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Data Science in Science

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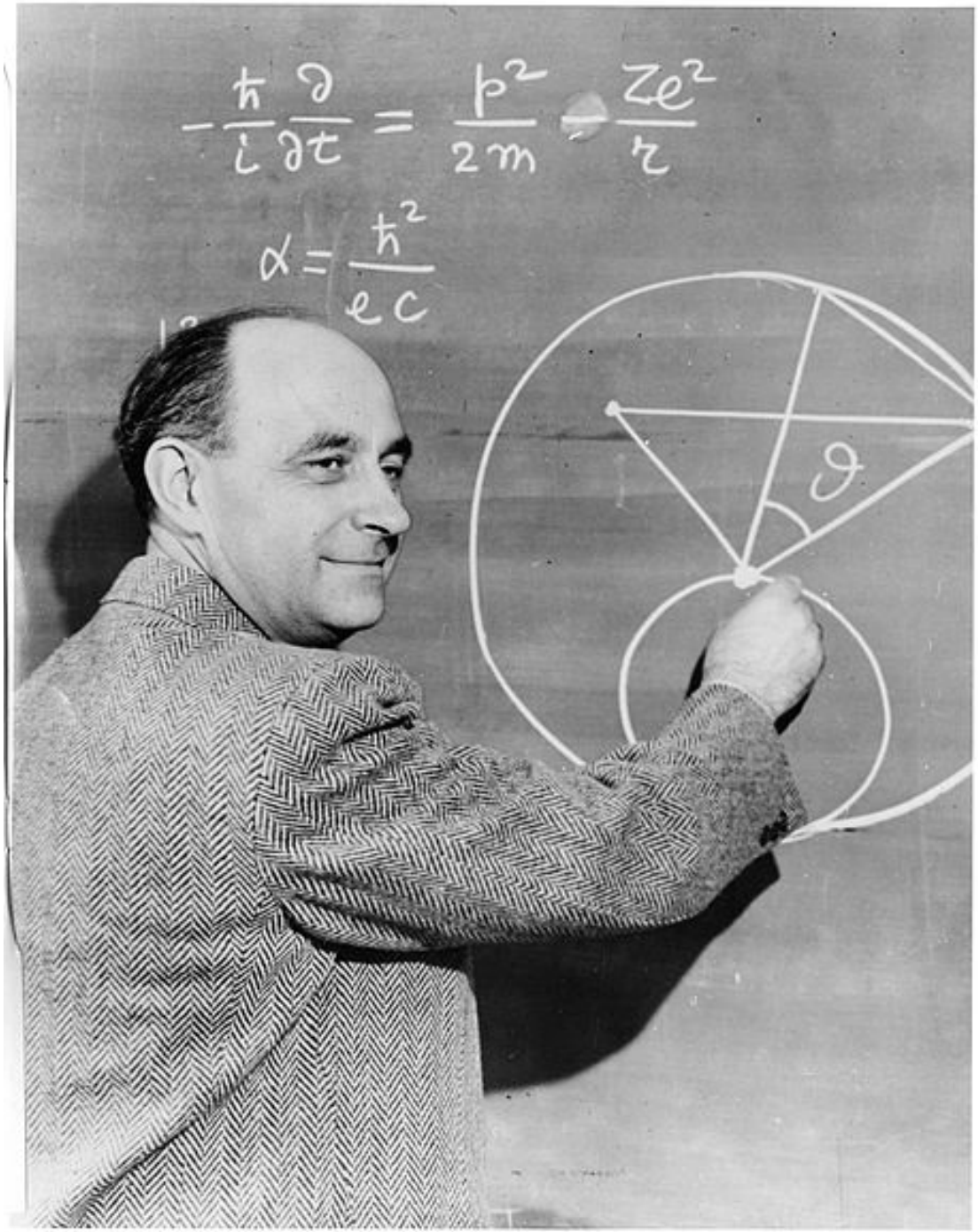
“eScience” = “Data Science”

public domain

Empirical

Theoretical

Computational



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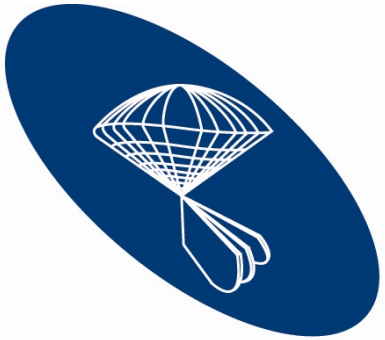


