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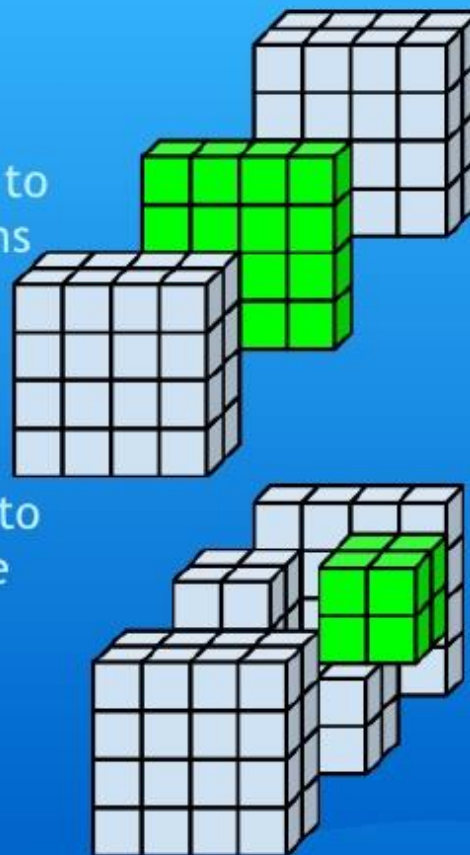
# Outline

1. Cube for time series
2. Time Series Cube structure
3. Use cases supported
4. Open Questions

# What is a data cube

## OLAP Cubes - operations

- **Slice** = choose values corresponding to ONE value on one or more dimensions
- **Dice** = choose values corresponding to one slice or a number of consecutive slices on more than 2 dimensions of the cube



