

Data Mining and Data Warehousing  
Laboratory  
(CSPC-328)

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## Practical1

### Aim:-DesigningDatabaseUsingERModelling

#### Que1CreatedatabasedesignforHospitalManagementSystemusingER Modelling

The patient, physician, department, room, and appointment are the entities that make up the hospital administration system.

The following is a relationship between these entities areas:

An appointment is for one patient and one doctor. A patient may have one or more appointments. A doctor may schedule many appointments with various patients.

One department is assigned to a doctor.

A department may employ several physicians.

One patient can be assigned to one room, and one or more patients can be housed in a room.

A doctor is in charge of each room, however they can oversee more than one. These relationships allow us to develop the subsequent ER model:

#### 1.Entities:

- Patient with attributes (Name, Age, Room Number, and Patient ID).
- Physician with the following attributes: DepartmentID, Name, Specialty, DoctorID.
- Department including features like DepartmentName, DepartmentID.
- Room has the following attributes: bed count, supervising doctor ID, room number.
- Appointment with the following attributes: PatientID, DoctorID, Date, Time, Appointment ID.

#### 2. Relationships:

A patient's relationship with an appointment is symbolized by a "has" relationship.

A doctor-patient connection is based on a "conducts" relationship.

A department and a doctor are associated, represented by a "assignedto" relationship. Multiple doctors are associated with a department through the "employs" relationship. A patient and a room are connected through a "assignedto" relationship. A room can have a relationship with numerous patients, represented by a "houses" relationship. A room has a relationship with a doctor, which is represented by a "supervisedby" relationship. An diagram representing things as boxes and relationships as lines linking these boxes—often with additional symbols to signify the kind and cardinality of the interactions—would be the visual representation of the ER model. The relationships and entities within the hospital management system are shown in Fig. 1.1.

The patient, doctor, department, room, and appointment are the five main entities that are included. Patients may schedule many appointments, with a doctor and a single patient at each visit. Physicians are assigned to departments, and each department may have more than one physician on staff. Patients are assigned to rooms, and each room can accommodate several patients under a single doctor's care. The ER graphic also shows how a doctor is able to oversee many rooms. The entities are linked together by a number of links, including "has," "conducts," "assigned to," "employees," "houses," and "supervisedby," which illustrate the many relationships and interactions that exist in a medical setting. The diagram shows the relationships between the various components of the system and acts as a visual representation of the data model.

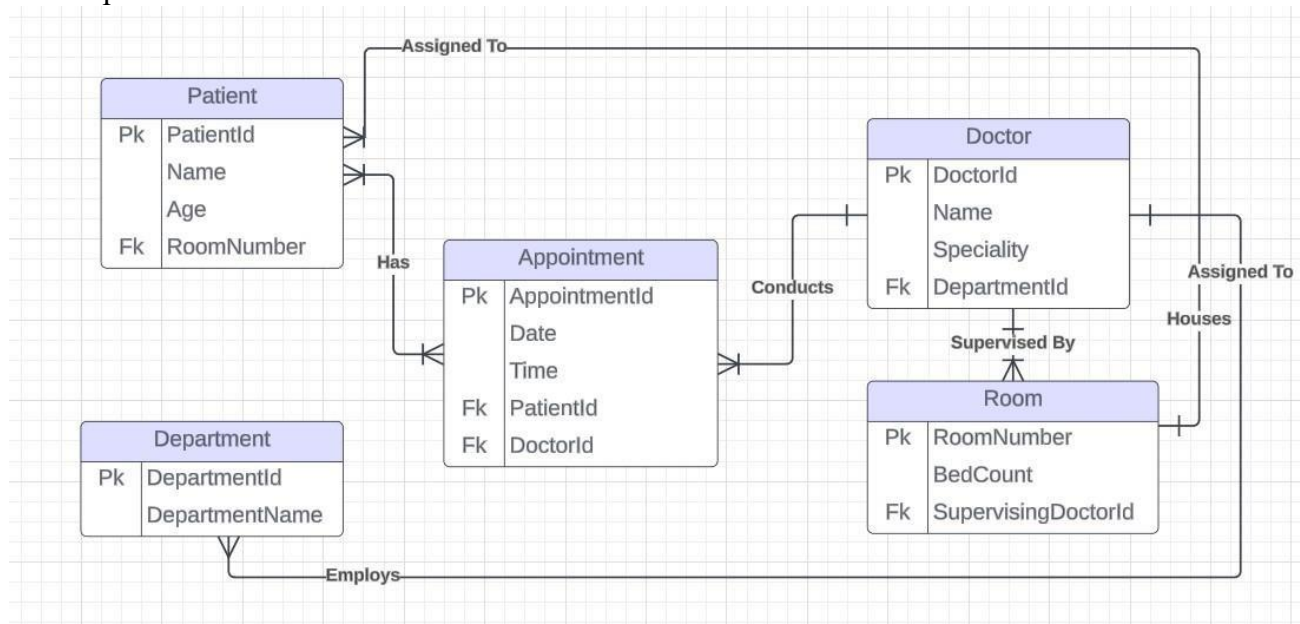


Fig.1.1:ERdiagramforHospitalManagementSystem

## Que2CreatedatabasedesignforLibraryManagementSystemusingER Modelling

The following entities are included in the library management system: book, author, borrower, genre, and loan. The following is a relationship between these entities areas: A book is authored by one or more writers. • A writer can pen one or more books. • A borrower may check out many books, but a book may be checked out by just one borrower. • in real time.

- A book falls into a specific genre.
- A genre can be connected to more than one book.
- The loan specifies when a book was checked out and when it must be returned.

These relationships led us to derive the subsequent ER model:

### 1. Entities

- Book with attributes: Title, ISBN, BookID, GenreID.
- Author with attributes: Name, BirthDate, and AuthorID.
- Borrower with properties: Name, Address, Phone, and Borrower ID.
- Genre with attributes (GenreName, GenreID).
- Loan with attributes: BookID, BorrowerID, Borrow Date, Due Date, Loan ID.

### 2. Relationships:

- A book is linked to its author(s) by means of a "writtenby" relationship.
- One or more books are associated with an author via a "writes" relationship.
- A "borrows" relationship connects a borrower with books.
- A book and borrower have a relationship thanks to the "isborrowedby" connection.
- A book and a genre are connected by a "belongsto" relationship.
- A loan is related to a borrower and a book through a "issued for" relationship. • A genre is connected to many books through a "encompasses" relationship.

To visualize the ER model, entities would be shown as boxes with relationships between them shown as lines or arrows. The types and cardinality of each link would be represented by annotations or symbols.

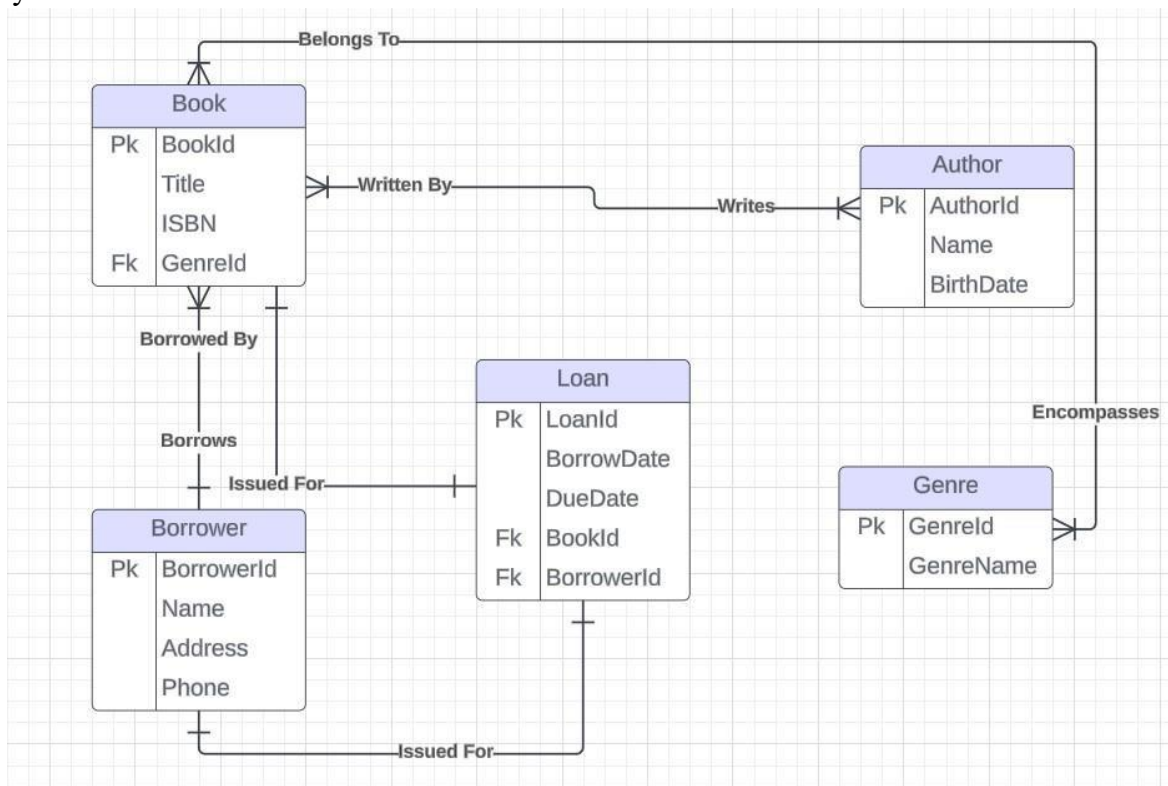


Fig.1.2:ERdiagramforLibraryManagementSystem

Figure 1.2 illustrates the connections and entities in the Library Management System. There are five main components to it: Book, Author, Borrower, Genre, and Loan. The graphic shows how a book is linked to one or more writers by a "written by" relationship, enabling numerous authors to contribute to a single work. Books are linked to authors by a "writes" relationship, meaning that an author is able to write more than one book. The relationship "borrows" links borrowers to books; this means that one borrower may check out numerous books at once, but only one borrower may check out a book at a time. Books are grouped by genres using a "belongsto" relationship, which indicates that a given book is part of a particular genre. Genres might include more than one book. The "issuedfor" relationships bind loans to both borrowers and books, indicating the date a book was borrowed and the return deadline.

## Practical2

### Aim:-NormalisingaDatabaseUsingGriffithNormalisation Tool

Que1Understandthefunctionaldependenciesandnormalizeeach functional dependencyupto2NF,3NF,andBCNFusingnormalizationtoolfrom GriffithUniversity.

Foreachquestion:

- Findtheminimalcover.
- Identifythecandidatekey(s)orprimarykey.
- Checkforpartialdependencies todetermineiftherelationisin2NF.
- Checkfortransitivedependencies toassessiftherelationisin3NF.
- Checkfortransitivedependencies toassessiftherelationisinBCNF.

A.StudentDatabase:

Given therelation:

StudentCourses(StudentID,CourseName,Instructor,CourseCredits)

andthefunctionaldependencies: StudentID,CourseName→Instructor

CourseName→CourseCredits

PreviousFunctionalDependencies

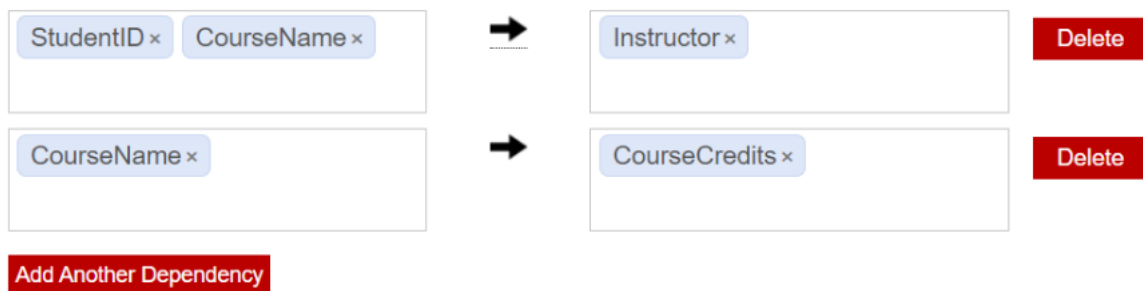


Fig1.A.1 ModifiedFunctionalDependencies

### Attributes in Table

! Separate attributes using a comma ( , )

StudentID, CourseName, Instructor, CourseCredits

### Functional Dependencies

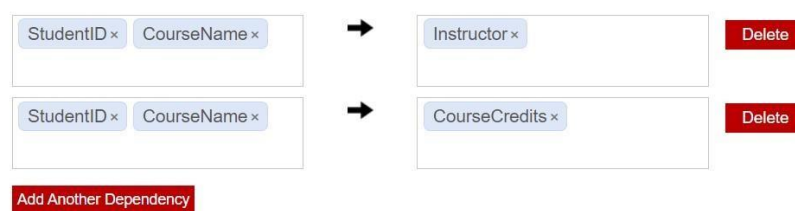


Fig1.A.2

Result

## Check Normal Form



### 2NF

The table is in 2NF



### 3NF

The table is in 3NF



### BCNF

The table is in BCNF

Show Steps



Fig1.A.3

Fig1.A.1 shows previous Functional Dependencies which are not in BCNF. Fig1.A.2 shows new Functional Dependencies which show if you know a student's ID and the name of the course they're retaking, you can determine the instructor who teaches that course and how many credits that course carries. Fig1.A.3 shows the result that new FDs are in BCNF.

## B. Employee Management:

Given the relation:

EmployeeProjects(EmployeeID, ProjectName, Manager, Department)

with the functional dependencies:

EmployeeID → Department

ProjectName → Manager    Department → Manager

## Previous Functional Dependencies



Fig1.B.1 Modified Dependencies



## Attributes in Table

! Separate attributes using a comma ( , )

EmployeeID, ProjectName, Manager, Department

## Functional Dependencies

EmployeeID ×	→	Department × ProjectName ×	Delete
Department ×	→	Manager × EmployeeID ×	Delete
<b>Add Another Dependency</b>			

Fig1.B.2 Result

### Check Normal Form



#### 2NF

The table is in 2NF



#### 3NF

The table is in 3NF



#### BCNF

The table is in BCNF

Show Steps



Fig1.B.3

Fig1.B.1 shows previous Functional Dependencies which are not in BCNF. Fig1.B.2 shows new Functional Dependencies which shows Given an EmployeeID, we can determine the ProjectName and Department associated with that employee. Given a Department, we can determine the Manager and EmployeeID associated with that department. Fig1.B.3 shows the result that new FDs are in BCNF.

C.LibrarySystem:

Consider the relation:

BookLending(BookID, MemberID, BorrowDate, DueDate, MemberAddress)

and the functional dependencies: BookID → DueDate

MemberID → MemberAddress

Previous Functional Dependencies



Fig1.C.1

Modified Dependencies

## Attributes in Table

! Separate attributes using a comma ( , )

BookID, MemberID, BorrowDate, DueDate, MemberAddress

## Functional Dependencies



Fig1.C.2 Result

## Check Normal Form



### 2NF

The table is in 2NF



### 3NF

The table is in 3NF



### BCNF

The table is in BCNF

Show Steps



Fig1.C.3

Fig1.C.1 shows previous Functional Dependencies which are not in BCNF. Fig1.C.2 shows new Functional Dependencies which show that if you know which book is borrowed by which member, you can determine the member's address, the due date of the book, and the date it was borrowed. Fig1.C.3 shows the result that the new FDs are in BCNF.

D. Hospital Management:

-For the relation:

PatientTreatment(PatientID,Treatment,Doctor,DoctorSpecialization)  
with the functional dependencies: Doctor→DoctorSpecialization PatientID,Treatment→Doctor

Previous Functional Dependencies



Fig1.D.1 Modified Dependencies

## Attributes in Table

! Separate attributes using a comma ( , )

PatientID, Treatment, Doctor, DoctorSpecialization

## Functional Dependencies



Fig1.D.2 Result

## Check Normal Form



**2NF**  
The table is in 2NF



**3NF**  
The table is in 3NF



**BCNF**  
The table is in BCNF

Show Steps



Fig1.D.3

Fig1.D.1 shows previous Functional Dependencies which are not in BCNF. Fig1.D.2 shows new Functional Dependencies which show that if you know the PatientID and the treatment they are undergoing, you can determine which doctor is responsible for providing that treatment, along with the doctor's specialization. Fig1.D.3 shows the result that new FDs are in BCNF.

E. Airline Reservation System:

-Given the relation:

FlightReservations(FlightNumber,Date,PassengerID,SeatNumber,ClassType,Price,DepartureTime,ArrivalTime,DepartureCity,ArrivalCity) -Functional dependencies are:

FlightNumber,Date→DepartureTime,ArrivalTime,DepartureCity,ArrivalCity

SeatNumber,Date,FlightNumber→PassengerID,ClassType,Price

ClassType→Price

PassengerID→DepartureCity

Previous Functional Dependencies

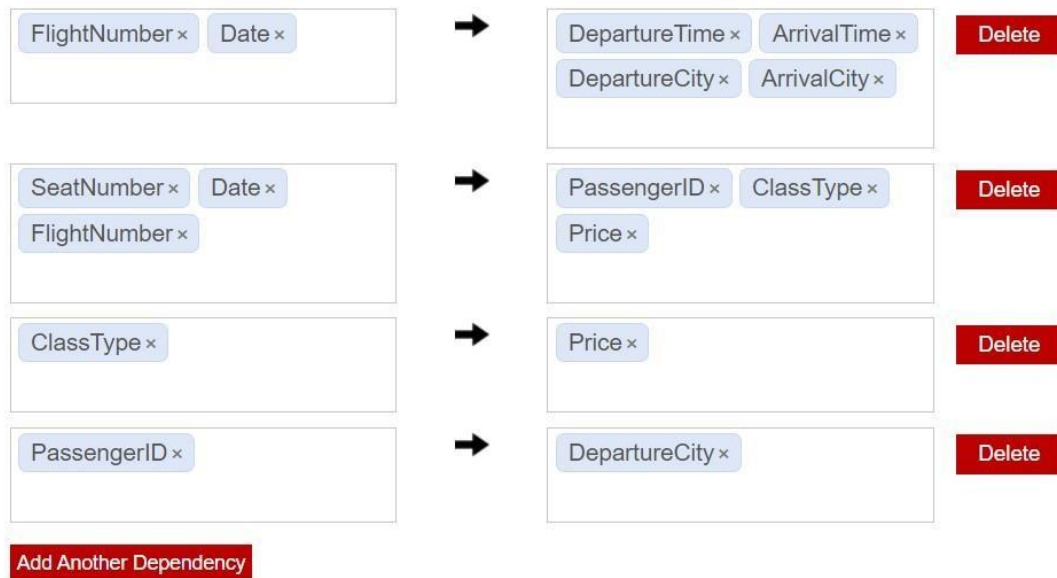


Fig1.E.1 Modified Dependencies

## Attributes in Table

! Separate attributes using a comma ( , )

FlightNumber, Date, PassengerID, SeatNumber, ClassType, Price, DepartureTime, ArrivalTime, DepartureCity, ArrivalCity

## Functional Dependencies



Fig1.E.2 Result

Check Normal Form

✓

**2NF**  
The table is in 2NF

✓

**3NF**  
The table is in 3NF

✓

**BCNF**  
The table is in BCNF

Show Steps ☐

Fig1.E.3

Fig1.E.1 shows previous Functional Dependencies which are not in BCNF. Fig1.E.2 shows new Functional Dependencies which show that if you have information about the flight number, date, and seat number, you can determine the details related to that specific booking, including the departure and arrival times, cities, passenger ID, class type, and price associated with that booking. Fig1.E.3 shows the result that new FDs are in BCNF.

