The road to highlights is paved with good intentions: envisioning a paradigm shift in OLAP modeling

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Why the need for a paradigm shift?

- After many years of research on efficiency, ETL, highly distr. progr., …, we have neglected what kind of analysis we offer to end-users
- Unless we provide a principled way to handle end-user operations, the industry will do it before us (again) and in ad-hoc manner (again)

- We envision a **paradigm shift for OLAP**, meaning that we need to ….
- … Re-invent / Revive / Redefine OLAP with
  - A new model of what a query is
  - A new model of what a query answer is

Redefining what a query is

THE INTENTIONAL ANALYTICS MODEL

Intentional Analytics model

SQL aggregate queries

Direct implementation in SQL at the db level

At the beginning:
Reporting, but the "kid-who-knows-programming"
Focused on
HOW TO GIVE THE BOSS
WHAT I THINK HE NEEDS

Intentional Analytics model

OLAP: Roll-Up, Drill-Down, Drill-Across, Slice	Manipulation at the cube level	**On-line processing, by the user himself, focused on WHAT DATA I NEED**
SQL aggregate queries	Direct implementation in SQL at the db level	**At the beginning: Reporting, but the "kid-who-knows-programming" Focused on HOW TO GIVE THE BOSS WHAT I THINK HE NEEDS**