SLOAN DIGITAL SKY SURVEY

Science is about asking questions

Traditionally: "Query the world"
Data acquisition activities coupled to a specific hypothesis

eScience: "Download the world"
Data acquired en masse in support of many hypotheses

The cost of data acquisition has dropped precipitously thanks to advances in technology

- **Astronomy: High-resolution, high-frequency sky surveys (SDSS, LSST, PanSTARRS)**
- **Life Sciences: lab automation, high-throughput sequencing,**
- **Oceanography: high-resolution models, cheap sensors, satellites**

The cost of finding, integrating, and analyzing data, then communicating results, is the new bottleneck

eScience is driven by *data* more than by computation

- Massive volumes of data from sensors and networks of sensors

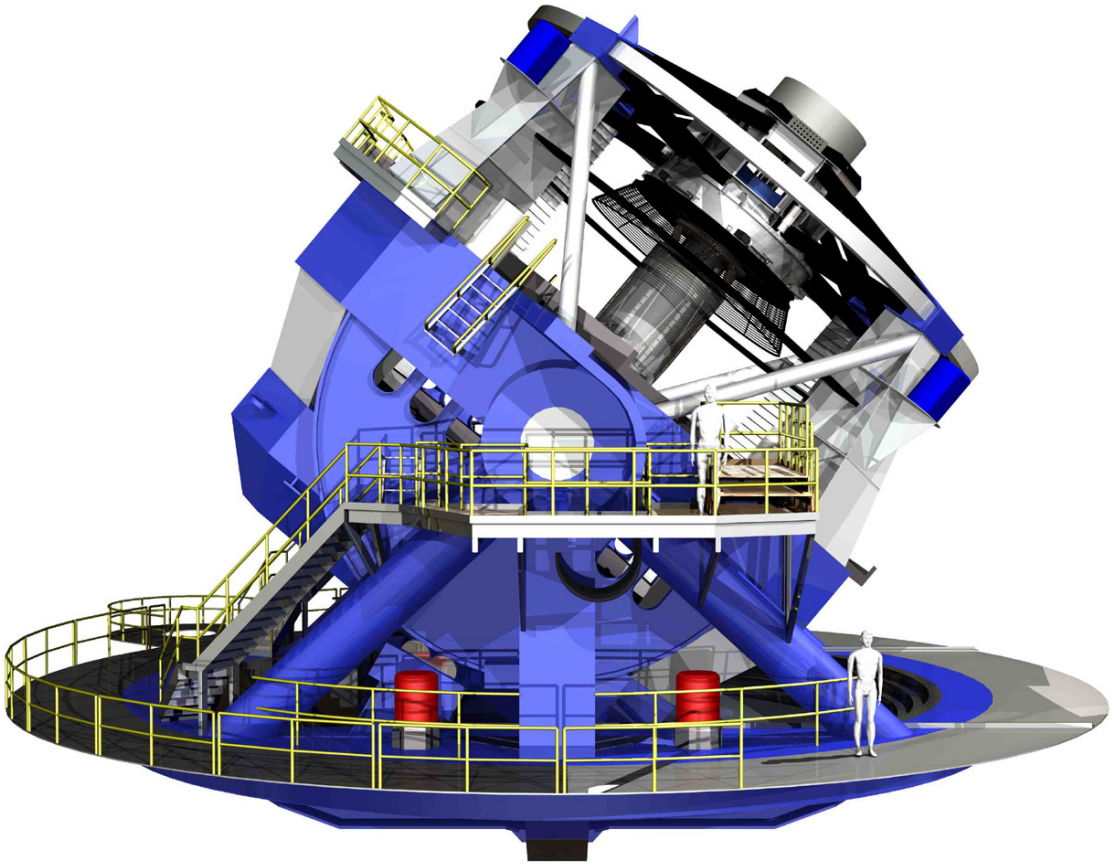
Apache Point telescope, SDSS

80TB of raw image data (80,000,000,000,000 bytes) over a 7 year period

Large Synoptic Survey Telescope (LSST)

