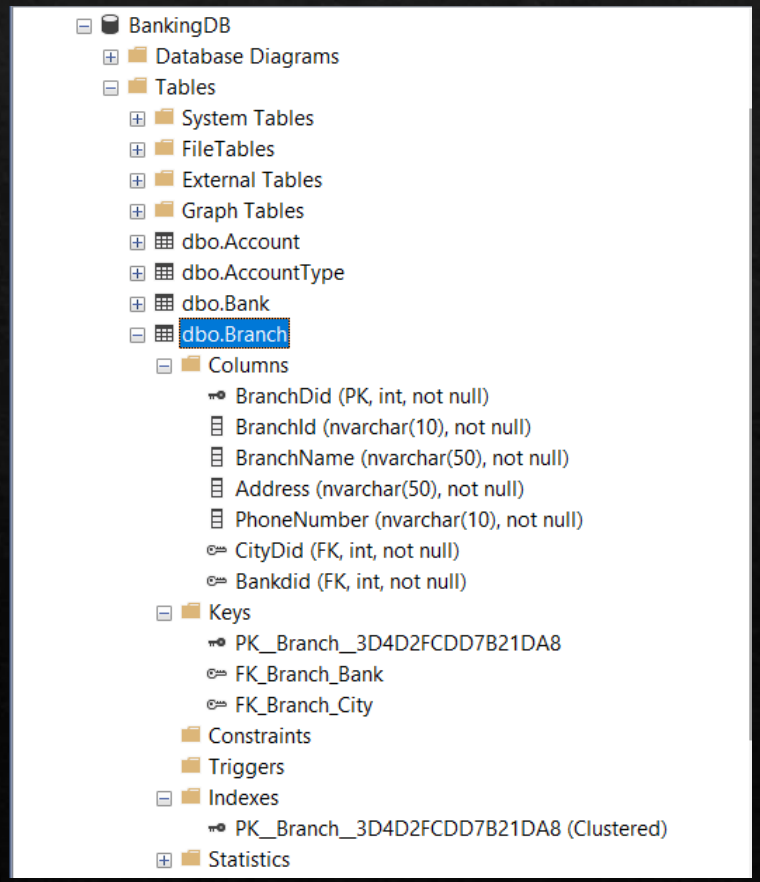


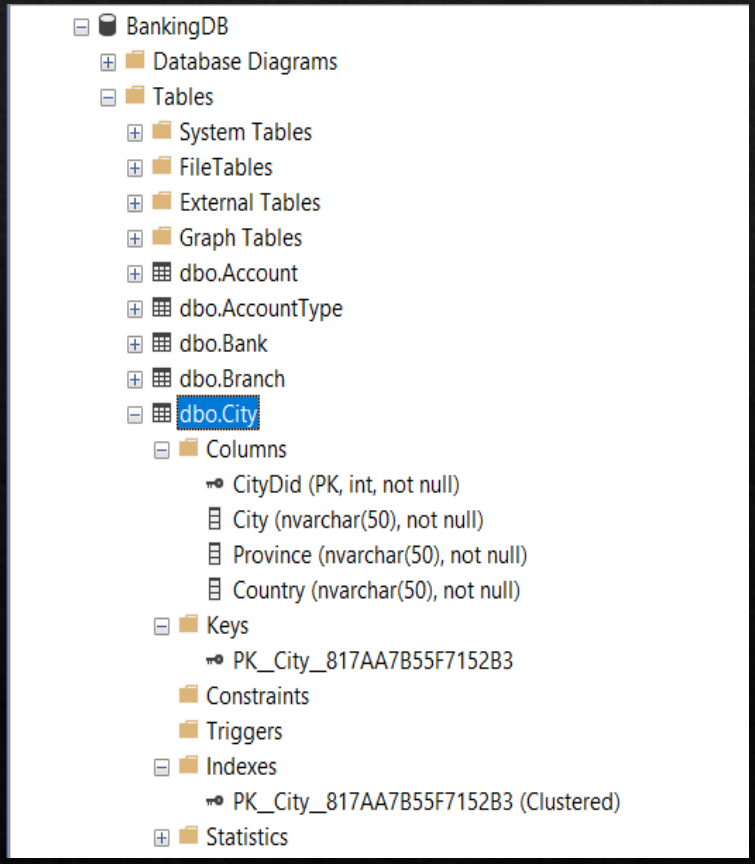
Constraint & Indices

Database Tables

- Account Table
- Branch Table
- City Table

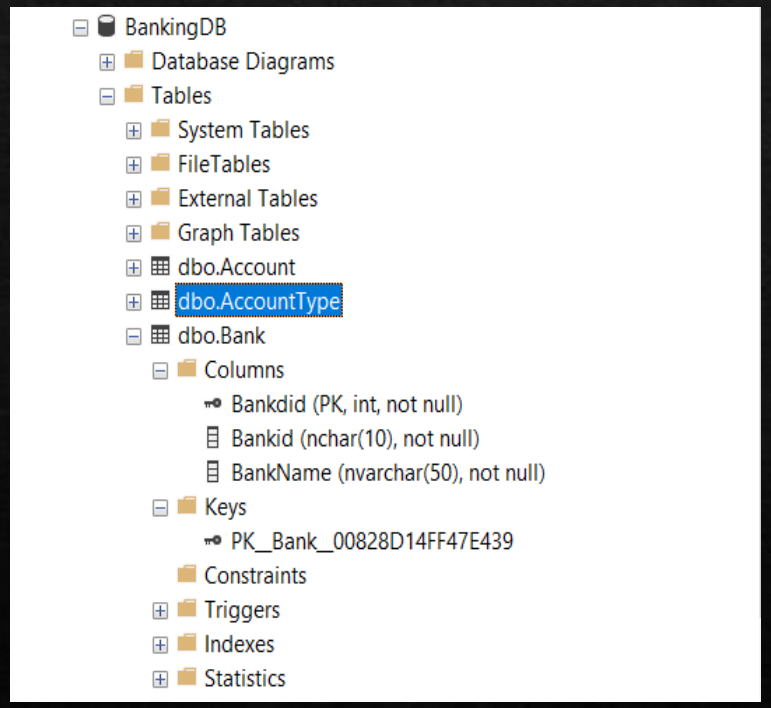




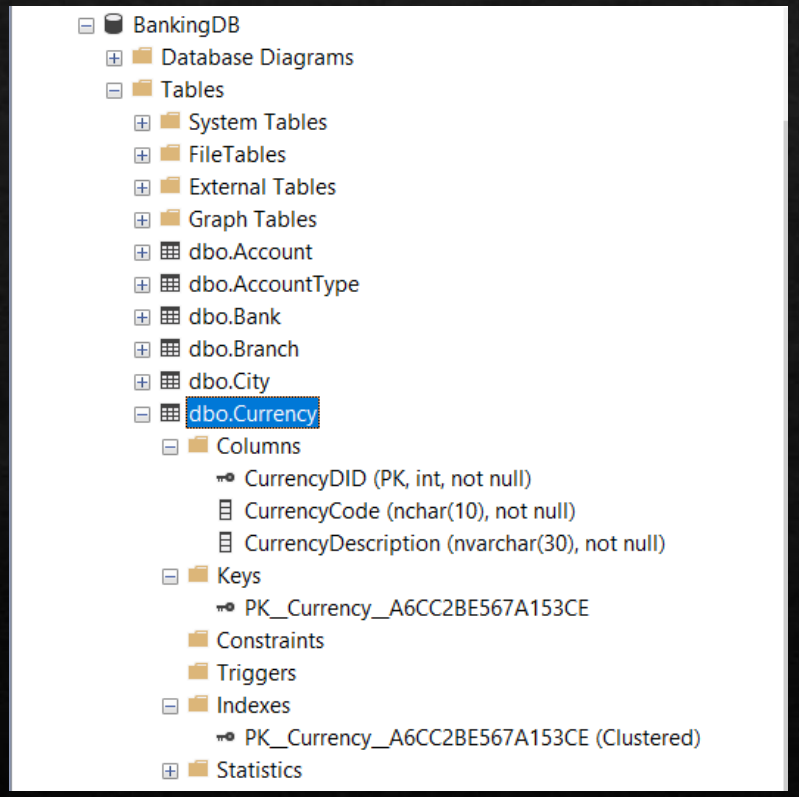


Database Tables Cont.

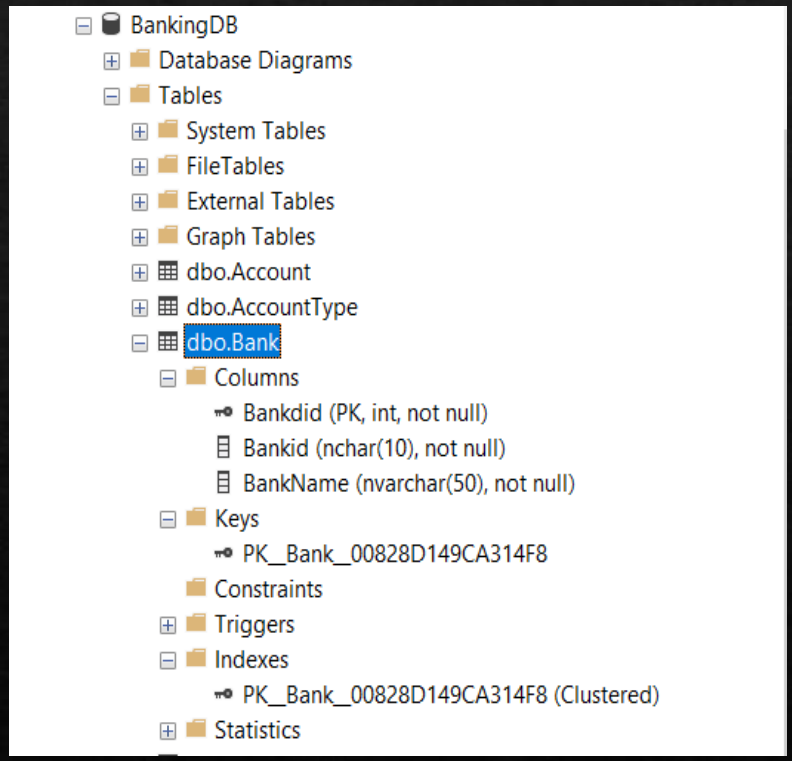
- Account Type Table



- Currency Table

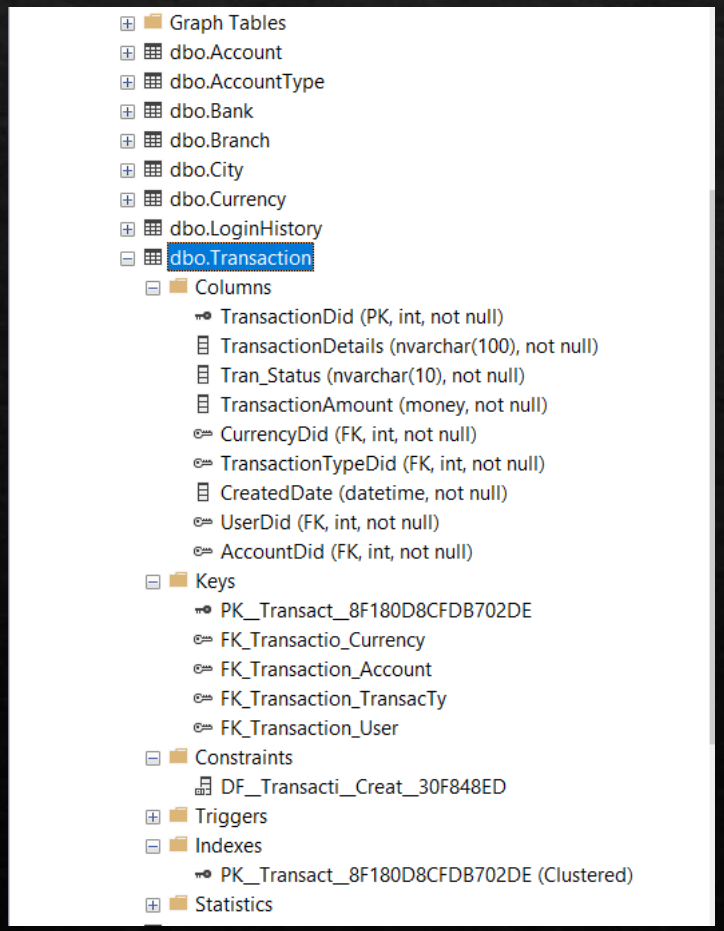


- Bank Table

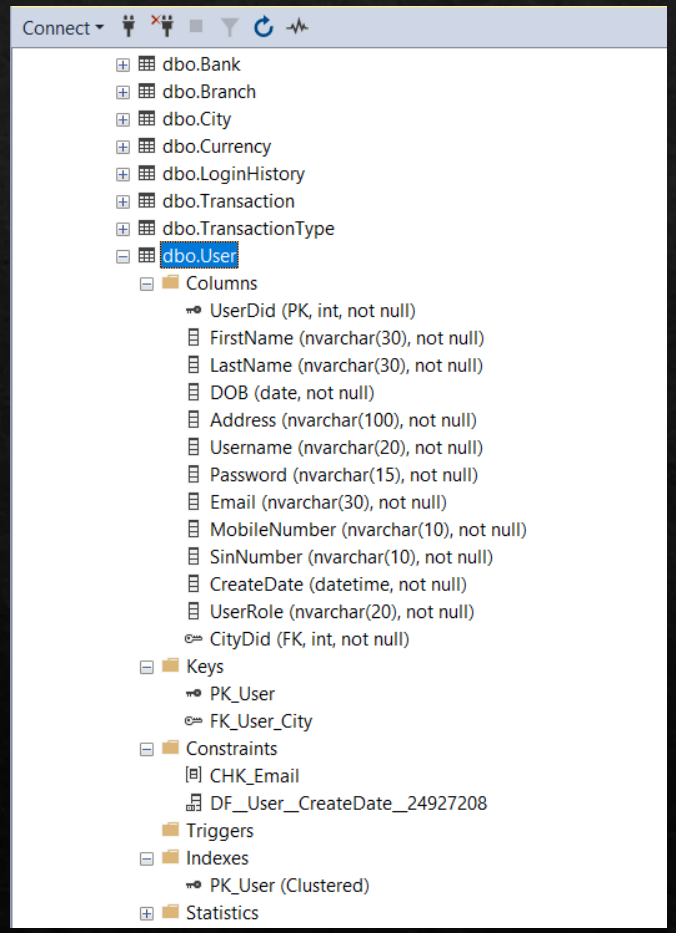


Database Tables Cont.