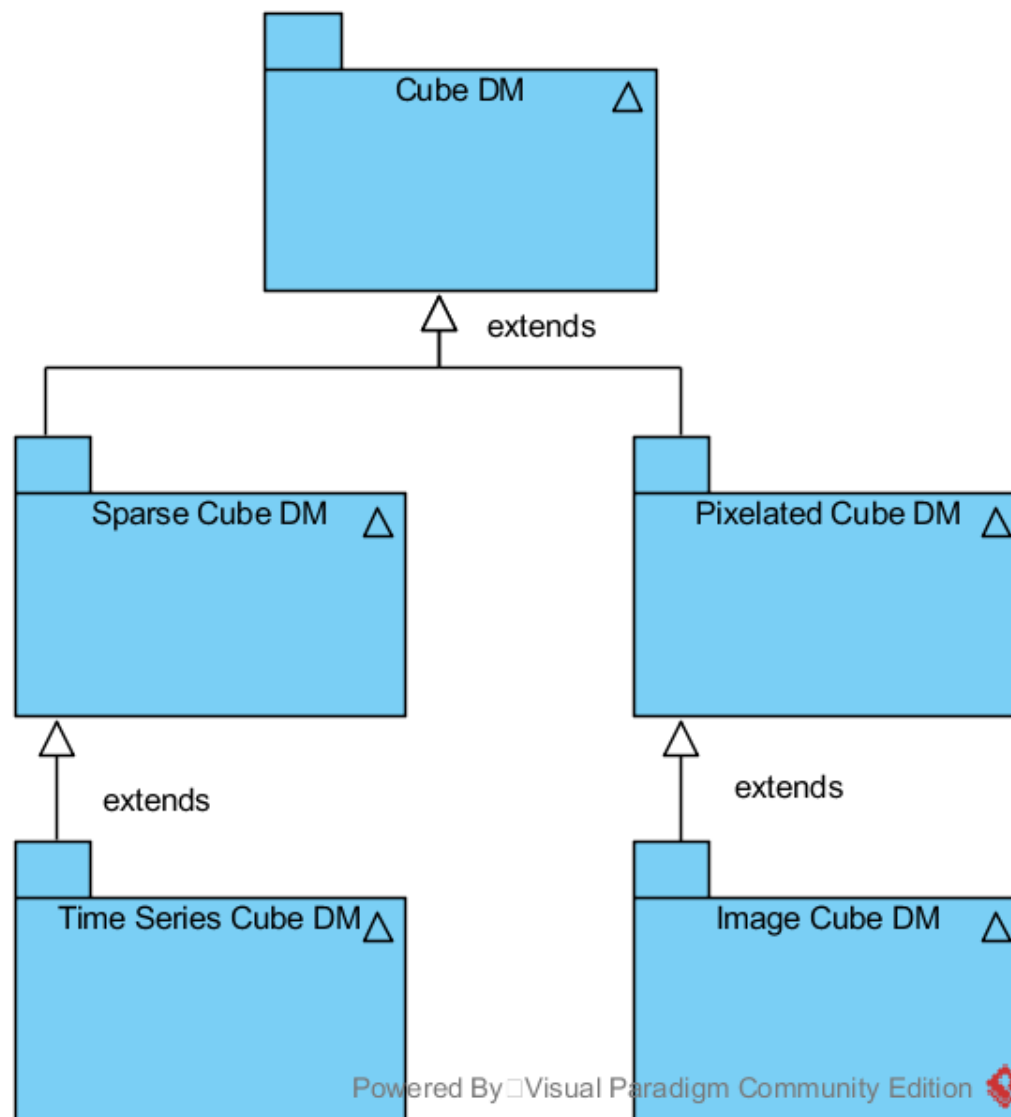
# Sparse Cube

- *“Sparse data are commonly used for higher-dimensional cubes, and are frequently sparse along one or more axes. For example, a multi-band image has 7 data at only a few given spectral coordinates, (each corresponding to a spectral bandpass). A spectral (or velocity) data cube may contain data for a number of widely spaced spectral bands, each of which may differ in the spectral resolution and number of channels. **A time cube likewise may contain data, either individual points, or time series, arbitrarily spaced along the time axis with time regions where no data was taken.** A multiobject spectral data cube may be sparse in the spatial plane. Event data can be considered a data cube which is sparse in all measurement axes.”(N-Dimensional Cube Model)*