Intentional Analytics model

OLAP: Explain, Predict, Focus, … "I want the tool, to explain to me, why sales are dropping"	Manipulation at the INTENTION level	**On-line processing, mostly by the tool, focused on WHAT IS THE GOAL OF MY ANALYSIS (data is for the db, Info is for the user)**
OLAP: Roll-Up, Drill-Down, Drill-Across, Slice	Manipulation at the cube level	**On-line processing, by the user himself, focused on WHAT DATA I NEED**
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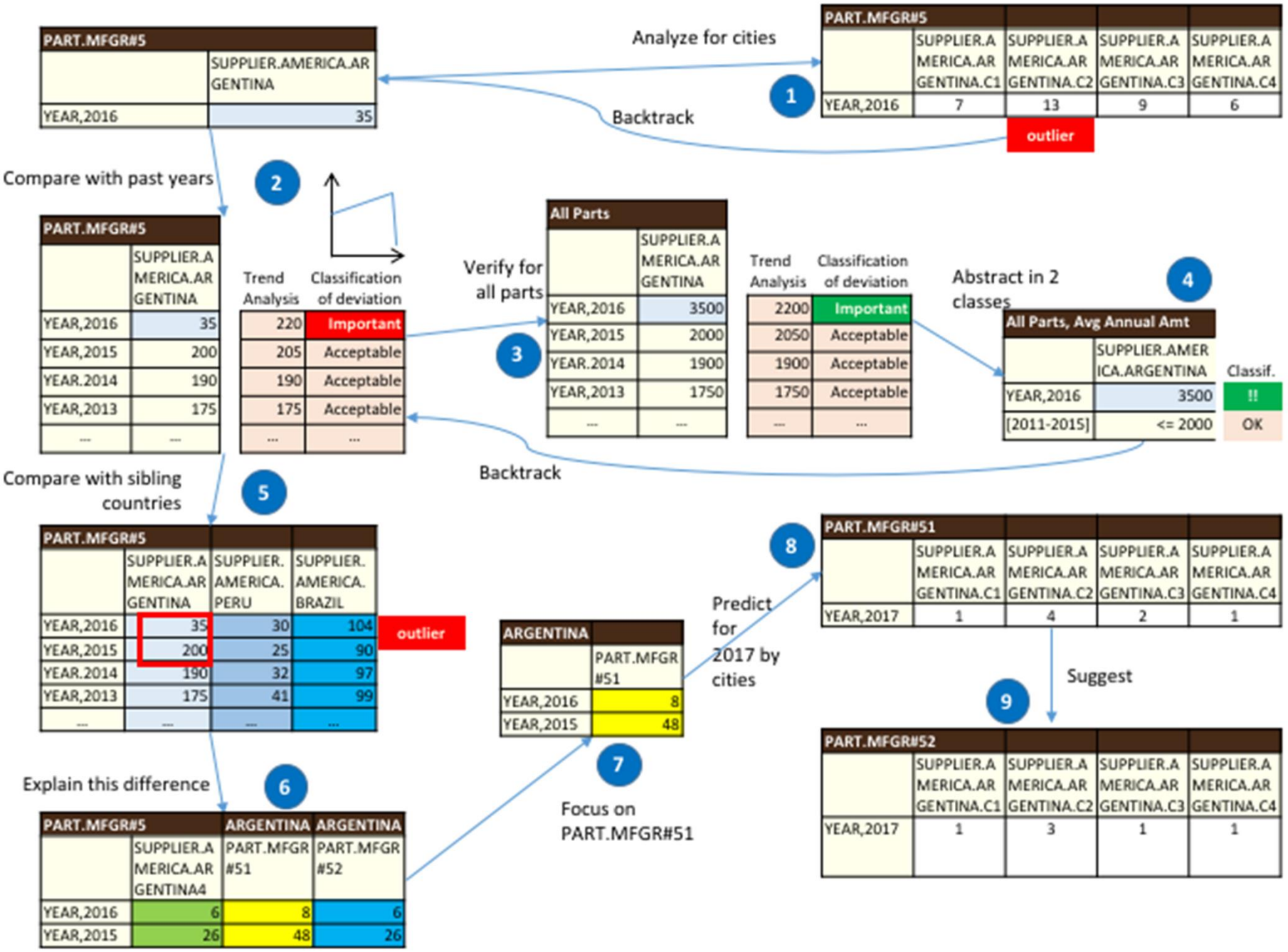
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SUPPLIER.AMERICA.ARGENTINA
YEAR,2016 35
Analyze for cities
1
PART.MFGR#5
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SUPPLIER.AMERICA.ARGENTINA.C2
SUPPLIER.AMERICA.ARGENTINA.C3
SUPPLIER.AMERICA.ARGENTINA.C4
YEAR,2016 7 13 9 6
outlier
Backtrack
Compare with past years
2
PART.MFGR#5
SUPPLIER.AMERICA.ARGENTINA
YEAR,2016 35
YEAR,2015 200
YEAR.2014 190
YEAR,2013 175
Trend Analysis
Classification of deviation
220 Important
205 Acceptable
190 Acceptable
175 Acceptable
Verify for all parts
3
All Parts
SUPPLIER.AMERICA.ARGENTINA
YEAR,2016 3500
YEAR,2015 2000
YEAR.2014 1900
YEAR,2013 1750
Trend Analysis
Classification of deviation
2200 Important
2050 Acceptable
1900 Acceptable