#### F.6. University Enrolment System:

- Given the relation:

Enrollments(StudentID, CourseCode, Semester, Grade, InstructorID, CourseName, CourseCredits, Department)

- Functional dependencies are:

StudentID, CourseCode, Semester → Grade, InstructorID

CourseCode → CourseName, CourseCredits, Department

InstructorID, CourseCode → Department

InstructorID → Department

Previous Functional Dependencies

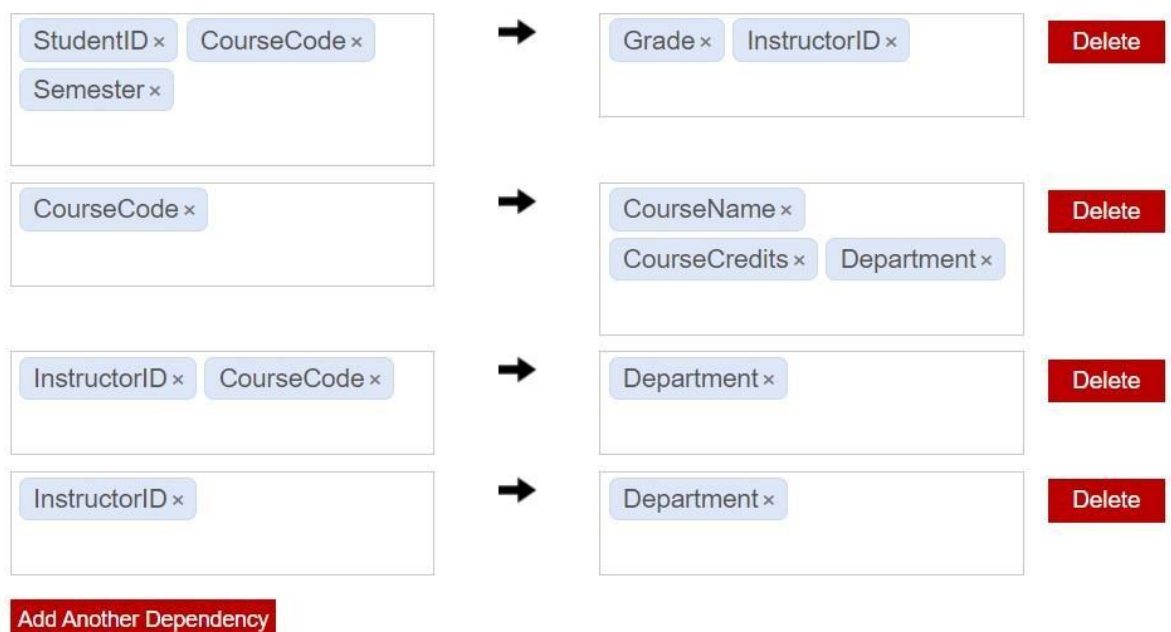


Fig1.F.1

Modified Dependencies

## Attributes in Table

! Separate attributes using a comma ( , )

StudentID, CourseCode, Semester, Grade, InstructorID, CourseName,  
CourseCredits, Department

## Functional Dependencies

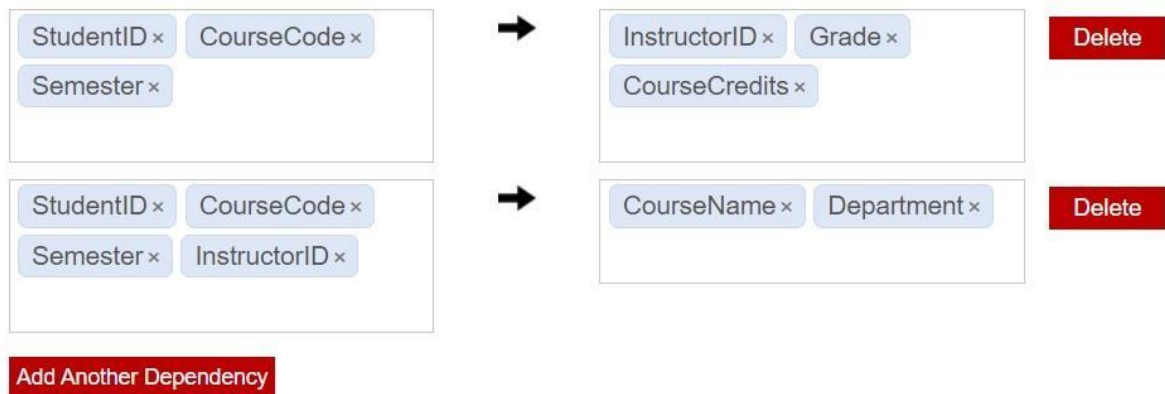


Fig1.F.2 Result

Check Normal Form



**2NF**

The table is in 2NF



**3NF**

The table is in 3NF



**BCNF**

The table is in BCNF

Show Steps



Fig1.F.3

Fig1.F.1 shows previous Functional Dependencies which are not in BCNF. Fig1.F.2 shows new Functional Dependencies which show that for a given student, a specific course in a particular semester uniquely determines the grade received by the student, the instructor teaching the course, and the number of credits associated with the course. It means that for a given student taking a specific course in a particular semester with a particular instructor, there is only one department to which the course belongs and one specific name for the course. Fig1.F.3 shows the result that new FDs are in BCNF.

G.MusicStreamingPlatform:

-For the relation:

UserPlays(UserID, SongID, Date, ArtistName, Album, Genre, PlayCount, SubscriptionType)

-Functional dependencies are:

UserID, SongID, Date  $\rightarrow$  PlayCount

SongID  $\rightarrow$  ArtistName, Album, Genre

UserID  $\rightarrow$  SubscriptionType

ArtistName, Album  $\rightarrow$  Genre

## PreviousFunctionalDependencies



Fig1.G.1 ModifiedDependencies

## Attributes in Table

① Separate attributes using a comma ( , )

UserID, SongID, Date, ArtistName, Album, Genre, PlayCount, SubscriptionType

## Functional Dependencies



Fig1.G.2 Result

Check Normal Form

- ☒ **2NF**  
The table is in 2NF
- ☒ **3NF**  
The table is in 3NF
- ☒ **BCNF**  
The table is in BCNF

Show Steps ☐

Fig1.G.3

Fig1.G.1 shows previous Functional Dependencies which are not in BCNF. Fig1.G.2 shows new Functional Dependencies which show that for a given user, listening to a specific song on a particular date uniquely determines various attributes related to



that listening event, such as how many times the song was played (PlayCount), the type of subscription the user has (SubscriptionType), the name of the artist, the album, and the genre of the song. Fig 1.G.3 shows the result that new FDs are in BCNF.

H. Real Estate System:

- For the relation:

PropertyListings(PropertyID, OwnerID, AgentID, Price, Location, HouseType, NumberOfRooms, AgentName, CommissionRate) - Functional dependencies are:

PropertyID → Price, Location, HouseType, NumberOfRooms, OwnerID, AgentID

AgentID → AgentName, CommissionRate HouseType → NumberOfRooms

Previous Functional Dependencies

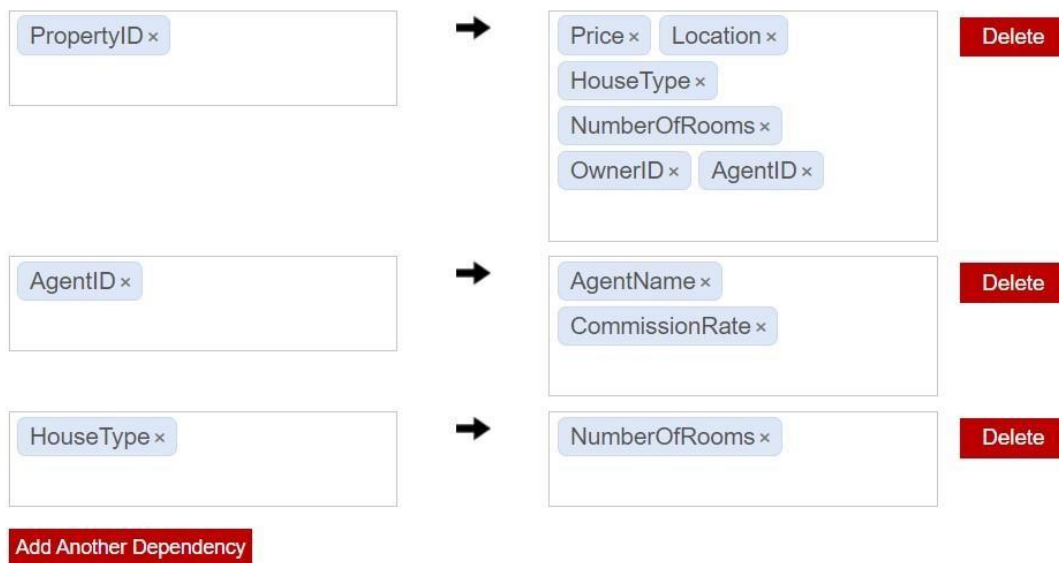


Fig1.H.1 Modified Dependencies



## Attributes in Table

① Separate attributes using a comma ( , )

PropertyID, OwnerID, AgentID, Price, Location, HouseType,  
NumberOfRooms, AgentName, CommissionRate

## Functional Dependencies



Fig1.H.2 Result

Check Normal Form



**2NF**

The table is in 2NF



**3NF**

The table is in 3NF



**BCNF**

The table is in BCNF

Show Steps



Fig1.H.3

Fig1.H.1 shows previous Functional Dependencies which are not in BCNF. Fig1.H.2 shows new Functional Dependencies which show that each property in the table is uniquely identified by its PropertyID, and for each PropertyID, there is a fixed price, location, house type, ownerID, and agentID associated with it.

It means that each agent assigned to a specific property is uniquely identified by their AgentID, and for each combination of AgentID and PropertyID, there is a fixed name for the agent and a fixed commission rate associated with that agent's involvement in that property transaction.

It means that the number of rooms in a property is uniquely determined by the combination of its PropertyID and HouseType. Fig1.H.3 shows the result that new FDs are in BCNF.

Que2 Design a BCNF Normalized Database and verify using Griffith Tool.

Ans Database is Flight Reservation System.

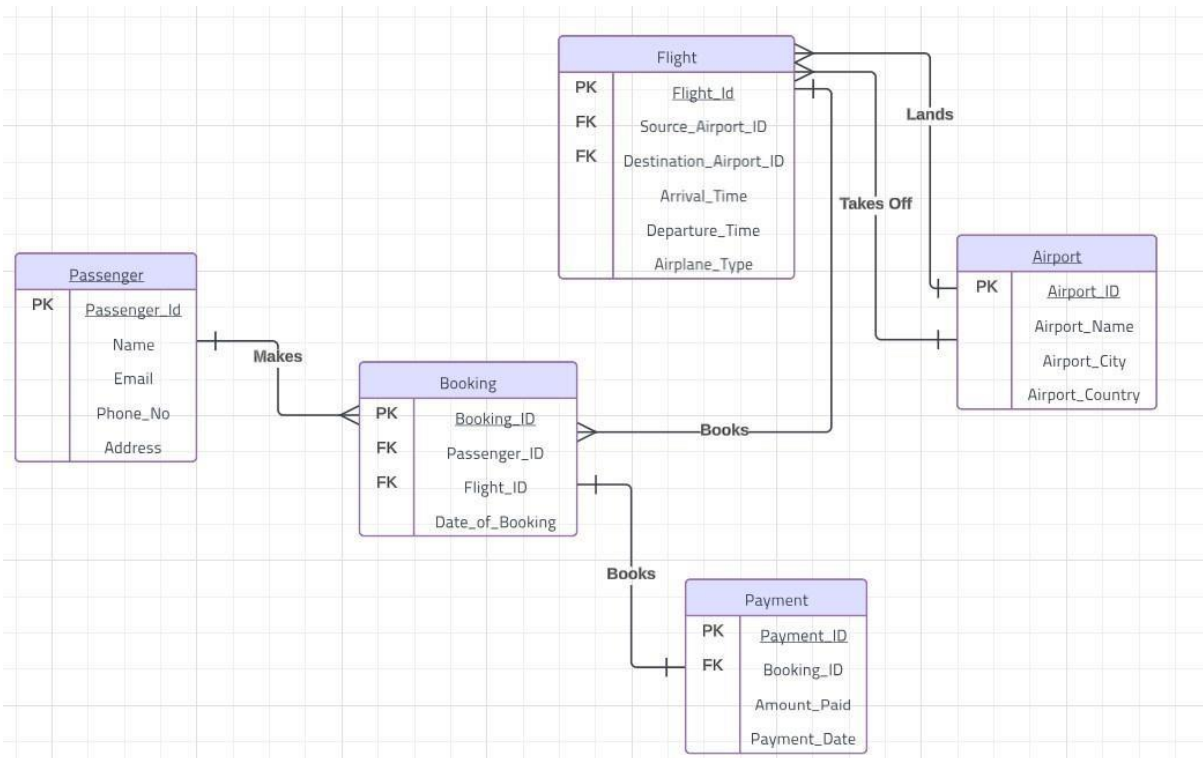


Fig2.1

Fig2.1showsthedesignofairlinerreservationsystemdatabase.

FunctionalDependenciesare:

FlightsTable:

- Flight\_ID->Source\_Airport\_ID
- Flight\_ID->Destination\_Airport\_ID
- Flight\_ID->Departure\_Time
- Flight\_ID->Arrival\_Time
- Flight\_ID->Airplane\_Type

AirportsTable: Airport\_Code->Airport\_Name  
 Airport\_Code->Airport\_City

Airport\_Code->Airport\_Country PassengerTable:

- Customer\_ID->Name
- Customer\_ID->Email
- Customer\_ID->Phone\_No
- Customer\_ID->Address

BookingsTable:

Booking\_ID->Flight\_ID

Booking\_ID->Passenger\_ID

Booking\_ID->Date\_of\_Booking PaymentsTable:

- Payment\_ID->Booking\_ID
- Payment\_ID->Amount\_Paid

- Payment\_ID->Payment\_Date

VerificationUsingGriffithTool

Check Normal Form

---



**2NF**

The table is in 2NF



**3NF**

The table is in 3NF



**BCNF**

The table is in BCNF

Show Steps



Fig2.2

Result

Fig2.2showsthatEachTableisinBCNF.

## Practical-3

Aim:-CreateProcedures,TriggersandCursors

Que1WriteastoredprocedurenamedUpdateCountryPopulationthat updatesthepopulationofagivencountrybasedonaprovidedcountry codeandnewpopulationvalue.Additionally,theprocedureshouldlog theoldandnewpopulationvaluestoapopulation\_change\_logtable. Ans

DELIMITER//

```
CREATEPROCEDUREUpdateCountryPopulation(INCountryCodeCHAR(3),IN  
NewPopulationINT)
```

```
BEGIN
```

```
    DECLAREOldPopulationINT;
```

```
    --Gettheoldpopulation
```

```
    SELECTPopulationINTOOldPopulation
```

```
    FROMcountry
```

```
    WHERECode=CountryCode;
```

```
    --Updatethepopulation
```

```
    UPDATEcountry
```

```
    SETPopulation=NewPopulation WHERECode=CountryCode;
```

```
    --Logthepopulationchange
```

```
    INSERTINTOpopulation_change_log(CountryCode,OldPopulation,  
NewPopulation,ChangeDate)
```

```
    VALUES(CountryCode,OldPopulation,NewPopulation,NOW());--NOW()isused  
fortheurrenttimestampinMySQL
```

```
END//
```

```
DELIMITER;
```

```
CALLUpdateCountryPopulation('USA',350000000);
```

	LogID	CountryCode	OldPopulation	NewPopulation	ChangeDate
▶	1	USA	NULL	2000000	NULL
	2	USA	2000000	350000000	2024-02-18 15:21:44
•	NULL	NULL	NULL	NULL	NULL

Fig3.1

Fig3.1showspopulation\_change\_logtablewhichhasoldpopulation,new populationanddateofchange.

Que2Developatriggernamedafter\_country\_insertthatchecksifthe insertedcountry'spopulationexceeds1million.Ifitdoes,inserta recordintoahigh\_population\_countriestable.

Ans

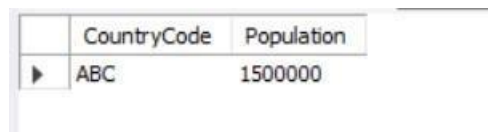
```
CREATETRIGGERafter_country_insert
AFTERINSERTONcountry
FOREACHROW
BEGIN
    DECLARECountryPopulationINT;

    --Getthepopulationoftheinsertedcountry
    SELECTPopulationINTOCountryPopulation
    FROMcountry
    WHERECode=NEW.Code;

    --Checkifpopulationexceeds1million
    IFCountryPopulation>1000000THEN
        --Insertinto high_population_countries table
        INSERTINTO high_population_countries(CountryCode,Population)
        VALUES(NEW.Code,CountryPopulation);
    ENDIF; END//
DELIMITER;

INSERTINTOcountry(Code,Population)VALUES('ABC',1500000);

select*fromhigh_population_countries;
```



	CountryCode	Population
▶	ABC	1500000

Fig3.2

Fig3.2 showshigh\_population\_countriestablewithcountrycodeandpopulation. Que3 DevelopaprocedureAdjustCityPopulationsusingacursorthat decreasesthepopulationby10%forallcitiesinagivencountrycode, providedthecurrentpopulationisbetween500,000and1million. Additionally,logthesechangestoacity\_population\_adjustmentstable withcityID,oldpopulation,andnewpopulation.