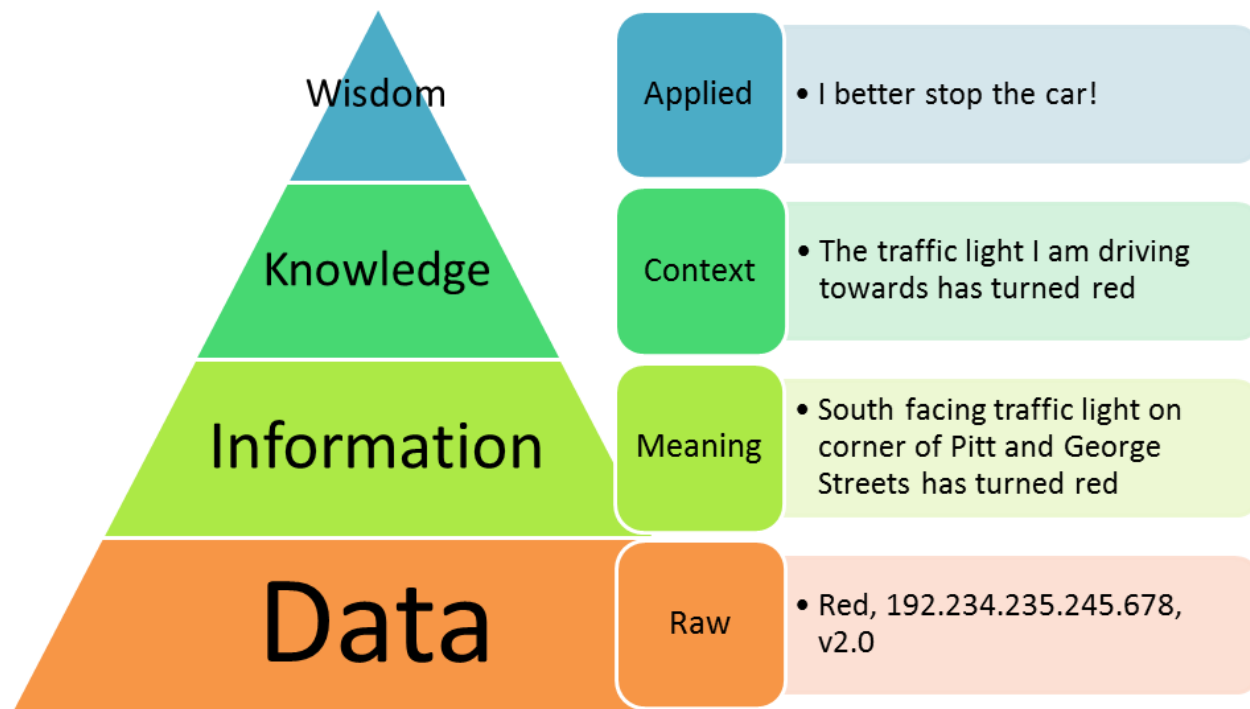
# Sparse Cube DM

- Can describe any time series axes.
- Is flexible
- Is extensible

# Time Series Cube DM



# Separation of Data vs. Information



Data + Information = God Object

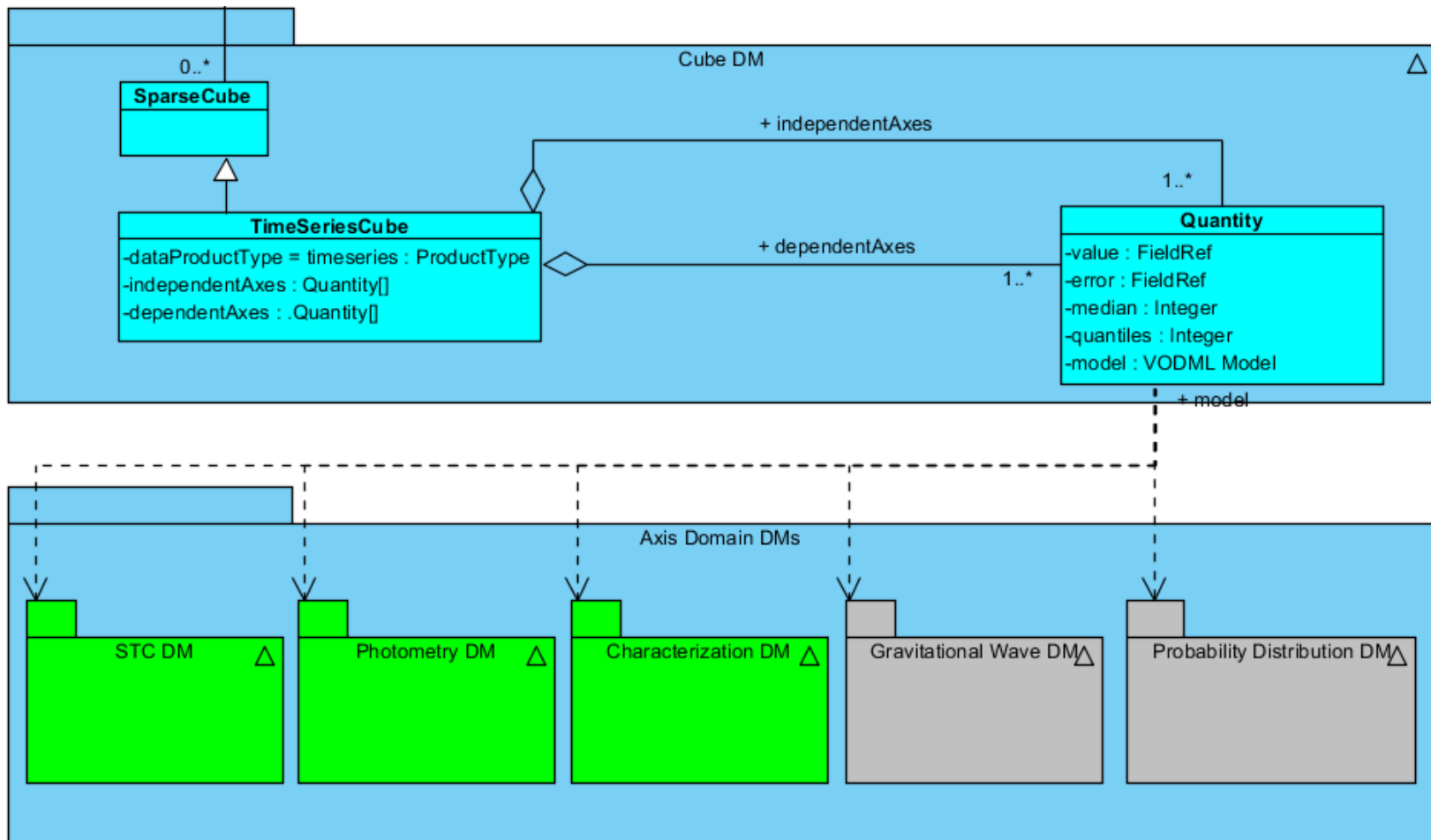




# Separation of Data vs. Information

- Describing meaning (**information layer**) for any possible data in the Cube DM will create a god object
- Cube DM can still describe information about its axes (**data layer**) without needing to know every physical domain model
- Changes to physical domain models (STC, Phot DM, Provenance) won't require Cube DM to change

# Time Series Cube UML



# Time Series Cube UML

- Through **Time Series Cube class** I can find the axes of the cube
- From there we can go to the metadata about the data (distribution of values) in an axis stored in the **Quantity class**
- From there we can go to the information (**Axis domain DMs**) metadata stored in already existing models (STC, Phot DM) or potentially to new models without the need to change Cube DM

