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KDD-IG and CANFAR

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NRC·CNRC From Discovery to Innovation... De la découverte à l'innovation...

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KDD-IG wants to deploy practical data mining algorithms:

“We will develop and test scalable data mining algorithms and the accompanying new standards for VObs interfaces and protocols, so that these algorithms can be discovered and used transparently within VO science workflows or in standalone data exploration applications.”

(KDD-IG draft charter)

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CANFAR provides an infrastructure:

“The Canadian Advanced Network for Astronomical Research (CANFAR) is a project ... to provide the delivery, processing, storage, analysis, and distribution of astronomical datasets of unprecedented size. ... The project builds on CADC's existing infrastructure to provide IVOA-compliant tools and services for astronomers, and access to Cloud Computing on the Compute Canada Grid, via a Virtual Machine environment.”

(CANFAR Statement of Work 2008)

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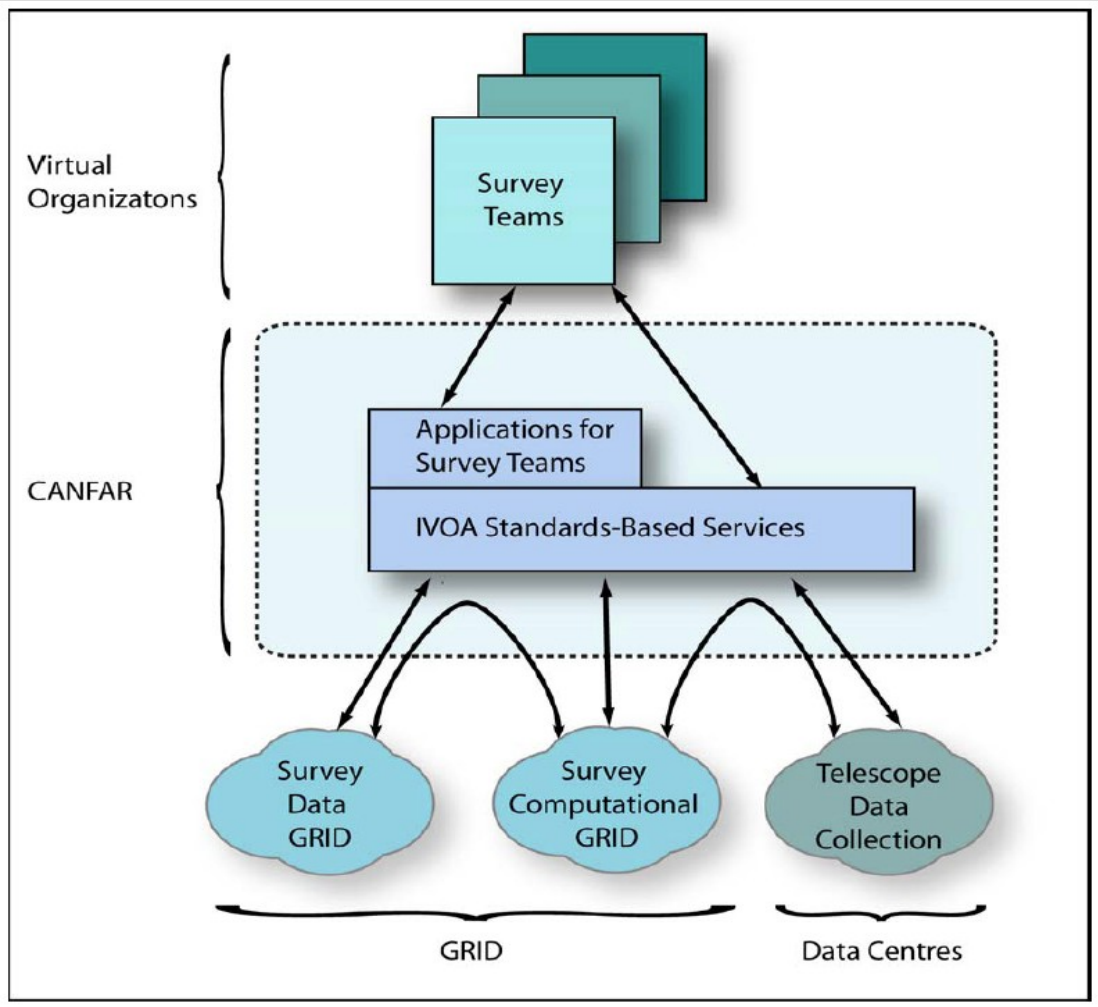
CANFAR infrastructure

http://www.astro.uvic.ca/~canfar



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But data mining algorithms have been N^2

Need NlogN to make them tractable on large datasets

Are now libraries available that do this

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E.g. Gray @ IJCAI '09

Computational complexity using fast algorithms

- **Querying:** nearest-neighbor **O(logN),** spherical range-search **O(logN),** orthogonal range-search **O(logN),** contingency table
- **Density estimation:** kernel density estimation **O(N) or O(1),** mixture of Gaussians **O(logN)**
- **Regression:** linear regression **O(D) or O(1),** kernel regression **O(N) or O(1),** Gaussian process regression **O(N) or O(1)**
- **Classification:** nearest-neighbor classifier **O(N)**, nonparametric Bayes classifier **O(N)**, support vector machine **O(N)**
- **Dimension reduction:** principal component analysis **O(D) or O(1)**, non-negative matrix factorization, kernel PCA **O(N) or O(1)**, maximum variance unfolding **O(N)**
- **Outlier detection:** by robust L_2 estimation, by density estimation, by dimension reduction
- **Clustering:** k-means **O(logN)**, hierarchical clustering **O(NlogN),** by dimension reduction
- **Time series analysis:** Kalman filter **O(D) or O(1),** hidden Markov model, trajectory tracking
- **2-sample testing:** n-point correlation **O(N^{logn})**
- **Cross-match:** bipartite matching **O(N) or O(1)**

http://www.astro.caltech.edu/~george/AIworkshop/presentations.html

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-> install NlogN - capable libraries on the CANFAR infrastructure

Develop using CADC expertise (includes Astronomy+CS)

If the libraries need developing, their authors, KDD-IG activities, and charter can help guide this

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Example Science:

What is the faint end slope of the galaxy luminosity function in the Virgo Cluster?

Use the Next Generation Virgo Survey (NGVS, a CANFAR project)

The LF faint end constrains the baryonic component of the concordance ΛCDM cosmological model

NGVS expected survey size: 2.6T

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Extract catalogue of objects: SExtractor, template matching, KSOM, MARSIAA, etc.

Classify them as star/galaxy/other: PSF, SVM, etc.

Are they in Virgo or the background: EM algorithm?

Fit functions to the LF: SWML, etc.

Photometric redshifts: kNN, full PDF

N-point correlation function

Detailed profile fitting for morphology: GALFIT

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The science is specific

But the tools are not

Could install as part of a basis set of software on CANFAR VMs

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Summary

NlogN data mining algorithms

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=

New science!

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