1750 Acceptable
Abstract in 2 classes
4
All Parts, Avg Annual Amt
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Classif.
YEAR,2016 3500 !!
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Backtrack
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5
PART.MFGR#5
SUPPLIER.AMERICA.ARGENTINA
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YEAR,2016 35 30 104
YEAR,2015 200 25 90
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outlier
Explain this difference
6
PART.MFGR#5
ARGENTINA
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SUPPLIER.AMERICA.ARGENTINA4
PART.MFGR#51
PART.MFGR#52
YEAR,2016 6 8 6
YEAR,2015 26 48 26
ARGENTINA
PART.MFGR#51
YEAR,2016 8
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7
Focus on PART.MFGR#51
Predict for 2017 by cities
8
PART.MFGR#51
SUPPLIER.AMERICA.ARGENTINA.C1
SUPPLIER.AMERICA.ARGENTINA.C2
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SUPPLIER.AMERICA.ARGENTINA.C4
YEAR,2017 1 4 2 1
Suggest
9
PART.MFGR#52
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SUPPLIER.AMERICA.ARGENTINA.C2
SUPPLIER.AMERICA.ARGENTINA.C3
SUPPLIER.AMERICA.ARGENTINA.C4
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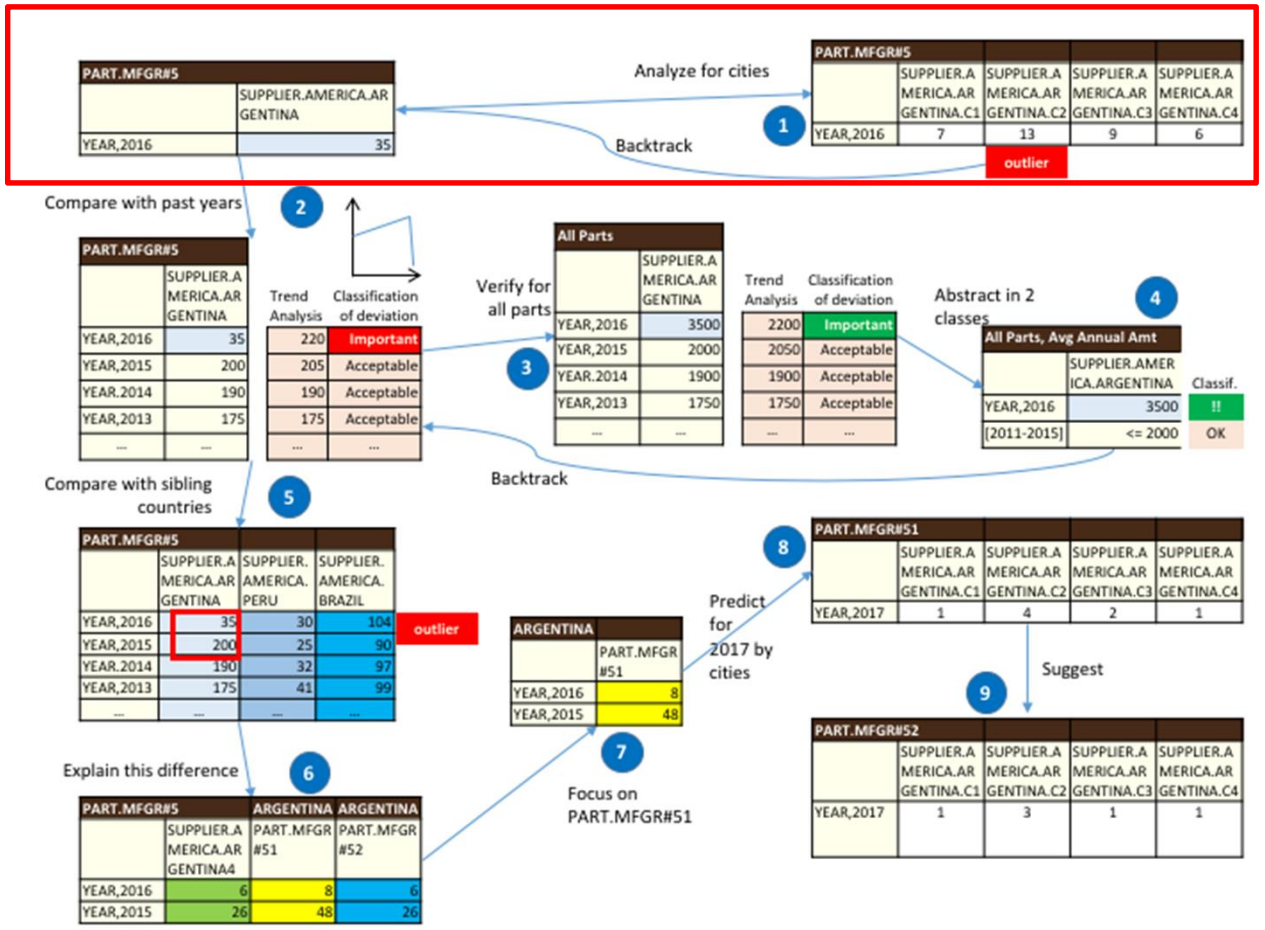
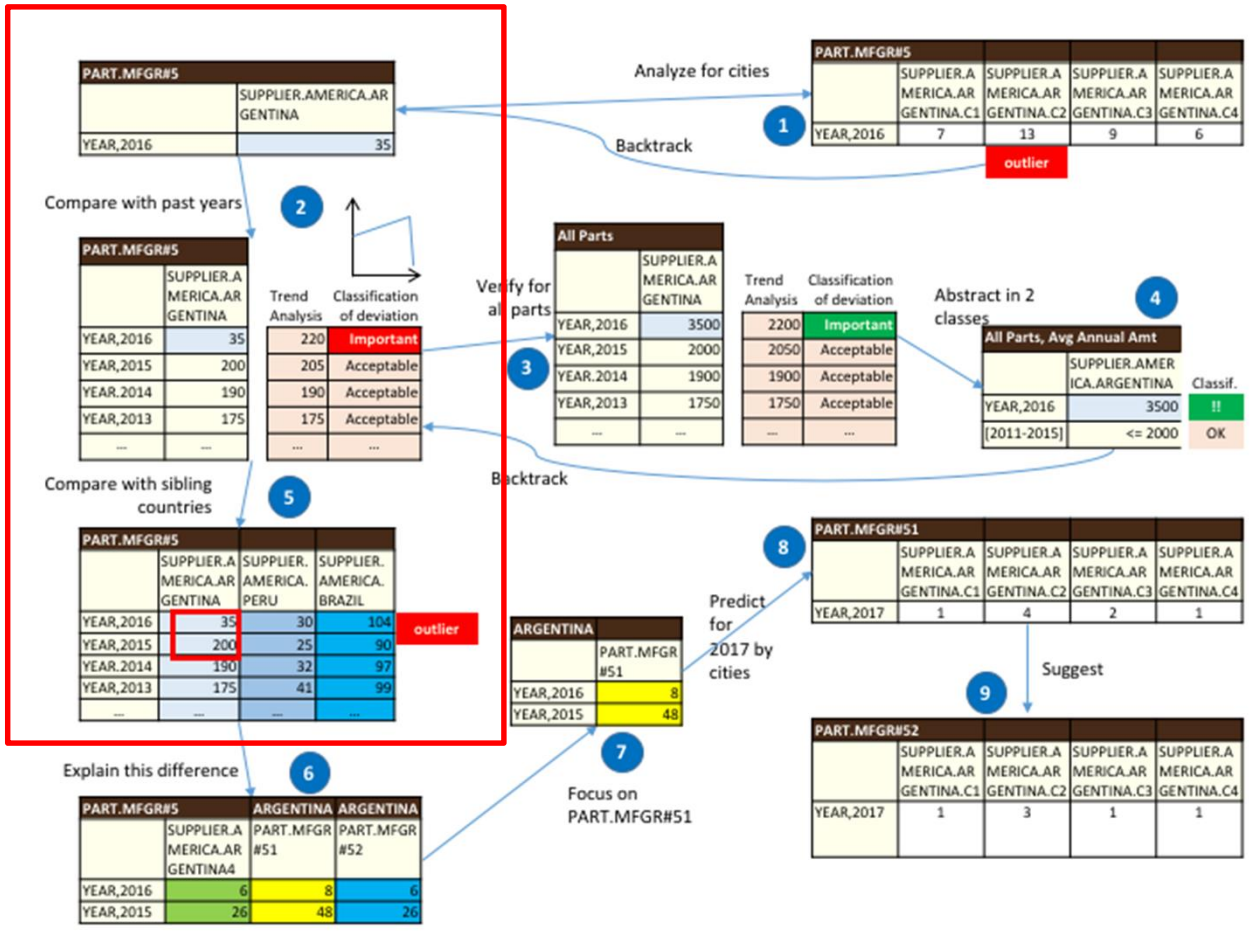
Operator: Analyze