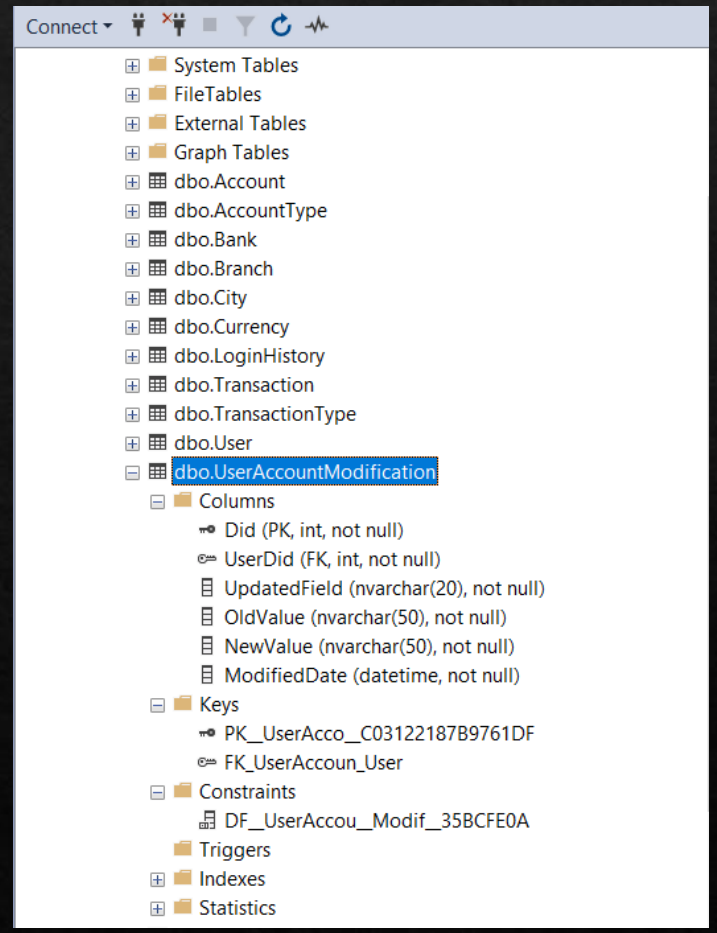
- Transaction Table



- User Table

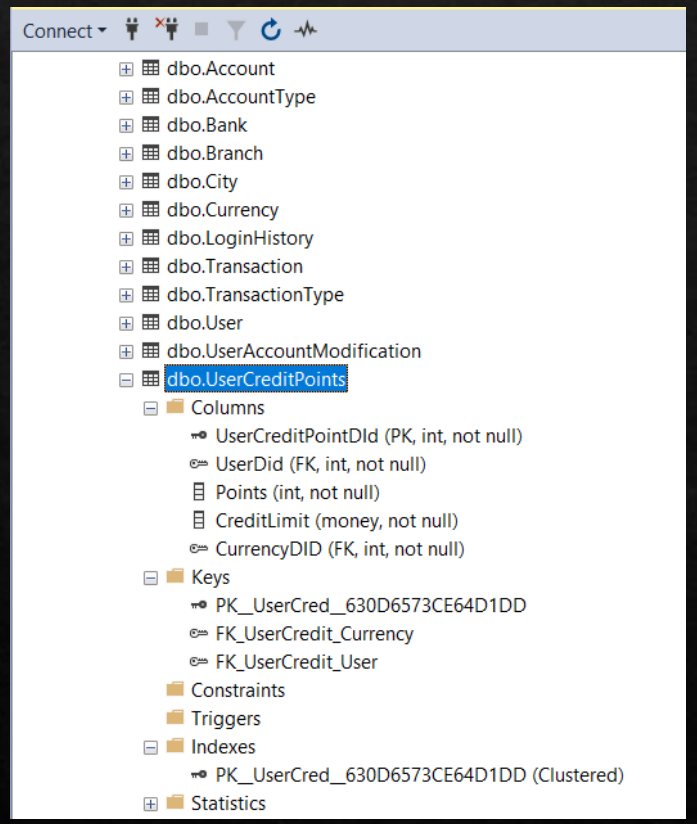


- User Account Modification Table

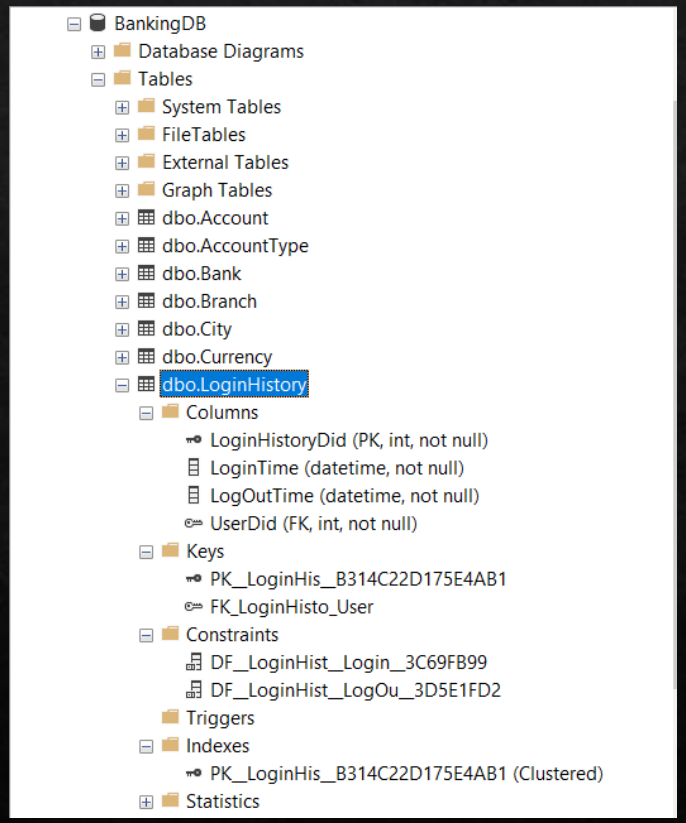


Database Tables Cont.

- User Credit Point Table



- Login History Table



- Transaction type Table

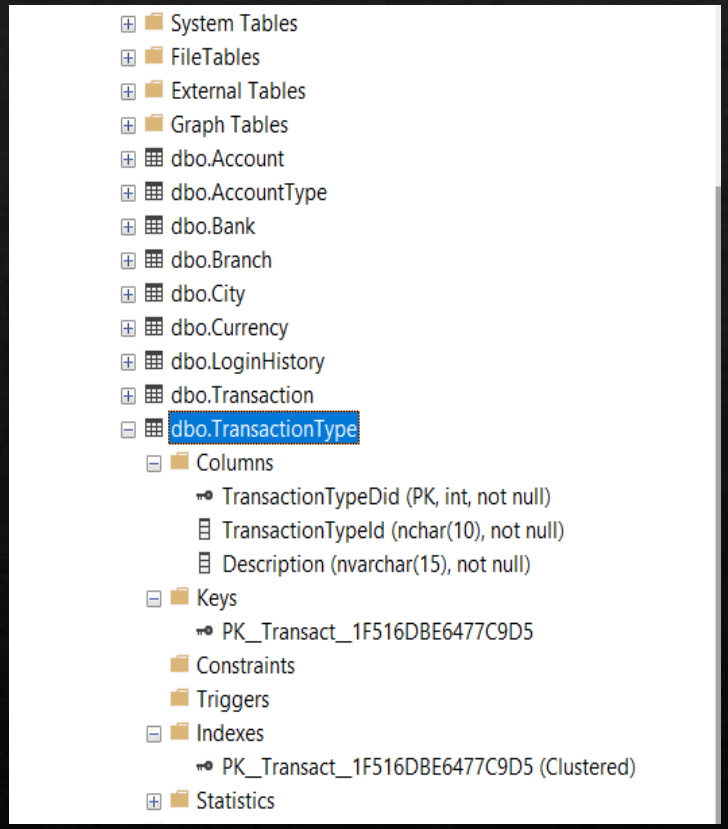
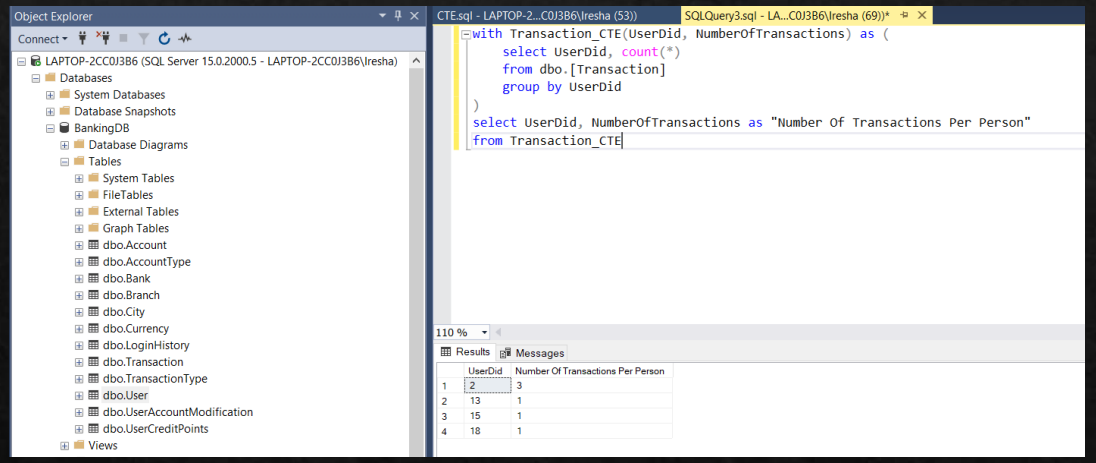


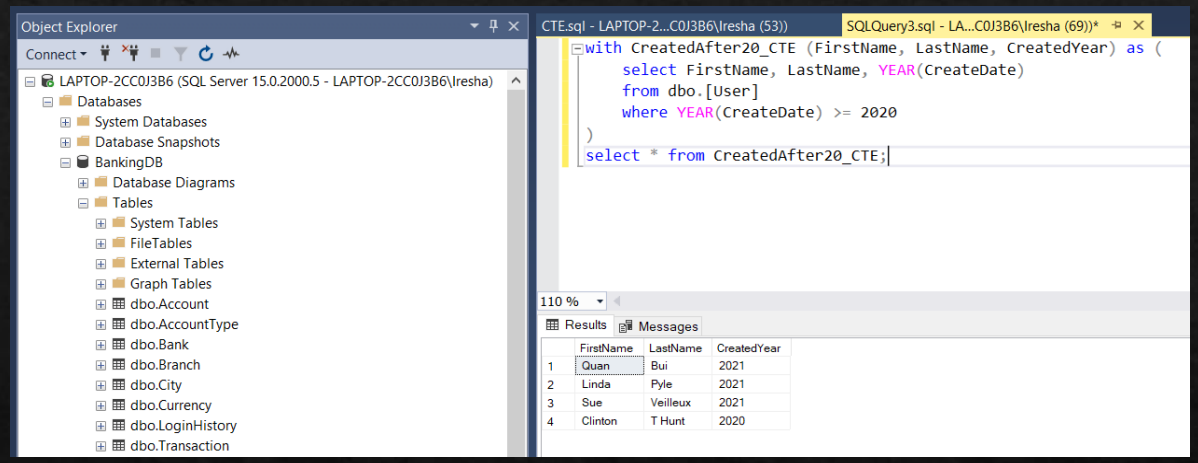
Table Expression & Group By-Having Queries

