UNIVERSITY OF TARTU
INSTITUTE OF COMPUTER SCIENCE

MTAT.03.183 Data Mining

OLAP

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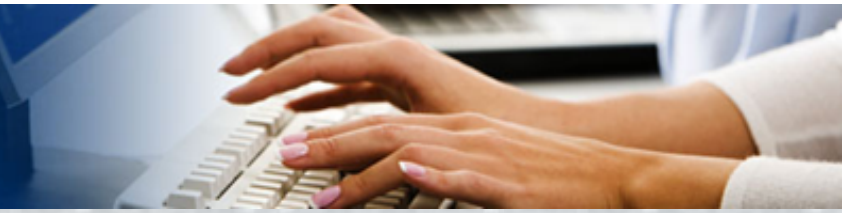
https://courses.cs.ut.ee/2017/dm/



Siim Karus

- PhD in Computer Science
- Microsoft Student Partner 2007-2009 (MSP)
  - http://www.microsoft.com/eesti/msp/
- Author of Estonian freeware portal **VabaVaraVeeb**
  - http://vabavara.eu
- More than 10 years of industry experience as programmer, information systems' auditor, architect and business intelligence developer.

Microsoft CERTIFIED Trainer

Microsoft CERTIFIED IT Professional
Database Administrator 2008
Business Intelligence Developer 2008

Microsoft CERTIFIED Technology Specialist
SQL Server 2008, Business Intelligence Development and Maintenance
Biztalk® Server 2006
Custom Applications

Seminar on Business Intelligence

- Introduce the practices and methods used for extracting and presenting relevant information for decision-making out of databases.
- Give background on data integration (including warehousing), data analysis in databases and data presentation.

Business Intelligence

"The ability to apprehend the interrelationships of presented facts in such a way as to guide action towards a desired goal."

– Hans Peter Luhn (1958, IBM)

Business Intelligence

"A broad category of applications and technologies for gathering, storing, analyzing, sharing and providing access to data to help enterprise users make better business decisions."
– Gartner