# Advantages

- Time Series Cube DM does not wait for STC v2.0, Phot DM, Gravitation wave DM, ...
- Domain-specific clients (Spectral, Photometry, etc.) can still use cube **without change**. Cube is just adding metadata about the data
- Discovery of “pure” cube metadata -> Time Series Cube can cutout itself without knowing about physical meaning of the data
- **Ability** to use Cube DM without the need to understand **everything** that can be stored within Cube DM

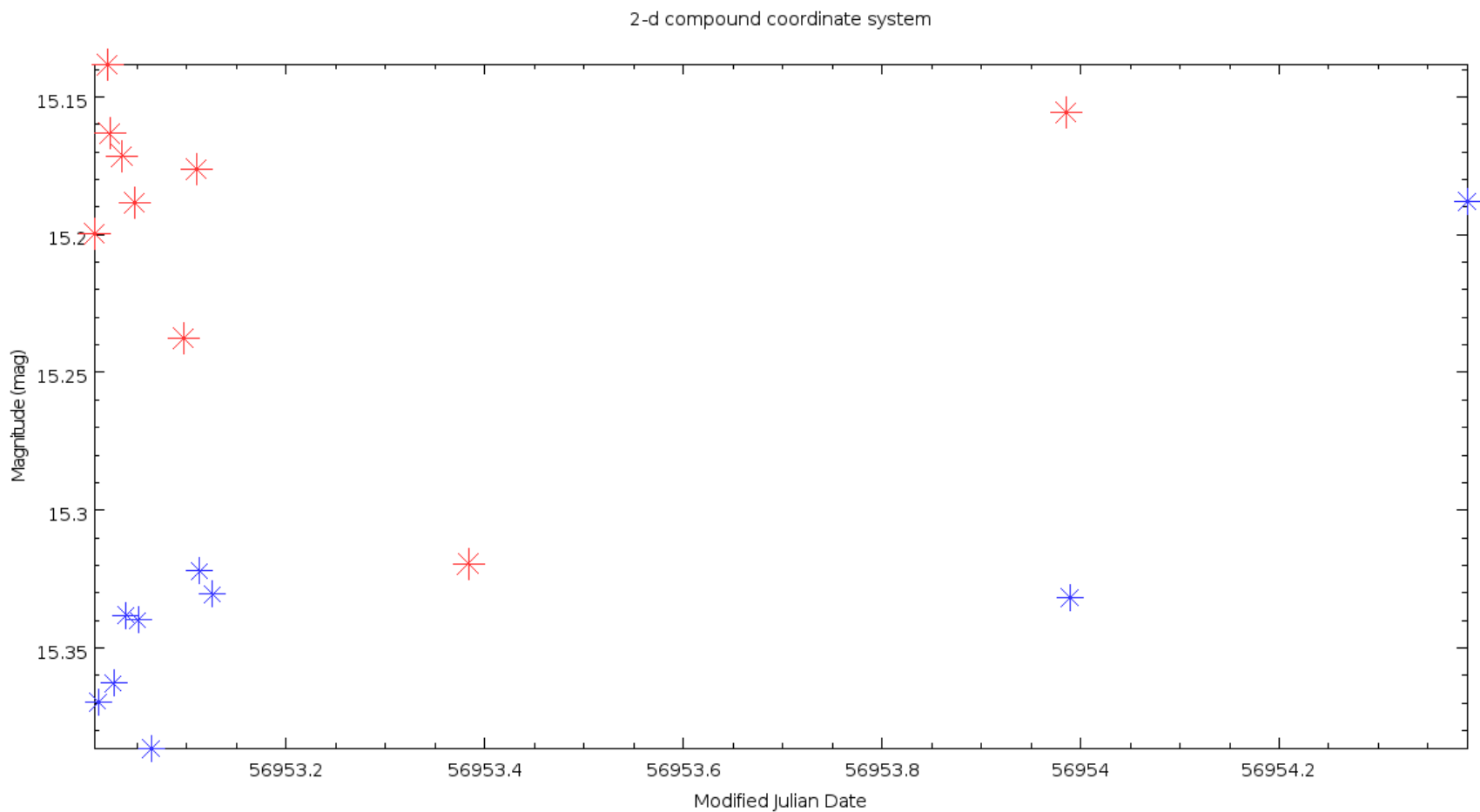
# Advantages

- Adding new filters during the survey
- Adding new data sources to the survey

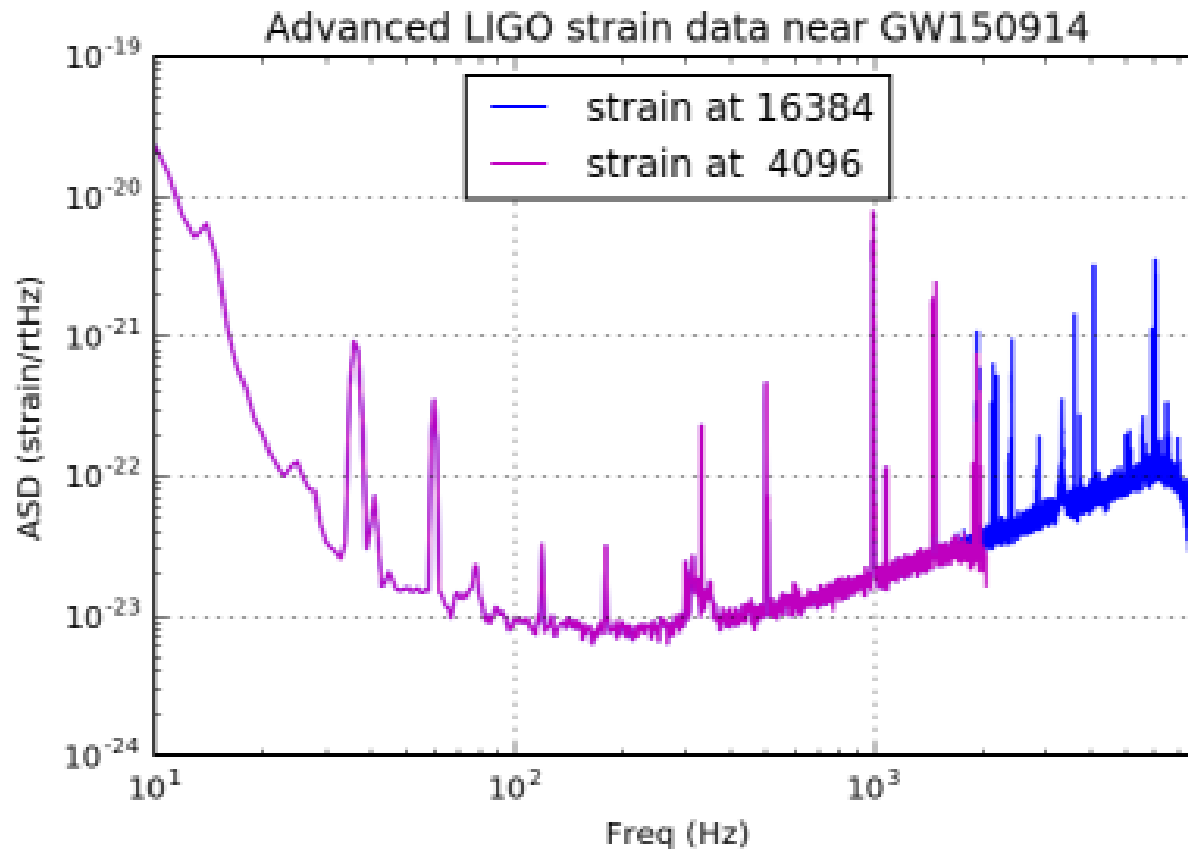
# Science use Cases for Time Series

- [Use cases - \(2012-10-20, Enrique Solano\)](#)
- 3 groups of requirements
  - Group A: Combine photometry and light curves of a given object/list of objects in the **same photometric band**
  - Group B: Combine photometry and light curves of a given object/list of objects in **different photometric bands**
  - Group C: Time series **other** than light curves

# Light curves (Group A, Group B)



# Gravitational wave data (Group C)





# Other use cases

- Looking for stars with more than  $N$  photometric points 5 sigma higher than the mean value.
- Looking for observations only between 1 p.m.-2 p.m. local time
- Plot light curves from multiple data sources
- Fermi has detected a flaring blazar. It has a certain error ellipse, say a few arc-minutes. An optical counterpart is not known. How can one get **light curves for all objects in the error-ellipse** to look for variability and thus possible counterparts to the blazar?
- Retrieve all catalogues which have measurements for a given date (e.g., date of a Gaia observation )

# Protocols

- ObsCore for discovery
- Datalink for cutout

# Open Questions

- What to put into Quantity DM
- What do I need to discover about the data cube
- Datalink for cutouts of cubes (time series) seems like the best option