Table Expression

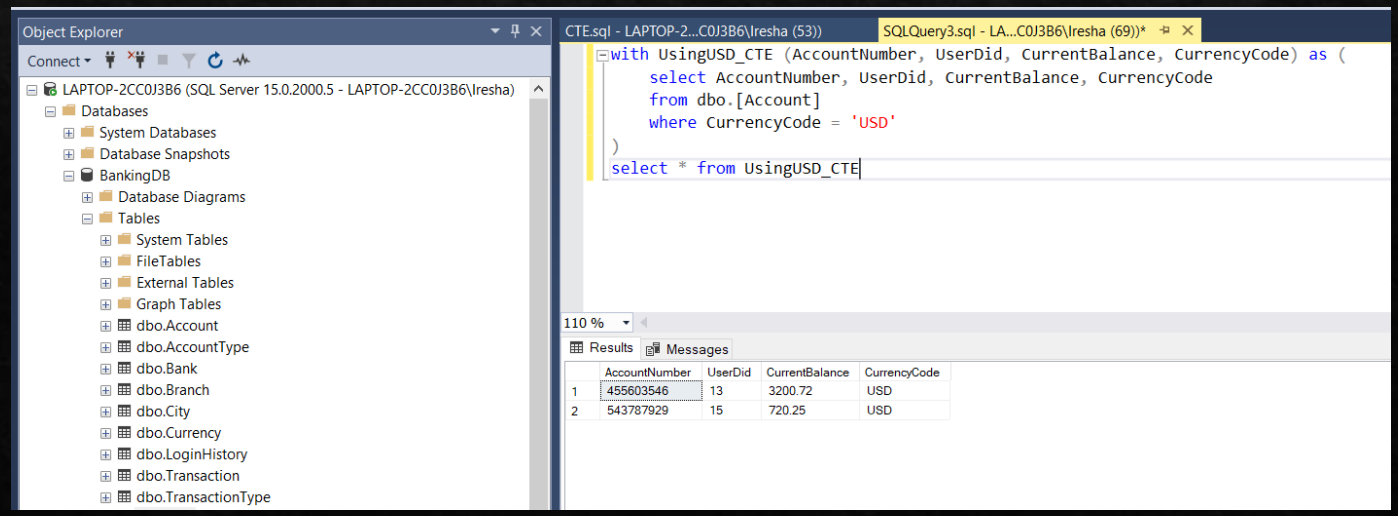
- Number Of Transactions Per User



- Accounts created after 2020

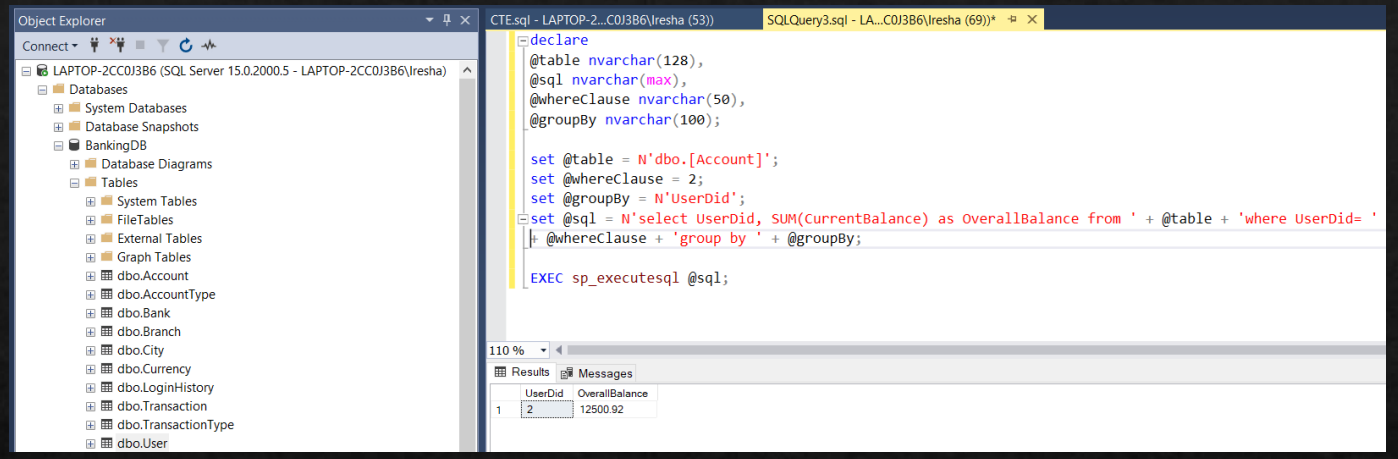


- Account balance with currency USD

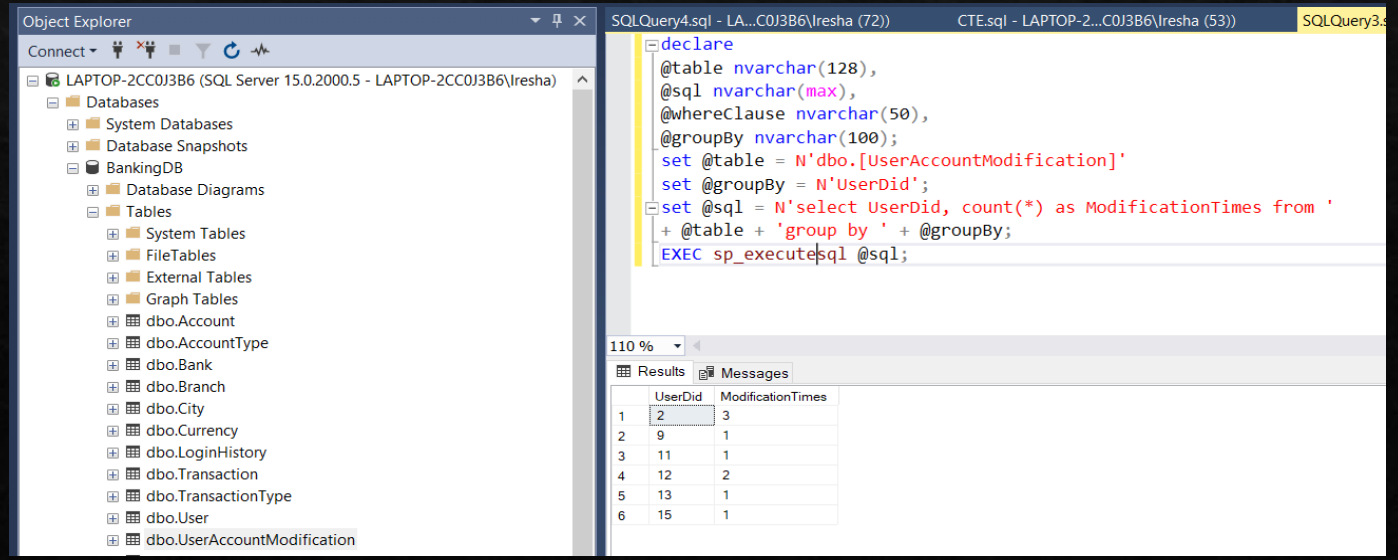


Group By – Having Queries

- Total User Account balance whose user id = 2

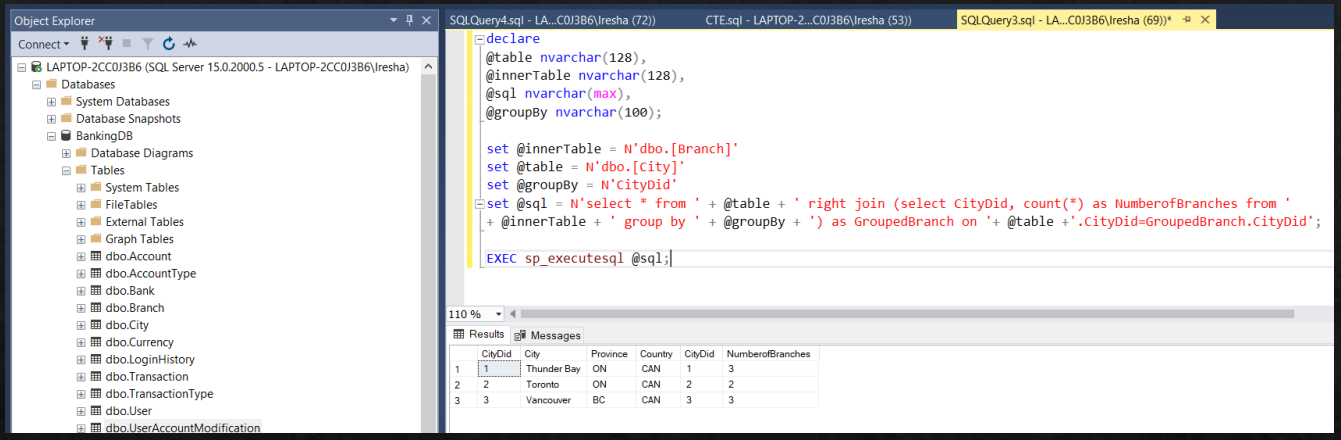


- User Account modification time per person

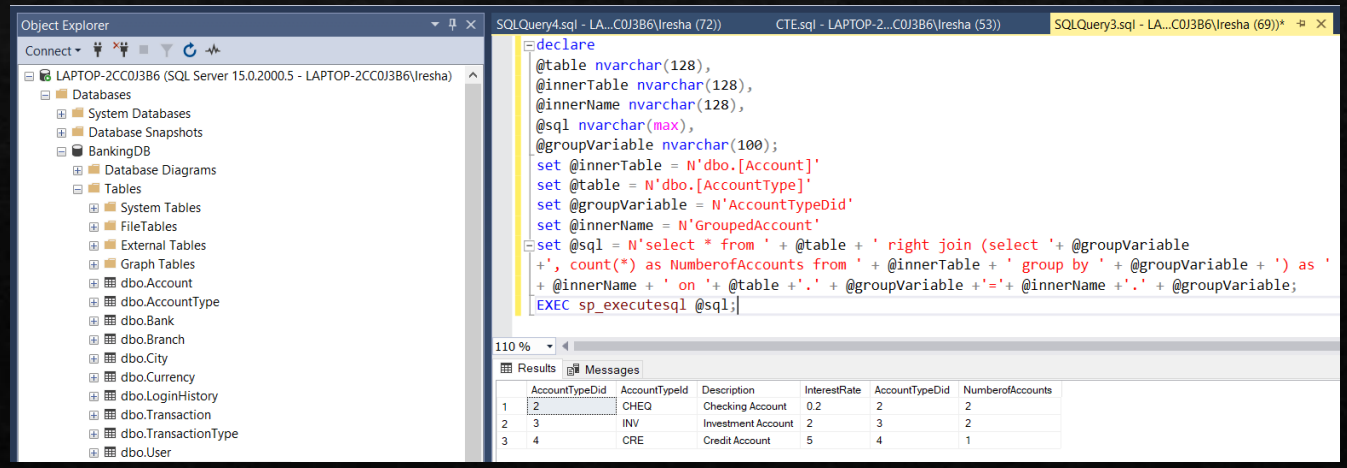


Group By – Having Queries Cont.

- Number of branches in each city

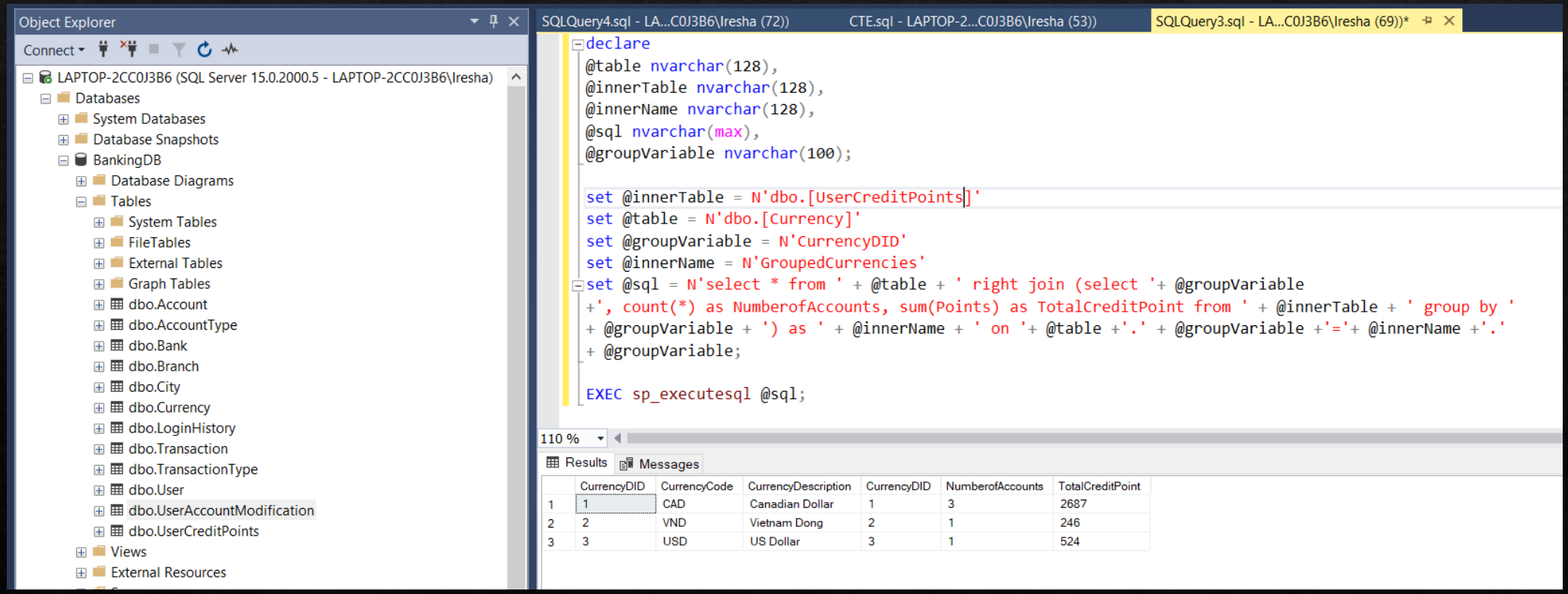


- Number of bank accounts in each bank account type



Group By – Having Queries Cont.