- **Analyze**: I want details on the data you present
- Implemented via one drill down or all possible (Cinecubes' 'detail' operator)



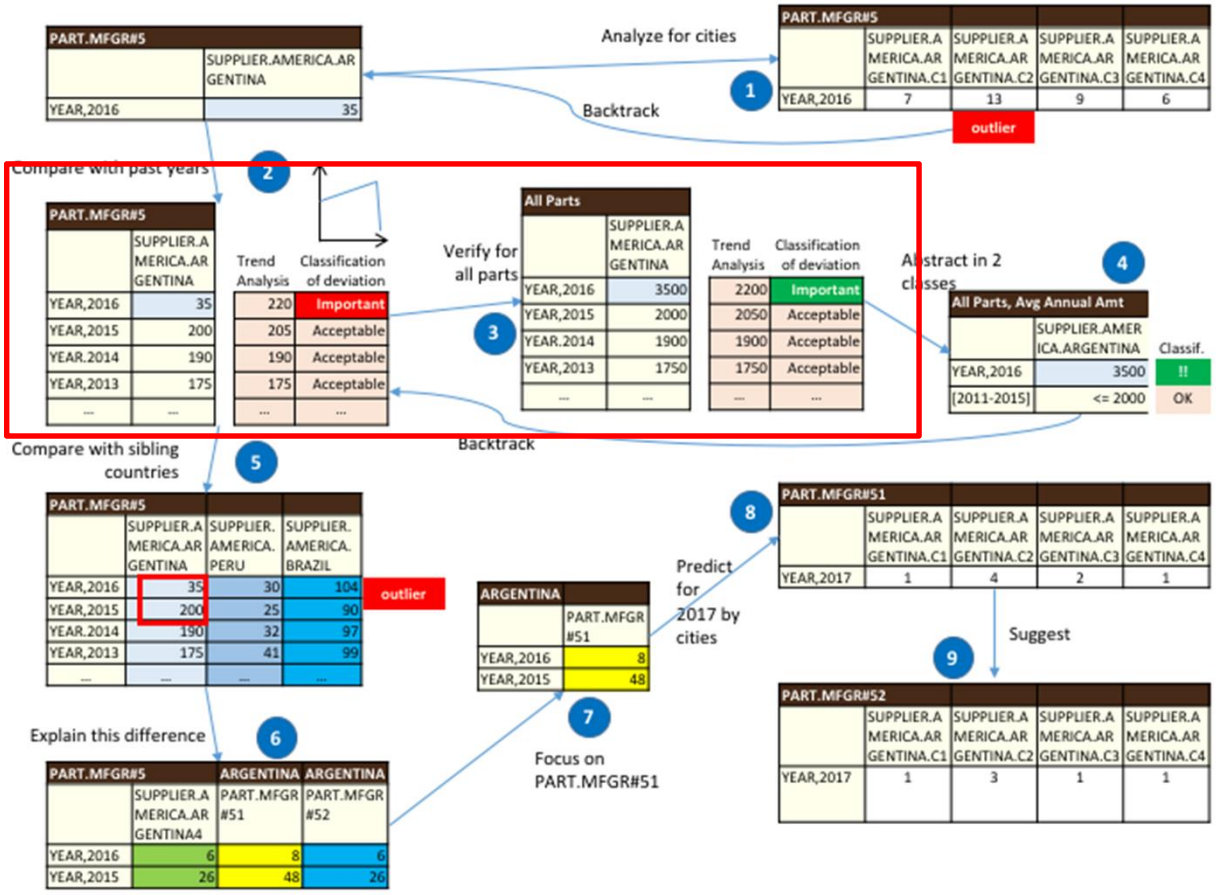
Operator: Compare

- **Compare**: contrast a cube/cell with its peer, "similar" cubes/cells
- Implemented via drill across or Cinecubes' 'put-in-context' operator



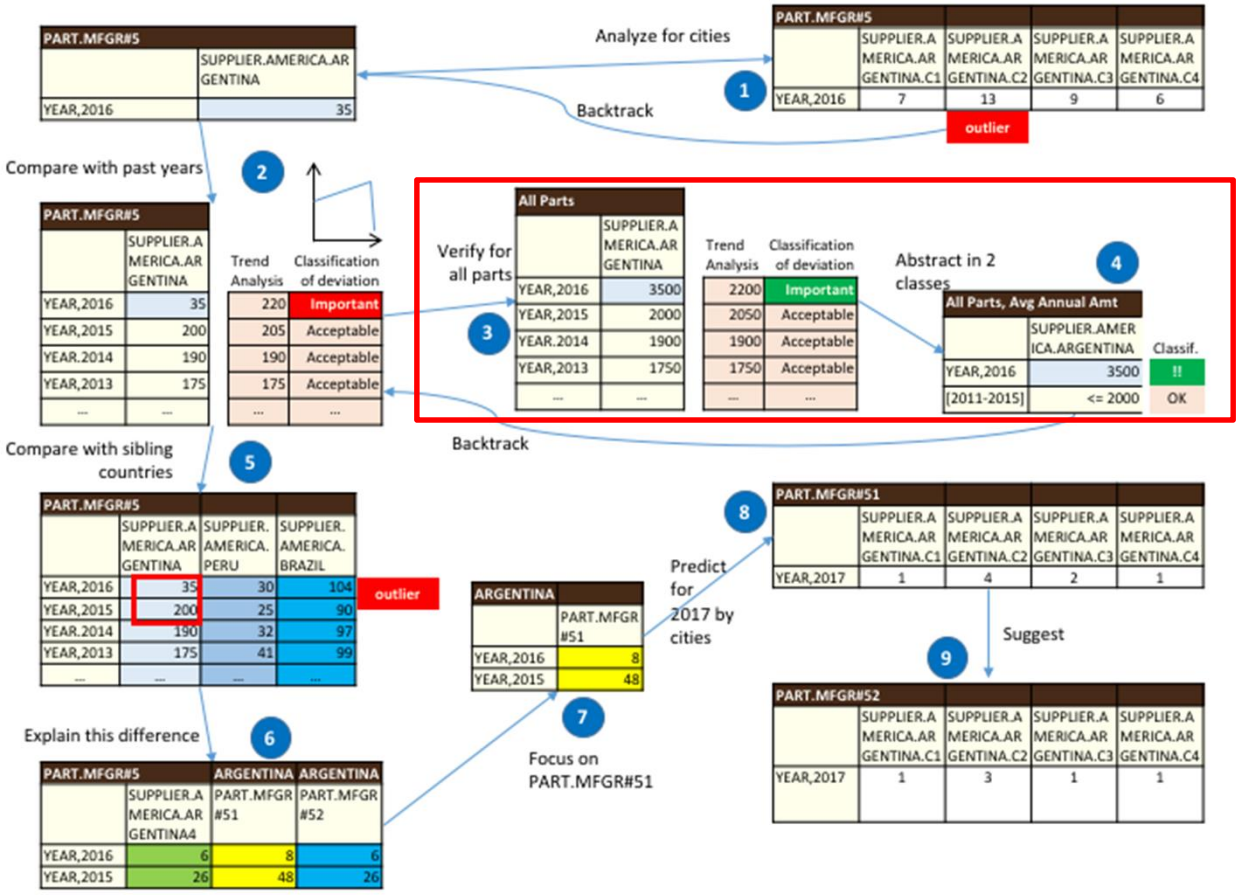
Operator: Verify

- **Verify**: check if a pattern you observe happens also at a broader context
- Implemented via Relax operator (observe that the specific part on the left is generalized to all parts at the right)