Ans

```
DELIMITER//
CREATEPROCEDUREAdjustCityPopulations(INCountryCodeCHAR(3))
BEGIN
    DECLAREdoneINTDEFAULTFALSE;
    DECLARECityIDINT;
    DECLAREOldPopulationINT;
    DECLARENewPopulationINT;
    --Declarecursor
```

```

DECLAREcity_cursorCURSORFOR
SELECTCityID,Population
FROMcity
WHERECountryCode=CountryCode
ANDPopulationBETWEEN500000AND1000000;

--Declarehandlerfornomorerows
DECLARECONTINUEHANDLERFORNOTFOUNDSETdone=TRUE;

--Openthecursor
OPENcity_cursor;

--Startloopingthroughthecursor
adjust_loop:LOOP --Fetchtherow
    FETCHcity_cursorINTOCityID,OldPopulation;

    --Checkifnomorerows IFdoneTHEN
        LEAVEadjust_loop;
    ENDIF;

    --Calclatenewpopulation(decreaseby10%)
    SETNewPopulation=ROUND(OldPopulation*0.9,0);

    --Updatecitypopulation
    UPDATEcity
    SETPopulation=NewPopulation WHERECityID=CityID;

    --Logpopulationadjustment
    INSERTINTOcity_population_adjustment(CityID,OldPopulation,
NewPopulation,AdjustmentDate)
    VALUES(CityID,OldPopulation,NewPopulation,NOW()); ENDLOOPadjust_loop;

--Closethecursor
CLOSEcity_cursor;
END//
DELIMITER;
CALLAdjustCityPopulations('USA'); select*fromcity_population_adjustment;

```

	CityID	OldPopulation	NewPopulation	AdjustmentDate
►	NULL	731200	658080	2024-02-18 16:17:55
	NULL	593321	533989	2024-02-18 16:17:55
	NULL	609823	548841	2024-02-18 16:17:55
	NULL	669181	602263	2024-02-18 16:17:55
	NULL	907718	816946	2024-02-18 16:17:55
	NULL	622013	559812	2024-02-18 16:17:55
	NULL	559249	503324	2024-02-18 16:17:55
	NULL	538918	485026	2024-02-18 16:17:55
	NULL	521936	469742	2024-02-18 16:17:55
	NULL	512880	461592	2024-02-18 16:17:55
	NULL	978100	880290	2024-02-18 16:17:55
	NULL	663340	597006	2024-02-18 16:17:55
	NULL	536827	483144	2024-02-18 16:17:55
	NULL	935361	841825	2024-02-18 16:17:55
	NULL	758141	682327	2024-02-18 16:17:55

Fig3.3

Fig3.3 shows city\_population\_adjustment table which records the population statistics and date of change.

## Practical-4

Aim:-Writeprogramstoimplementandunderstandusageof Datamarts.

Question1:Designadatamartforabanktostorethecredithistoryof customersinabank.Usethiscreditprofilingtoprocessfutureloan applications.(Suggestivetables:CustomerProfile,accounts,loans, creditcards,paymenthistorytable,inquiries,Collections,CreditScore History). Ans createdatabasebank;

```
createtablecustomer_profile(customer_idintprimarykey,first_name
varchar(25),last_namevarchar(25),d_o_bdate,addressvarchar(50),phone_no
int,emailvarchar(25),incomeint);
```

```
createtableaccounts(account_idintprimarykey,customer_idint,accounttype
varchar(25),dateofopendate,accountstatusvarchar(25),foreignkey(customer_id)
referencescustomer_profile(customer_id),balanceint);
```

```
createtableloans(loan_idintprimarykey,customer_idint,loantype
varchar(25),loanamountint,termint,interest_ratedecimal(4,2),loanstatus
varchar(25),foreignkey(customer_id)referencescustomer_profile(customer_id));
```

```
createtablecreditcards(card_idintprimarykey,customer_idint,cardtype
varchar(25),creditlimitdecimal(10,2),cardissuedatedate,foreignkey(customer_id)
referencescustomer_profile(customer_id),currentbalancedecimal(10,2));
```

```
createtablepaymenthistory(payment_idintprimarykey,customer_idint,account_id
int,paymentamountdecimal(10,2),paymentdatedate,foreignkey(customer_id)
referencescustomer_profile(customer_id),foreignkey(account_id)references
accounts(account_id));
```

```
createtableinquiries(inquiry_idintprimarykey,customer_idint,inquirydate
date,inquirytypevarchar(25),foreignkey(customer_id)references
customer_profile(customer_id));
```

```
createtablecollections(collection_idintprimarykey,customer_idint,collectiondate
date,collectiontypevarchar(25),amountint,foreignkey(customer_id)references
customer_profile(customer_id));
```

```
createtablecredit_score_history(creditscore_idintprimarykey,customer_id
int,creditscoreint,scoredatedate,foreignkey(customer_id)references
customer_profile(customer_id)); --DATAMART:
```



```

createtablecustomerrisk(customer_idintprimarykey,riskcategoryvar
char(25));
insertintocustomerrisk(customer_id,riskcategory)selectc.customer_id,case
whenc.income>75000andsum(a.balance)>100000then'lowrisk'
whenc.income>50000andsum(a.balance)>60000then'moderaterisk' else'highrisk'
endasriskcategory
fromcustomer_profilecjoinaccountsaonc.customer_id=a.customer_idgroupby c.customer_id;

```



customer_id	riskcategory
1	low risk
2	high risk
3	moderate risk
4	moderate risk
5	high risk
NULL	NULL

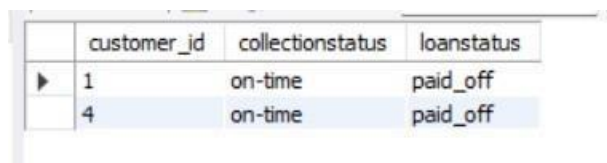
Fig4.1

InFig4.1,itshowsthatitdividesthecustomersintodifferentriskcategorybaseon incomeandbalanceofcustomers.

```

createtableloanassessmentasselectc.customer_idas
customer_id,c.collectionstatusascollectionstatus,l.loanstatusasloanstatusfrom
collectionscjoinloanslonc.customer_id=l.customer_idwherecollectionstatus='ontime'andloanst
atus='paid_off';

```



customer_id	collectionstatus	loanstatus
1	on-time	paid_off
4	on-time	paid_off

Fig4.2

InFig4.2itshowstheresultofcustomerswhoseloanstatusispaidoffand collectionstatusisontime.

```

createtableloanpassasselectl.customer_idfromloanassessmentljoin
customerriskconl.customer_id=c.customer_idjoincredit_score_historychon
ch.customer_id=c.customer_idwhererec.riskcategory='lowrisk'and ch.creditscore>750;

```



customer_id
1

Fig4.3

InFig4.3itshowsthecustomerswhichhaslowriskcategoryhasloanstatusas paidoffandontimeandcreditscoregreaterthan750.

```

CREATEPROCEDURELOAN_PASS_RESULT(INCUSTOMERIDINT) BEGIN
DECLAREMESSAGE_TEXTVARCHAR(50);
IFEXISTS(
    SELECT1FROMloanpass

```

```

WHERE customer_id=CUSTOMERID
)THEN
    SELECT CUSTOMERID,'PASSED' AS LOAN_ELIGIBILITY;
ELSE
    SELECT CUSTOMERID,'REJECTED' AS LOAN_ELIGIBILITY;
ENDIF;
END//
DELIMITER; call LOAN_PASS_RESULT(1);

```

Output1

	CUSTOMERID	LOAN_ELIGIBILITY
▶	1	PASSED

Fig4.4

call LOAN\_PASS\_RESULT(2); Output2

	CUSTOMERID	LOAN_ELIGIBILITY
▶	2	REJECTED

Fig4.5

RESULT: Successfully implemented and learnt the usage of Datamarts.

## PRACTICAL#5

**Objective:** Feature Selection and Variable Filtering.

**Question#:**

- A) Select a dataset that has a minimum of 150 features.
- B) Apply 3 Feature Selection Techniques
- C) For each feature selection technique apply 3 machine learning models on it.
- D) Compare the results.

**TOOL USED: Weka**

**Feature Selection Technique->Gain Ratio->**The gain ratio is a metric in decision trees that balances the information gain with the intrinsic information of attributes, helping to select the best attribute for splitting nodes.

**No. of selected attribute->** 20

**Algorithm: Naive Bayes->**Probabilistic classification algorithm based on Bayes' theorem with an assumption of independence between features

```
=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances      150           86.2069 %
Incorrectly Classified Instances    24           13.7931 %
Kappa statistic                    0.7249
Mean absolute error                 0.1365
Root mean squared error             0.3592
Relative absolute error             27.3077 %
Root relative squared error         71.8425 %
Total Number of Instances          174

=== Detailed Accuracy By Class ===

          TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
          0.798    0.071    0.922    0.798    0.855     0.932    P
          0.929    0.202    0.814    0.929    0.868     0.936    H
Weighted Avg.  0.862    0.135    0.869    0.862    0.862     0.934

=== Confusion Matrix ===

  a  b  <-- classified as
71 18 |  a = P
 6 79 |  b = H
```

**Fig 5.1 Naive Bayes with 20 attributes**

**Algorithm:Random tree->**It works by building multiple decision trees during training, where each tree is trained on a random subset of the training data and a random subset of the features.The random trees vote on the final classification or regression output, and the most popular outcome is chosen.Random Trees help reduce overfitting and improve accuracy, especially when dealing with noisy or high-dimensional data

```

Correctly Classified Instances      135          77.5862 %
Incorrectly Classified Instances    39          22.4138 %
Kappa statistic                    0.5518
Mean absolute error                 0.2241
Root mean squared error             0.4734
Relative absolute error             44.8438 %
Root relative squared error        94.6953 %
Total Number of Instances          174

=== Detailed Accuracy By Class ===

          TP Rate   FP Rate   Precision   Recall   F-Measure   ROC Area   Class
          0.764     0.212     0.791      0.764     0.777       0.776     P
          0.788     0.236     0.761      0.788     0.775       0.776     H
Weighted Avg.   0.776     0.224     0.776      0.776     0.776       0.776

=== Confusion Matrix ===

  a  b  <-- classified as
68 21 |  a = P
18 67 |  b = H

```

**Fig 5.2 Random Tree with 20 attributes**

**Algorithm: AdaBoost**→It works by combining multiple weak learners (typically decision trees) to create a strong learner. It begins by assigning equal weights to all training samples. Then, it iteratively trains weak learners, focusing more on incorrectly classified samples in each iteration. The predictions of weak learners are combined through weighted voting, where more accurate learners have higher weights. This process continues until a predetermined number of iterations is reached or until perfect predictions are achieved.

```

Correctly Classified Instances      147          84.4828 %
Incorrectly Classified Instances    27          15.5172 %
Kappa statistic                    0.6904
Mean absolute error                0.1812
Root mean squared error            0.3165
Relative absolute error            36.2572 %
Root relative squared error        63.3048 %
Total Number of Instances         174

=== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
      0.787    0.094    0.897    0.787    0.838    0.941    P
      0.906    0.213    0.802    0.906    0.851    0.941    H
Weighted Avg.  0.845    0.152    0.851    0.845    0.844    0.941

=== Confusion Matrix ===

  a  b  <-- classified as
70 19 |  a = P
 8 77 |  b = H

```

**Fig 5.3 AdaBoost with 20 attributes**

**Feature Selection Technique->Gain Ratio**

**No. of selected attribute-> 40**

**Algorithm: Naive Bayes**

```

=== Detailed Accuracy By Class ===

      TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
      0.865    0.106    0.895    0.865    0.88    0.955    P
      0.894    0.135    0.864    0.894    0.879    0.959    H
Weighted Avg.  0.879    0.12    0.88    0.879    0.879    0.957

=== Confusion Matrix ===

  a  b  <-- classified as
77 12 |  a = P
 9 76 |  b = H

```

**Fig 5.4 Naive Bayes with 40 attributes**

**Algorithm: Random Tree**

```

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances      141          81.0345 %
Incorrectly Classified Instances    33          18.9655 %
Kappa statistic                    0.6208
Mean absolute error                 0.1897
Root mean squared error             0.4355
Relative absolute error             37.9447 %
Root relative squared error        87.107 %
Total Number of Instances          174

=== Detailed Accuracy By Class ===

                TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
                0.798    0.176    0.826     0.798    0.811     0.811    P
                0.824    0.202    0.795     0.824    0.809     0.811    H
Weighted Avg.    0.81     0.189    0.811     0.81     0.81     0.811

=== Confusion Matrix ===

  a  b  <-- classified as
71 18 |  a = P
15 70 |  b = H

```

**Fig 5.5 Random Tree with 40 attributes**

**Algorithm:AdaBoost**

**Fig 5.6**

```

Correctly Classified Instances      151          86.7816 %
Incorrectly Classified Instances    23          13.2184 %
Kappa statistic                    0.7356
Mean absolute error                 0.1766
Root mean squared error             0.3322
Relative absolute error             35.3247 %
Root relative squared error        66.441 %
Total Number of Instances          174

=== Detailed Accuracy By Class ===

                TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
                0.865    0.129    0.875     0.865    0.87     0.929    P
                0.871    0.135    0.86     0.871    0.865     0.929    H
Weighted Avg.    0.868    0.132    0.868     0.868    0.868     0.929

=== Confusion Matrix ===

  a  b  <-- classified as
77 12 |  a = P
11 74 |  b = H

```

**Fig 5.6 AdaBoost with 40 attributes**

**Feature Selection Technique->Gain Ratio**

**No. of selected attribute-> 50**

**Algorithm:** Naive Bayes

```
=== Detailed Accuracy By Class ===  
  
          TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class  
          0.876    0.118    0.886    0.876    0.881    0.952    P  
          0.882    0.124    0.872    0.882    0.877    0.96     H  
Weighted Avg.  0.879    0.121    0.879    0.879    0.879    0.956  
  
=== Confusion Matrix ===  
  
  a  b  <-- classified as  
78 11 |  a = P  
10 75 |  b = H
```

**Fig 5.7 Naive Bayes with 50 attributes**

**Algorithm:** Random Tree

```
Correctly Classified Instances      140          80.4598 %  
Incorrectly Classified Instances    34          19.5402 %  
Kappa statistic                     0.6086  
Mean absolute error                 0.1954  
Root mean squared error             0.442  
Relative absolute error              39.0946 %  
Root relative squared error         88.4169 %  
Total Number of Instances          174  
  
=== Detailed Accuracy By Class ===  
  
          TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class  
          0.831    0.224    0.796    0.831    0.813    0.804    P  
          0.776    0.169    0.815    0.776    0.795    0.804    H  
Weighted Avg.  0.805    0.197    0.805    0.805    0.804    0.804  
  
=== Confusion Matrix ===  
  
  a  b  <-- classified as  
74 15 |  a = P  
19 66 |  b = H
```

**Fig 5.8 Random Tree with 50 attributes**

**Algorithm:** AdaBoost

```

=== Detailed Accuracy By Class ===
                TP Rate  FP Rate  Precision  Recall  F-Measure  ROC Area  Class
                0.809    0.129    0.867    0.809    0.837    0.93     P
                0.871    0.191    0.813    0.871    0.841    0.93     H
Weighted Avg.    0.839    0.16    0.841    0.839    0.839    0.93

=== Confusion Matrix ===
  a  b  <-- classified as
72 17 |  a = P
11 74 |  b = H

```

**Fig 5.9 AdaBoost with 50 attributes**

#### **TOOL USED:- ORANGE**

Orange is an open-source data visualization, analysis, and machine learning toolkit. It provides a user-friendly interface for data preprocessing, exploration, visualization, and predictive modeling. Orange offers a wide range of machine learning algorithms for classification, regression, clustering, and other tasks. Users can easily compare and evaluate different algorithms using built-in evaluation widgets.

**KNN**->K-Nearest Neighbors (KNN) is a simple yet effective supervised machine learning algorithm used for both classification and regression tasks. It's based on the idea that similar data points tend to belong to the same class or have similar values. When making predictions for a new data point, KNN calculates the distance between that point and all other points in the training dataset. Common distance metrics include



Euclidean distance, Manhattan distance, or cosine similarity.

