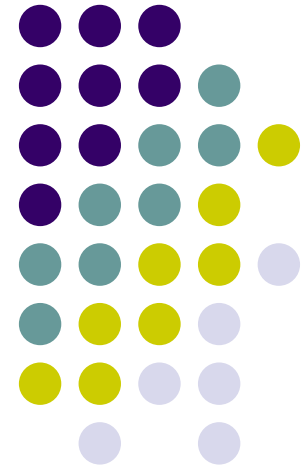
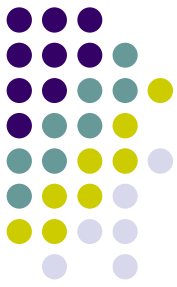


# Towards a Logical Multidimensional Model for Spatial Data Warehousing and OLAP

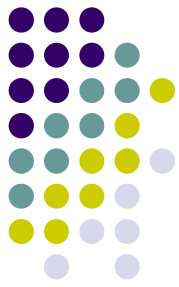
Marcus Sampaio, André Sousa, Cláudio Baptista  
University of Campina Grande  
Brazil





# Outline

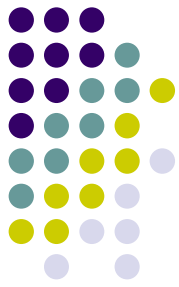
- Introduction
- The Multi-Dimensional Model
- Mapwarehouse prototype
- Case study
- Optimization techniques
- Conclusion



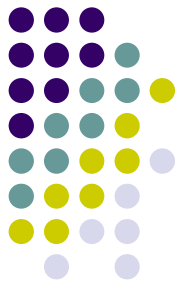
# Introduction

- Spatial data exist in more than 80% of enterprise data:
  - Client address, supplier address, sales by region, etc
- Traditional Decision-support systems use location as a text information.
- Spatial databases enable searching space through spatial operators
- Thus:
  - GIS + DW = advanced information system, with enhancements in:
    - Quantity
    - Quality

# Introduction



- Two types of architectures:
  - Federated
    - GIS + DW
  - Integrated
    - Spatial DW