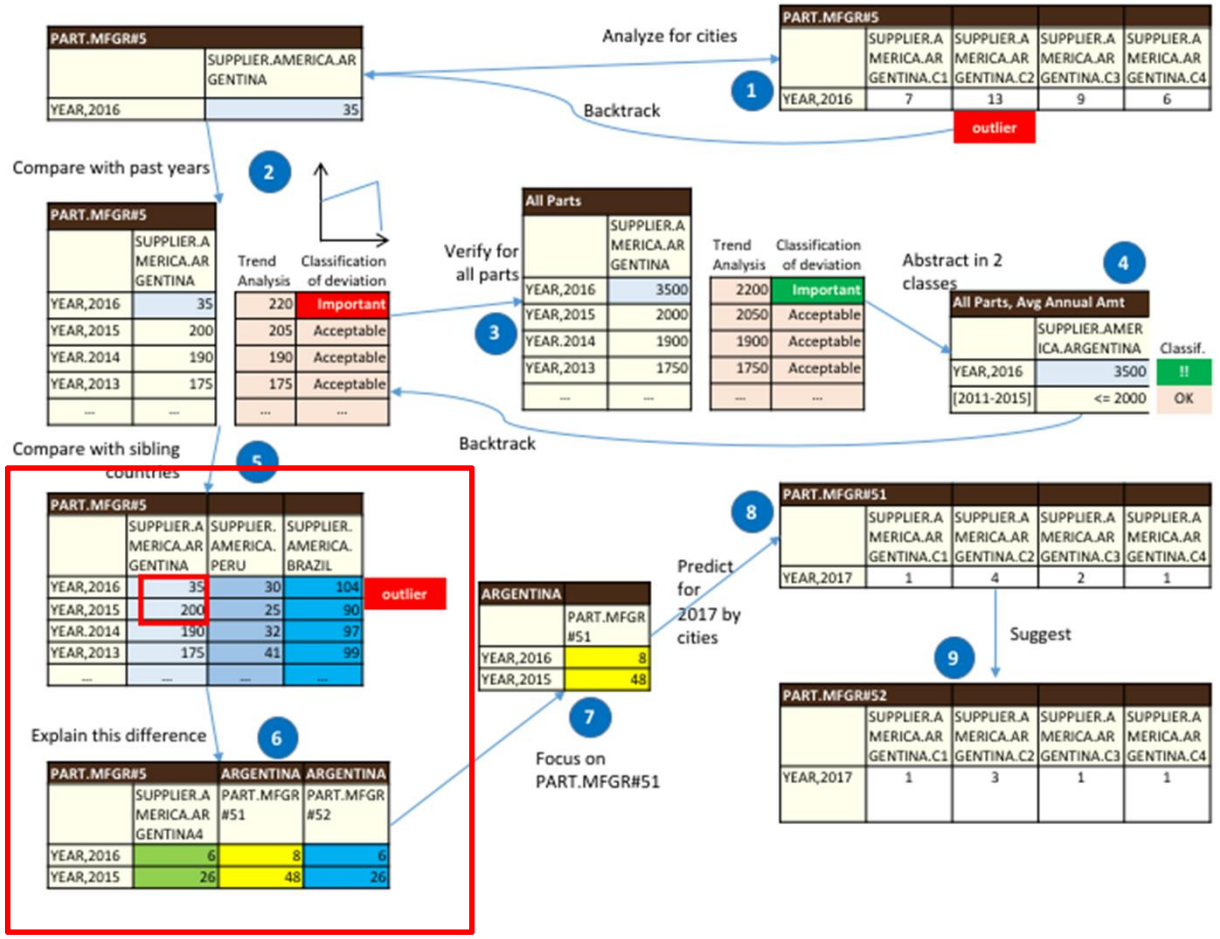
Operator: Abstract

- **Abstract**: show me less details and a broader context
- Implemented via Rollup, clustering, shrink, etc (here: abstract the year dimension)