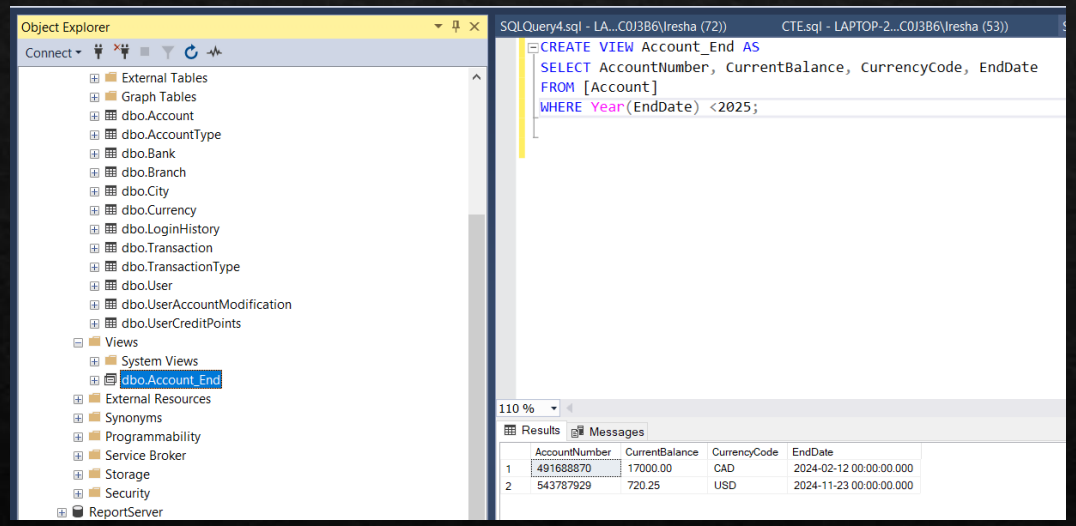
- Total credit points per currency code



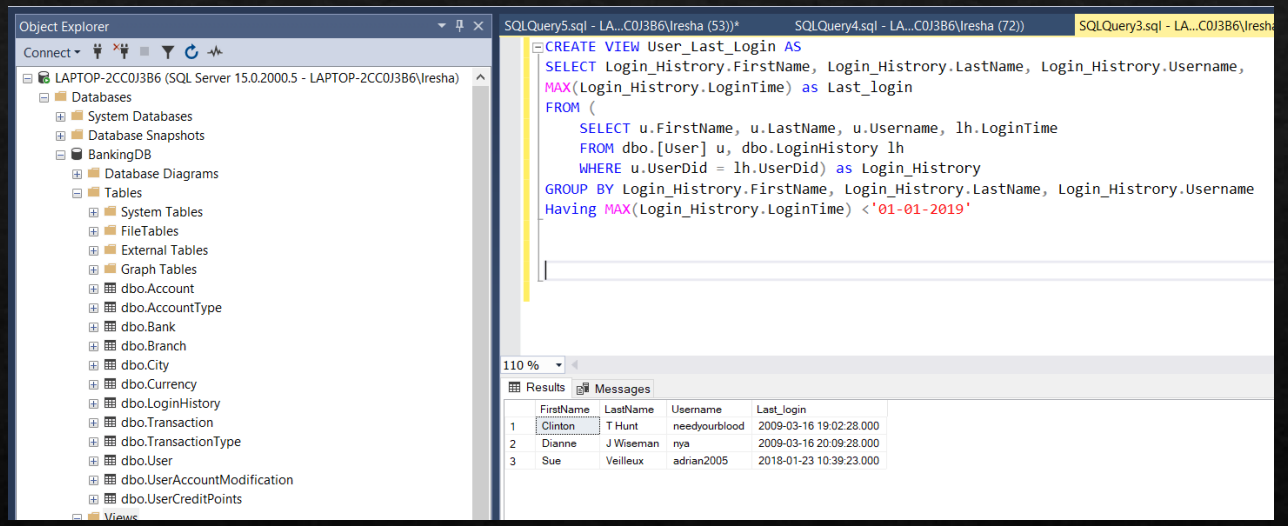
Views, Transaction & Sub Queries

Views

- Accounts which is going to be expired before 2025

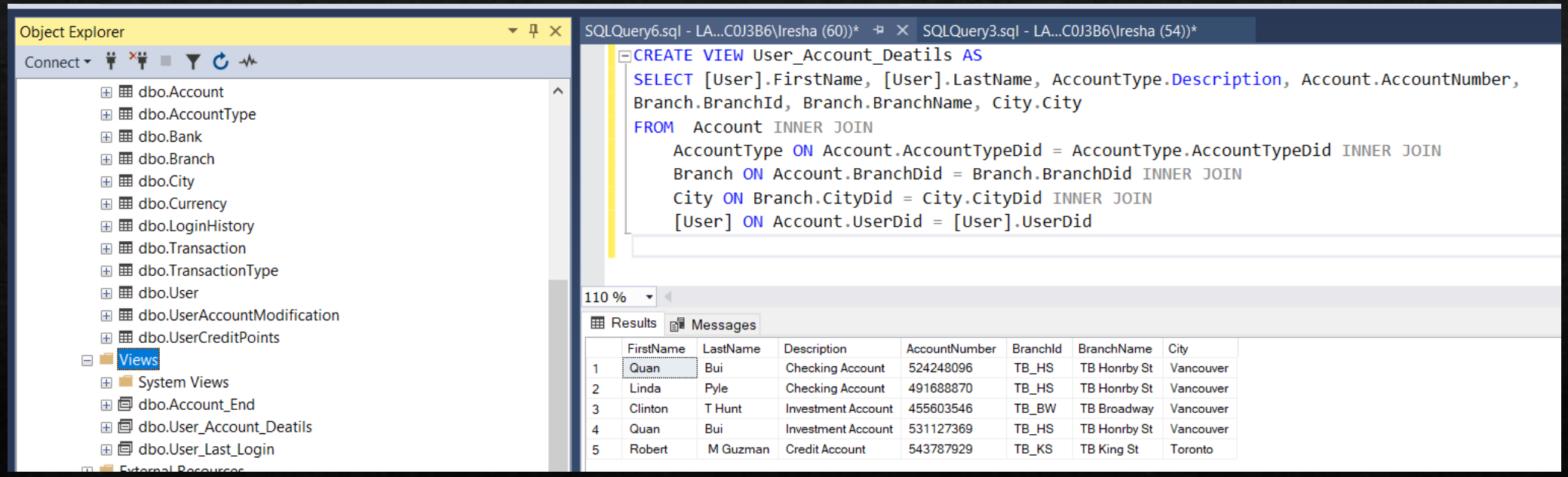


- User details who have not login to their account after 2019



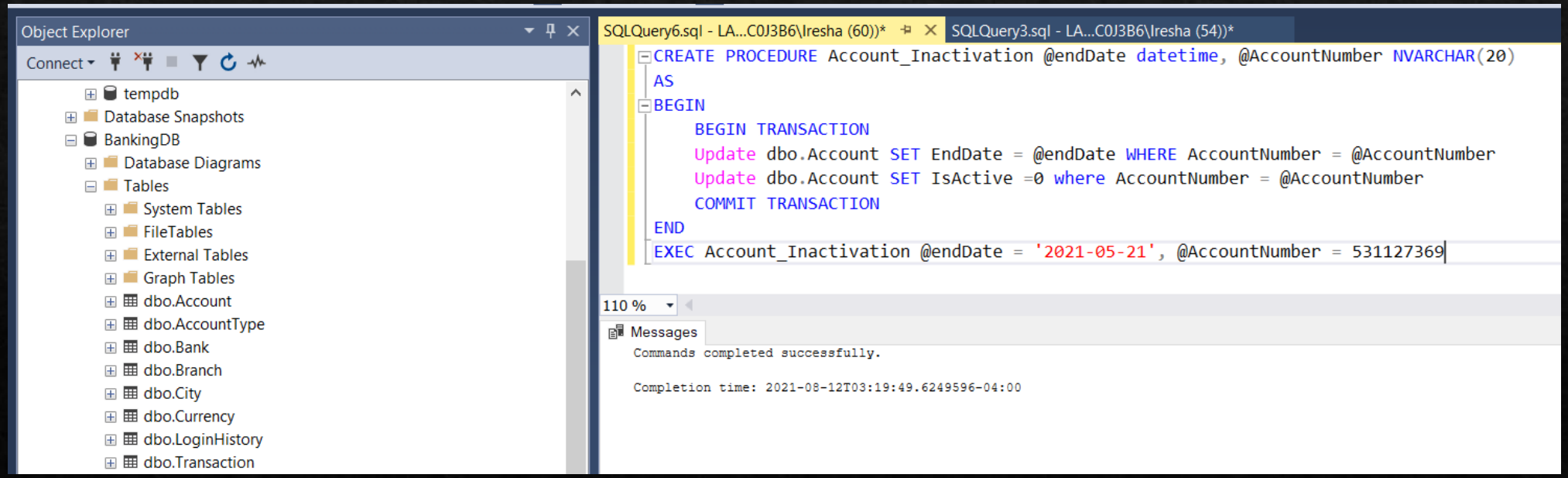
Views Cont.

- All user accounts details



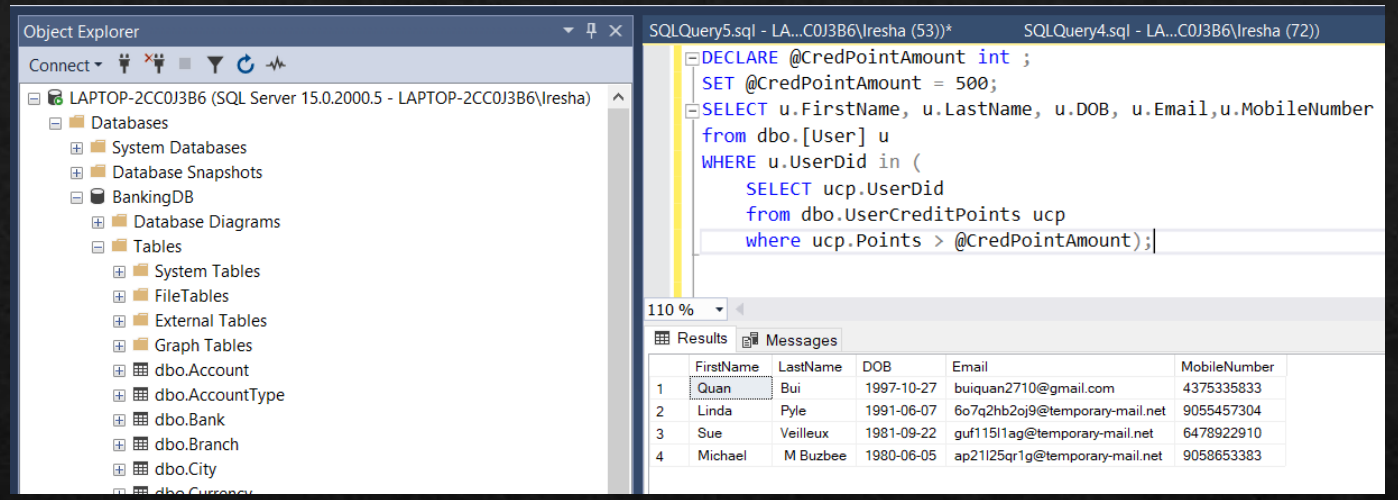
Transaction

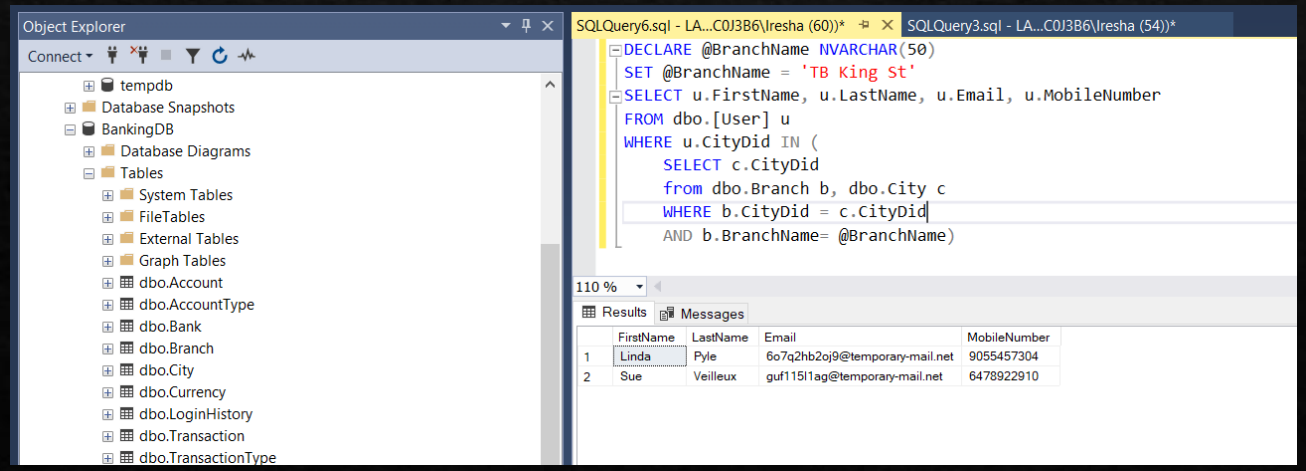
- Account is getting inactive when the account end date is updated



Sub Queries

- Users whose credit points are greater than 500

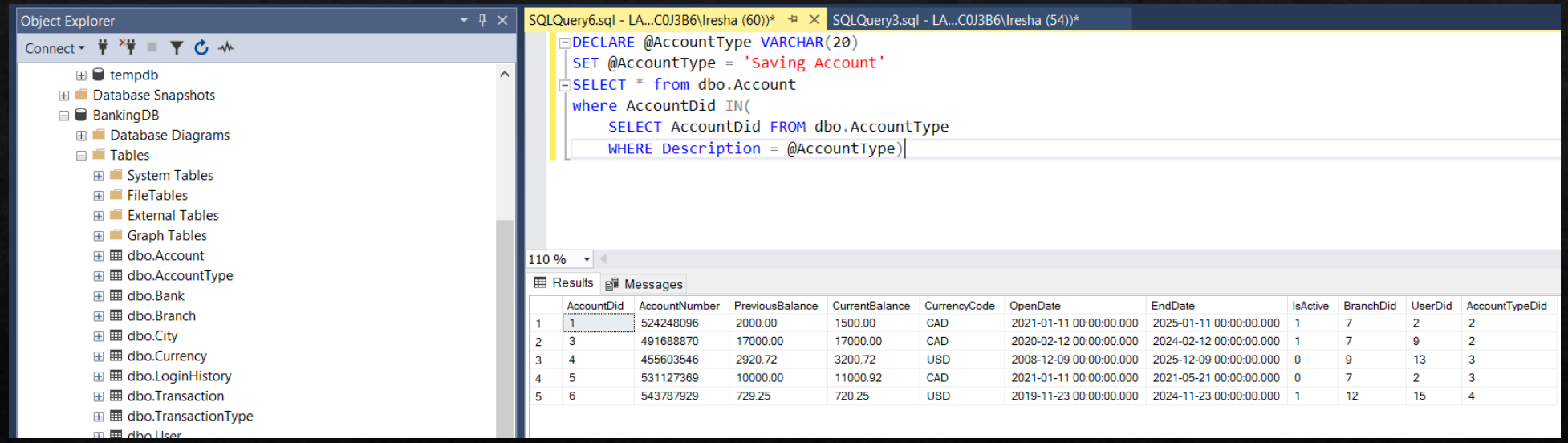




- Users who are in the same city of the give branch TB King St

Sub Queries Cont.