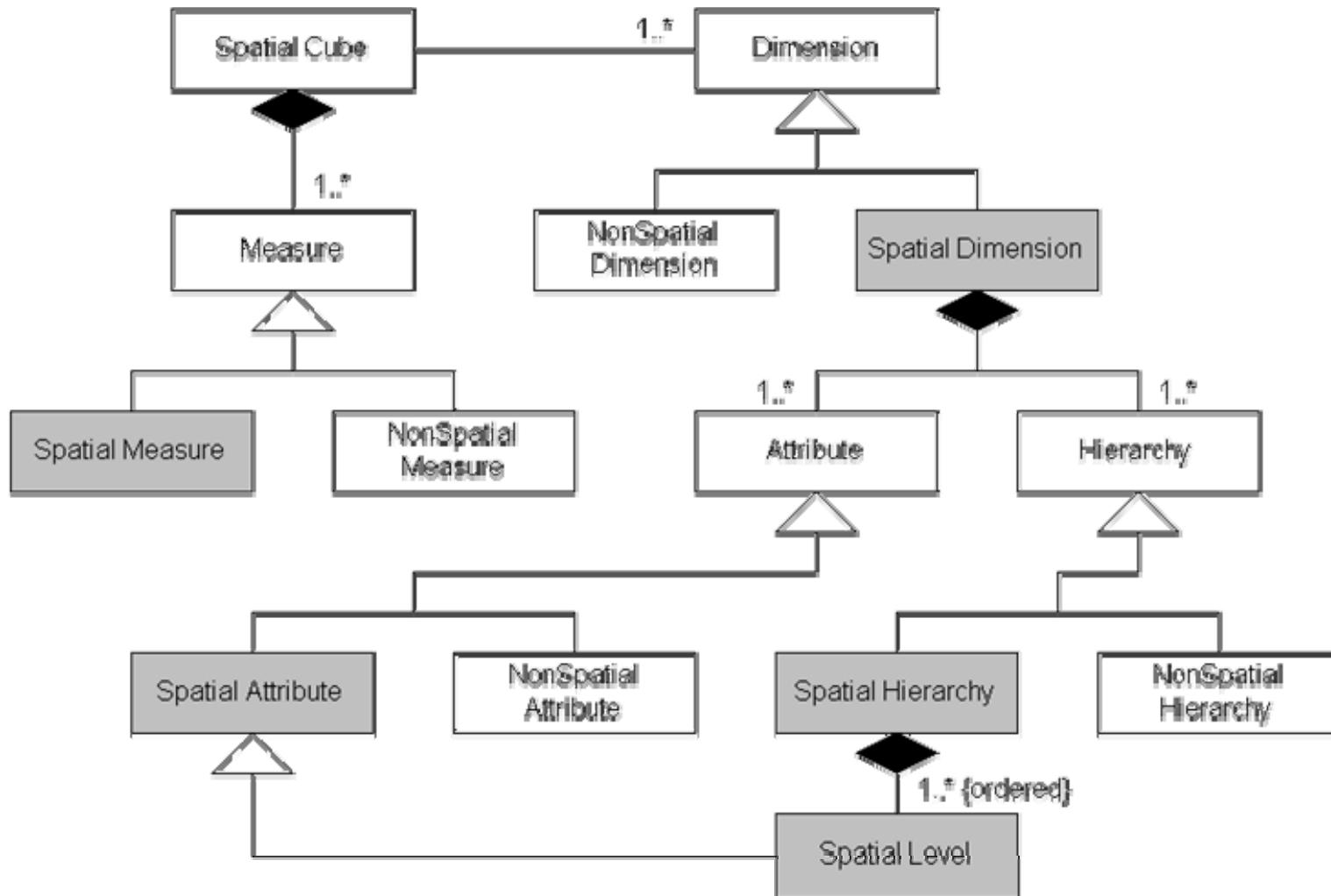


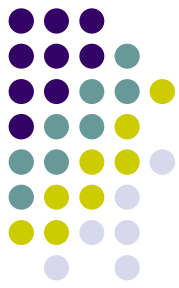
# Multidimensional Model

- We propose a logical multidimensional model
- Extension of the classical star-schema:
  - (1) object-relational concepts and structures; and
  - (2) spatial components.

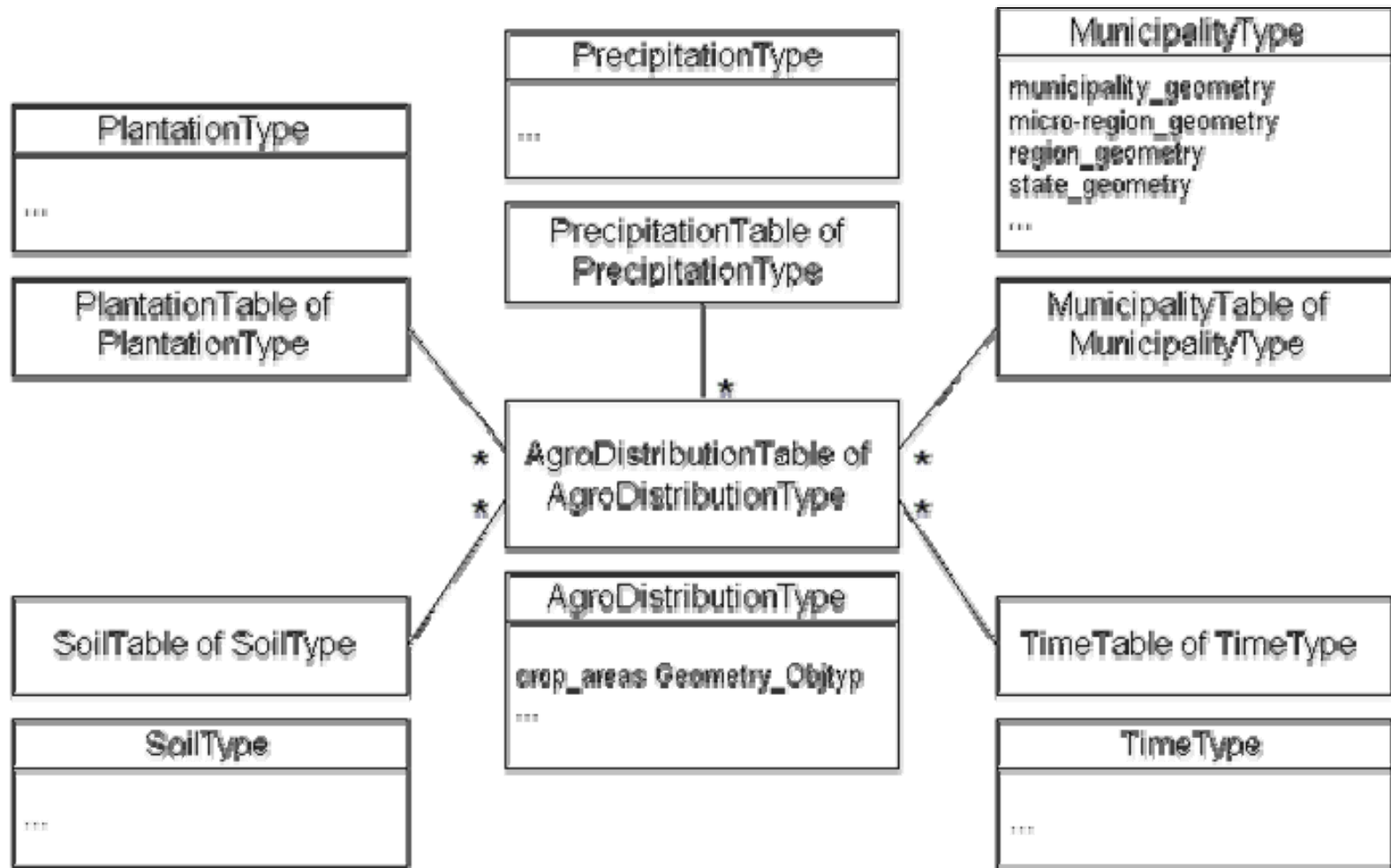


# Multidimensional Model





# Agro-distribution Star-schema



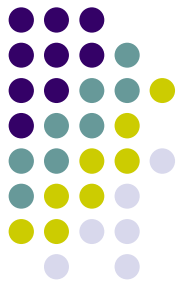
# Spatial OLAP operators

- Spatial roll-up
- Spatial drill-down





# Case study – agricultural crops



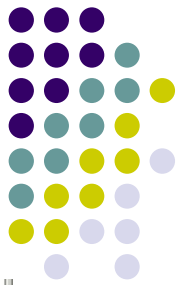
- To achieve an efficient seed distribution policy to Brazilian farmers, several issues are relevant:
  - soil and plantation types,
  - precipitation and
  - location.
- Hence, a SDW may help authorities in finding the best policy for a particular situation, according to different aggregation criteria, based on:
  - dynamic maps,
  - tables,
  - graphics,
  - reports and so on.