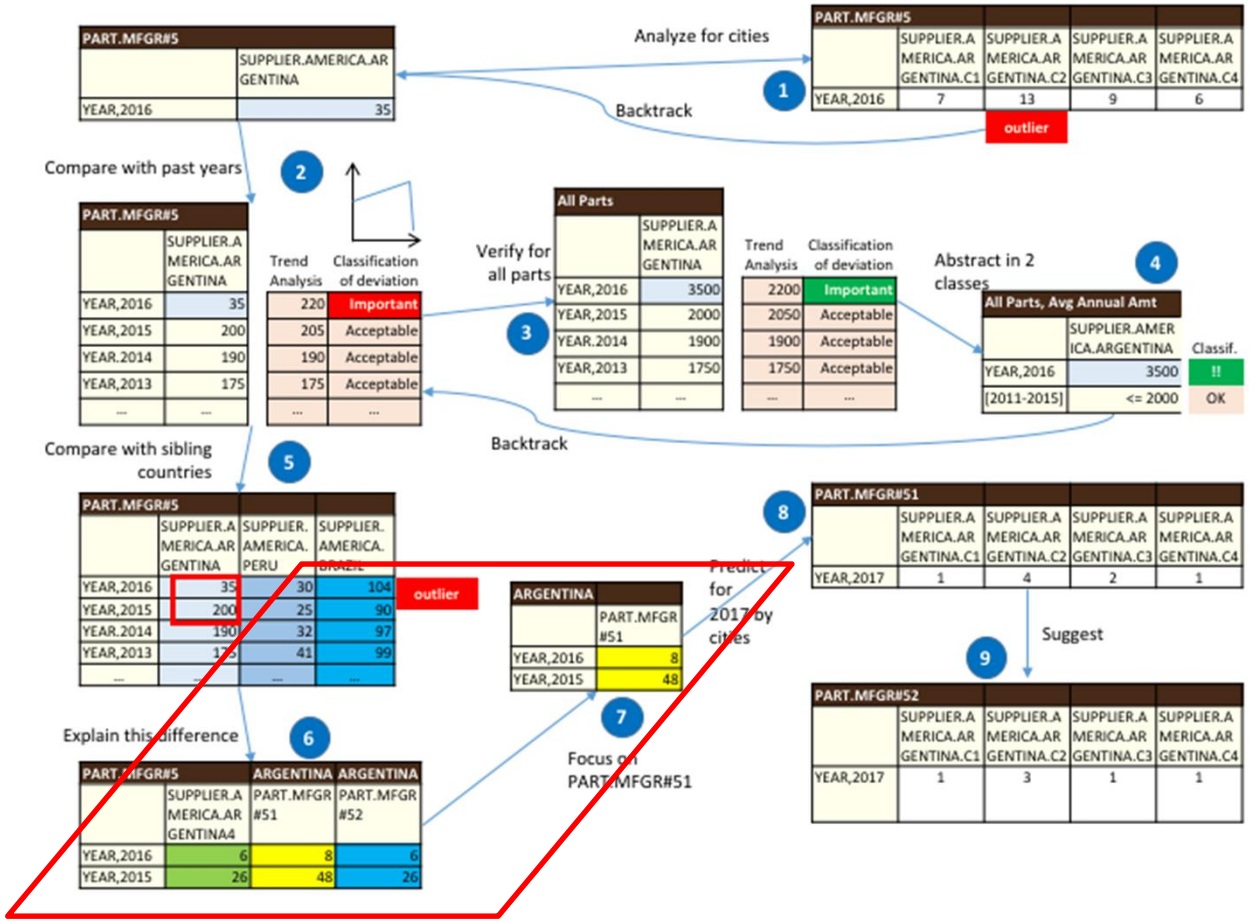
Operator: Explain

- **Explain**: show me what makes a difference
- Implemented via the Diff operator (here in the Fig.) or outlier detection, etc



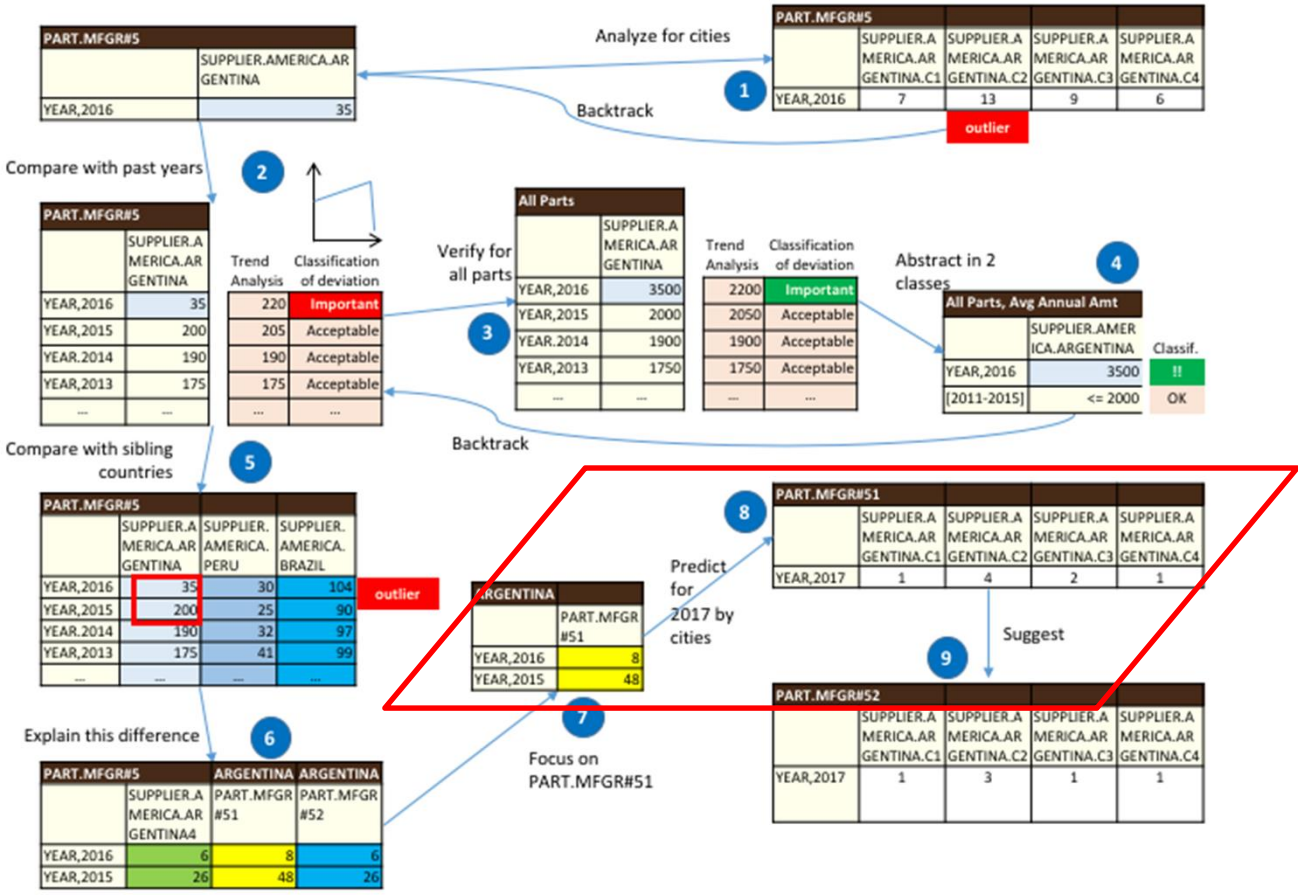
Operator: FocusOn

- **Focus On**: constrain the scope of analysis
- Implemented via sliceNDice, skyline, winnow (top-k), etc.