- All the savings accounts details



	AccountDid	AccountNumber	PreviousBalance	CurrentBalance	CurrencyCode	OpenDate	EndDate	IsActive	BranchDid	UserDid	AccountTypeDid
1	1	524248096	2000.00	1500.00	CAD	2021-01-11 00:00:00.000	2025-01-11 00:00:00.000	1	7	2	2
2	3	491688870	17000.00	17000.00	CAD	2020-02-12 00:00:00.000	2024-02-12 00:00:00.000	1	7	9	2
3	4	455603546	2920.72	3200.72	USD	2008-12-09 00:00:00.000	2025-12-09 00:00:00.000	0	9	13	3
4	5	531127369	10000.00	11000.92	CAD	2021-01-11 00:00:00.000	2021-05-21 00:00:00.000	0	7	2	3
5	6	543787929	729.25	720.25	USD	2019-11-23 00:00:00.000	2024-11-23 00:00:00.000	1	12	15	4

Explanation and usage of predicate logic

Predicate Logic

- Database table represent the lots of fact and logics that exist between the tables, and database queries produce result sets based on query predicates. A predicate defines a logical condition being applied to rows in a table. The common logical conditions with two values (true, false) are extended in the SQL language by a third value (unknown). SQL Predicates are found on the tail end of clauses, functions, and SQL expressions in existing query statements.

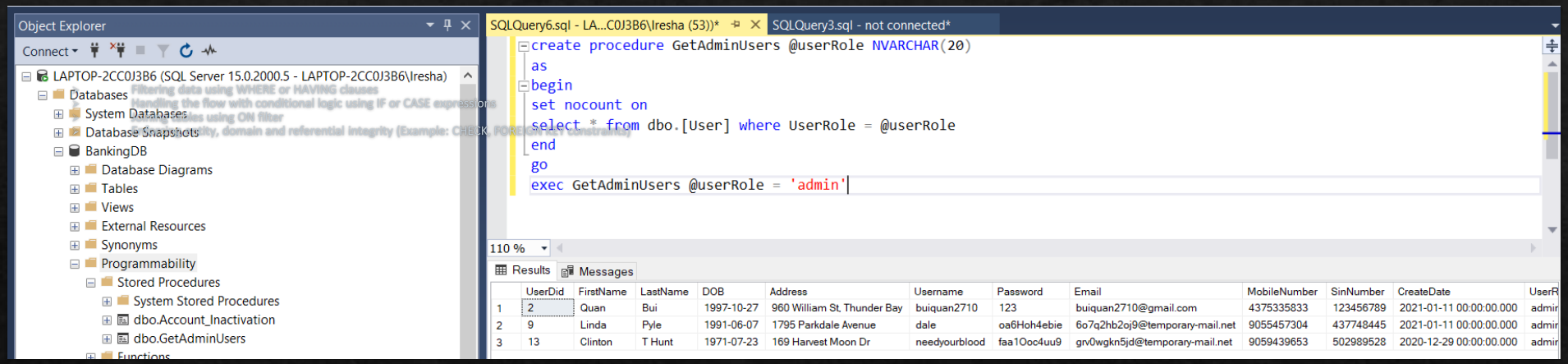
Usage of Predicate logics in Database

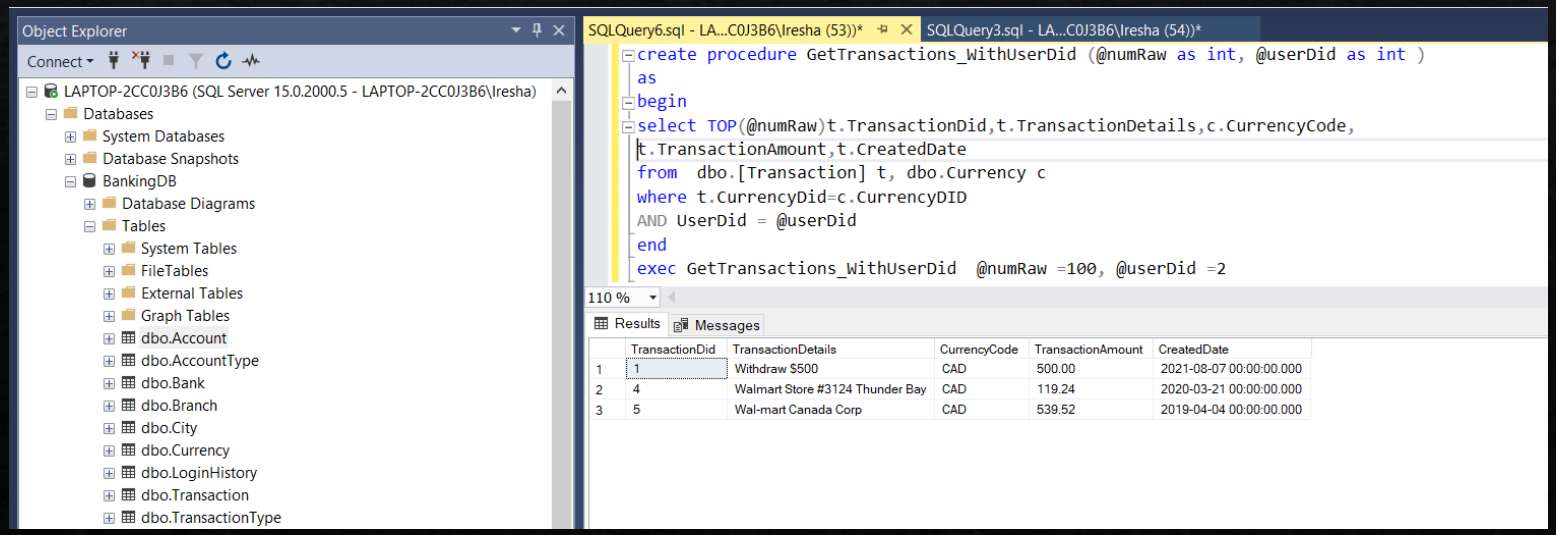
- Filtering data using WHERE or HAVING clauses
- Handling the flow with conditional logic using IF or CASE expressions
- Joining tables using ON filter
- Enforcing entity, domain and referential integrity (Example: CHECK, FOREIGN KEY constraints)

Stored Procedures, Function and Triggers

Stored Procedure

- Get the user details whose role is admin

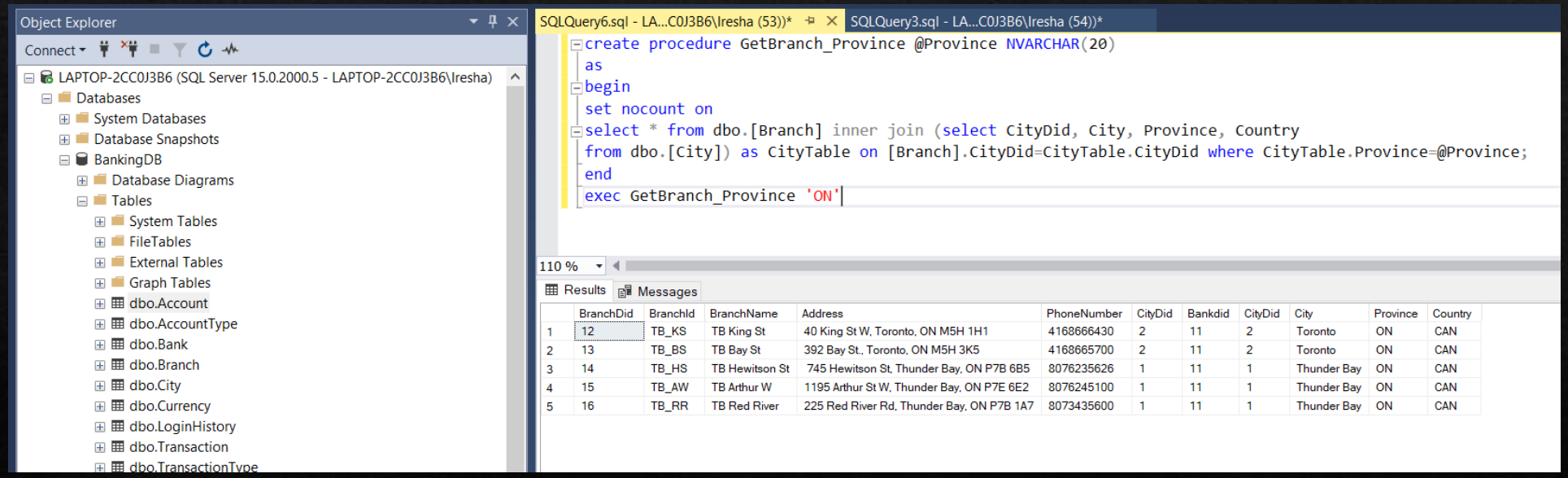




- Get the top 100 transaction details for user whose userdid=2

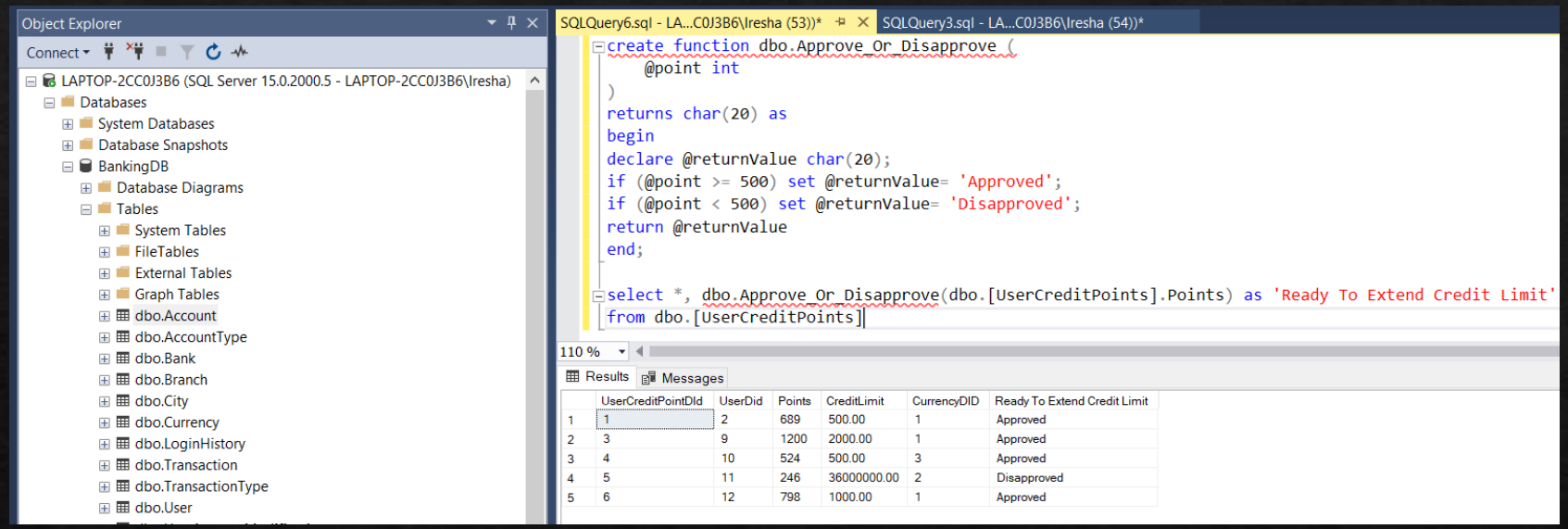
Stored Procedure Cont.