# Question



- *Retrieve the corn crop areas inside a given rectangular window, for each micro-region (region) and for each region (micro-region) of the state of Paraíba, during May 2003.*

# Creating the Query



The screenshot shows a web browser window with the address bar displaying `http://localhost:8080/igisDw/queriesDw/createQuery.jsp`. The browser's menu bar includes "Arquivo", "Editar", "Exibir", "Favoritos", "Ferramentas", and "Ajuda". The toolbar contains various navigation and utility icons. Below the address bar, there are buttons for "ShowSQL", "Execute Query", "Reset Query", "Rollup", and "Group by".

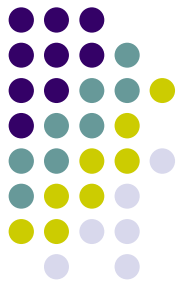
The main content area displays a data model diagram with four tables:

- Plantation (Dimension)**:
  - Type
  - Name**
- AgroDistribution (Fact Table)**:
  - Quantity**
  - CropArea**
- Location (Spatial Dimension)**:
  - MunicipalityName
  - MicroregionName
  - RegionName
  - StateName
  - MunicipalityGeom**
  - MicroregionGeom**
  - RegionGeom
  - StateGeom
- Time (Dimension)**:
  - DayName
  - Day
  - MonthName
  - Month
  - TrimesterName
  - Trimester
  - SemesterName
  - Semester
  - Year

Dotted lines indicate relationships: Plantation is connected to AgroDistribution, AgroDistribution is connected to Location, and AgroDistribution is connected to Time.

The browser's status bar at the bottom shows "Concluído" on the left and "Intranet local" on the right.

# Time constraints



Dimension Time - Microsoft Internet Explorer

*Dimension Time*

Ok

Constraints

Field: Year

Operator: =

Value: 2003

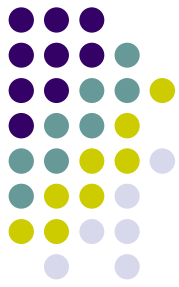
Add Constraint And Or Not ( ) Reset

time.month = 5 AND time.year = 2003

Ok

Concluído Intranet local

# Spatial Constraints



Dimension Location - Microsoft Internet Explorer

***Dimension Location***

Ok

Constraints

Field: StateName

Operator: =

Value: Paraíba

Add Constraint And Or Not ( ) Reset

location.StateName = 'Paraíba'