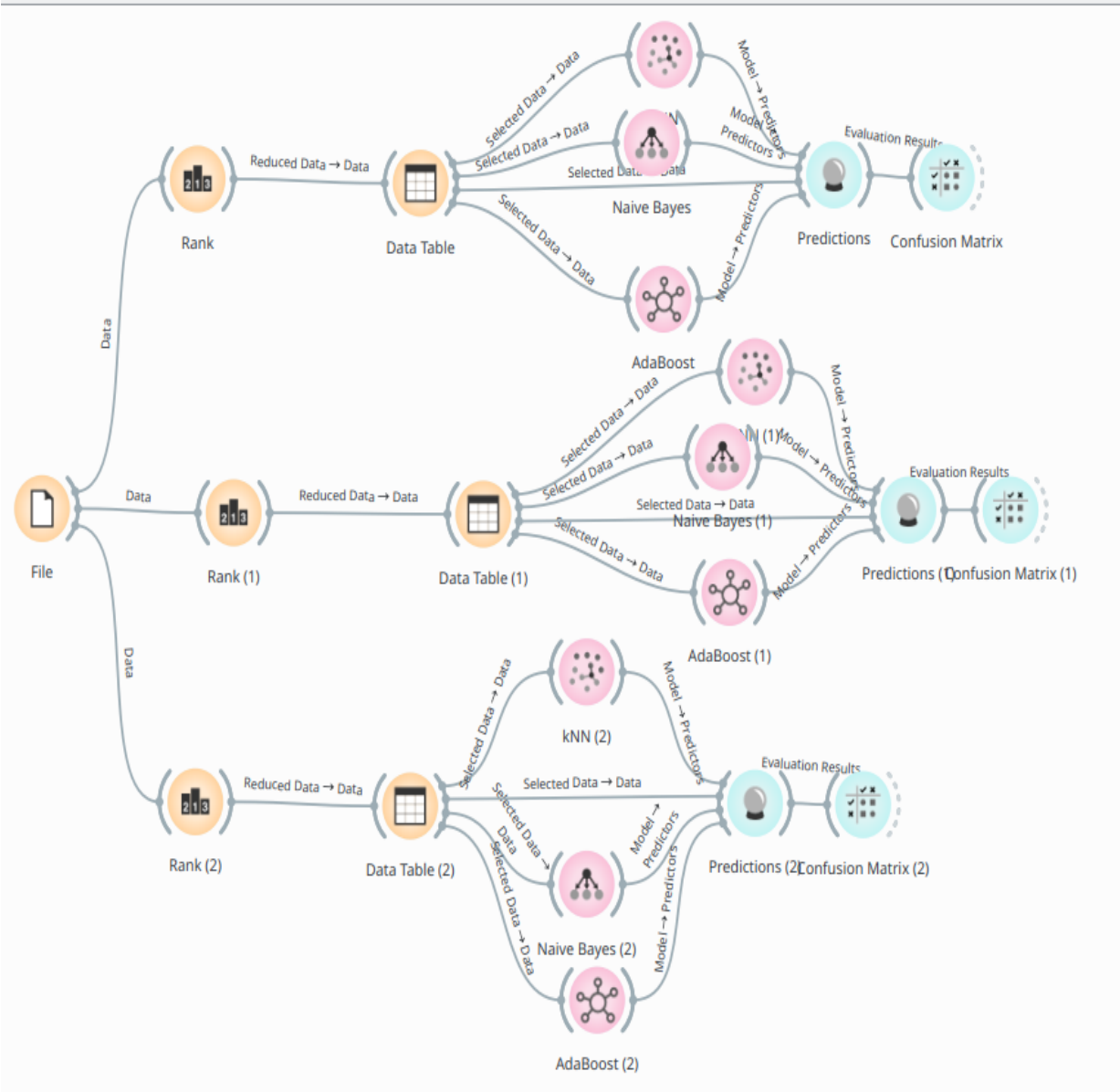


Fig 5.10

Feature Selection Technique->Gain Ratio

No. of selected attribute-> 20

	Model	AUC	CA	F1	Prec	Recall	MCC
selected	kNN	0.957	0.868	0.867	0.874	0.868	0.742
	Naive Bayes	0.966	0.908	0.908	0.908	0.908	0.816
	AdaBoost	1.000	1.000	1.000	1.000	1.000	1.000

No. of

**attribute-> 40**

No. of	Model	AUC	CA	F1	Prec	Recall	MCC
	kNN	0.963	0.885	0.885	0.890	0.885	0.776
	Naive Bayes (1)	0.976	0.885	0.885	0.887	0.885	0.772
	AdaBoost (1)	1.000	1.000	1.000	1.000	1.000	1.000

**selected attribute-> 50**

Model	AUC	CA	F1	Prec	Recall	MCC
kNN	0.951	0.868	0.868	0.870	0.868	0.738
Naive Bayes (2)	0.973	0.891	0.891	0.891	0.891	0.782
AdaBoost (2)	1.000	1.000	1.000	1.000	1.000	1.000

## PRACTICAL#6

**Aim :-** Perform Associative Mining In Weka and Orange on large datasets

**Theory :-** To perform association mining on large datasets, algorithms such as Apriori or FP-growth are employed. These algorithms efficiently extract frequent itemsets by iteratively identifying patterns within transactional data. With the support of these algorithms, associations between items can be discovered, aiding in tasks such as market basket analysis or recommendation systems. Efficient implementation and optimization are crucial for handling the computational complexity posed by large datasets, ensuring scalability and practical applicability in real-world scenarios.

### PROCEDURE:

#### USING WEKA TOOL:

**Scenario#1:WITH VALUE OF SUPPORT = 0.3 AND CONFIDENCE = 0.5**

```
Apriori
=====

Minimum support: 0.45 (2082 instances)
Minimum metric <confidence>: 0.5
Number of cycles performed: 11

Generated sets of large itemsets:

Size of set of large itemsets L(1): 13

Size of set of large itemsets L(2): 7

Best rules found:

1. biscuits=t 2605 ==> bread and cake=t 2083    conf:(0.8)
2. milk-cream=t 2939 ==> bread and cake=t 2337    conf:(0.8)
3. fruit=t 2962 ==> bread and cake=t 2325    conf:(0.78)
4. baking needs=t 2795 ==> bread and cake=t 2191    conf:(0.78)
5. frozen foods=t 2717 ==> bread and cake=t 2129    conf:(0.78)
6. vegetables=t 2961 ==> bread and cake=t 2298    conf:(0.78)
7. vegetables=t 2961 ==> fruit=t 2207    conf:(0.75)
8. fruit=t 2962 ==> vegetables=t 2207    conf:(0.75)
9. bread and cake=t 3330 ==> milk-cream=t 2337    conf:(0.7)
10. bread and cake=t 3330 ==> fruit=t 2325    conf:(0.7)
```

**Fig 6.1 he rules found based on Support = 0.3 and Confidence = 0.5**

The Apriori method, with a minimum support of 0.3 and a minimum confidence of 0.5 over 11 cycles, produced 2082 instances in Figure 6.1. Large itemset sets were produced by it; L(1) contained 13 sets, while L(2) contained 7. Among the notable rules are those describing associations, such biscuits leading to cake and bread or fruit leading to cake and bread.

#### Scenario#2:WITH VALUE OF SUPPORT = 0.5 AND CONFIDENCE = 0.7

```
Apriori
=====

Minimum support: 0.5 (2314 instances)
Minimum metric <confidence>: 0.7
Number of cycles performed: 10

Generated sets of large itemsets:

Size of set of large itemsets L(1): 10

Size of set of large itemsets L(2): 2

Best rules found:

1. milk-cream=t 2939 ==> bread and cake=t 2337    conf:(0.8)
2. fruit=t 2962 ==> bread and cake=t 2325    conf:(0.78)
3. bread and cake=t 3330 ==> milk-cream=t 2337    conf:(0.7)
```

**Fig 6.2 The rules found based on Support = 0.5 and Confidence = 0.7**

The Apriori method, with a minimum support of 0.5 and a minimum confidence of 0.7 over 10 cycles, produced 2314 instances in Figure 6.2. Large itemset sets were produced by it. L(1) contained 10 sets, while L(2) contained 2.

Some Associations are milk-cream to bread and cake or fruit to bread and cake

#### Scenario#3:WITH VALUE OF SUPPORT = 0.3 AND CONFIDENCE = 0.7

```
=== Run information ===

Scheme:      weka.associations.Apriori -N 10 -T 0 -C 0.9 -D 0.05 -U 1.0 -M 0.7 -S -1.0 -c -1
Relation:    supermarket
Instances:   4627
Attributes:  217
[list of attributes omitted]
=== Associator model (full training set) ===

No large itemsets and rules found!
```

**Fig 6.3 The rules found based on Support = 0.7 and Confidence = 0.9**

In Figure 6.3, no rules were found in this iteration of the Apriori method, with a minimum support of 0.7 and a minimum confidence of 0.9 applied. This finding might be explained by the strict confidence and support standards that were established, which might have led to too few examples satisfying these requirements to create meaningful correlations. The lack of rules implies that there might not be frequent itemsets in the dataset that meet the designated confidence and support requirements.

## Practical #7

**Aim :** Perform K-Nearest Neighbour Classification in Weka and Orange

### Theory:

K-Nearest Neighbors (KNN) is a simple yet powerful algorithm used for classification and regression tasks in machine learning. It's a non-parametric and instance-based learning algorithm, meaning it doesn't make strong assumptions about the underlying data distribution and it memorizes the entire training dataset. The choice of K (the number of nearest neighbors to consider) is crucial. A smaller K value can lead to more complex decision boundaries, while a larger K value can lead to smoother boundaries.

**Using :** WEKA tool

**Database used :** Darwin

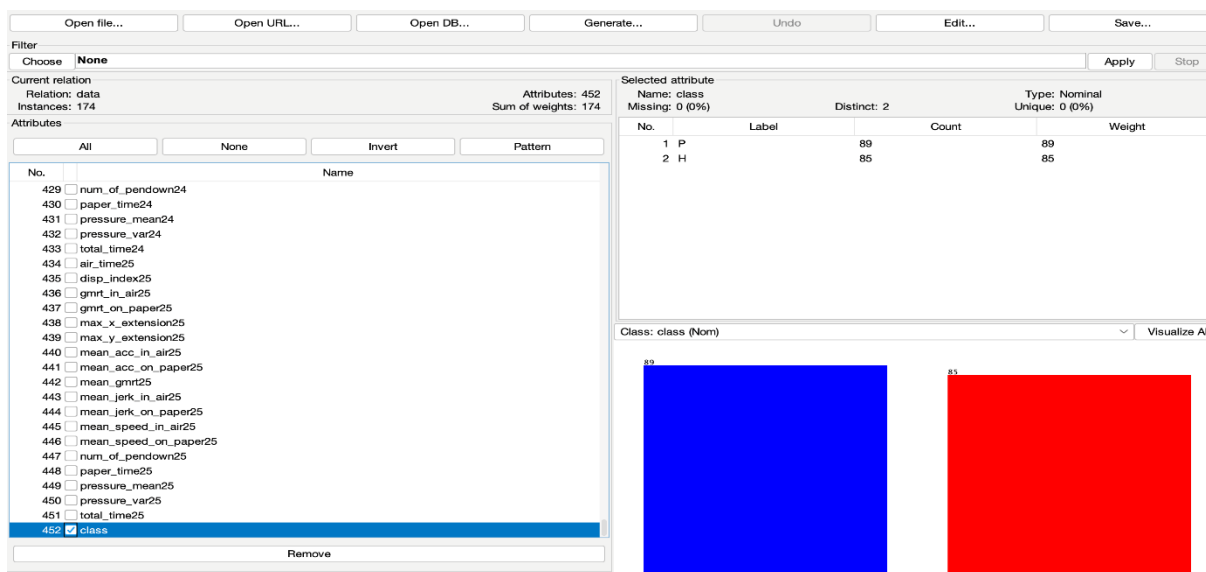


Fig 7.1 uploading labelled data

Linear NN Search

Classifier

Choose **IBk -K 5 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""**

Test options

☐ Use training set

☐ Supplied test set

☒ Cross-validation Folds **10**

☐ Percentage split % **66**

More options...

(Nom) class

Start Stop

Result list (right-click for options)

13:57:37 - lazy.IBk

13:59:20 - lazy.IBk

14:00:42 - lazy.IBk

Classifier output

=== Run information ===

Scheme: weka.classifiers.lazy.IBk -K 5 -W 0 -A "weka.core.neighboursearch.LinearNNSearch -A \"weka.core.EuclideanDistance -R first-last\""

Relation: data

Instances: 174

Attributes: 452

Test mode: 10-fold cross-validation

=== Classifier model (full training set) ===

IB1 instance-based classifier  
using 5 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances	128	73.5632 %
Incorrectly Classified Instances	46	26.4368 %
Kappa statistic	0.4773	
Mean absolute error	0.2661	
Root mean squared error	0.4341	
Relative absolute error	53.2422 %	
Root relative squared error	86.8301 %	
Total Number of Instances	174	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.483	0.000	1.000	0.483	0.652	0.560	0.902	0.908	P
	1.000	0.517	0.649	1.000	0.787	0.560	0.902	0.843	H
Weighted Avg.	0.736	0.252	0.828	0.736	0.718	0.560	0.902	0.877	

=== Confusion Matrix ===

a b ← classified as

43	46	a = P
0	85	b = H

Fig 7.2 KNN using linear NN search

## Cover Tree

=== Classifier model (full training set) ===

IB1 instance-based classifier  
using 5 nearest neighbour(s) for classification

Time taken to build model: 0 seconds

=== Stratified cross-validation ===

=== Summary ===

Correctly Classified Instances	128	73.5632 %
Incorrectly Classified Instances	46	26.4368 %
Kappa statistic	0.4773	
Mean absolute error	0.2661	
Root mean squared error	0.4341	
Relative absolute error	53.2422 %	
Root relative squared error	86.8301 %	
Total Number of Instances	174	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.483	0.000	1.000	0.483	0.652	0.560	0.902	0.908	P
	1.000	0.517	0.649	1.000	0.787	0.560	0.902	0.843	H
Weighted Avg.	0.736	0.252	0.828	0.736	0.718	0.560	0.902	0.877	

=== Confusion Matrix ===

a b ← classified as

43	46	a = P
0	85	b = H

Fig 7.3 KNN using Cover tree

## Ball Tree

```

=== Classifier model (full training set) ===

IB1 instance-based classifier
using 5 nearest neighbour(s) for classification

Time taken to build model: 0.05 seconds

=== Stratified cross-validation ===
=== Summary ===

Correctly Classified Instances      128           73.5632 %
Incorrectly Classified Instances    46           26.4368 %
Kappa statistic                    0.4773
Mean absolute error                 0.2661
Root mean squared error             0.4341
Relative absolute error             53.2422 %
Root relative squared error         86.8301 %
Total Number of Instances          174

=== Detailed Accuracy By Class ===
                TP Rate  FP Rate  Precision  Recall   F-Measure  MCC      ROC Area  PRC Area  Class
                0.483    0.000    1.000     0.483    0.652     0.560    0.902    0.908     P
                1.000    0.517    0.649     1.000    0.787     0.560    0.902    0.843     H
Weighted Avg.   0.736    0.252    0.828     0.736    0.718     0.560    0.902    0.877

=== Confusion Matrix ===
  a  b  <-- classified as
43 46 | a = P
 0 85 | b = H

```

Fig 7.4 KNN using Ball tree

Using : Orange tool

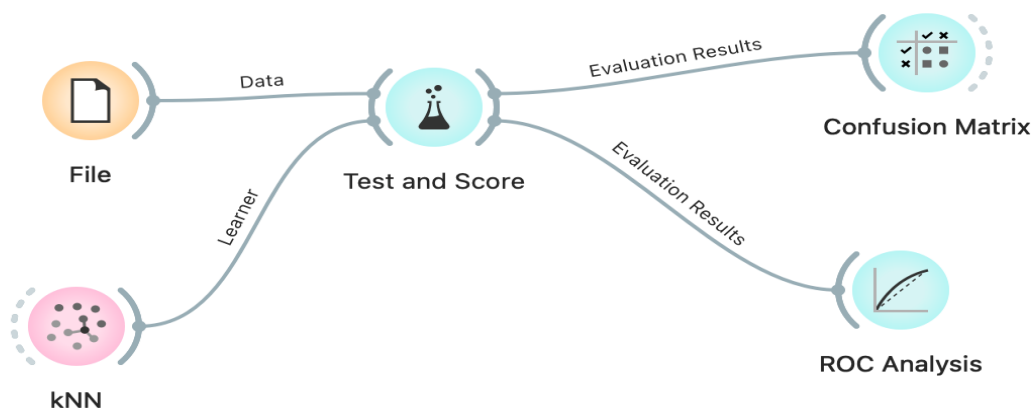


Fig 7.5 KNN using Orange tool

Matric : Euclidean



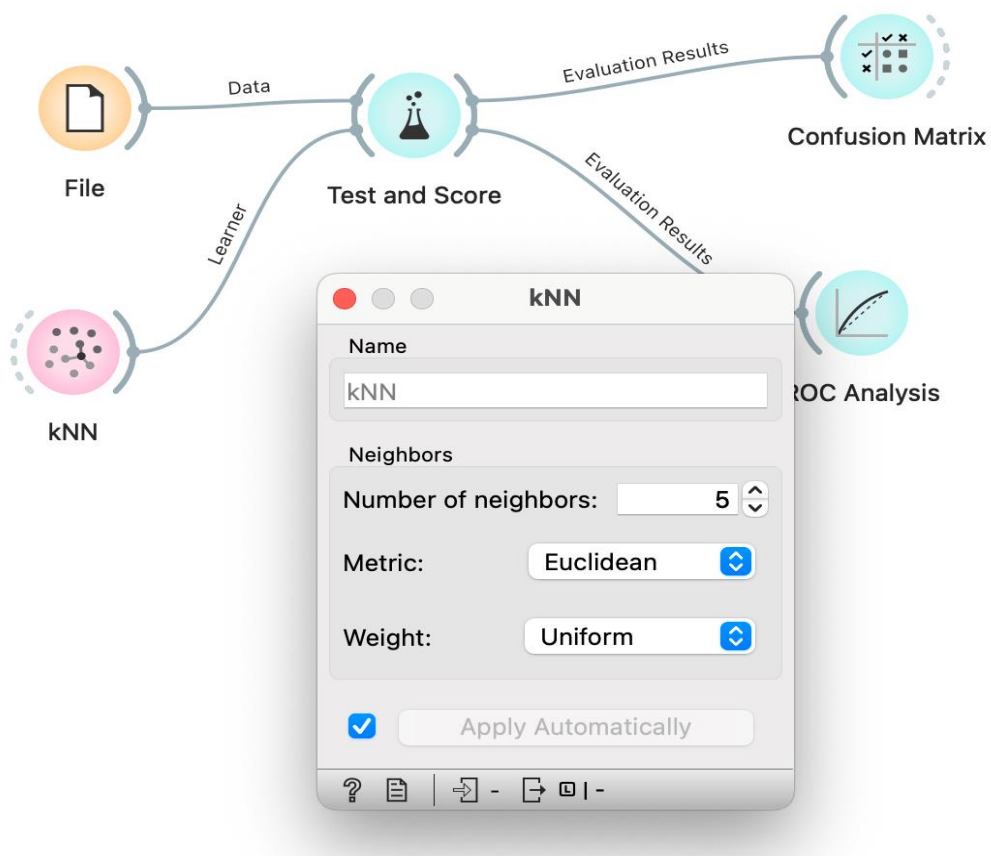


Fig 7.6 using Euclidean metric

<input checked="" type="radio"/> Cross validation Number of folds: 5 <input checked="" type="checkbox"/> Stratified <input type="radio"/> Cross validation by feature <input type="radio"/> Random sampling Repeat train/test: 10 Training set size: 66 % <input checked="" type="checkbox"/> Stratified <input type="radio"/> Leave one out <input type="radio"/> Test on train data <input type="radio"/> Test on test data		Evaluation results for target (None, show average over classes)					
Model	AUC	CA	F1	Prec	Recall	MCC	
kNN	0.815	0.724	0.713	0.773	0.724	0.497	

