UNIVERSITÉ DE GENÈVE
FACULTÉ DES SCIENCES
Département d'astronomie

OBSERVATOIRE DE GENÈVE
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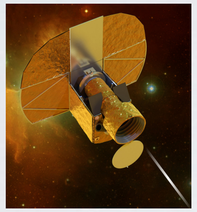
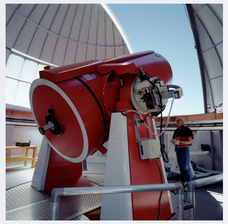
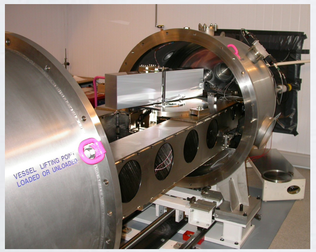
NoSQL Databases

An efficient way to store and query heterogeneous astronomical data in DACE

Nicolas Buchschacher - University of Geneva - ADASS 2018

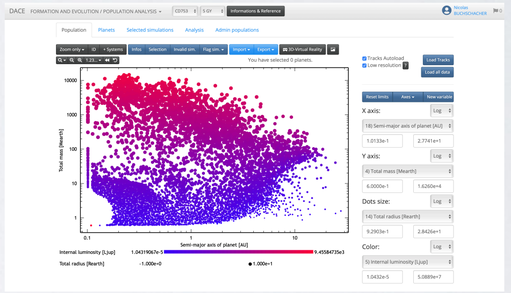


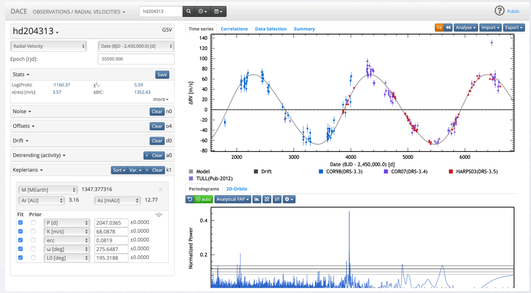




Solr

cassandra





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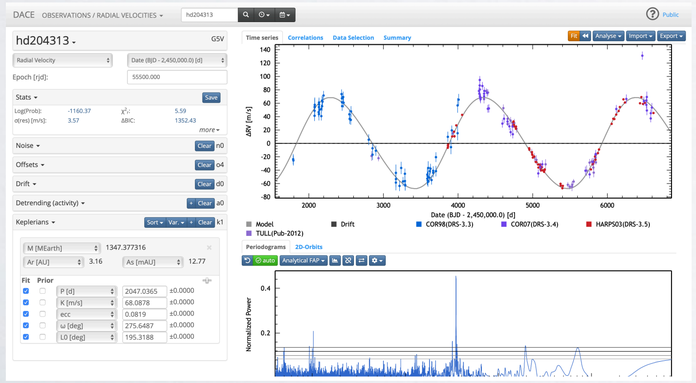
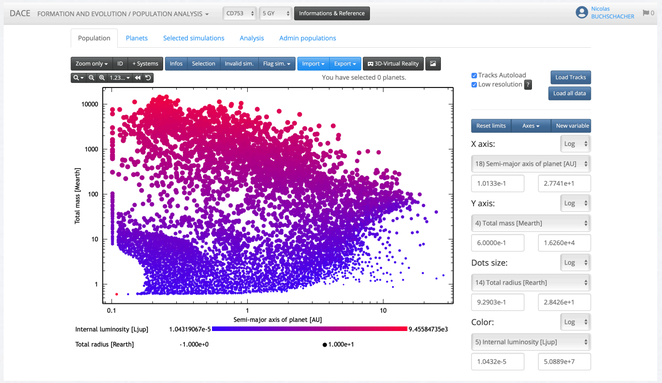
DACE

https://dace.unige.ch

- **D**ata and **A**nalysis **C**enter for **E**xoplanets.
- Facility to store, exchange and analyse data related to exoplanets (observations and synthetic populations).
- Web front end and python API to query the database (in dev).
- **3D visualisation** (come to the demo booth !)





The Requirements

- Store heterogeneous observational data produced by different instruments.
- Regularly adapt the data model (we are at the end of the chain).
- Store synthetic population simulations data points (~500M / Pop).
- Ensure high availability (load balancing) and persistence (replications).

CASSANDRA

- Fully distributed database developed by Apache.
- Column oriented storage => can have thousand columns in a table.
- High availability (no Master-Slave). Every node is equivalent.
- Asynchronous and automatic replication across the nodes based on a replication factor.
- Consistency level can be controlled for each query.

CAP (Brewer) Theorem

This is impossible for a distributed database to simultaneously provide more than 2 of the 3 following requirements:

- **Consistency**: Every read receives the most recent value, or an error.
- **Availability**: Every read or write request receives a non-error reply.
- **Partition tolerance**: The system continues to work properly if there are some missing nodes.