Create Spatial window on map

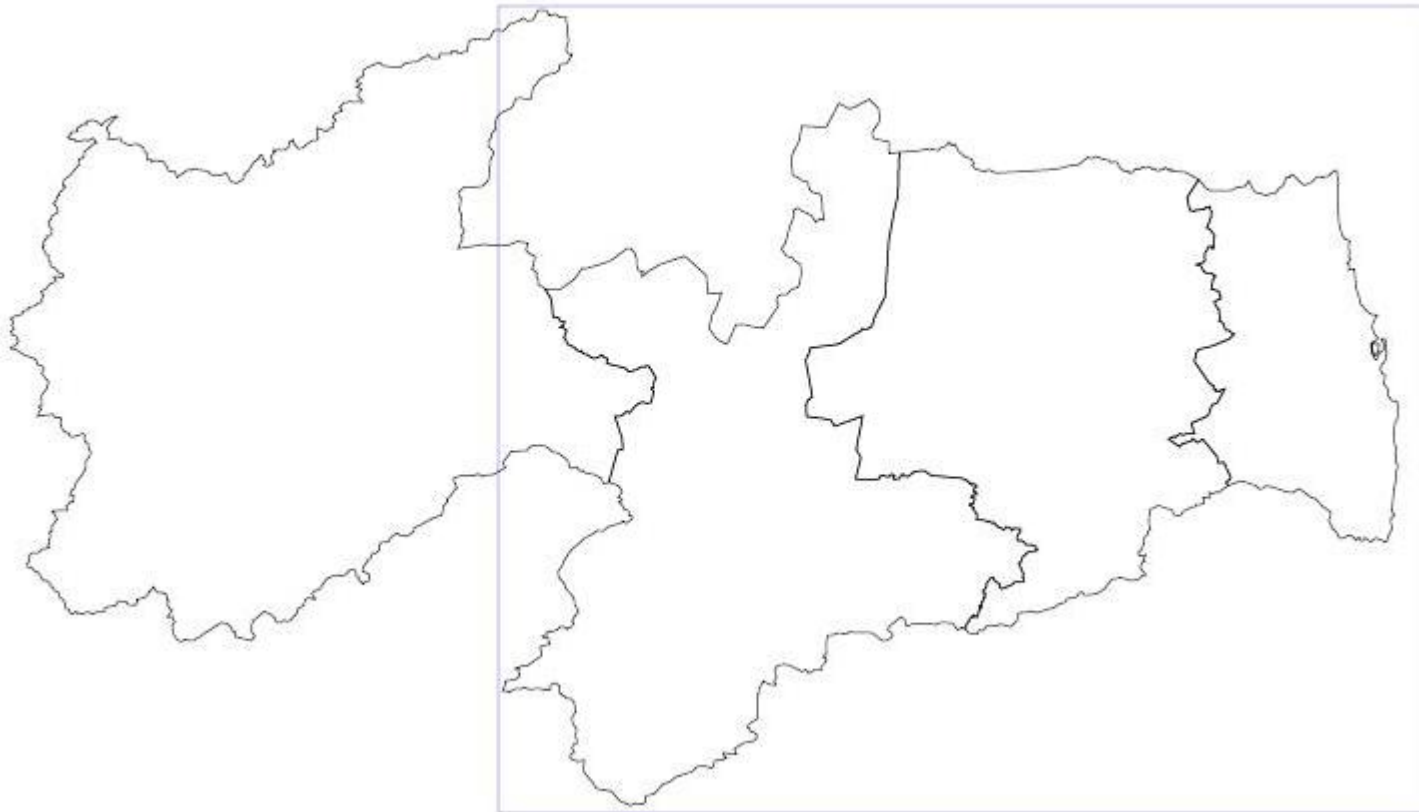
Spatial window defined

Concluído Intranet local

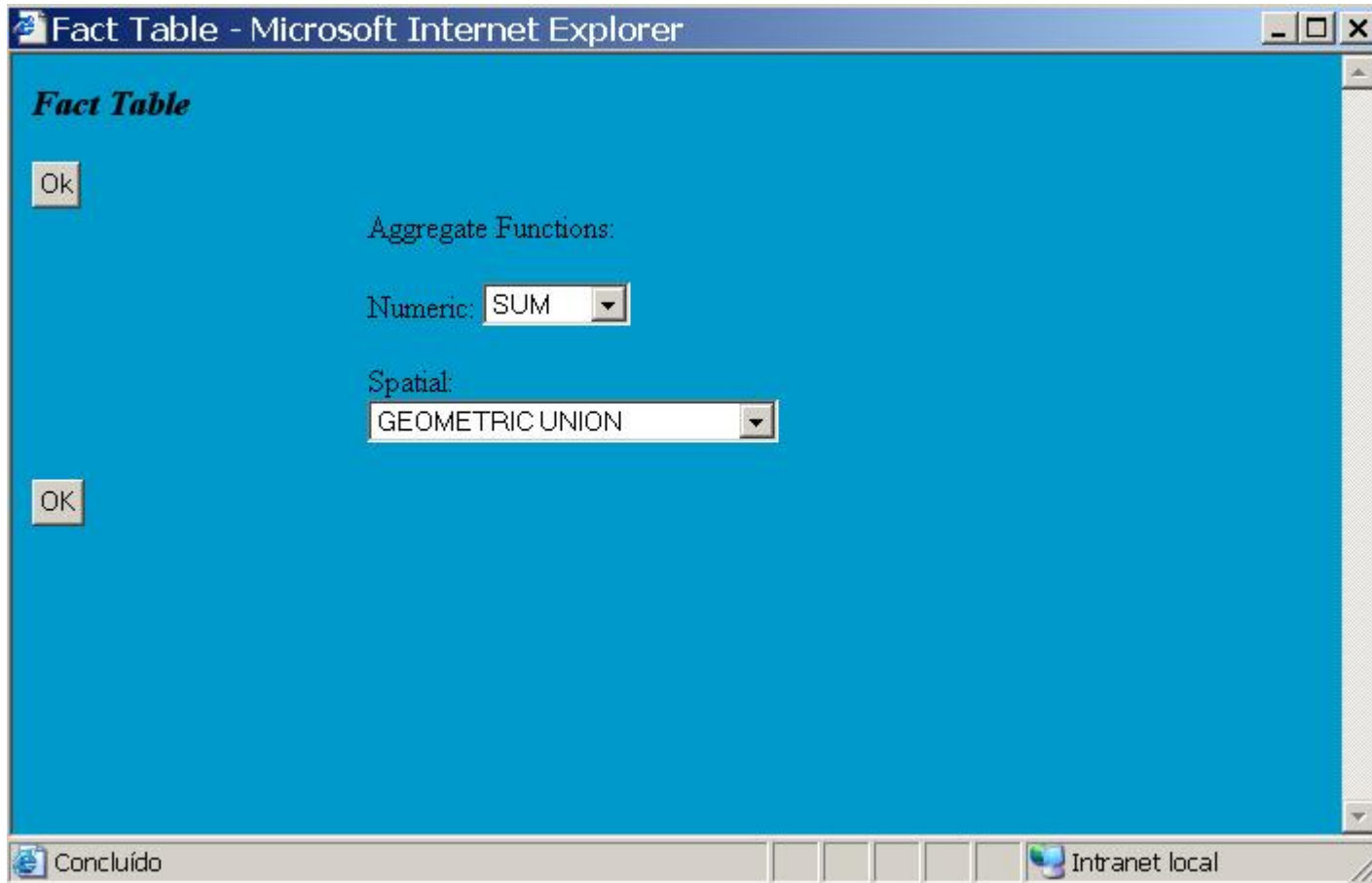
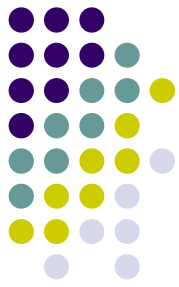
# Spatial Constraints : spatial window



Region  OK Redefine



# Aggregate Functions



# Rollup



Fact Table - Microsoft Internet Explorer

***Rollup***

Ok

Select a dimension.