Fig 7.7 Evaluation result

Matric : Manhattan

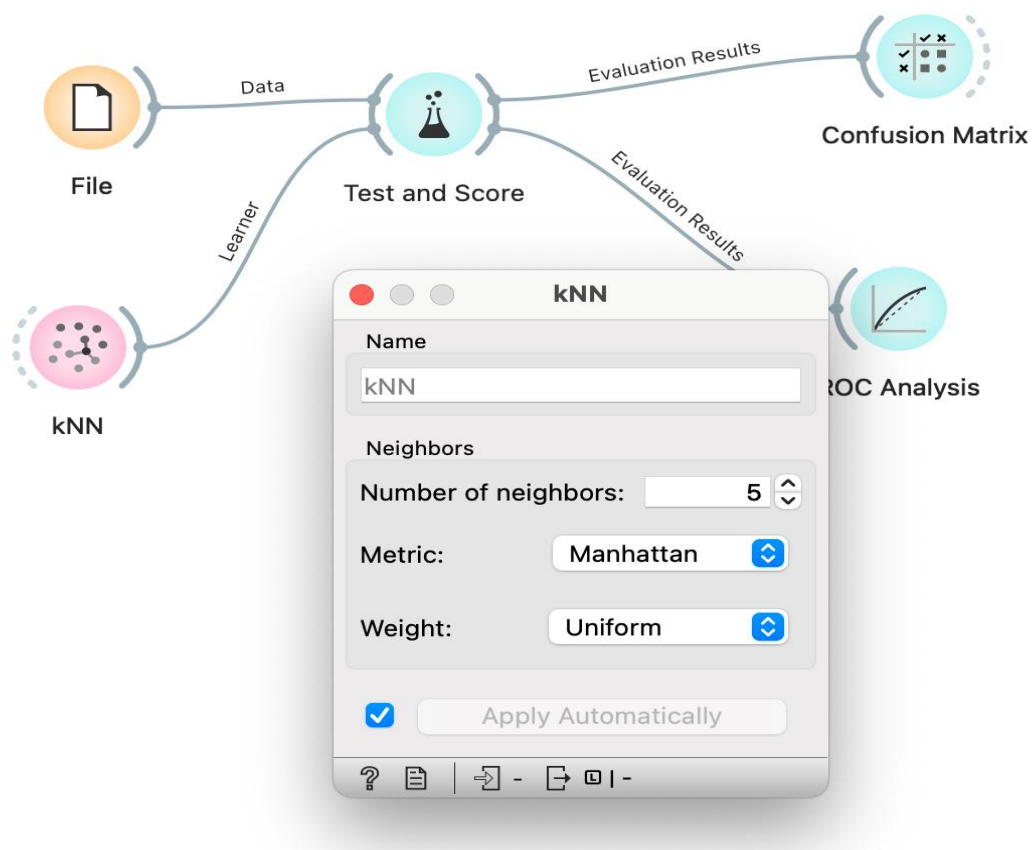


Fig 7.8 KNN using Manhattan metric

☒ Cross validation

Number of folds: 5

☒ Stratified

☐ Cross validation by feature

☐ Random sampling

Repeat train/test: 10

Training set size: 66 %

☒ Stratified

☐ Leave one out

☐ Test on train data

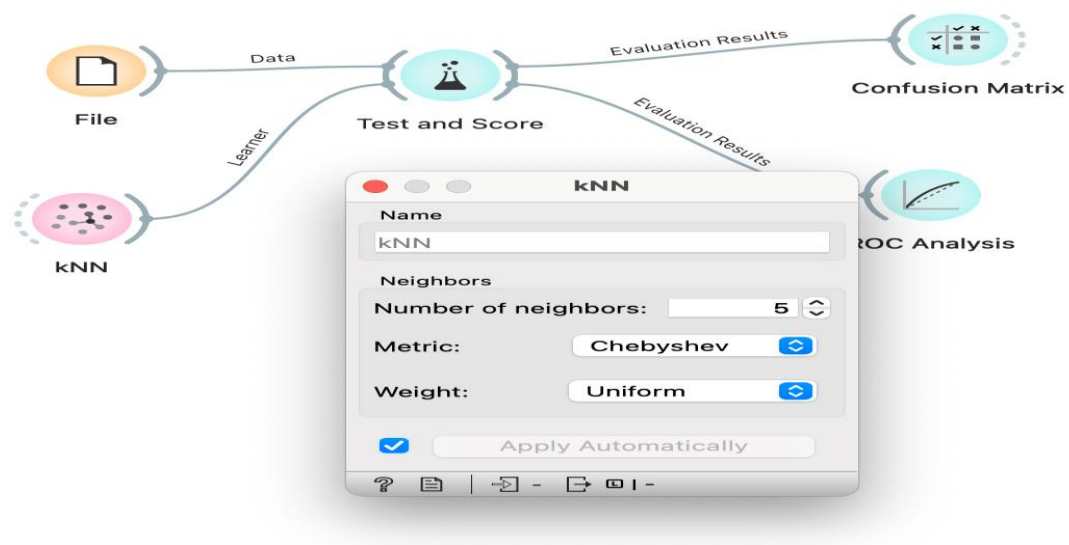
☐ Test on test data

Evaluation results for target (None, show average over classes)

Model	AUC	CA	F1	Prec	Recall	MCC
kNN	0.898	0.718	0.696	0.821	0.718	0.534

Fig 7.9 Evaluation result

Matric: Chebyshev



☒ Cross validation

Number of folds: 5

☒ Stratified

☐ Cross validation by feature

☐ Random sampling

Repeat train/test: 10

Training set size: 66 %

☒ Stratified

☐ Leave one out

☐ Test on train data

☐ Test on test data

Evaluation results for target (None, show average over classes)

Model	AUC	CA	F1	Prec	Recall	MCC
kNN	0.692	0.655	0.654	0.658	0.655	0.314

Fig 7.10 using Chebyshev metric

## Practical#8

**Aim :-** Perform DBSCAN Clustering in Weka and Orange

**Theory :** DBSCAN, which stands for Density-Based Spatial Clustering of Applications with Noise, is a popular clustering algorithm in data mining and machine learning. It's used to group together points that are closely packed together, marking as outliers those that lie alone in low-density regions.

Here's a brief overview of how DBSCAN works:

1. **Density-Based:** DBSCAN groups together points based on their density. It doesn't require the user to specify the number of clusters beforehand.
2. **Core Points:** It defines two parameters: epsilon ( $\epsilon$ ), which specifies the radius of the neighborhood around each point, and MinPts, the minimum number of points required to form a dense region (cluster).
3. **Reachability:** A point is considered reachable from another if it is within the  $\epsilon$  distance of that point.
4. **Core, Border, and Noise Points:**
  - Core points: Points with at least MinPts within  $\epsilon$  distance.
  - Border points: Points within  $\epsilon$  distance of a core point but with fewer than MinPts neighbors.
  - Noise points: Points that are neither core nor border points.
5. **Clustering:** DBSCAN starts with an arbitrary point and expands the cluster by adding all reachable points to the cluster. It continues this process until the cluster is maximally expanded, and then it starts a new cluster with a new unvisited point.

### In Weka :-

In Weka, we can perform clustering using various algorithms such as k-means, hierarchical clustering, and EM (Expectation-Maximization) clustering. Although DBSCAN is not available out-of-the-box, we can implement a similar approach using the "DBSCAN" package in Weka. This package provides a DBSCAN implementation that we can use within Weka.

We can install the DBSCAN package in Weka by following these steps:

1. Download the DBSCAN package (JAR file) from the Weka package repository or other sources.
2. Place the JAR file in the weka/packages directory.
3. Restart Weka.
4. We should now see DBSCAN listed among the available algorithms.

Dataset chosen is generated by Weka.

Dataset is Breast Cancer Data.

```
=== Run information ===

Scheme:      weka.clusterers.MakeDensityBasedClusterer -M 1.0E-6 -W weka.clusterers.MakeDensityBasedClusterer -- -M 1.0E-6 -W weka.clusterers.SimpleKMeans --
Relation:    weka.datagenrators.clusterers.BIRCHCluster-S_1-a_10-k_4-N_1..50-R_0.1..1.41-O
Instances:   136
Attributes:  10
              X0
              X1
              X2
              X3
              X4
              X5
              X6
              X7
              X8
              X9

Test mode:   evaluate on training data

=== Clustering model (full training set) ===

MakeDensityBasedClusterer:

Wrapped clusterer: MakeDensityBasedClusterer:

Wrapped clusterer:
kMeans
=====

Number of iterations: 2
Within cluster sum of squared errors: 50.97177257745203

Initial starting points (random):

Cluster 0: 1.915494,1.414456,1.323085,0.829596,3.465952,0.392677,1.994256,2.307067,0.69608,2.977559
Cluster 1: 1.954207,2.310913,1.992524,0.715432,2.703527,0.748335,-0.443097,0.953935,0.868533,2.24718
```

Fig 8.1 shows the application of DBSCAN on dataset.

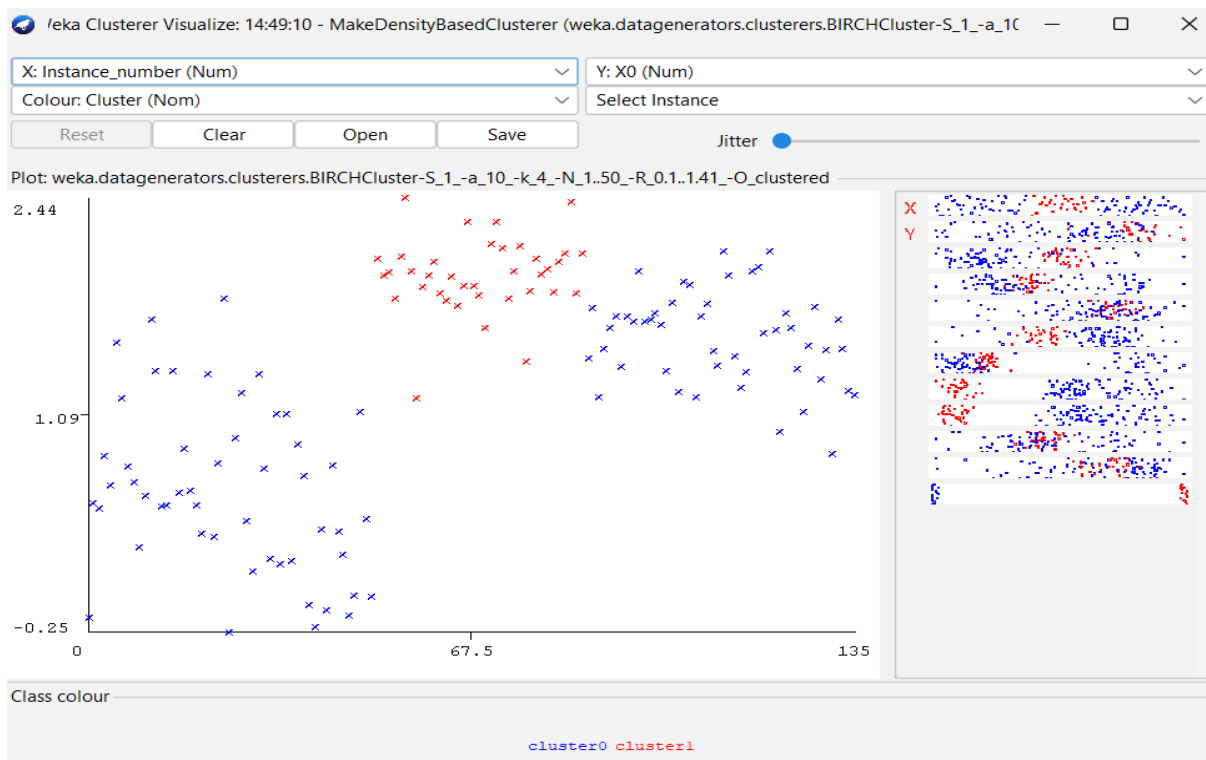


Fig 8.2 shows the visualization of clusters after applying DBSCAN algorithm.

Dataset is Breast Cancer Data.

```

=== Run information ===

Scheme:      weka.clusterers.MakeDensityBasedClusterer -M 1.0E-6 -W weka.clusterers.MakeDensityBasedClusterer -- -M 1.0E-6 -W weka.clusterers.SimpleKMeans -- -:
Relation:    breast-cancer-data
Instances:   286
Attributes:  10
    age
    menopause
    tumor-size
    inv-nodes
    node-caps
    deg-malig
    breast
    breast-quad
    irradiat
    Class
Test mode:   evaluate on training data

=== Clustering model (full training set) ===

MakeDensityBasedClusterer:

Wrapped clusterer: MakeDensityBasedClusterer:

Wrapped clusterer:
kMeans
=====

Number of iterations: 3
Within cluster sum of squared errors: 1177.0

Initial starting points (random):

Cluster 0: 50-59,premeno,10-14,0-2,no,2,right,left_up,no,no-recurrence-events
Cluster 1: 40-49,premeno,15-19,0-2,yes,3,right,left_up,no,recurrence-events

```

Fig 8.3 shows the application of DBSCAN algorithm on the dataset.

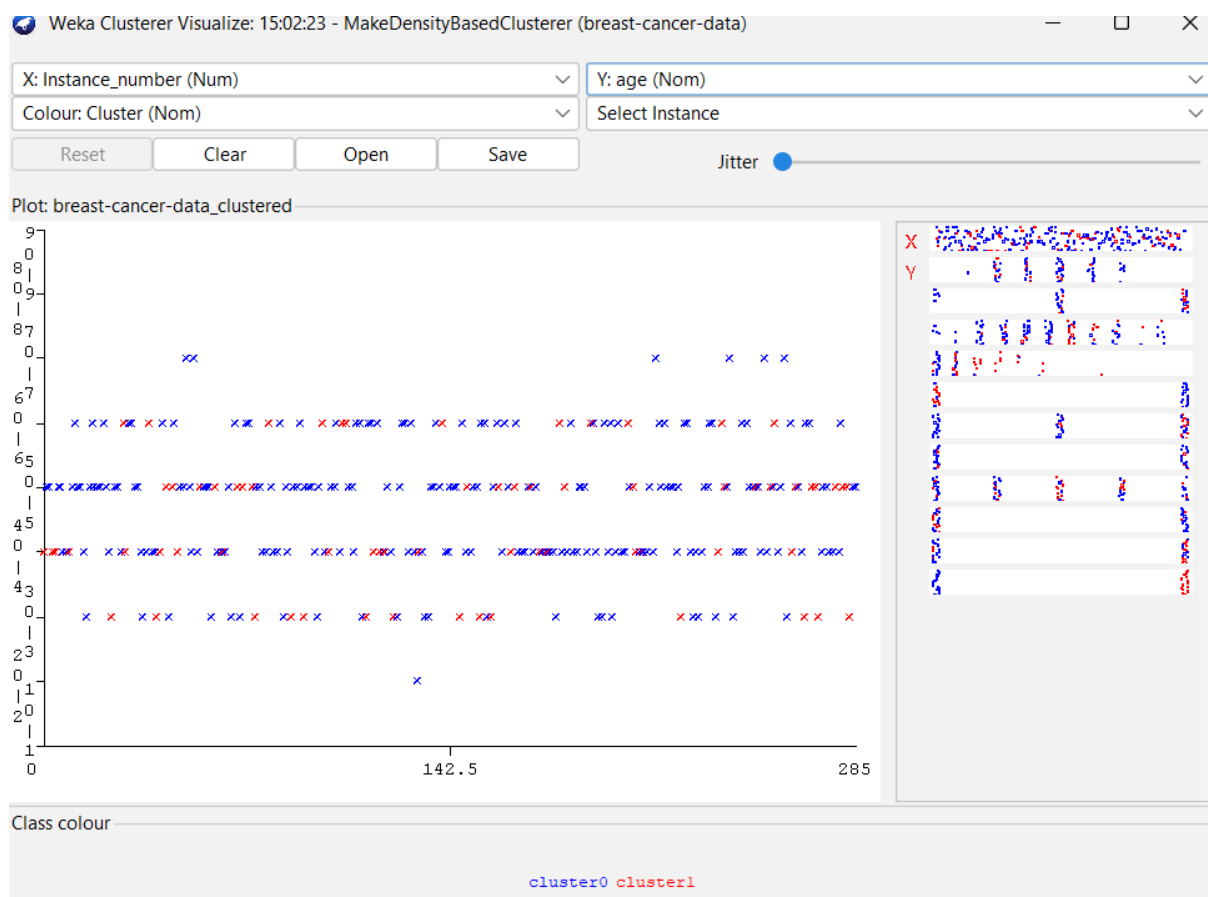


Fig 8.4 shows the visualization of clusters after applying DBSCAN Algorithm.

Dataset is archive.

```

=== Run information ===

Scheme:      weka.clusterers.MakeDensityBasedClusterer -M 1.0E-6 -W weka.clusterers.MakeDensityBasedClusterer -- -M 1.0E-6 -W weka.clusterers.SimpleKMeans --
Relation:    Clustering_gmm (2)
Instances:   500
Attributes:  2
              Weight
              Height
Test mode:   evaluate on training data

=== Clustering model (full training set) ===

MakeDensityBasedClusterer:

Wrapped clusterer: MakeDensityBasedClusterer:

Wrapped clusterer:
kMeans
=====

Number of iterations: 4
Within cluster sum of squared errors: 20.136372959052295

Initial starting points (random):

Cluster 0: 54.621946,163.3439
Cluster 1: 54.633868,162.960433

```

Fig 8.5 shows the applying of DBSCAN on the dataset.