=> **Cassandra** is considered as an **AP** database. But consistency can be managed with the "consistency level" in each query.

CASSANDRA (Storage)

Row Oriented (SQL)

ID	Param1	Param2	Param3
1	v 11	v 21	NULL
2	v 12	NULL	NULL
3	v 13	NULL	v 33
4	v 14	v 24	NULL

Column Oriented

ID	Param1
1	v 11
2	v 12
3	v 13
4	v 14

ID	Param2
1	v 21
4	v 24

ID	Param3
3	v 33

CASSANDRA (Storage)

Row Oriented (SQL)

ID	Param1	Param2	Param3	Param4
1	v 11	v 21	NULL	NULL
2	v 12	NULL	NULL	NULL
3	v 13	NULL	v 33	NULL
4	v 14	v 24	NULL	NULL
5	v 15	NULL	v 35	v 45

Column Oriented

ID	Param1
1	v 11
2	v 12
3	v 13
4	v 14
5	v 51

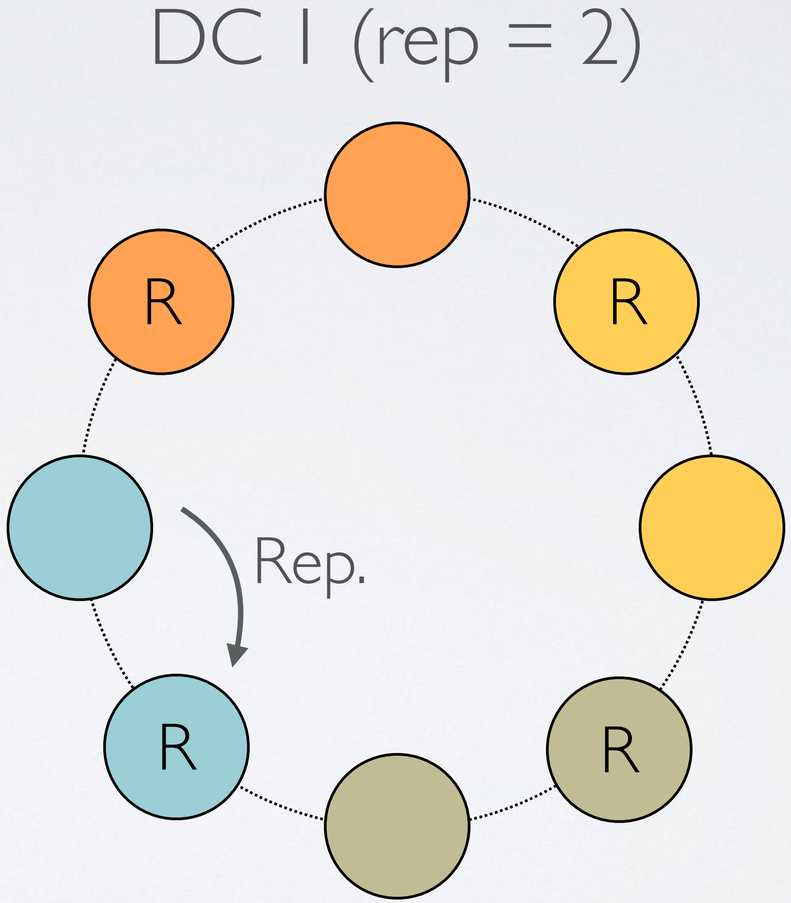
ID	Param2
1	v 21
4	v 24

ID	Param3
3	v 33
5	v 35

ID	Param4
5	v 45

CASSANDRA Partitions & Replication

ID	Param1	Param2	Param3	Param4
1	v 11	v 21	NULL	v 41
2	v 12	NULL	NULL	NULL
3	v 13	NULL	v 33	v 43
4	v 14	v 24	NULL	v 44