Location

Roll-up/Drill-Down

Initial Level:

Microregion

Final Level:

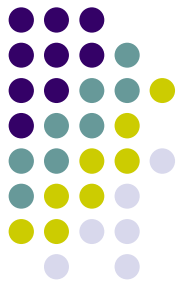
Region

OK

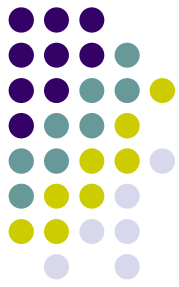
Concluido Intranet local



# MapWarehouse Query



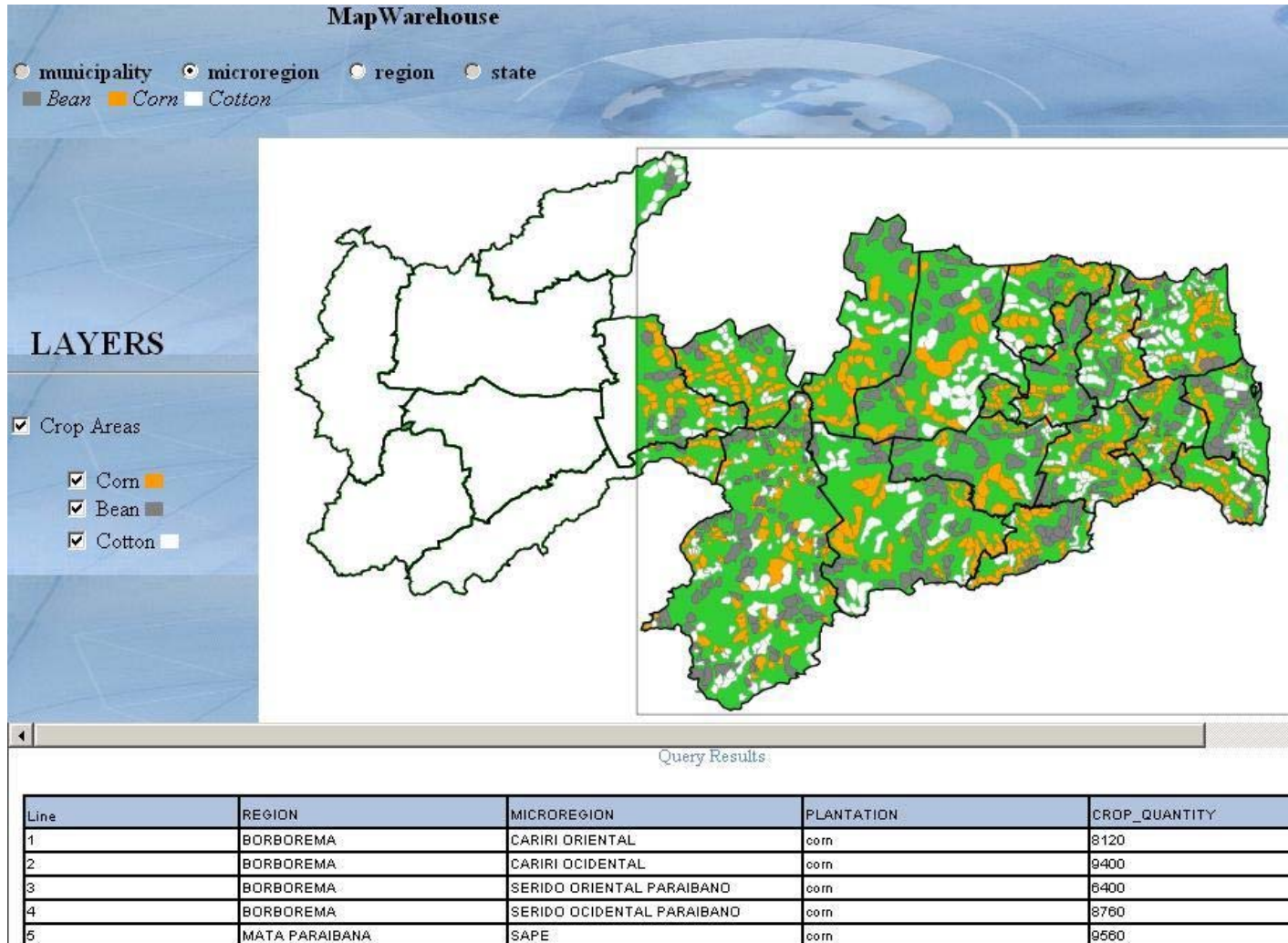
```
(SELECT a.municipality_ref.microregion_geometry,  
SDO_AGGR_UNION(MDSYS.SDOAGGRTYPE (a.crop_areas,  
0.005))  
FROM AgroDistribution_Objtab a  
WHERE a.plantation_ref.name = 'corn' And a.time_ref.month = 5  
And a.time_ref.year = 2003 And a.municipality_ref.state_name =  
'Paraíba' And SDO_INSIDE (a.crop_areas, SDO_GEOMETRY  
(2003, 8307, NULL, SDO_ELEM_INFO_ARRAY  
(1,1003,3), SDO_ORDINATE_ARRAY (-37.1,  
-6.0, -34.0, -9.0))) = 'TRUE'  
GROUP BY a.municipality_ref.micro-region_geometry)  
UNION ...
```