- All the branch details which are in Ontario province



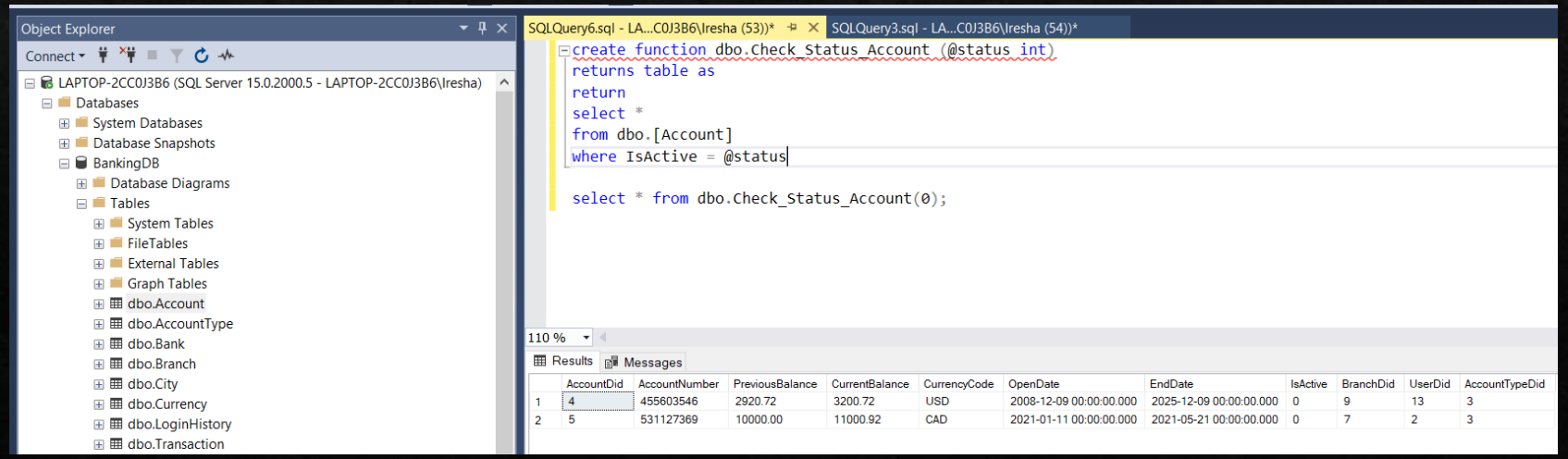
	BranchDid	BranchId	BranchName	Address	PhoneNumber	CityDid	Bankdid	CityDid	City	Province	Country
1	12	TB_KS	TB King St	40 King St W, Toronto, ON M5H 1H1	4168666430	2	11	2	Toronto	ON	CAN
2	13	TB_BS	TB Bay St	392 Bay St., Toronto, ON M5H 3K5	4168665700	2	11	2	Toronto	ON	CAN
3	14	TB_HS	TB Hewitson St	745 Hewitson St, Thunder Bay, ON P7B 6B5	8076235626	1	11	1	Thunder Bay	ON	CAN
4	15	TB_AW	TB Arthur W	1195 Arthur St W, Thunder Bay, ON P7E 6E2	8076245100	1	11	1	Thunder Bay	ON	CAN
5	16	TB_RR	TB Red River	225 Red River Rd, Thunder Bay, ON P7B 1A7	8073435600	1	11	1	Thunder Bay	ON	CAN

Functions



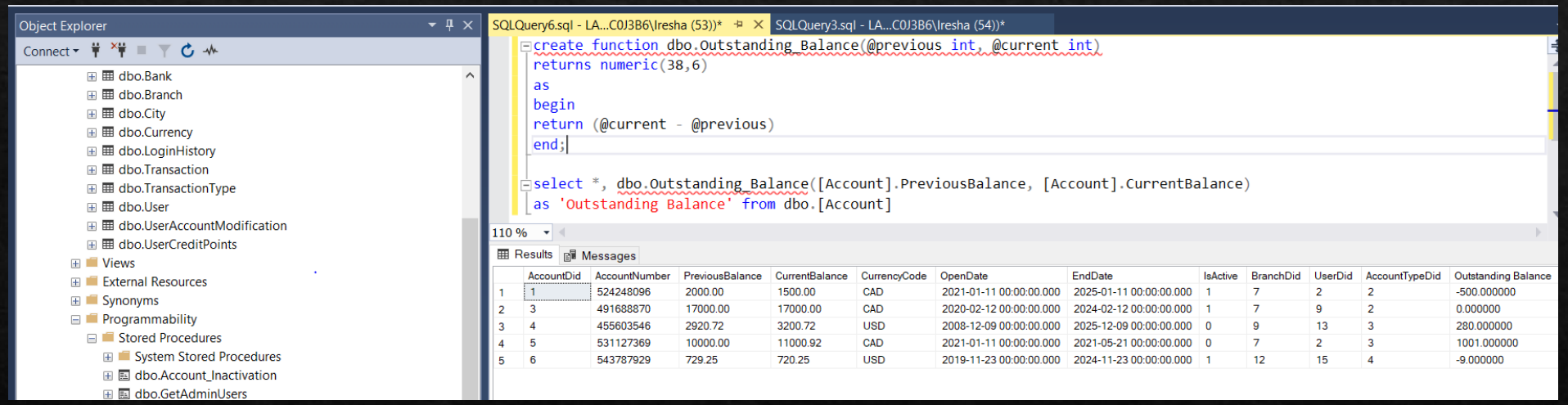
- check if user is allowed to increase the credit limit

- check the status of accounts



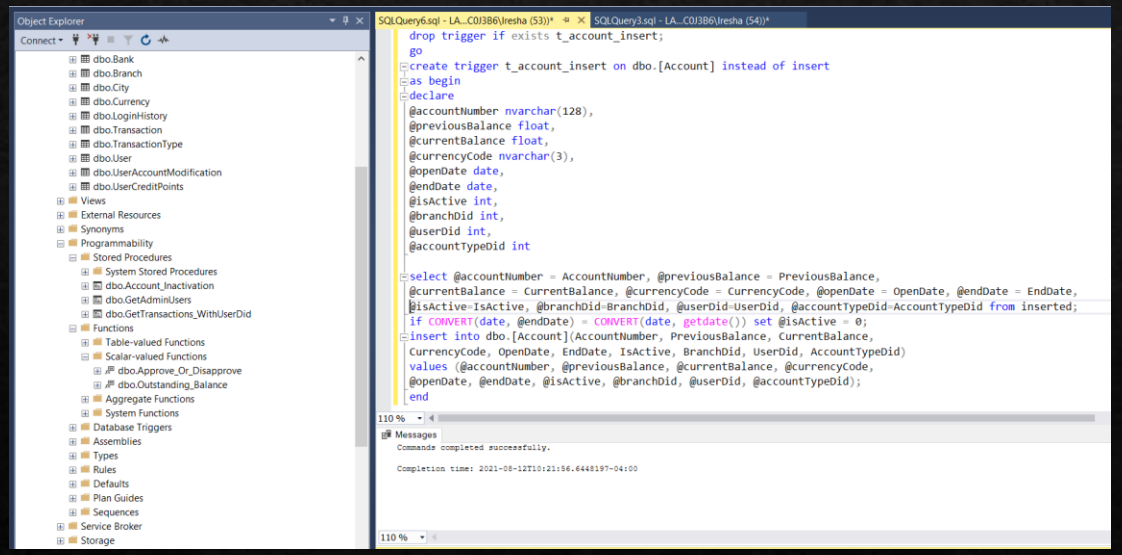
Functions Cont.

- To check the outstanding balance of accounts

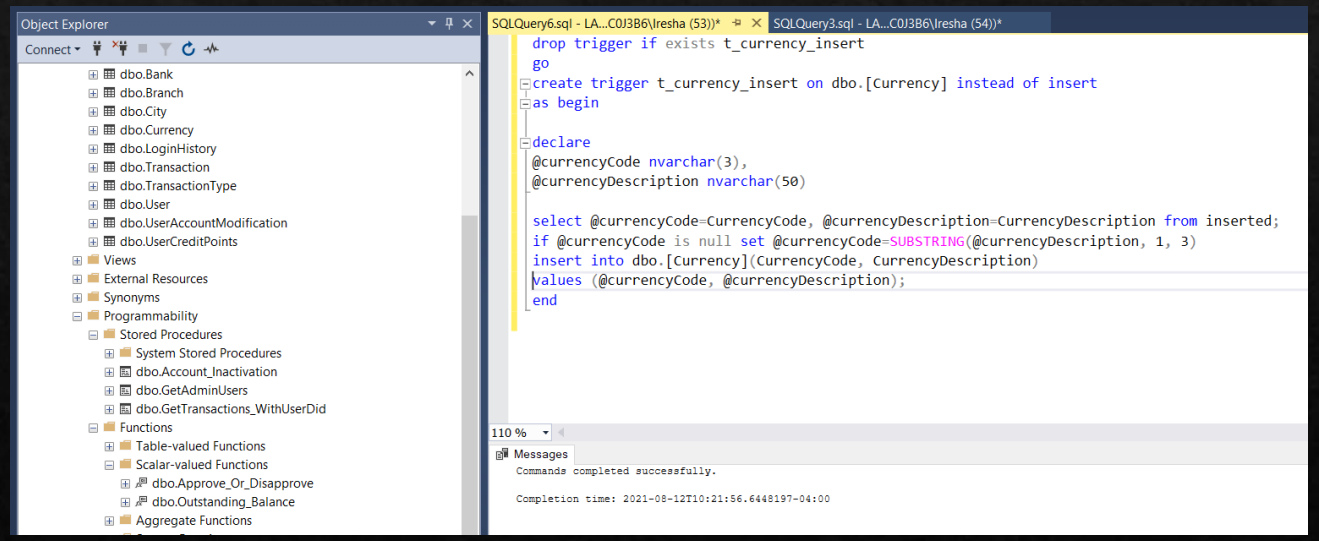


Triggers

- If the inserted account's expired date is equal to the date, the account will be disable

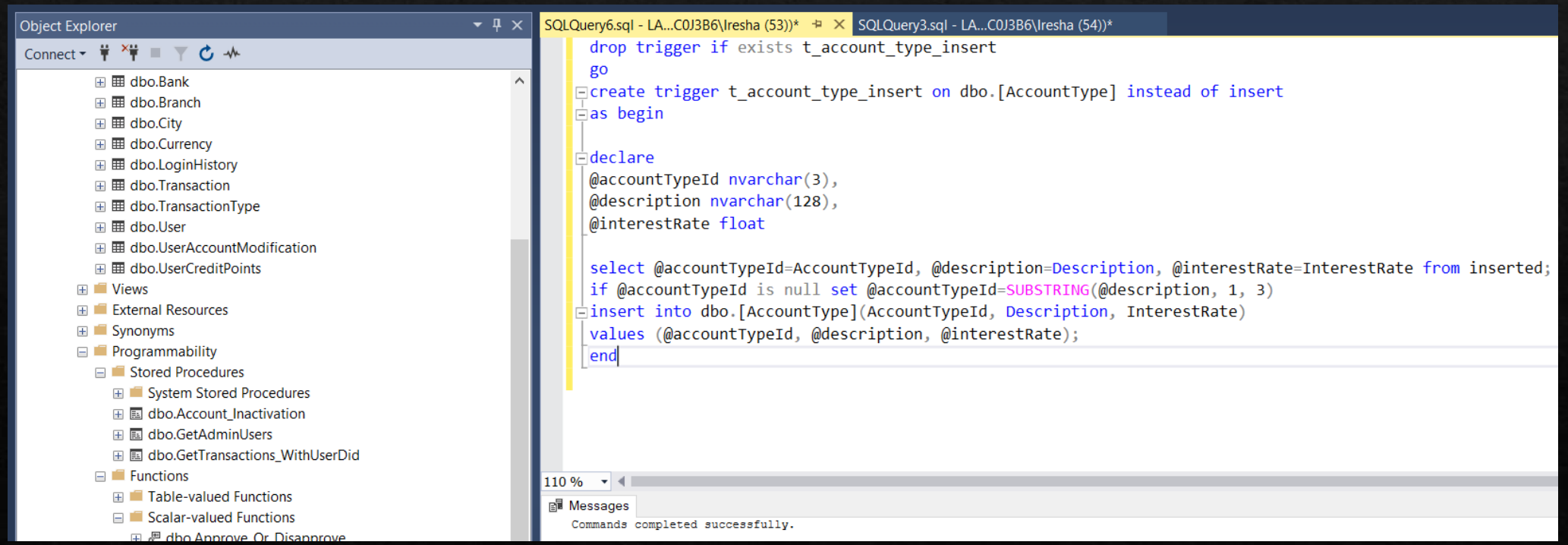


- If the inserted currency doesn't come with the currency code, trigger will be called to create a currency code substring from description



Triggers Cont.