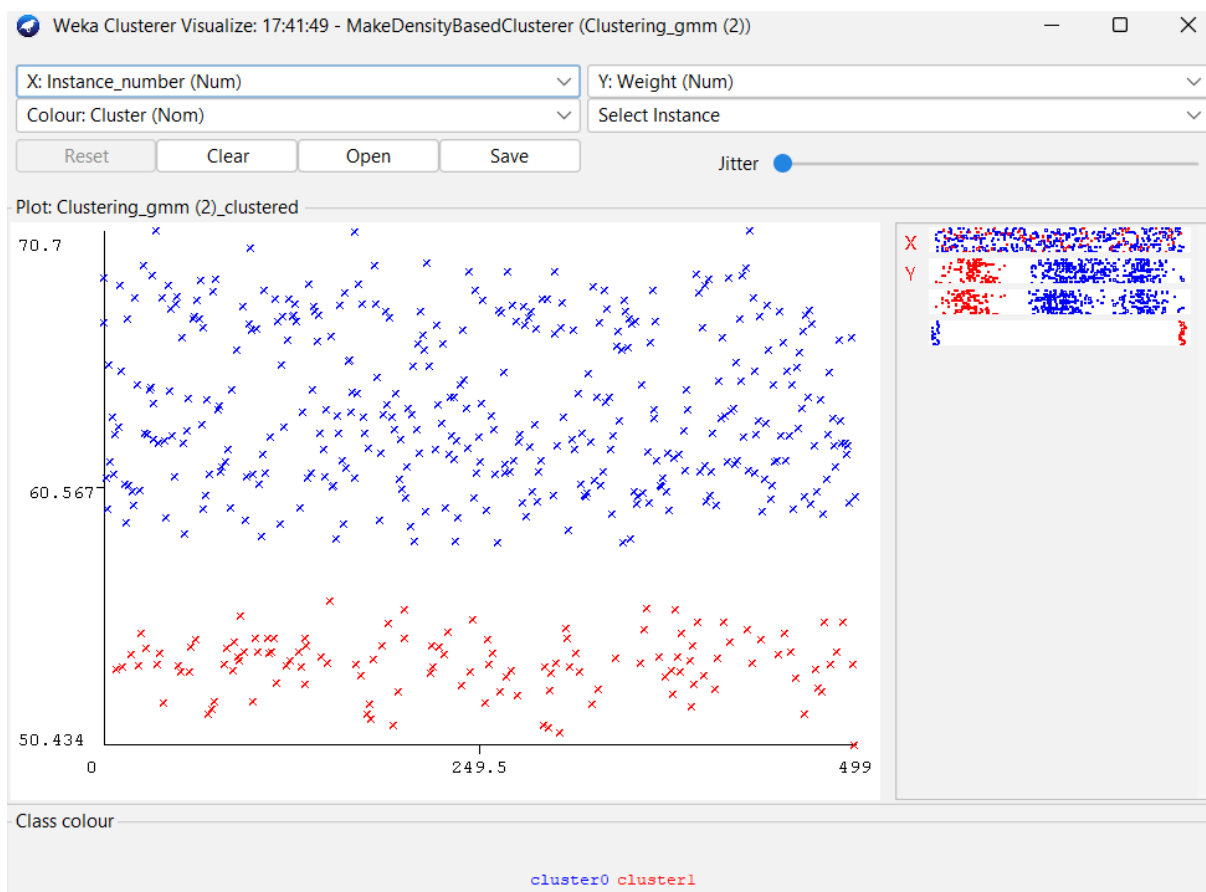


Fig 8.6 shows the visualization of cluster after applying DBSCAN Algorithm.

**In Orange :-** In Orange, we can perform clustering using algorithms such as k-means, hierarchical clustering, and DBSCAN-like clustering through the DBSCAN and OPTICS algorithms, available in the "orange3-associate" add-on. Here's how we can use DBSCAN-like clustering in Orange:

1. Install the "orange3-associate" add-on if we haven't already. We can do this through the Orange GUI or by using pip:  

```
pip install orange3-associate
```
2. Launch Orange and load wer dataset.
3. Drag the "DBSCAN" widget from the "Unsupervised" category into the workflow canvas.
4. Connect the dataset to the DBSCAN widget.
5. Configure the parameters of the DBSCAN algorithm, such as epsilon ( $\epsilon$ ) and MinPts.
6. Run the workflow to perform DBSCAN-like clustering on wer dataset.



Fig 8.7 shows the building of model on dataset.

Dataset is IRIS.

DBSCAN



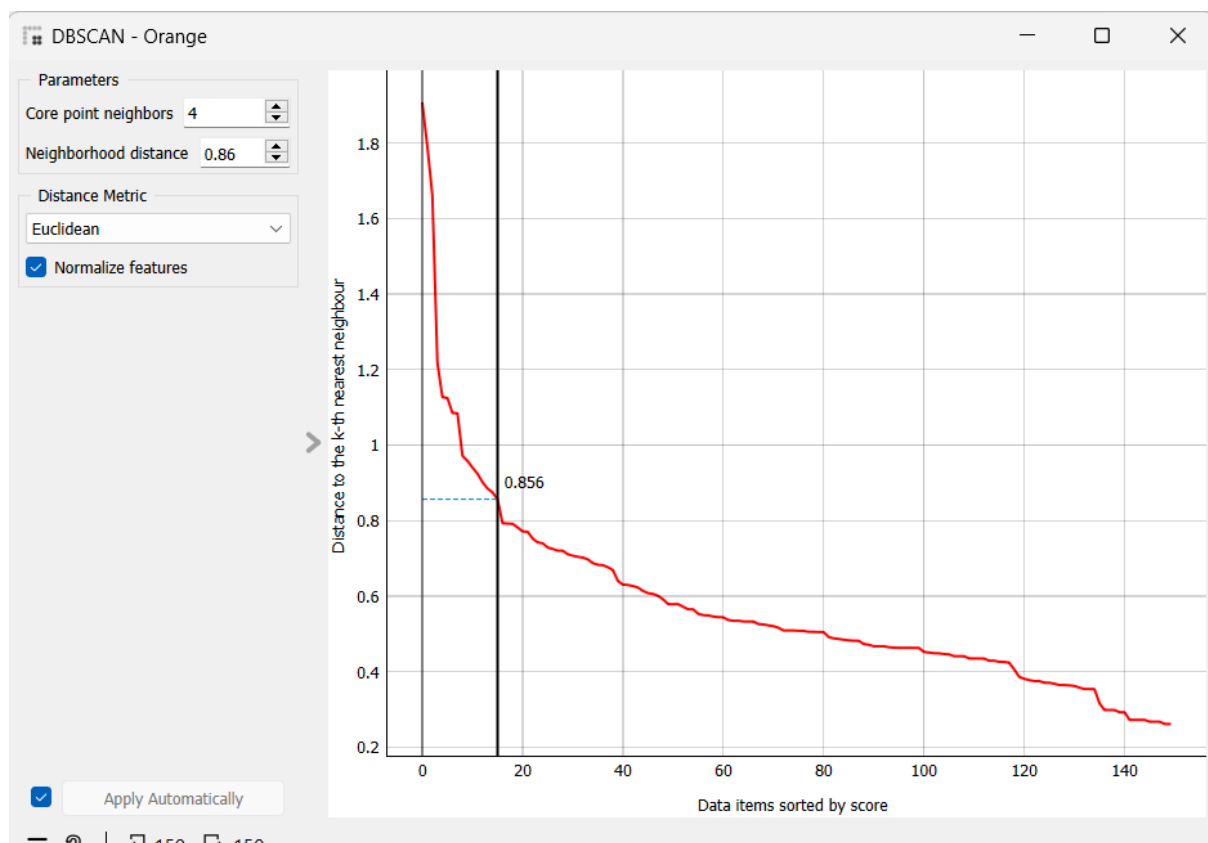


Fig 8.8 shows the DBSCAN applying on dataset.

## Scatter Plot

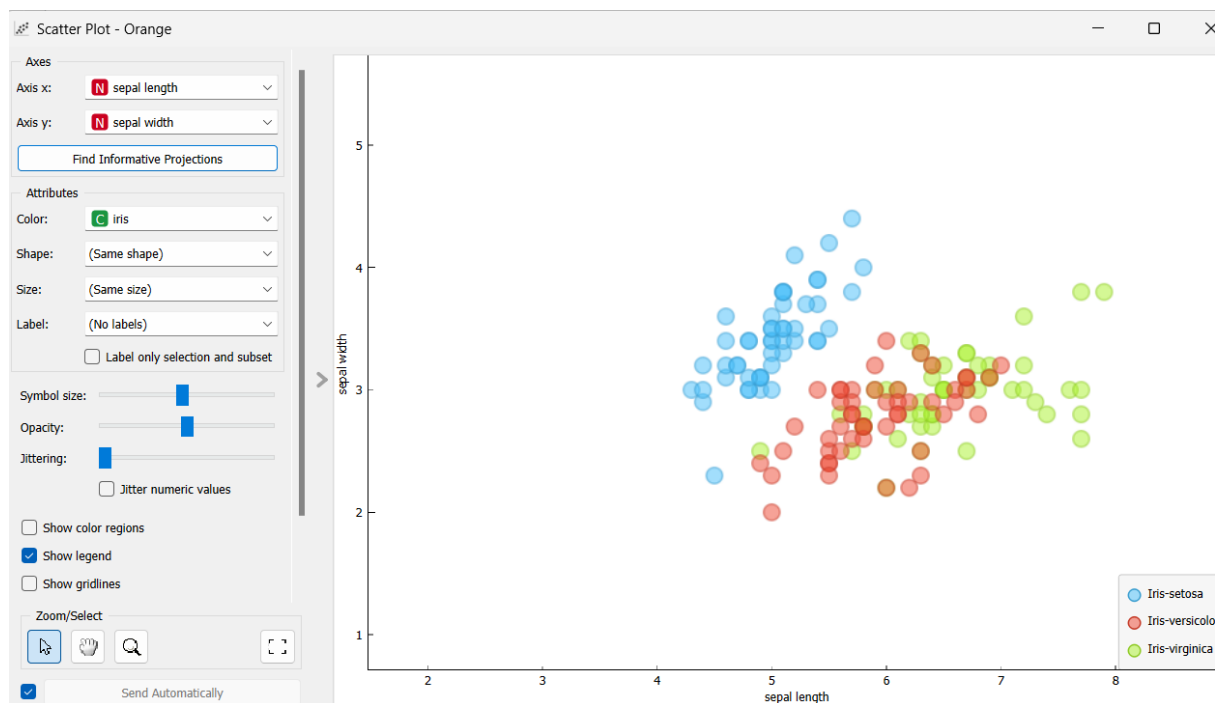


Fig 8.9 shows the scatterplot formed after applying DBSCAN on dataset.

Dataset is archive.

DBSCAN

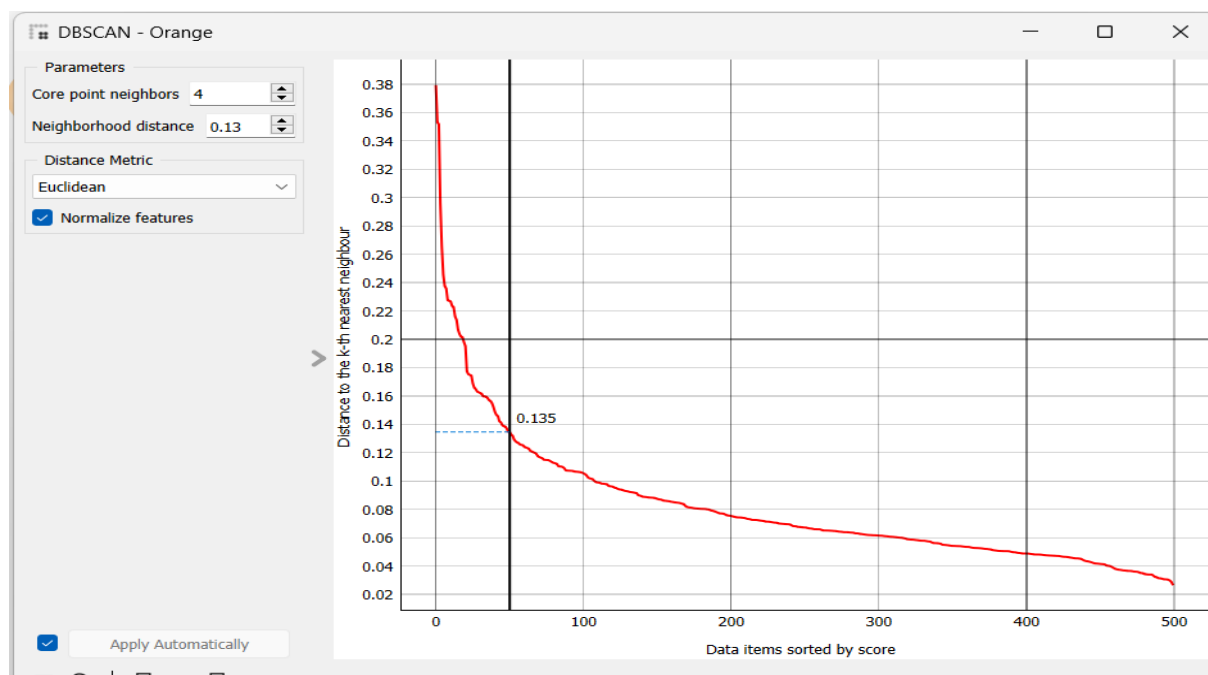


Fig 8.10 shows the DBSCAN applying on dataset.

## Scatter Plot

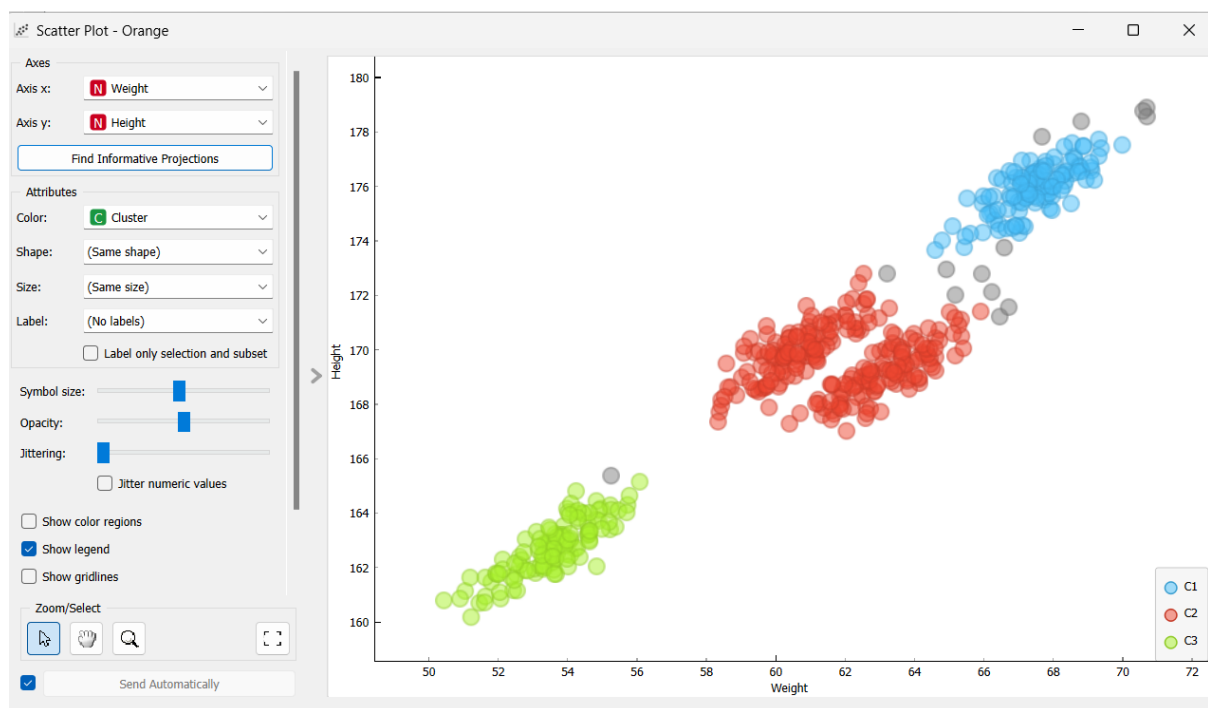


Fig 8.11 shows the scatterplot formed after applying DBSCAN on dataset

## Practical#9

**Objective:** Perform Hierarchical Clustering

### Theory:

Hierarchical clustering is a popular method used to group similar items into clusters. It builds a hierarchy of clusters either top-down (divisive) or bottom-up (agglomerative). Agglomerative clustering is more commonly used.

### PROCEDURE:

#### USING WEKA TOOL:

#### Scenario#1:

**WITH NUMBER OF CLUSTERS= 4 AND DISTANCE = EUCLIDEAN**

```
Time taken to build model (full training data) : 0.13 seconds
=== Model and evaluation on training set ===
Clustered Instances
0      164 ( 94%)
1       1 (  1%)
2       8 (  5%)
3       1 (  1%)
```

**7.9 Information with number of cluster =4 and distance =euclidean**

### Scenario#2:

**WITH NUMBER OF CLUSTERS= 4 AND DISTANCE = MANHATTAN**

```
Time taken to build model (full training data) : 0.1 seconds

=== Model and evaluation on training set ===

Clustered Instances

0      171 ( 98%)
1       1 (  1%)
2       1 (  1%)
3       1 (  1%)
```

**Fig 7.10 Information with number of cluster =4 and distance =manhattan**

### Scenario#3:

**WITH NUMBER OF CLUSTERS= 5 AND DISTANCE = CHEBYSHEV**

**Fig 7.11 Information with number of cluster =4 and distance =Chebyshev**

```
Time taken to build model (full training data) : 0.1 seconds

=== Model and evaluation on training set ===

Clustered Instances

0       2 (  1%)
1       1 (  1%)
2       1 (  1%)
3       1 (  1%)
4      169 ( 97%)
```

### USING ORANGE

Import your dataset into Orange using the graphical interface or Python scripting.

Drag and drop the "Hierarchical Clustering" widget onto the canvas.