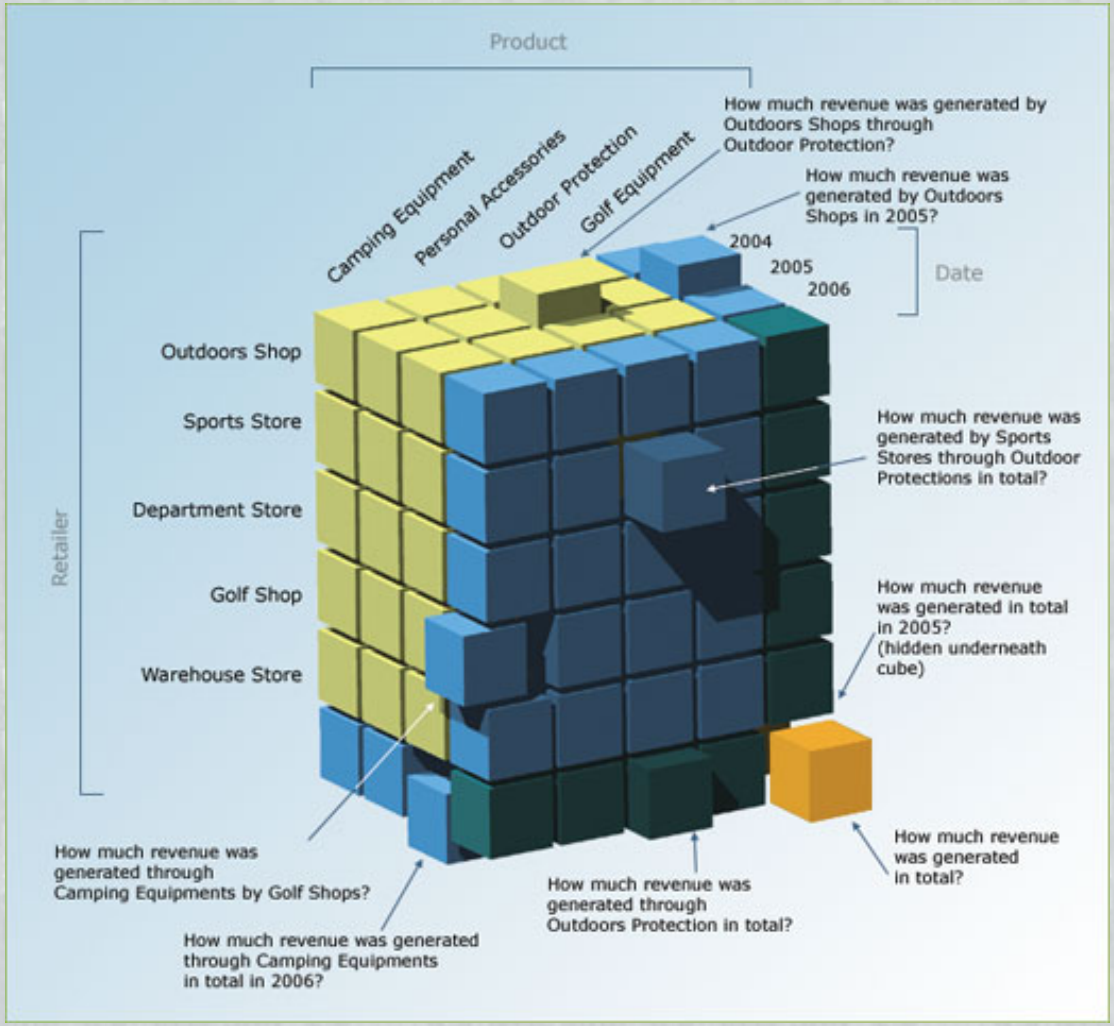
Visual Mining (cubes, dimensions, partitions)
Data Mining (choice of algorithms)
Visual Machine Learning (learning from user interactions with results)
Social BI
Interpretation

DATA ANALYSIS

OLAP

- On-line analytical processing
  - Optimised for information queries (SELECT)
  - Based on data warehouse principles (multiple data sources)
  - Fact-dimension logical view
    - ROLAP – relational-OLAP – multi-dimensional queries are translated into relational queries from relational database
    - MOLAP – multidimensional-OLAP – the data is stored in multi-dimensional storage
    - HOLAP – hybrid-OLAP