CASSANDRA Partitions & Replication

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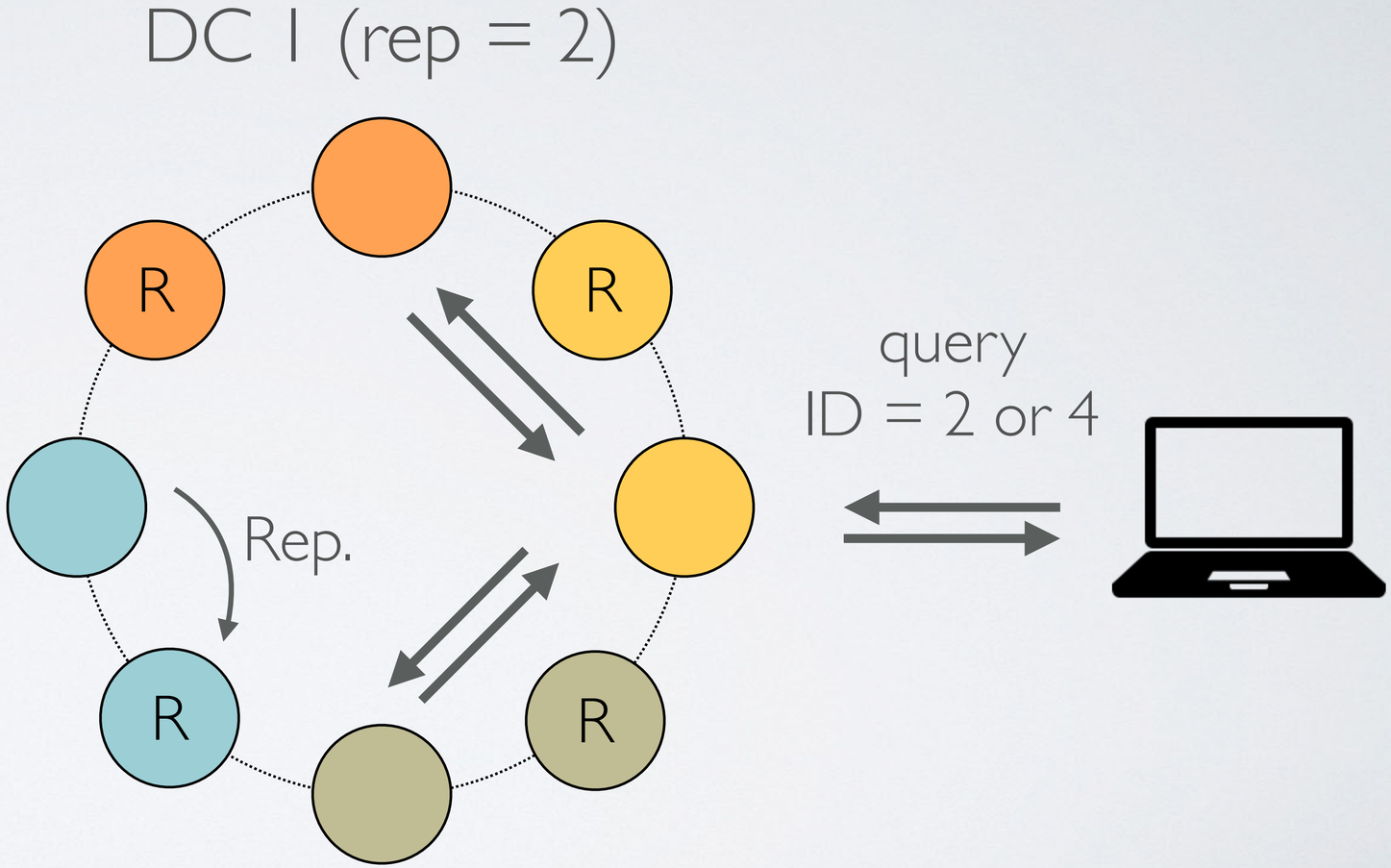
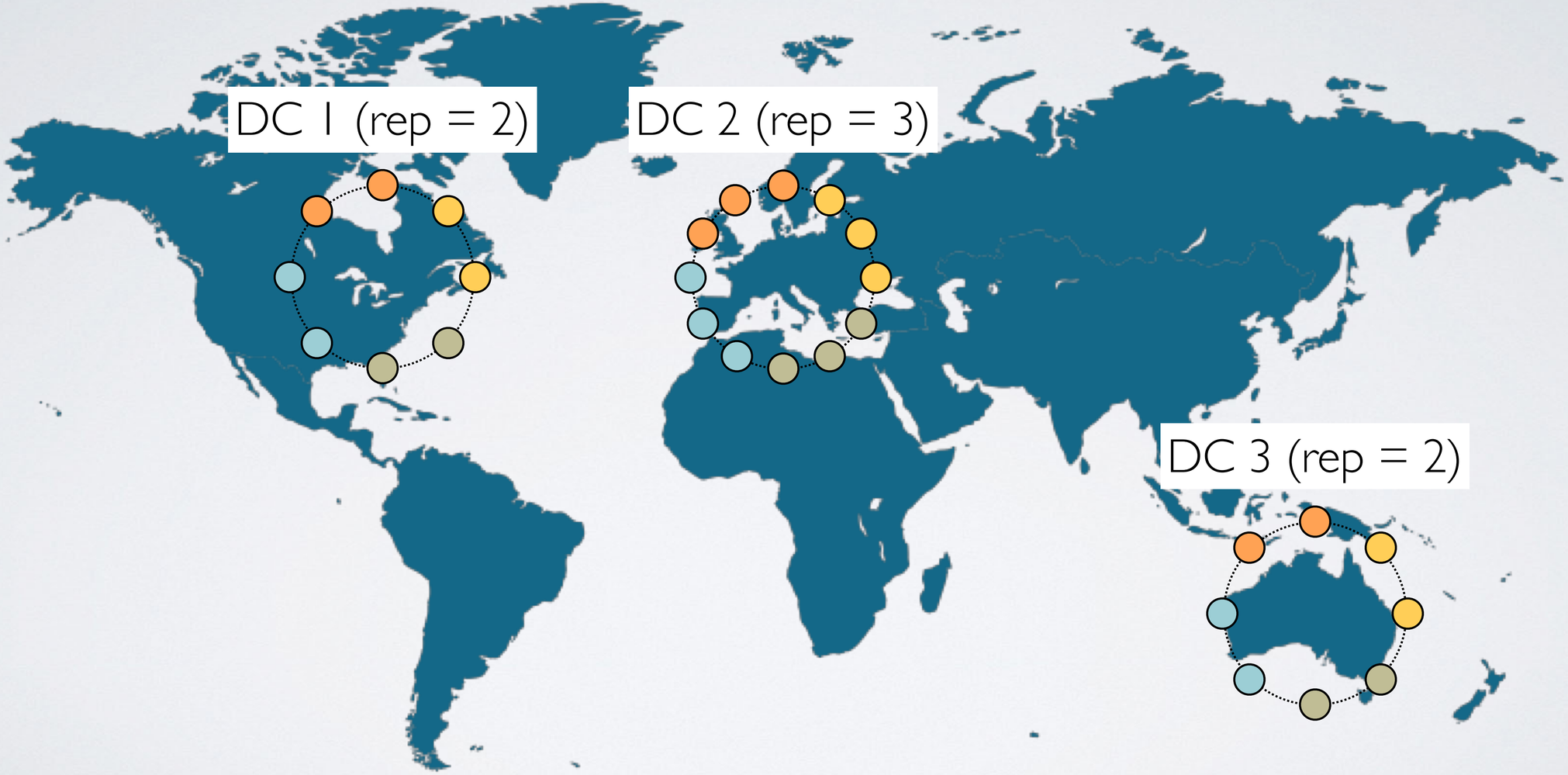