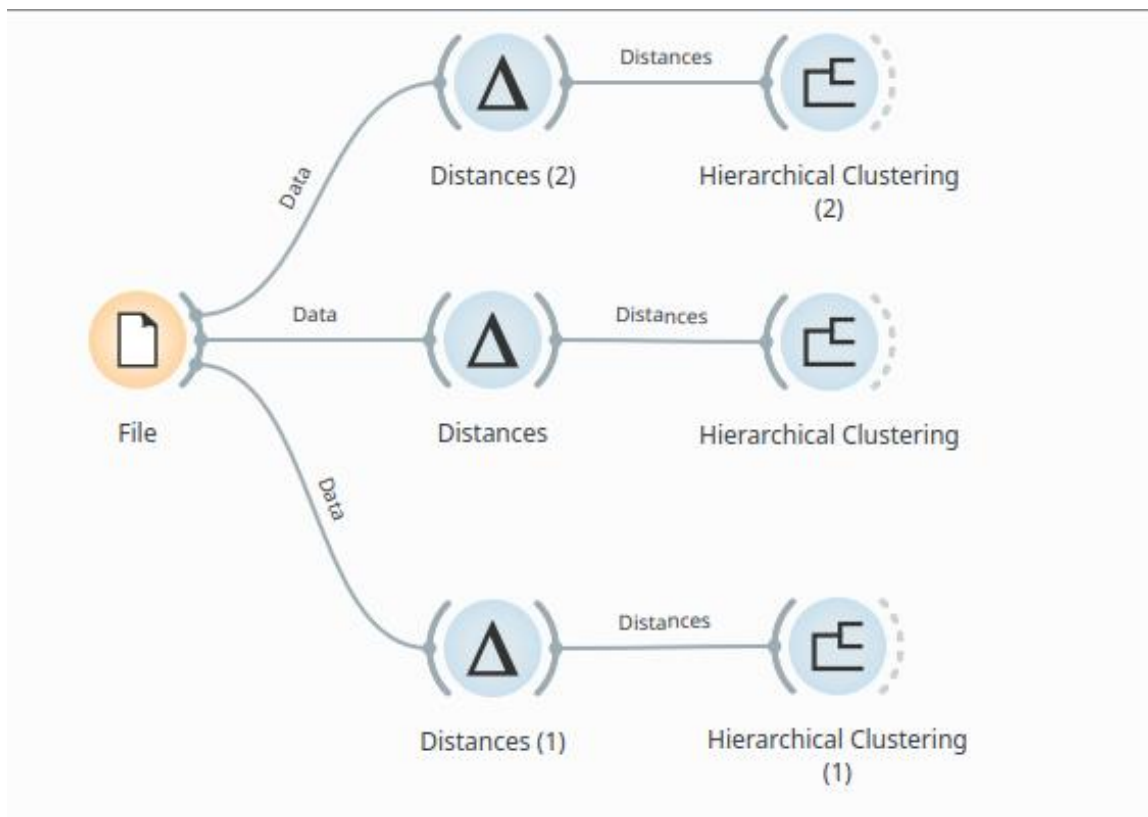
Set the parameters for hierarchical clustering, such as the distance metric (e.g., Euclidean, Manhattan) and the linkage method

Connect the output of your data source to the input of the Hierarchical Clustering widget.

Execute the workflow to perform hierarchical clustering and visualize the dendrogram, which illustrates the clustering hierarchy and how clusters merge.

Analyze the dendrogram to determine the optimal number of clusters based on the cluster fusion levels.

Optionally, use clustering widgets or Python scripting to extract clusters based on the dendrogram's structure.

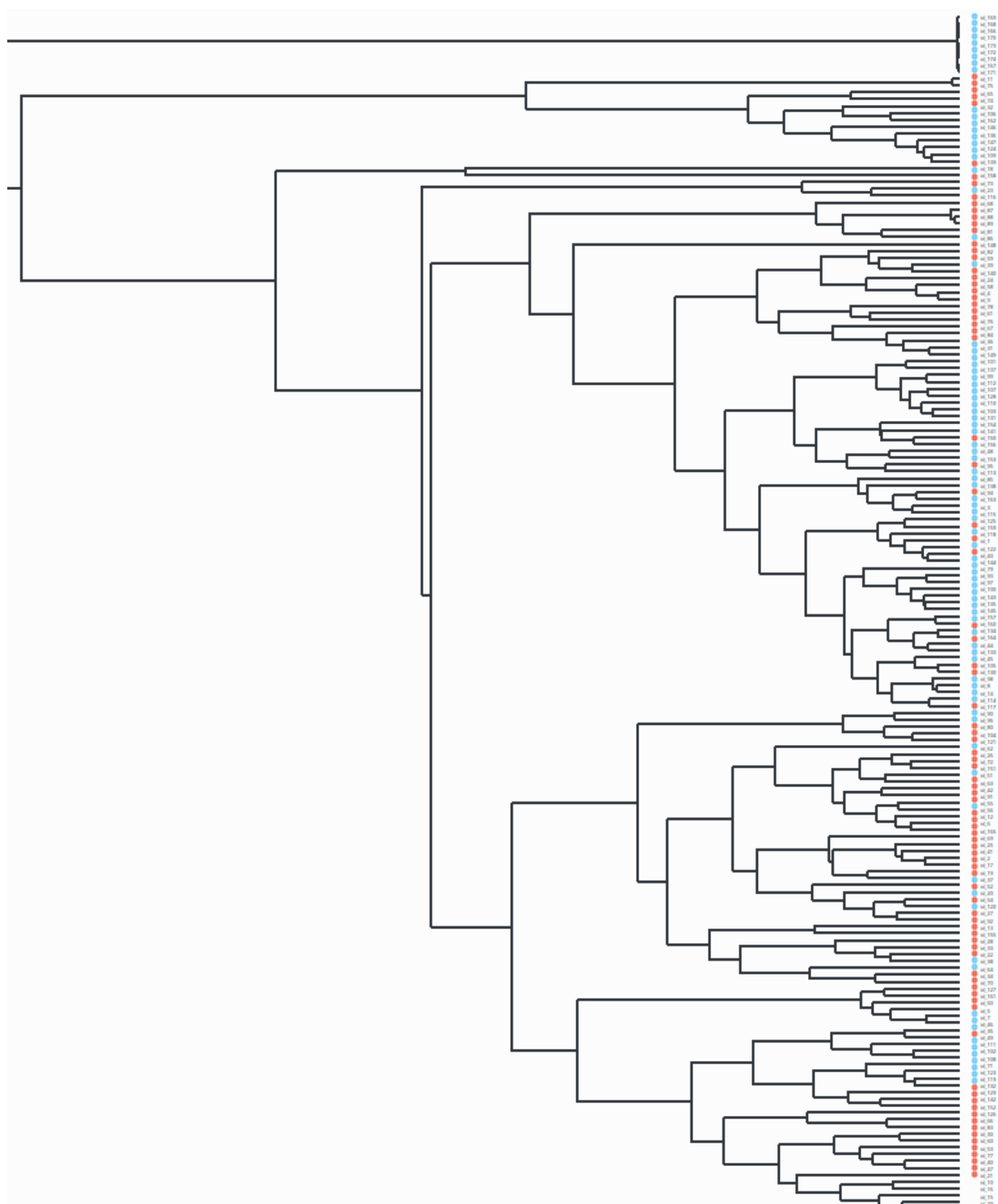


**Fig 7.12 Heirarchial clustering using orange**

A **dendrogram** is a tree-like diagram that illustrates the arrangement of the clusters produced by hierarchical clustering. It illustrates the order and distances at which clusters are merged. The y-axis of the dendrogram represents the distance or dissimilarity between clusters, while the x-axis represents individual data points or clusters.

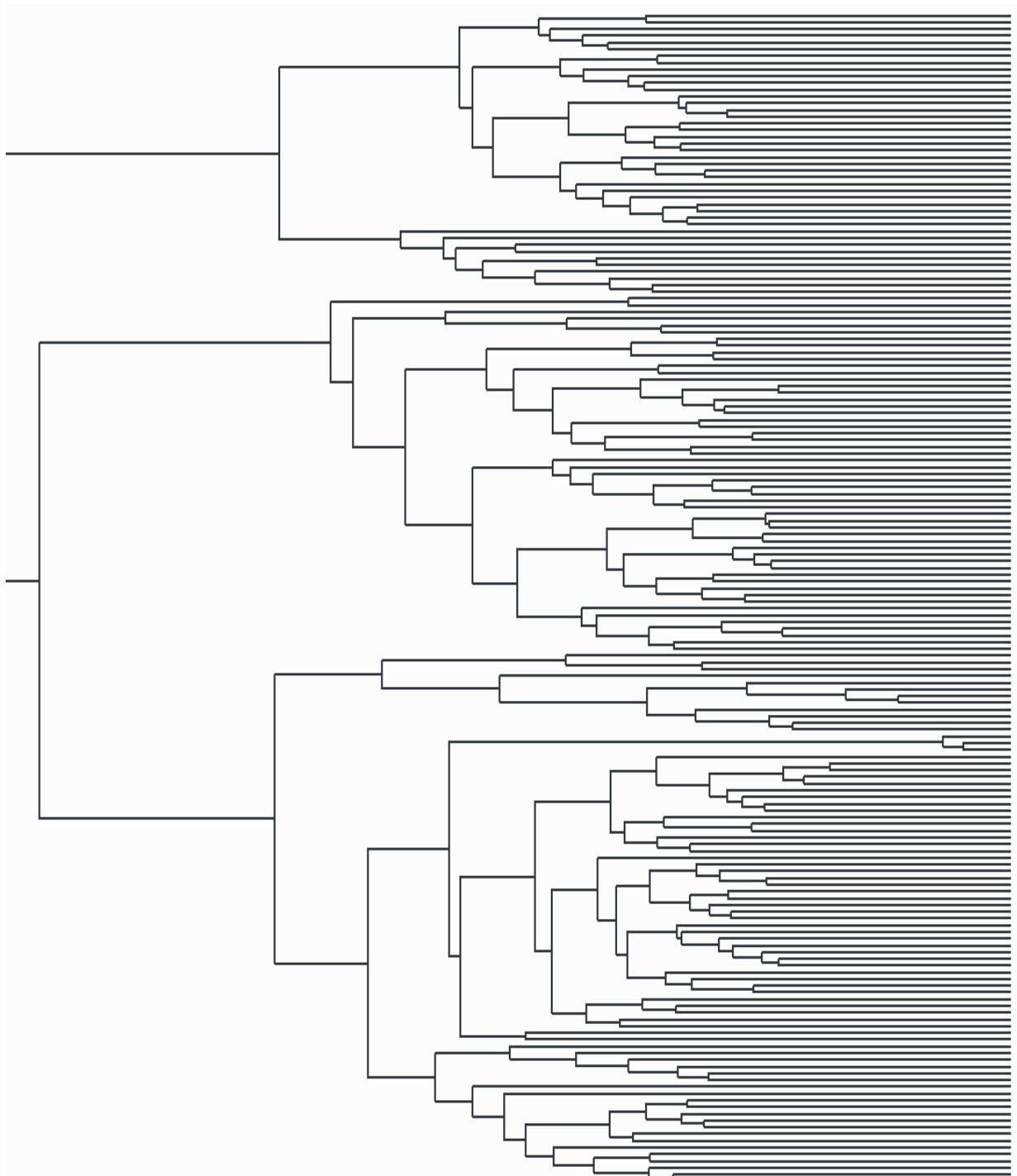
#### **Scenario#1: Using Pearson Distance**

The Pearson distance, also known as the Pearson correlation coefficient, is a measure of the linear correlation between two variables. It is commonly used as a distance metric in hierarchical clustering, especially when dealing with continuous variables.



**Fig 7.13 Using Pearson Distance**

**Scenario#2:**Using Euclidean Distance

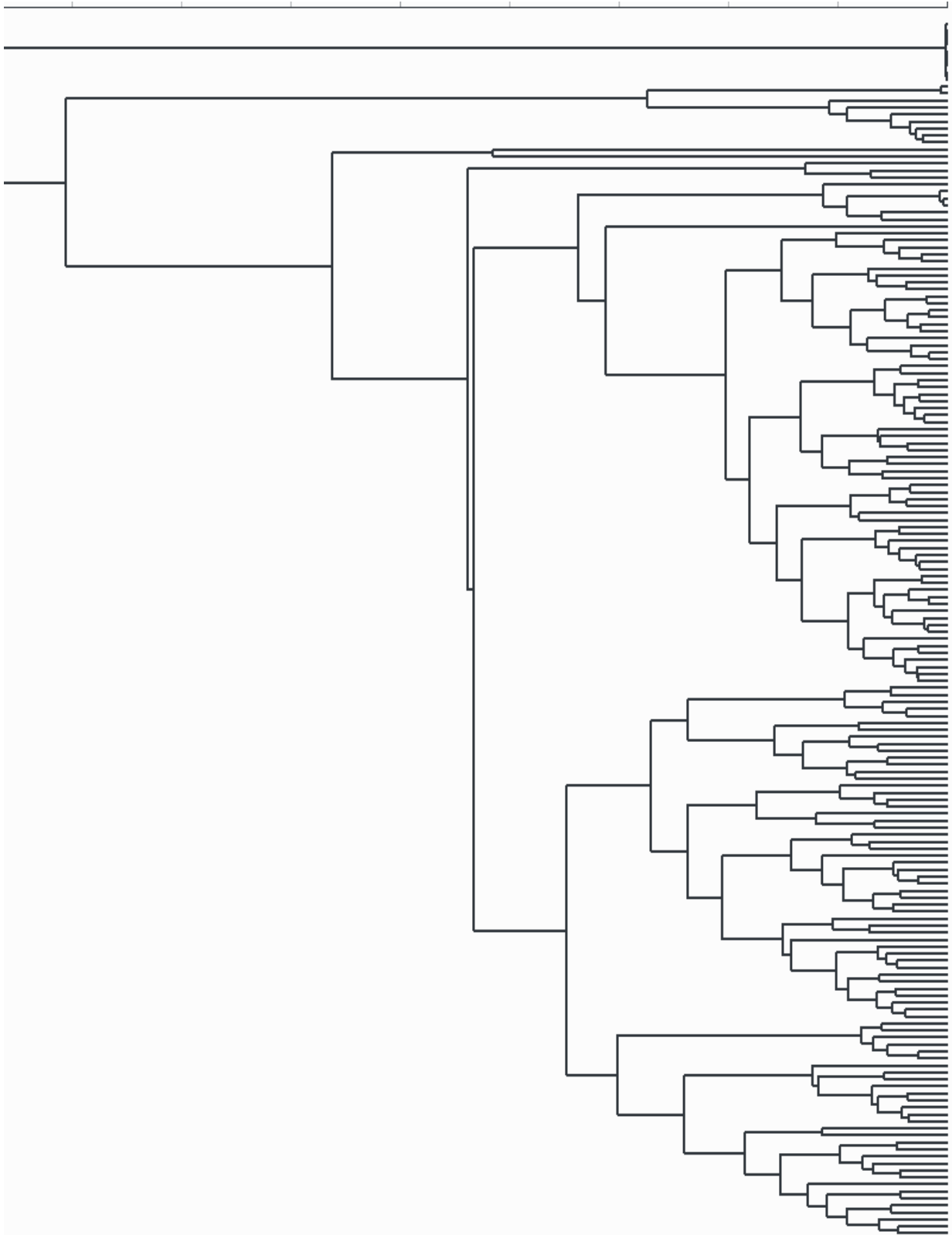


**Fig 7.14 Using Euclidean Distance**

### **Scenario#3:Using Cosine Distance**

The cosine distance, also known as the cosine similarity, is a measure of similarity between two vectors in a multidimensional space. It calculates the cosine of the angle between the two vectors, indicating the degree of alignment between them.





**Fig 7.15 Using Cosine Distance**

# Practical#10

**Objective:** Perform TimeSeries Analysis & Forecasting.

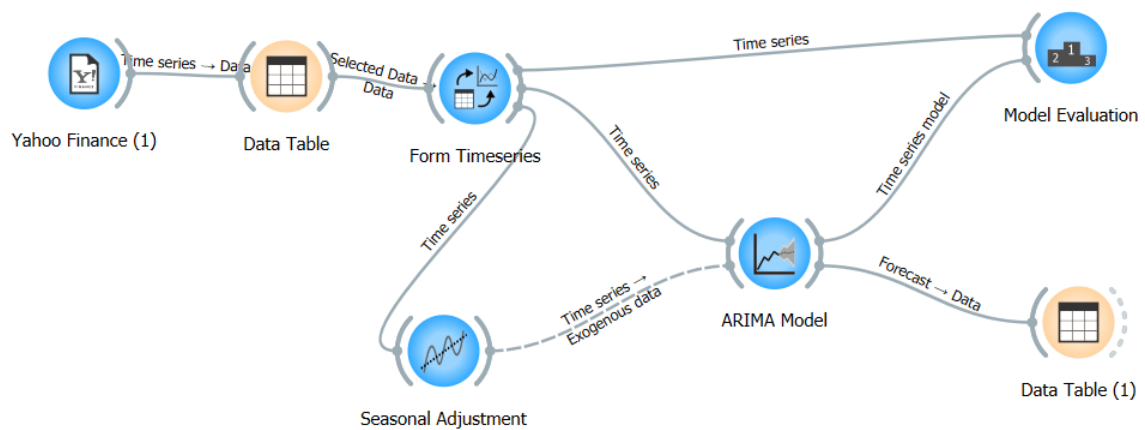
**Question#:** Apply ARIMA model on time series dataset in orange and do timeseries forecasting in weka .