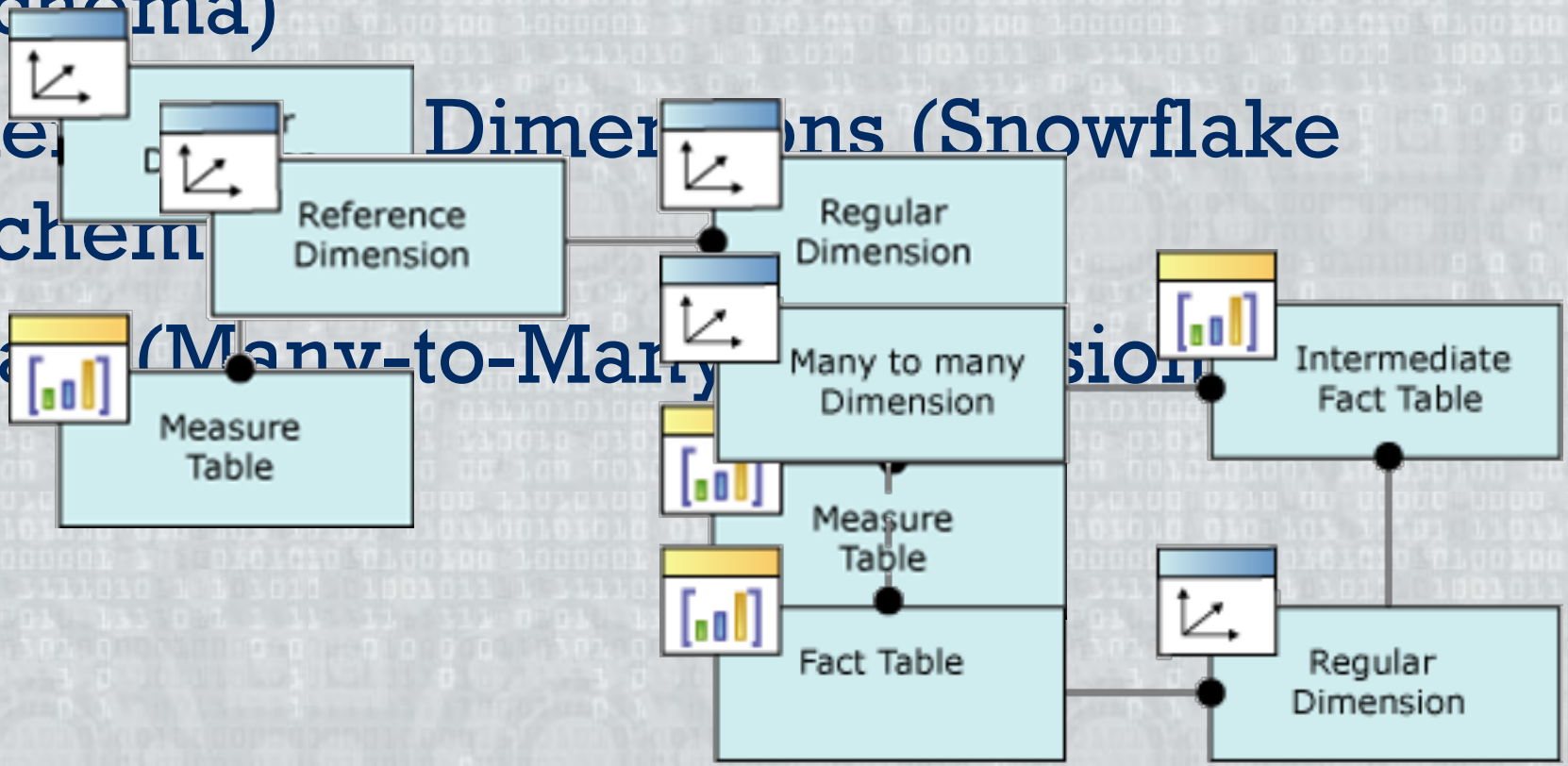
Data Cubes



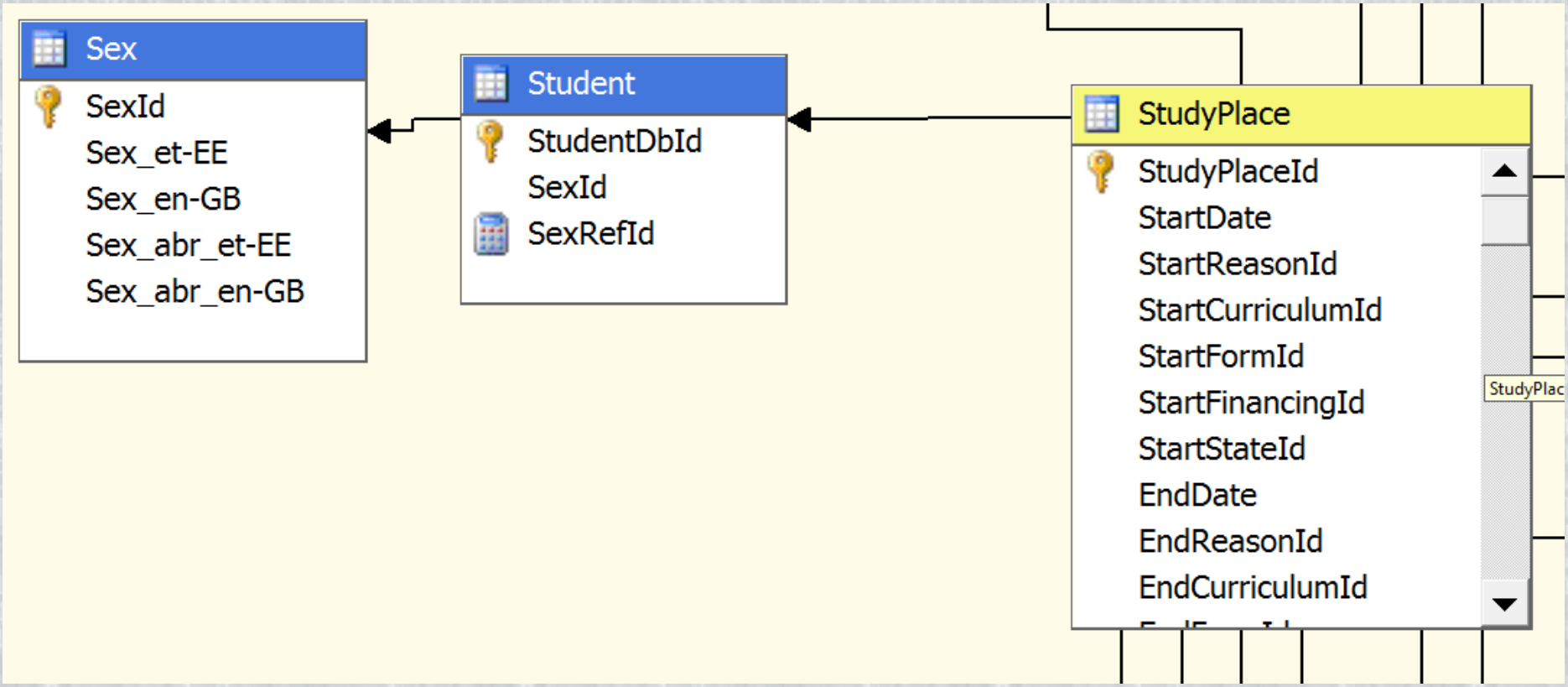
http://www.elml.uzh.ch/preview/fois/DSSII/en/html/lu2_learningObject3.html