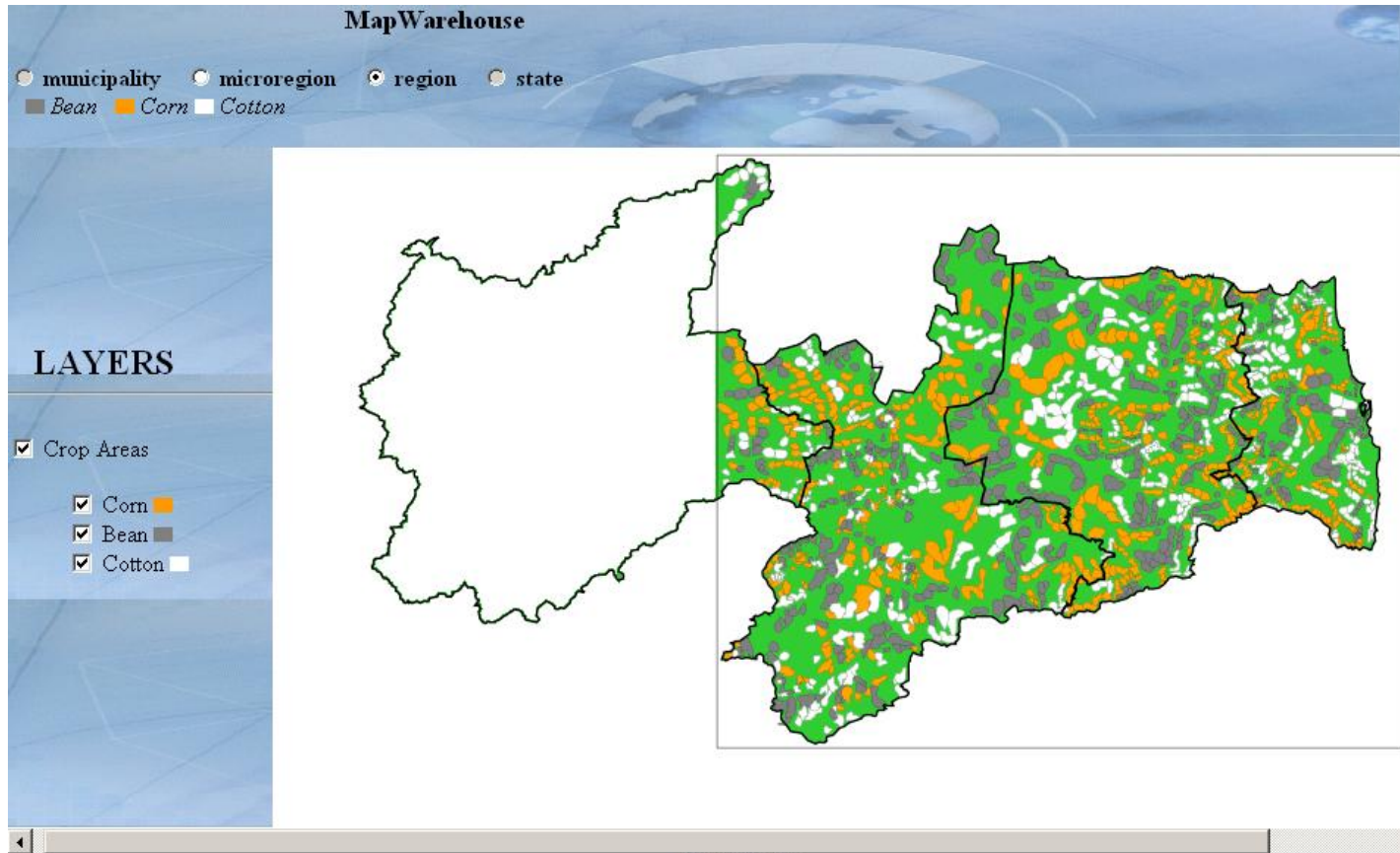
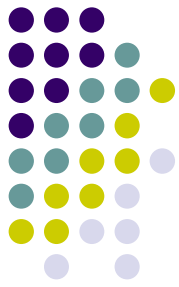
# MapWarehouse Query

```
(SELECT a.municipality_ref.region_geometry,  
SDO_AGGR_UNION(MDSYS.SDOAGGRTYPE  
  (a.crop_areas, 0.005))  
FROM AgroDistribution_Objtab a  
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  'Paraíba' And SDO_INSIDE (a.crop_areas, SDO_GEOMETRY  
    (2003, 8307, NULL, SDO_ELEM_INFO_ARRAY  
    (1,1003,3), SDO_ORDINATE_ARRAY (-37.1,  
    -6.0, -34.0, -9.0))) = 'TRUE'  
GROUP BY a.municipality_ref.region_geometry)
```