CASSANDRA Partitions & Replication



CASSANDRA Pros & Cons

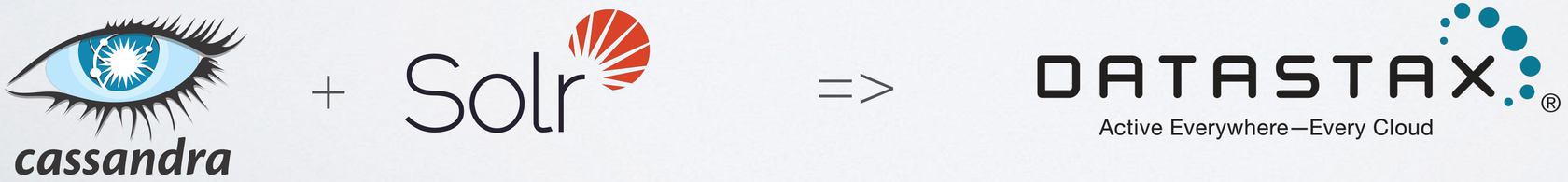
+ Store a lot of heterogenous columns without performance impact.
+ Fully distributed (no Master-Slave): all nodes are equivalent.
+ Easily scalable by adding new nodes.
+ Open source, compatible with major operating systems.
+ Easily expandable to the PB scale (Apple ex: 75'000 nodes).

- No relation between tables => No JOIN operations.
- Not transactional (not important in our case).
- Poor set of search and filter operations.

Solr / SolrCloud

- Open source enterprise search platform.
- Powerful indexer (full-text search, spatial, filtering, sort …) based on Apache Lucene.
- REST API with a lot of supported formats (JSON, CSV, Python,…).
- SolrCloud is the distributed version of Solr.

DSE combine both in a single software … but it's not free !!!



SQL vs NoSQL comparisons

SQL	NoSQL
Fixed schema, avoid column / table manipulations	Flexible schema, easily add new columns / parameters
Vertical scalability. Increase CPU, RAM and disks	Horizontal scalability (add nodes)
JOIN operations	No JOIN, no subqueries
Transactional operations	Not transactional
Centralised approach. Load balance using Master-Slave	De-centralised approach. Naturally load balanced
Long history and experience (1970)	New generation (~2000)

Conclusion

- Is NoSQL better ? **No !!!** It's different …
- Consider NoSQL databases if you need to store heterogeneous data and want a flexible data model.
- NoSQL is Big Data oriented.
- Consider NoSQL databases if availability and scalability is a strong requirement.
- SQL is still on the stage and very powerful (we still use Postgres)
- Are VO standards ready for NoSQL ?

Thank you