Dimension design

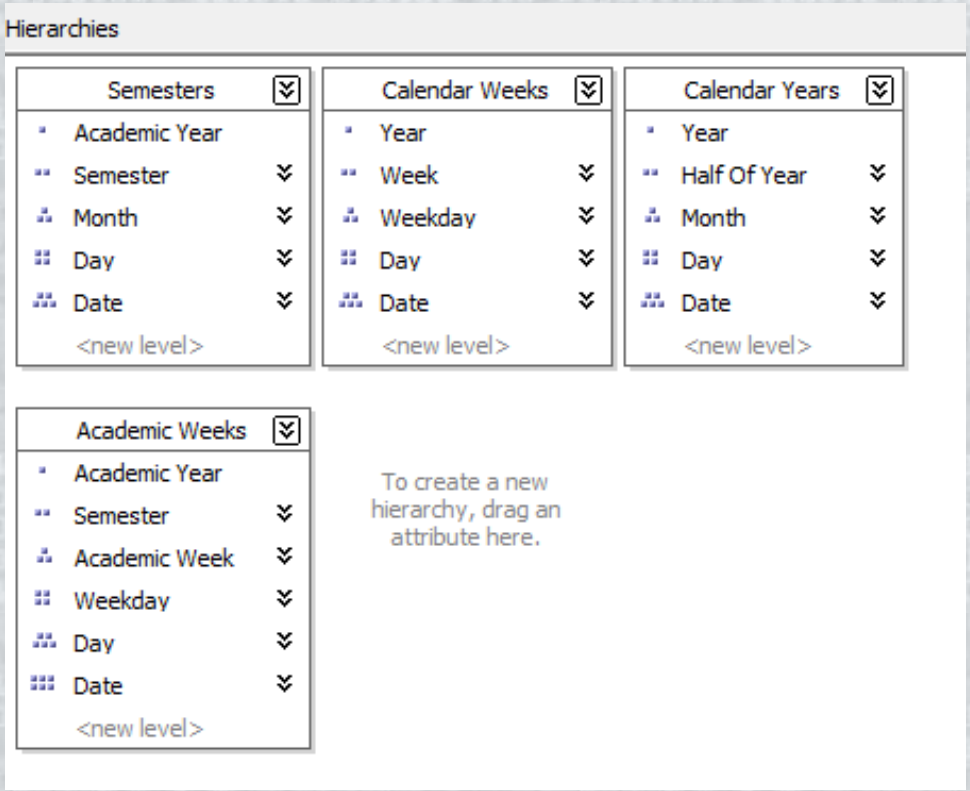
- Regular (Simple) Dimensions (Star schema)
- Re Dimen ns (Snowflake schem
- Fa (Many-to-Many sion