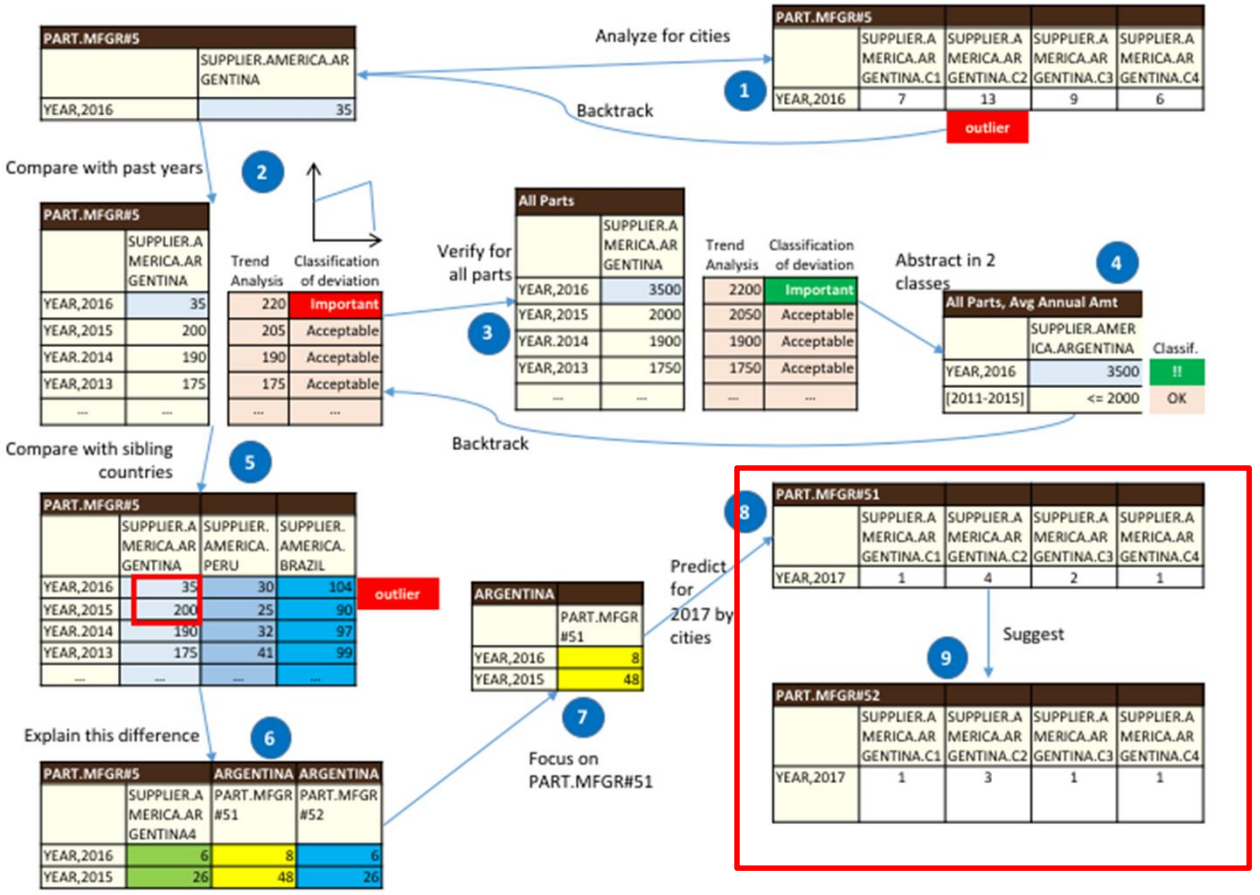
Operator: Predict

- **Predict**: forecast future values
- Implemented via typical timeseries analysis methods (regression, ARIMA, …) as well as classification methods



Operator: Suggest

- **Suggest**: any hint on what should I ask now?
- Implemented via query recommendation techniques, or via operators like Inform



How do we change querying?

- **Focus on the actual goal** of the analyst and NOT on the data she wants to get
- **Let the system decide which data to fetch**
  - OPEN ISSUE: instead of executing EVERY single OLAP operator that corresponds to an intentional operator can we AUTOMATICALLY optimize (a) what we execute and (b) what we show (see next too)
- Also in the paper: vision of a language for composing operators
- **On-Going work: further reduce the set of operators, by abstracting even more!**

OK, we redefined what an OLAP query is, but this is not enough. We also suggest that we urgently need to …

…REDEFINE WHAT THE ANSWER TO AN OLAP QUERY IS

Caught somewhere in time

- **Query result = (just) a set of tuples**
- No difference from the 70's when this assumption was established and tailored for
  - what people had available then
    - … a green/orange monochrome screen
    - … a dot-matrix(?) printer
    - … nothing else
  - users being programmers

Photos copied from http://en.wikipedia.org/

The answer to a query can be …

- … a set of tuples (traditionally)
- … a data movie that includes a set of complementary queries supporting a data story, whose results are properly visualized, enriched with textual comments, and vocally enriched (DOLAP13 Cinecubes for reporting)

The answer to a query can be …

- ~~… a set of tuples (traditionally)~~
- … a data movie that includes a set of complementary queries supporting a data story, whose results are properly visualized, enriched with textual comments, and vocally enriched (DOLAP13 Cinecubes for reporting)
- … a dashboard that apart from **data**, also comes with (i) the automatic mining of **models** and patterns, and (ii) the extraction of "jewels" hidden in the result, which we call **highlights**, plus, the aforementioned (iii) **visuals** and generated **text** (for OLAP)