# Rollup Operation: Micro-region

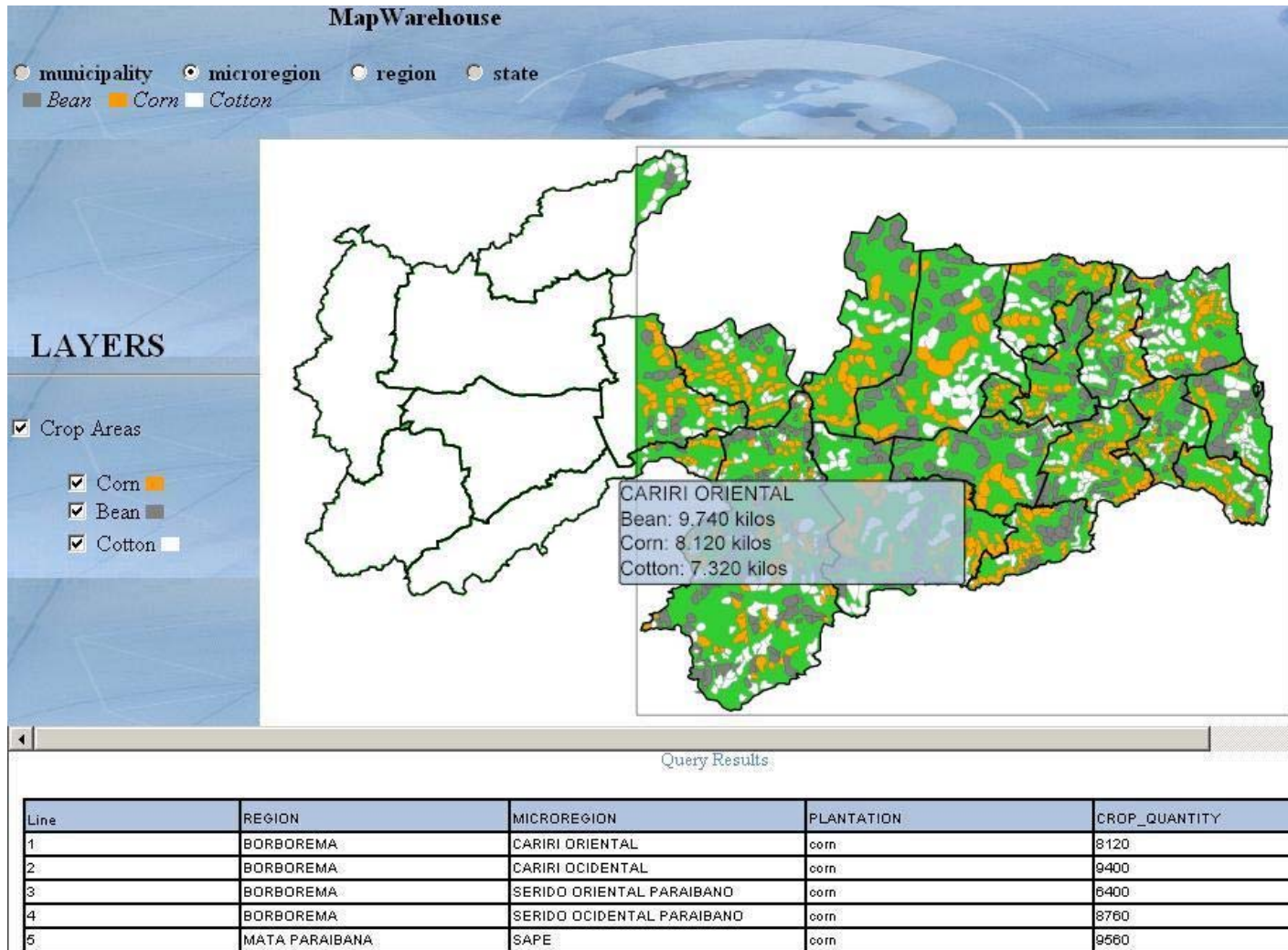
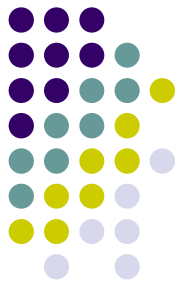