Example


Sex
SexId
Sex_et-EE
Sex_en-GB
Sex_abr_et-EE
Sex_abr_en-GB
Student
StudentDbId
SexId
SexRefId
StudyPlace
StudyPlaceId
StartDate
StartReasonId
StartCurriculumId
StartFormId
StartFinancingId
StartStateId
EndDate
EndReasonId
EndCurriculumId

Dimension hierarchies



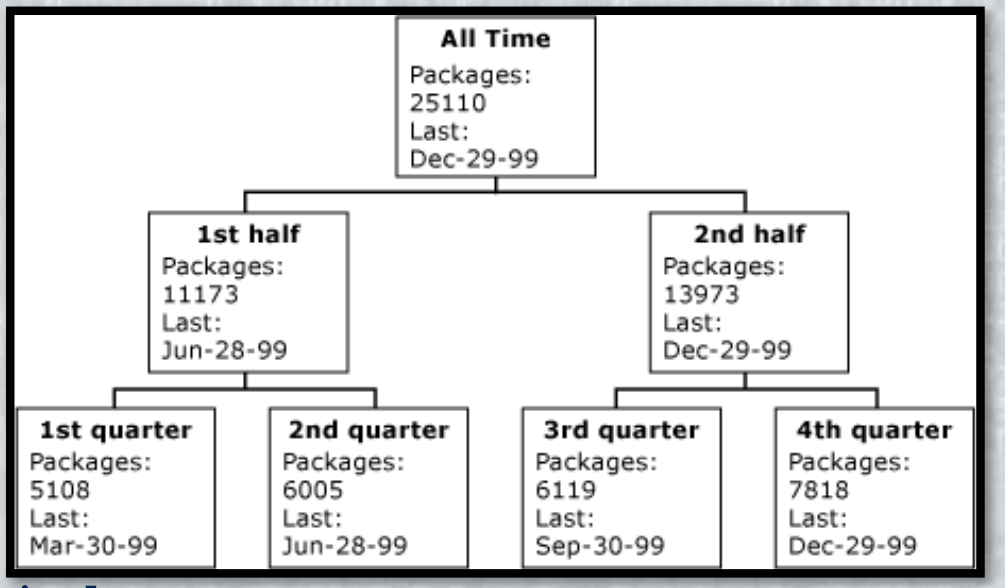
Dimension Granuality

Dimension changes

- Recomputed dimension -> recompute cube
- Dimension changes
  - Speed of change (slow, fast)
  - Type of change (appending, insertion, modification)
  - Reforms (e.g. Organisational structure changes)

Measures

- Simple aggregations
  - Min
  - Max
  - Average
  - Sum
  - Count
- Complex aggregations
  - Difference with previous period
  - Conditional sum or count