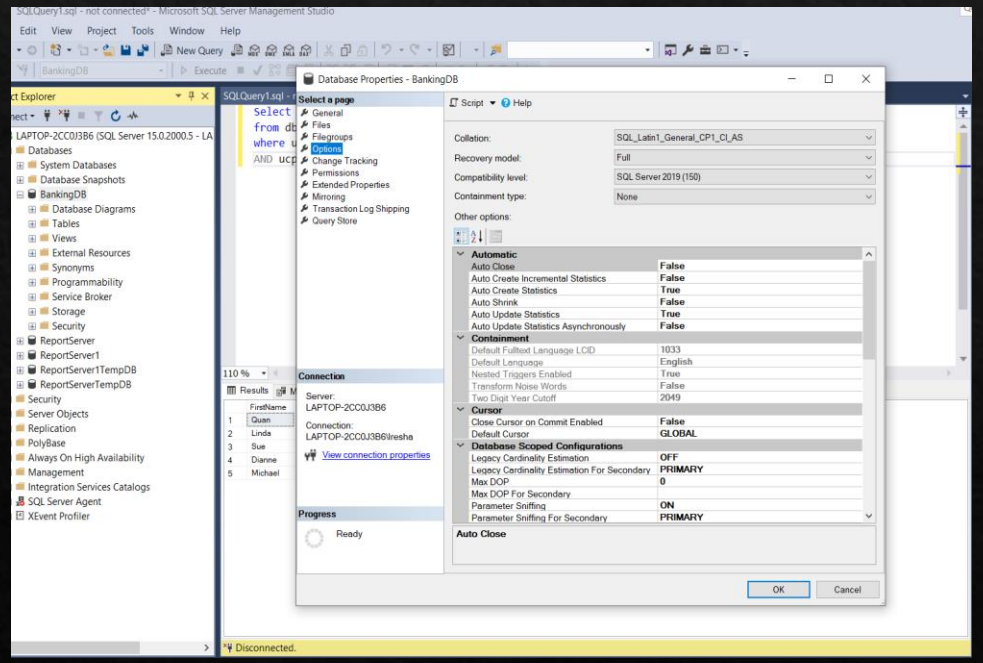
- Insert a new account type without account id will trigger the trigger and automatically create an account id substring from the account description



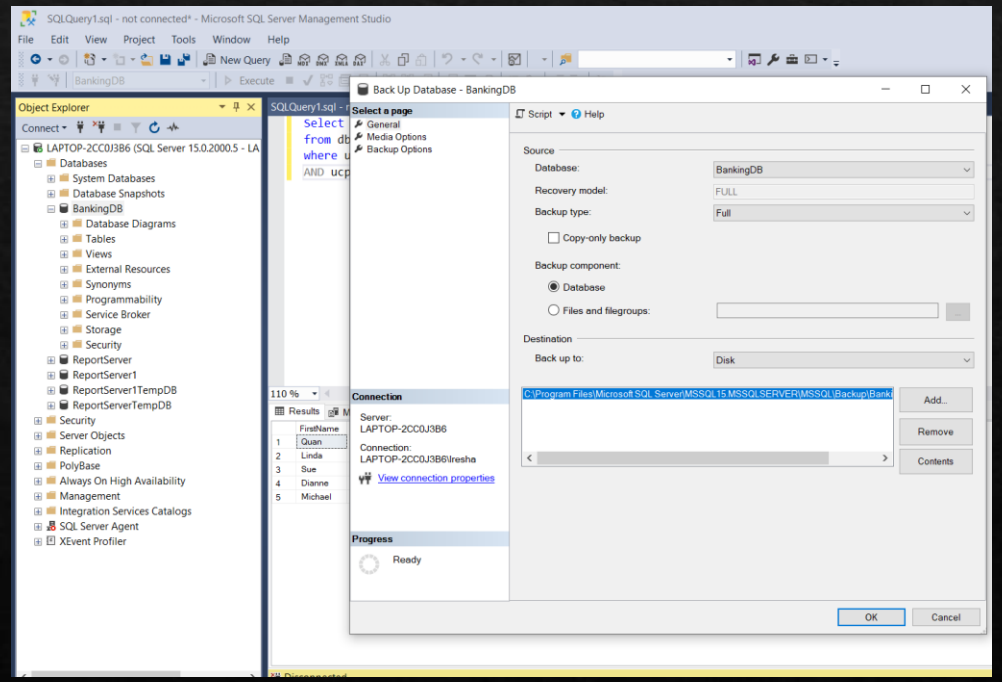
Backup & Logs

Backup & Logs

- We have selected the Recovery model as Full back up for our database

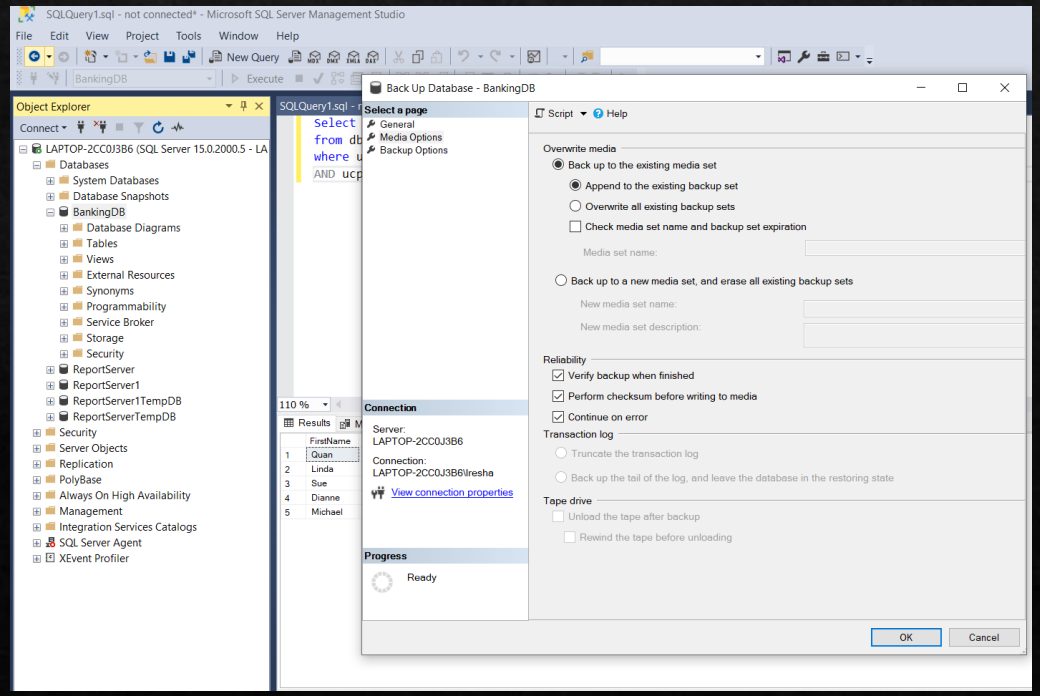


- Then we have selected back up type as Full backup and back up component as Database

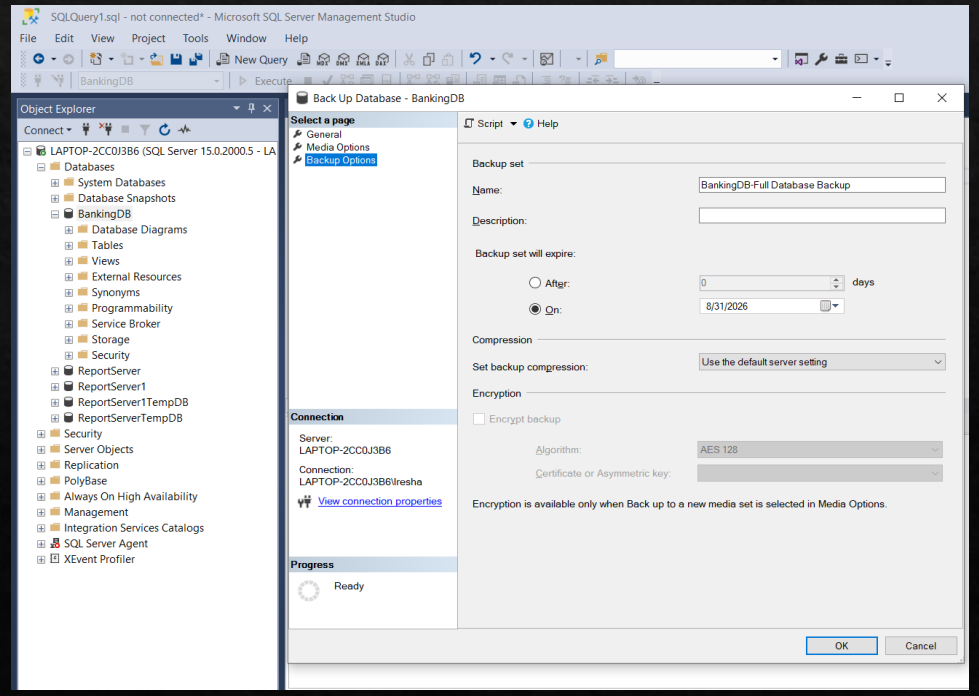


Backup & Logs

- We have selected the back up to be appended to the existing media and selected all Reliability option to ensure the reliability of the back up

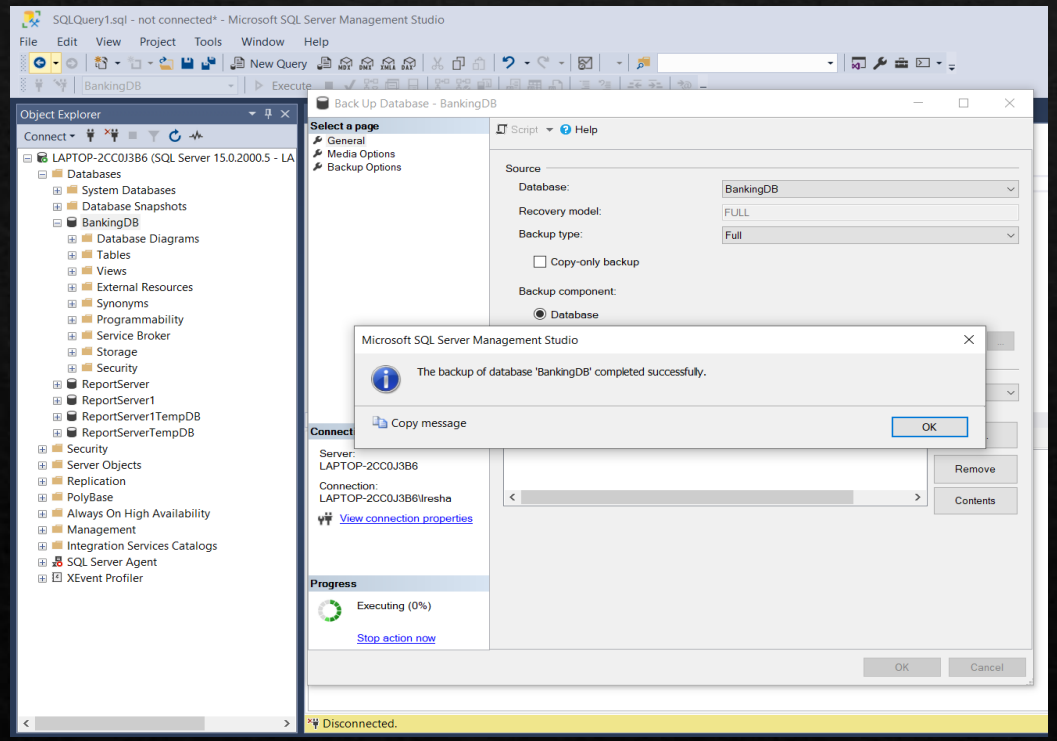


- In the back up option we have selected back up expiration date as we want to keep the back only for 5 years.