**A. TOOLS USED: ORANGE**

**STEP 1: Import Time Series Dataset.**

	Adj Close	Date	Open	High	Low	Close	Volume
1	93.0845	2019-04-18	93.4395	93.541	92.974	93.0845	54998000
2	94.3655	2019-04-22	92.77	94.421	92.282	94.3655	67476000
3	96.1885	2019-04-23	94.56	96.463	94.479	96.1885	92808000
4	95.0875	2019-04-24	96.25	96.4845	94.908	95.0875	73516000
5	95.1125	2019-04-25	95.85	96.1225	95.0155	95.1125	121982000
6	97.5315	2019-04-26	96.45	97.55	94.9	97.5315	168652000
7	96.9215	2019-04-29	97.45	97.817	96.7045	96.9215	80426000
8	96.326	2019-04-30	96.505	96.7855	95.3475	96.326	70120000
9	95.576	2019-05-01	96.6545	97.182	95.5275	95.576	62340000
10	95.041	2019-05-02	95.6665	96.0775	94.0935	95.041	79258000
11	98.123	2019-05-03	97.45	98.22	96.8	98.123	127632000
12	97.5275	2019-05-06	95.899	97.95	95.525	97.5275	108356000
13	96.05	2019-05-07	96.9995	97.455	95.169	96.05	118042000
14	95.8885	2019-05-08	95.9435	96.7685	95.5	95.8885	81572000
15	94.9935	2019-05-09	95	95.47	93.8	94.9935	106166000
16	94.499	2019-05-10	94.9	95.1895	92.8	94.499	114360000
17	91.134	2019-05-13	91.828	92.327	90.9	91.134	115668000
18	92.006	2019-05-14	91.975	92.622	90.7875	92.006	92582000
19	93.5575	2019-05-15	91.3975	93.7215	91.15	93.5575	93852000
20	95.3785	2019-05-16	94.297	95.8755	94.1145	95.3785	94156000
21	93.45	2019-05-17	94.6525	95.5265	93.3665	93.45	94732000
22	92.9485	2019-05-20	92.6345	93.389	91.777	92.9485	75964000
23	92.876	2019-05-21	93.7395	93.95	92.3	92.876	80102000
24	92.984	2019-05-22	92.589	93.5745	92.55	92.984	58732000
25	90.774	2019-05-23	91.8295	92.2	90.21	90.774	88486000
26	91.164	2019-05-24	91.7945	92.088	90.8925	91.164	67394000
27	91.8215	2019-05-28	91.6375	92.4635	91.3675	91.8215	64000000
28	90.9595	2019-05-29	91.156	91.5	90.3765	90.9595	85580000
29	90.816	2019-05-30	91.2745	91.4735	90.3915	90.816	62938000

**STEP 2: Apply ARIMA model on Time Series Dataset.**



**Fig 10.1: ARIMA Modelling in orange tool**

**OUTPUT#A.1:**

**MOVING AVERAGE : 5**

**MODEL EVALUATION:**

	RMSE	MAE	MAPE	POCID	R <sup>2</sup>	AIC	BIC
ARMA(1,0,5)	3.988	1.963	0.015	54.2	0.785	5942.7	5983.4
ARMA(1,0,5) (in-sample)	3.081	1.491	0.016	51.8	0.990	6237.0	6278.1

**OUTPUT#A.2:**

**MOVING AVERAGE : 10**

**MODEL EVALUATION:**

	RMSE	MAE	MAPE	POCID	R <sup>2</sup>	AIC	BIC
ARMA(1,0,10)	3.975	1.950	0.015	54.2	0.786	5950.2	6016.4
ARMA(1,0,10) (in-sample)	3.079	1.499	0.016	51.8	0.990	6245.0	6311.7

**OUTPUT#A.3:**

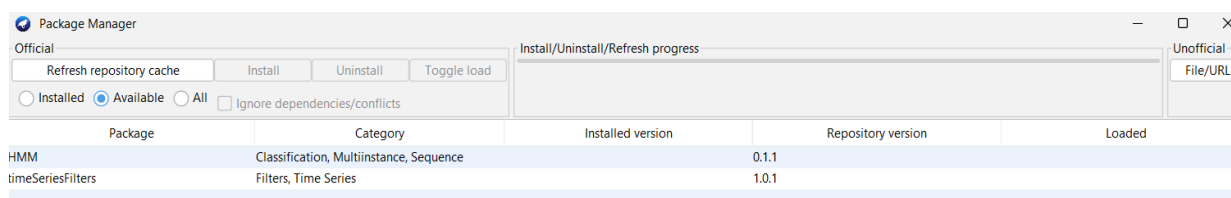
**MOVING AVERAGE : 15**

**MODEL EVALUATION:**

	RMSE	MAE	MAPE	POCID	R <sup>2</sup>	AIC	BIC
ARMA(1,0,15)	4.011	1.841	0.015	57.6	0.783	5954.5	6046.0
ARMA(1,0,15) (in-sample)	3.072	1.518	0.016	51.2	0.990	6248.5	6340.9

## B. TOOL USED: WEKA

### STEP 1: Download TimeSeries Forecasting Package.



### STEP 2: Choose target for prediction and configure the needed features.

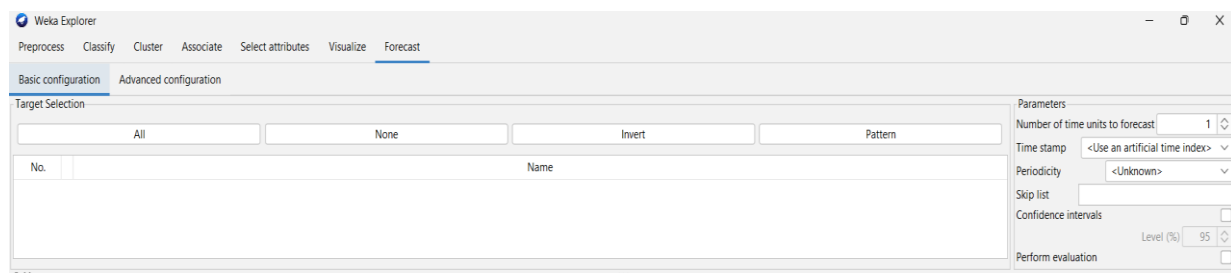


Fig 10.2: Time series forecast features menu

## OUTPUTS#B:

### DATASET:1

#### MODEL EVALUATION:

```

=== Evaluation on training data ===
Target          1-step-ahead  2-steps-ahead  3-steps-ahead
=====
sepal_length
  N              138          137          136
  Mean absolute error      0.4624      0.4669      0.4751
  Root mean squared error   0.5802      0.5932      0.6262

Total number of instances: 150

```

### DATASET:2

#### MODEL EVALUATION:

```

=== Evaluation on training data ===
Target                1-step-ahead  2-steps-ahead  3-steps-ahead
=====
sepal_width
N                    138            137            136
Mean absolute error   0.2726            0.2734            0.2734
Root mean squared error 0.3593            0.368            0.3695

Total number of instances: 150

```

### DATASET:3

#### MODEL EVALUATION:

```

=== Evaluation on training data ===
Target                1-step-ahead  2-steps-ahead  3-steps-ahead
=====
petal_length
N                    138            137            136
Mean absolute error   0.4343            0.4734            0.5068
Root mean squared error 0.6207            0.6866            0.7506

Total number of instances: 150

```

### DATASET:4

#### MODEL EVALUATION:

```

=== Evaluation on training data ===
Target                1-step-ahead  2-steps-ahead  3-steps-ahead
=====
petal_width
N                    138            137            136
Mean absolute error   0.198            0.2112            0.2271
Root mean squared error 0.2777            0.3              0.3204

Total number of instances: 150

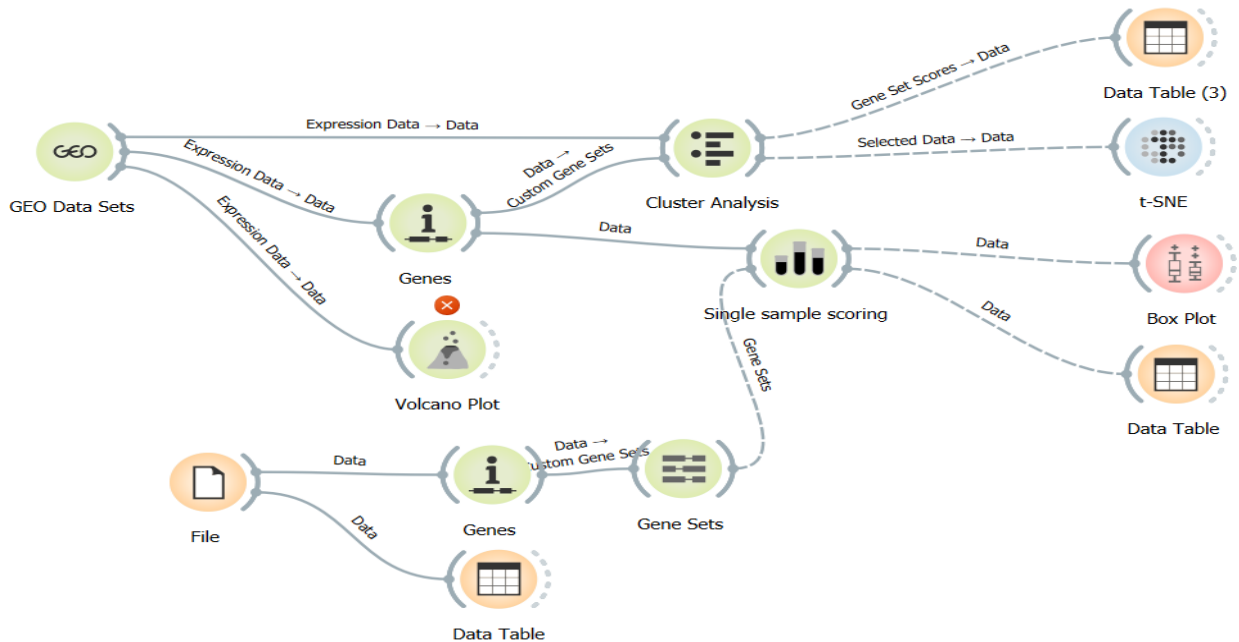
```

**Result:** Successfully performed ARIMA Model Analysis and time-series forecasting on Time Series data.

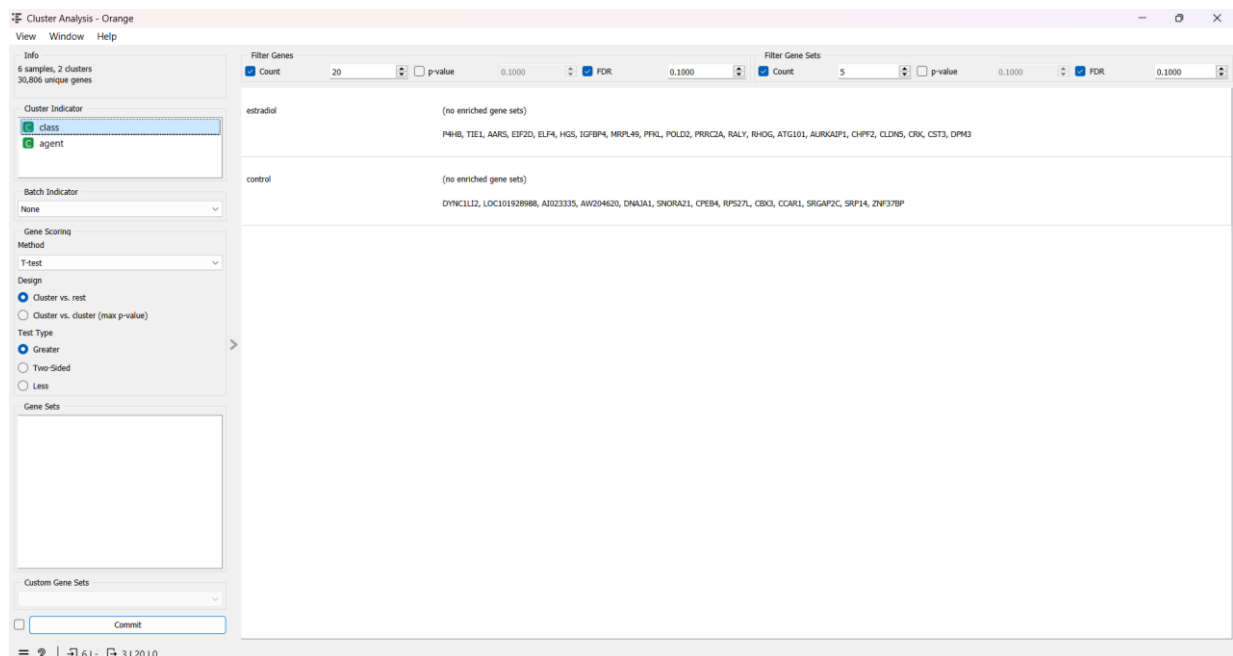
# Practical#11

**Objective:** Perform Genetic Algorithm Based Analysis.

**Question#:** Apply Bio informatics on genetic dataset in orange and apply cluster analysis and make volcano plot on 3 geo datasets with orange documentation brown dataset.



**Fig 11.1: Genetic Algorithm based analysis in orange tool**



**Fig 11.2: Cluster Analysis Menu**

**OUTPUT#:**

**GEO DATASET : 01**

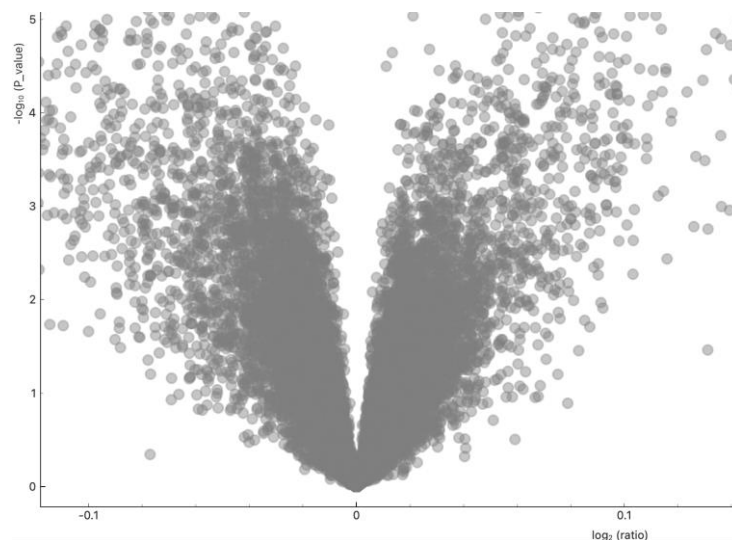
**Data Table (After Cluster Analysis):**

	class	protocol	Term	Term ID	Rank	P-value	FDR
1	Csnk1a1 knockdown	control	1	translation at synapse	GO:0140241	1	1.65648e-06
2	Csnk1a1 knockdown	control	1	translation at presynapse	GO:0140236	1	1.65648e-06
3	Csnk1a1 knockdown	control	1	translation at postsynapse	GO:0140242	1	1.65648e-06
4	Csnk1a1 knockdown	control	1	cytosolic large ribosomal subunit	GO:0022625	4	2.30926e-06
5	Csnk1a1 knockdown	control	1	positive regulation of xenophagy	GO:1904417	5	1.56647e-05

**t-SNE:**



**Volcano Plot:**

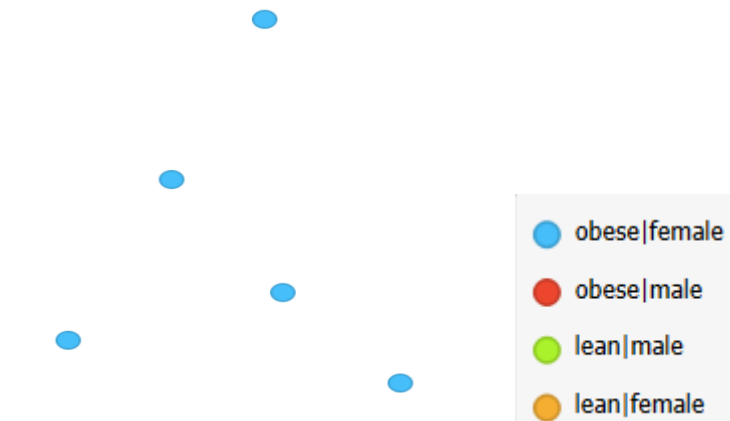


## GEO DATASET : 02

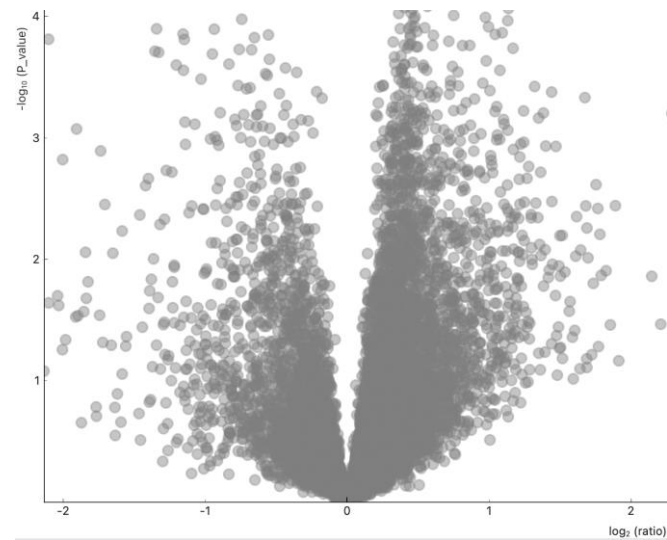
**Data Table (After Cluster Analysis):**

	class	disease state	gender	Term	Term ID	Rank	P-value	FDR
1	lean female	obese	male	1	pyruvate de...	GO:0004738	2	1.87481e-07
2	lean female	obese	male	1	pyruvate de...	GO:0034603	2	1.87481e-07
3	lean female	obese	male	1	pyruvate de...	GO:0034604	2	1.87481e-07
4	lean female	obese	male	1	mitochondri...	GO:0061732	1	9.38737e-08
5	lean female	obese	male	1	oxidoreduct...	GO:0016620	5	4.08097e-07

**t-SNE:**



**Volcano Plot:**



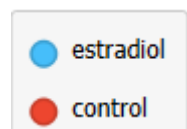
## GEO DATASET : 03

**Data Table (After Cluster Analysis):**

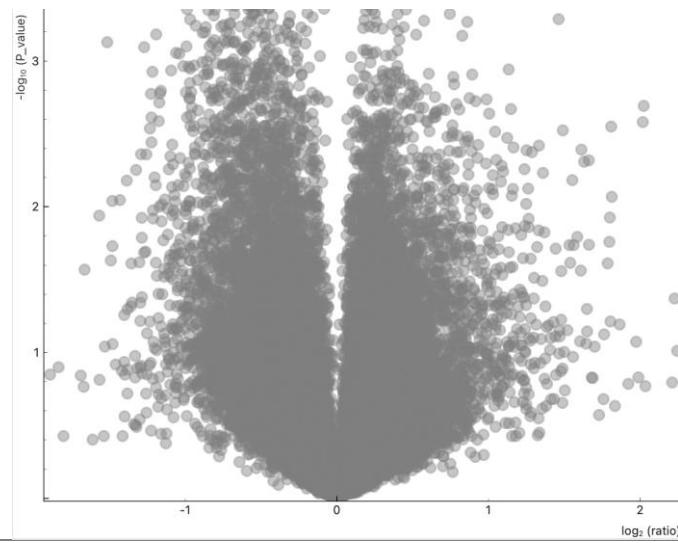
	class	agent	Term	Term ID	Rank	P-value	FDR
1	estradiol	estradiol	0	organic subs...	GO:0071704	1	1.56234e-06
2	estradiol	estradiol	0	metabolic pr...	GO:0008152	2	3.47743e-06
3	estradiol	estradiol	0	primary met...	GO:0044238	3	6.98155e-06
4	estradiol	estradiol	0	macromolec...	GO:0043170	4	1.27382e-05
5	estradiol	estradiol	0	nitrogen co...	GO:0006807	5	2.6423e-05

**t-SNE:**





**Volcano Plot:**



**Result:** Successfully performed Genetic Algorithm Based Analysis.