- Calculation types
  - Precomputed vs computed during runtime
  - Over visible nodes vs over all nodes

Partitions

- Split cube by dimension values
- Partitioning:
  - Different data sources
  - Different storage policies (e.g. Operative non-cached data ROLAP partition and historic cached data MOLAP partition)
  - Read-only vs. Read-write partitions

Perspectives

- Subsets of cubes (not necessarily subcubes)
- Purpose:
  - show cube data relevant to different stakeholders

KPIs

- Key Performance Indicators
  - Value
  - Target
  - Trend (indicator)
  - Status (indicator)

Operations

- Dimenstion-based
  - Roll-up (Drill-up)
  - Drill-down
- Interaction-based
  - Drill-through
- Dimensionality
  - Slice (2D) and Dice (3D)
  - Pivot (rotate)

MDX

- MDX – Multi-Dimensional eXpressions (to SQL)
- DMX – Data-Mining eXpressions (to SQL)
- DAX – Data Access eXpressions (from Excel, Power BI, self-service BI platforms)

MDX

- WITH
  <member definitions>
  SELECT
  <fact definition>,
  <dimendion definitions>
  FROM
  <cube selector>
  WHERE
  <filter expression>

MDX example

```
SELECT
 { [Measures].[Sales Amount], [Measures].[Tax Amount] } ON COLUMNS,
 { [Date].[Fiscal].[Fiscal Year].&[2002], [Date].[Fiscal].[Fiscal Year].&[2003] } ON
ROWS
FROM
 [Adventure Works]
WHERE (
 [Sales Territory].[Southwest] )
```

MDX example

```
WITH
  MEMBER [Measures].[ParameterCaption] AS [Start Form Ref].[Study Form
Id].CURRENTMEMBER.MEMBER_CAPTION
  MEMBER [Measures].[ParameterValue] AS [Start Form Ref].[Study Form
Id].CURRENTMEMBER.UNIQUENAME
  MEMBER [Measures].[ParameterLevel] AS [Start Form Ref].[Study Form
Id].CURRENTMEMBER.LEVEL.ORDINAL
SELECT
  {[Measures].[ParameterCaption], [Measures].[ParameterValue],
[Measures].[ParameterLevel]} ON COLUMNS ,
  [Start Form Ref].[Study Form Id].ALLMEMBERS ON ROWS
FROM
  [Student Semester]
```

OLAP Software

- Microsoft SQL Server Analysis Services
- Oracle Essbase (MOLAP only)
- Oracle OLAP – (ROLAP only)
- IBM Cognos TM1 (MOLAP only)
- IBM Cognos BI (no local or in-memory option)
- SAS OLAP Server (no local or in-memory option)

Distributed OLAP

- Druid
- Apache Kylin (eBay)
- Cubes
- Pinot (LinkedId)

OLAP clients

- ODBC
- XMLA (XML for Analysis)
- OLAP design tools
- Excel, PowerPivot

XMLA example

```
<soap:Envelope>
 <soap:Body>
  <Execute xmlns="urn:schemas-microsoft-com:xml-analysis">
   <Command>
    <Statement>SELECT Measures.MEMBERS ON COLUMNS FROM
Sales</Statement>
   </Command>
   <Properties>
    <PropertyList>
     <DataSourceInfo/>
     <Catalog>FoodMart</Catalog>
     <Format>Multidimensional</Format>
     <AxisFormat>TupleFormat</AxisFormat>
    </PropertyList>
   </Properties>
  </Execute>
 </soap:Body>
</soap:Envelope>
```

Alternatives

- SQL PIVOT, UNPIVOT, CUBE, ROLLUP expressions
- OLTP statistics
- Read-only OLTP mirror
- SQL Cube Views (DB2)

OLAP usage in DM

- Data Mining models to populate/augment cubes with data
- Certain machine learning algorithms operate on cubes (e.g. Shopping cart analysis)