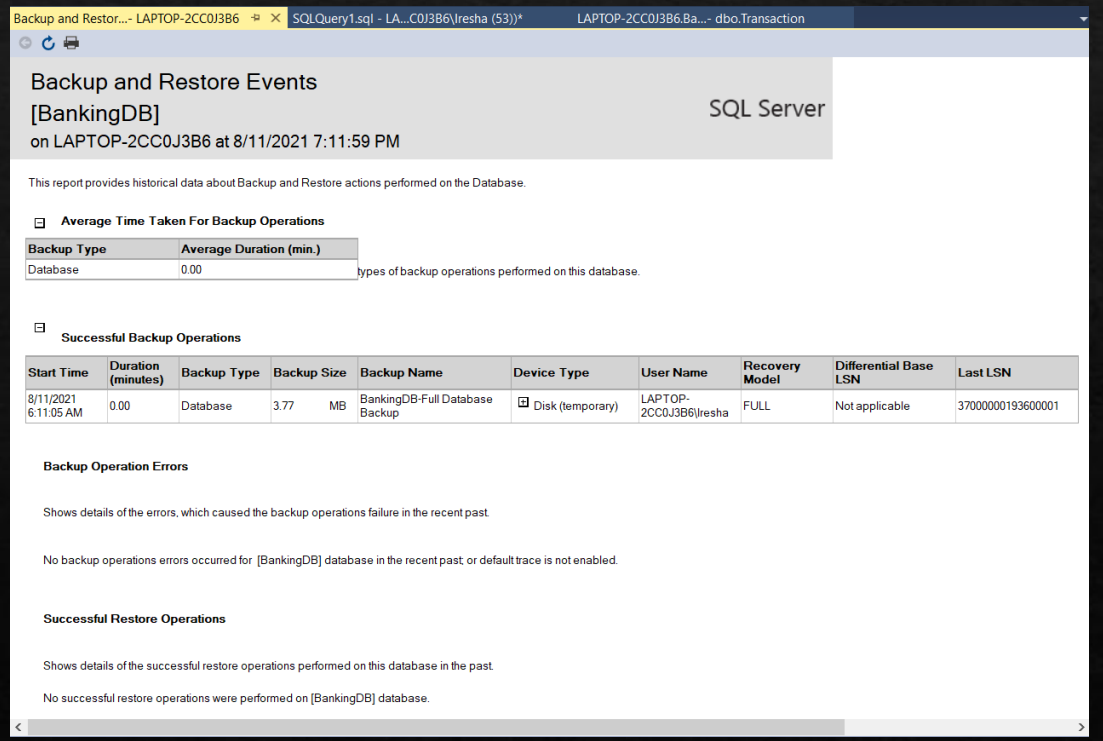


Backup & Logs

- Database back up completion



- Database Backup report

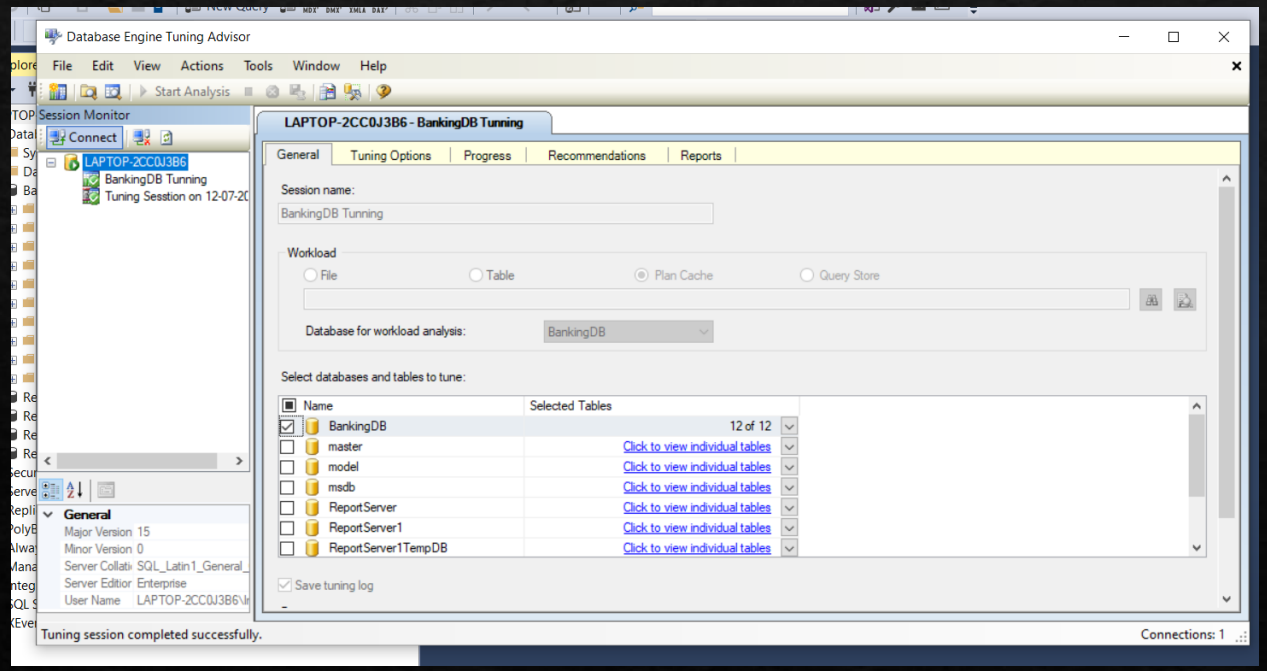


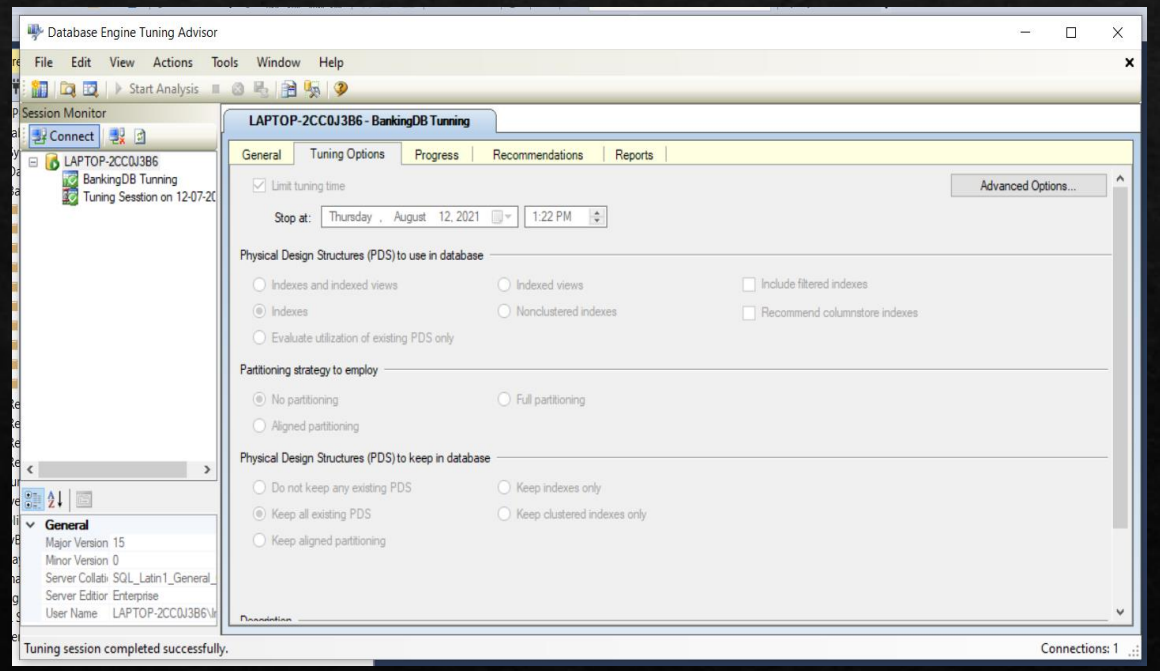
Database Tunning

- Database tuning aims to maximize use of system resources to perform work as efficiently and rapidly as possible. Most systems are designed to manage their use of system resources, but there is still much room to improve their efficiency by customizing their settings and configuration for the database and the DBMS.

Database Tunning Cont.

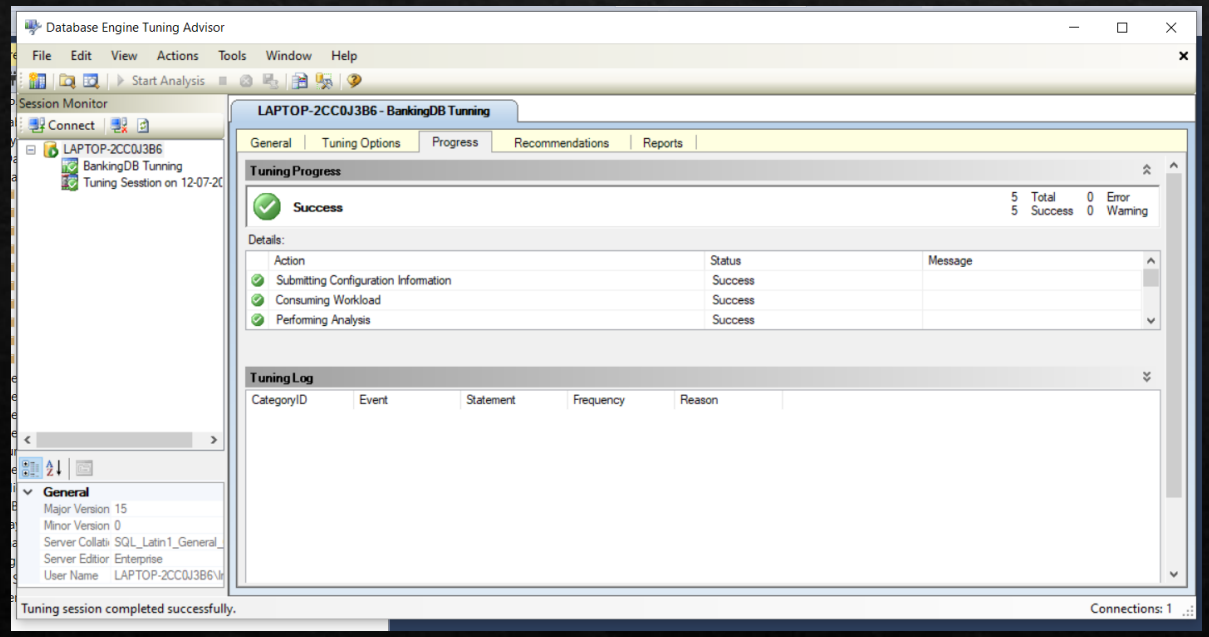
- We have selected Plan Cache tunning option to tune our database.



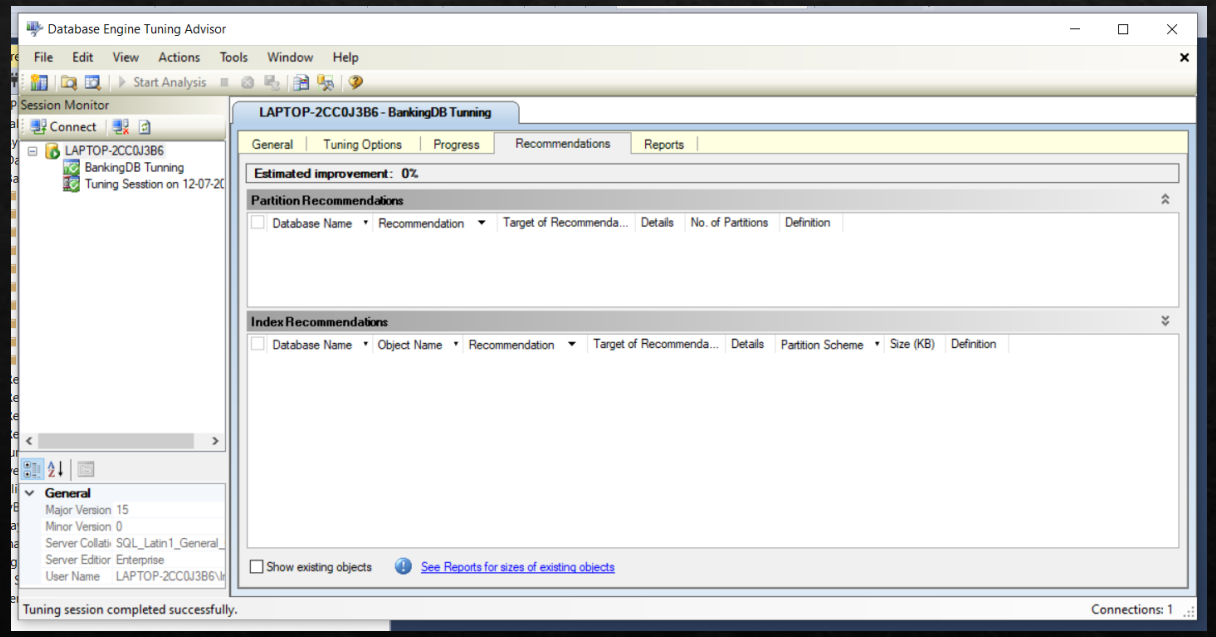


Database Tunning Cont.

- Database Tunning was succussed

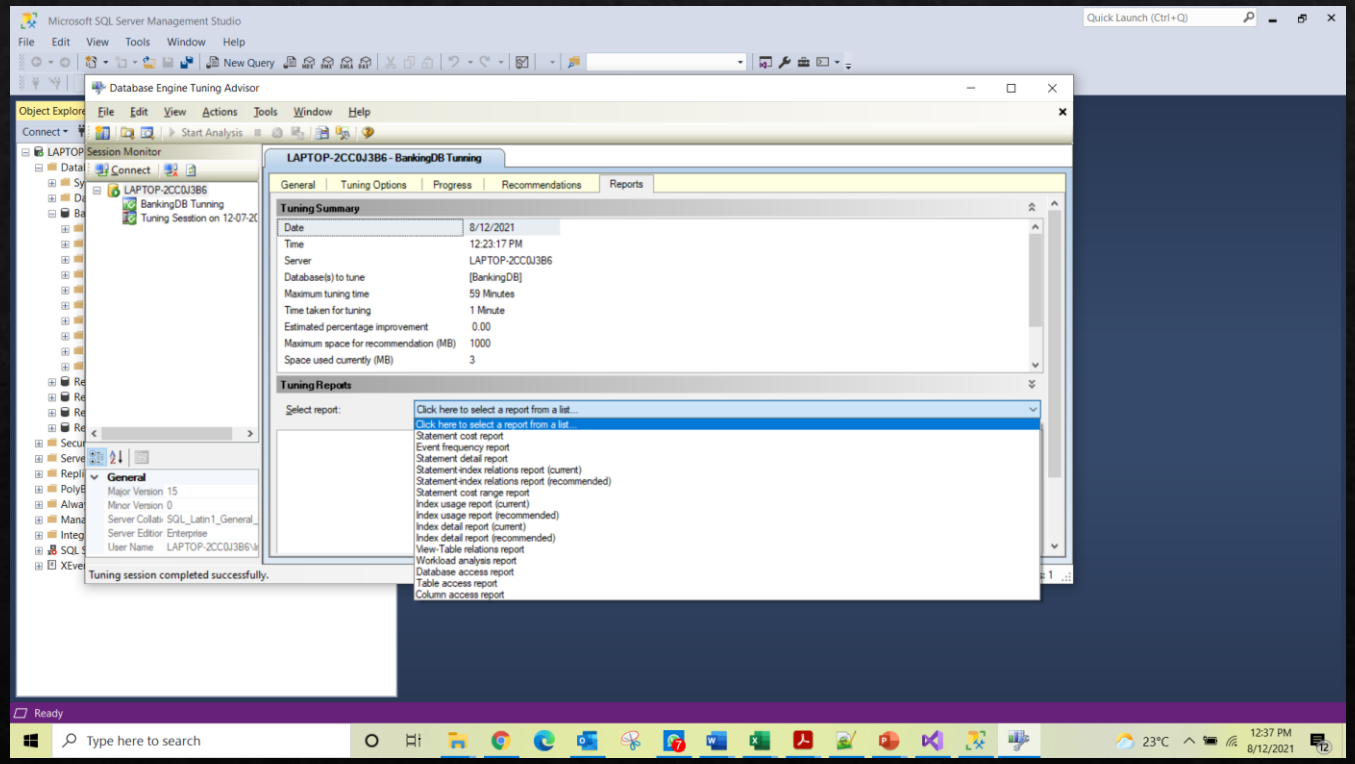


- There were no recommendation to be performed



Database Tunning Conti.

- Tunning summary



Thank You.