# Rollup Operation: Region



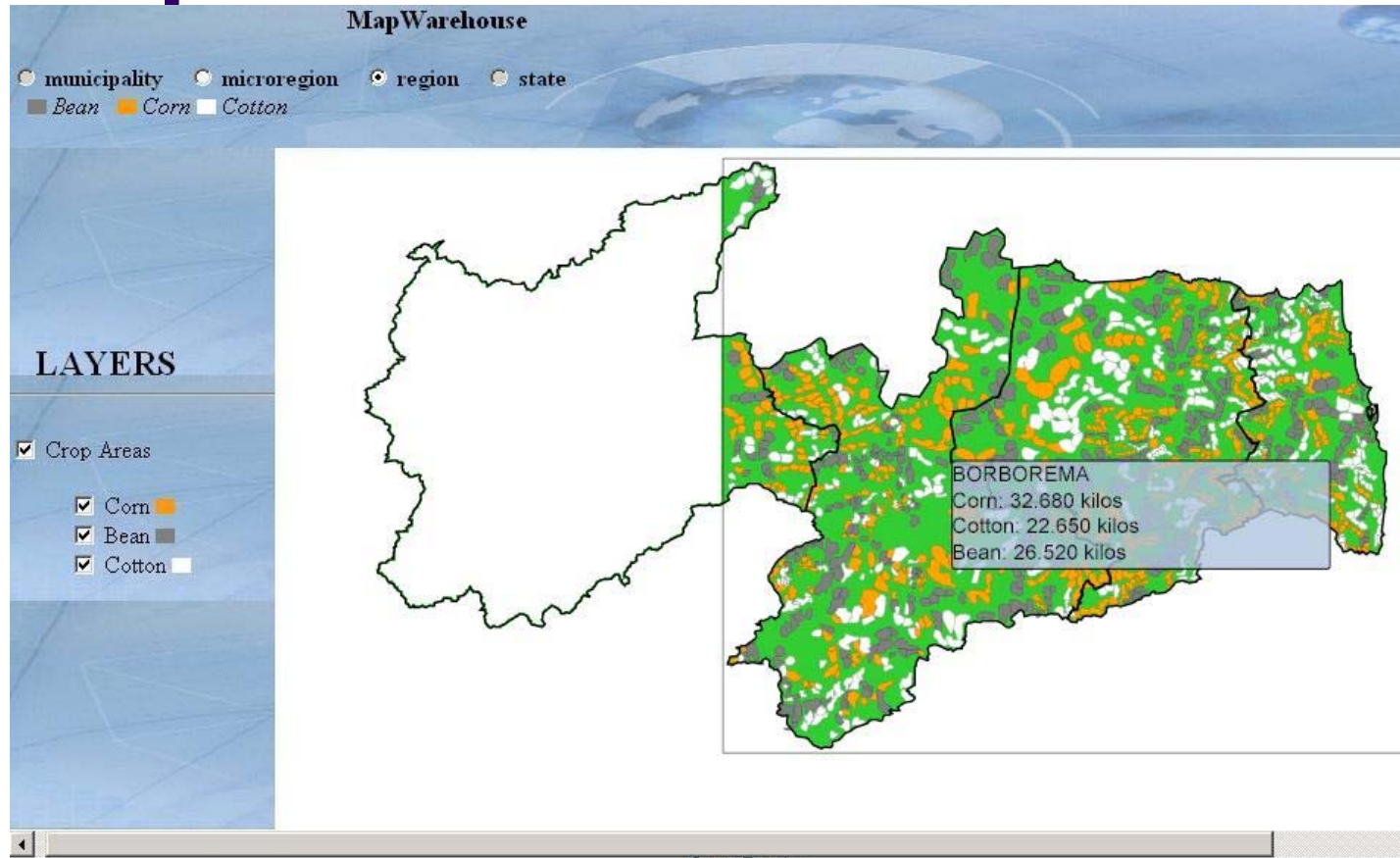
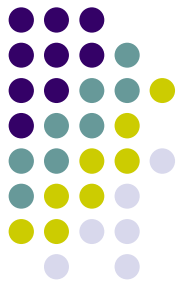
Line	REGION	MICROREGION	PLANTATION	CROP_QUANTITY
1	BORBOREMA	ALL	corn	32680
2	MATA PARAIBANA	ALL	corn	28710
3	SERTAO PARAIBANO	ALL	corn	5020
4	AGRESTE PARAIBANO	ALL	corn	49223
5	BORBOREMA	ALL	bean	26520

# Infotip

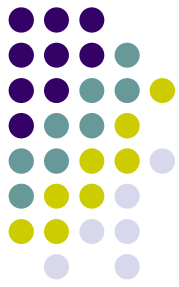




# Infotip

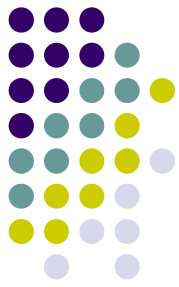


Line	REGION	MICROREGION	PLANTATION	CROP_QUANTITY
1	BORBOREMA	ALL	corn	32680
2	MATA PARAIBANA	ALL	corn	28710
3	SERTAO PARAIBANO	ALL	corn	5020
4	AGRESTE PARAIBANO	ALL	corn	40223
5	BORBOREMA	ALL	bean	26520



# Conclusion

- The incorporation of spatial dimension and measure enables to locate more efficiently tendencies in a given application domain by using dynamic maps with zooming, panning, aggregation and other GIS functionalities.

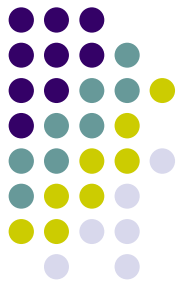


# Conclusion – Further Work

- Spatial Data Warehousing is still in its infancy and more research on this topic is due
- We need
  - to enhance usability and
  - to include other OLAP and spatial query capabilities.



# Acknowledgements



- Many Thanks!
- Questions?