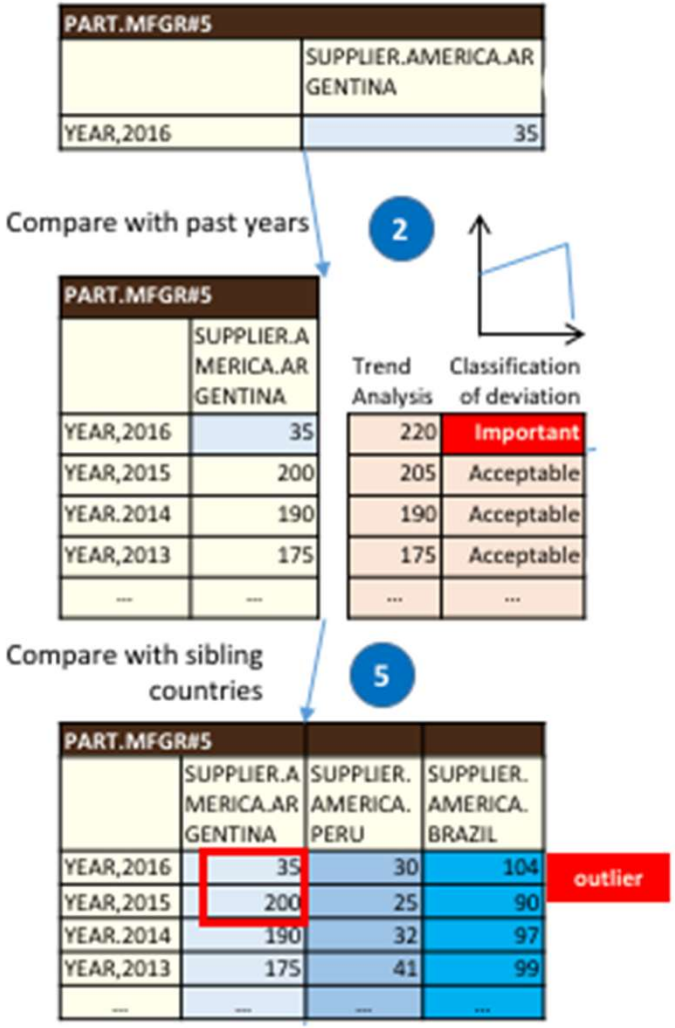
Data analysis and models

- We consider the plugging of **data analysis algorithms** in the back-stage of a dashboard as an indispensable part of OLAP.
- These algorithms can range …
  - … from very simple ones (e.g., finding the top values of a cuboid, or detecting whether a dimension value is systematically related to top or bottom sales)
  - …to very complicated ones (like, classification, outlier detection, dimensionality reduction, etc).
- The findings of these automatically invoked and executed data analysis algorithms will be the **models** of the data

Data analysis and models

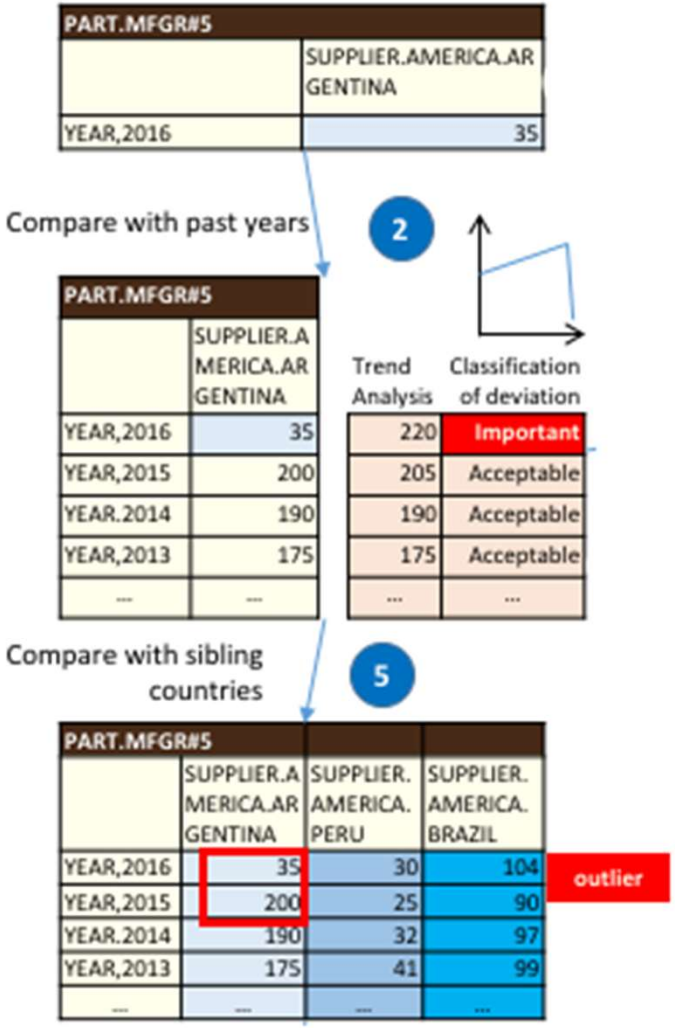
- The findings of automatically invoked and executed data analysis algorithms will be the **models** of the data
- Due to the vastness of the possible models, we need to automatically assess them on their significance for the user and retain the most important ones, which we call **highlights**

…and what are models and highlights?



- **Models**: concise information-rich abstractions that "mine" relationships and properties from data
- Here: (@2) a trend analysis of past sales produces a list of "expected" values + a classification of deviation of achieved sales compared to the actual, labels the result; (@5) an outlier analysis identifies points with high outlierness

…and what are models and highlights?



- **Highlights**: "important" parts of models, linked to data
- Here: (@2) sales = 35 having a large deviation from expected and classified as "important" is an important part of the model; similarly, (@5) the outlier is important too

Model components, data and highlights

- Models have **model components**, that **can link to source data** e.g.,
  - A time series model splits a time series measure to trend, seasonality and noise => the source measure is annotated with them
  - A cluster model = a set of clusters => the source cells can be annotated with the id of the cluster to which they belong.
  - A classification model groups source data by the label of the class to which they belong.
  - A model of top-k values of a measure labels source cells with their rank.

- Components are linked to their respective data:
  - *A notable property of our modeling is that we require model components to be directly mapped and linked to their generating data in a bidirectional mapping, so that the end-user can navigate back and forth between cube cells and their models.*

- ***Highlights are produced by identifying components with "interesting" information, according to the user's intention***

Important questions & challenges

Stay tuned for the long version of the paper for …

… sketch of solutions for:

- How do we select which algorithms to execute, how to fine-tune them, and how do we do it in real time?
- How do we select highlights out of the vast number of models generated?
  - Must investigate interestingness wrt intention

… solutions for:

- How do we handle the heterogeneity of models?
- How do we put data and highlights to work together?

… open for the future:

- How do we plug in (a) visualizations and (b) storytelling?

Concluding, we …

- … redefine what an OLAP query must be & propose…
  - Intention queries via **intentional operators**, that the user can use instead of R-UP's, DD's with more ease
  - *Compare, Analyze, Explain, Predict, Verify, Focus, Abstract, …*

- … redefine what the answer to an OLAP query must be = a dashboard with …
  - Data from several data cubes
  - **Models** with information-rich properties/relationships
  - **Highlights** with interesting pointsOfFocus
  - Visuals and Generated Text

- … **encourage & invite the community to actively pursue this research avenue now!**

http://www.cs.uoi.gr/~pvassil/publications/2018_DOLAP

Thank you!