40TB/day (an SDSS every two days), 100+PB in its 10-year lifetime

400mbps sustained data rate between Chile and NCSA



Illumina HiSeq 2000 Sequencer

~1TB/day

Major labs have 25-100 of these machines

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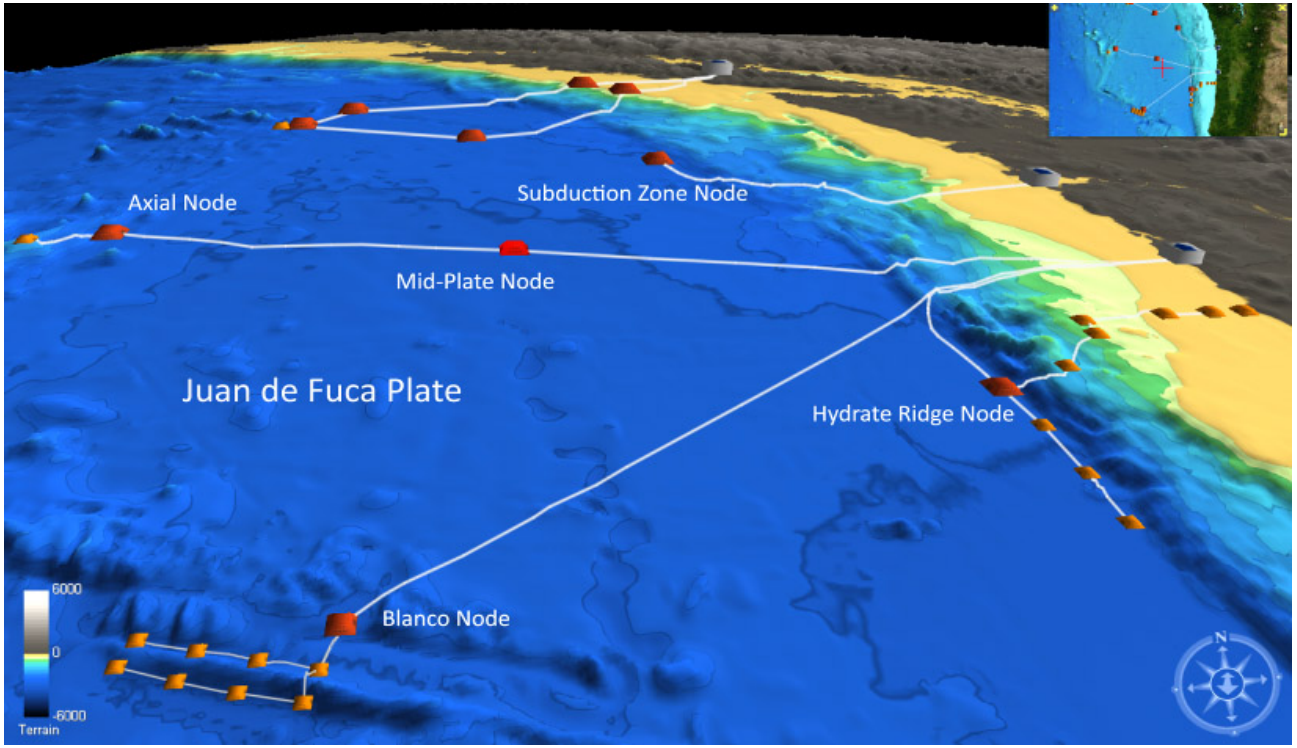
Regional Scale Nodes of the NSF Ocean Observatories Initiative

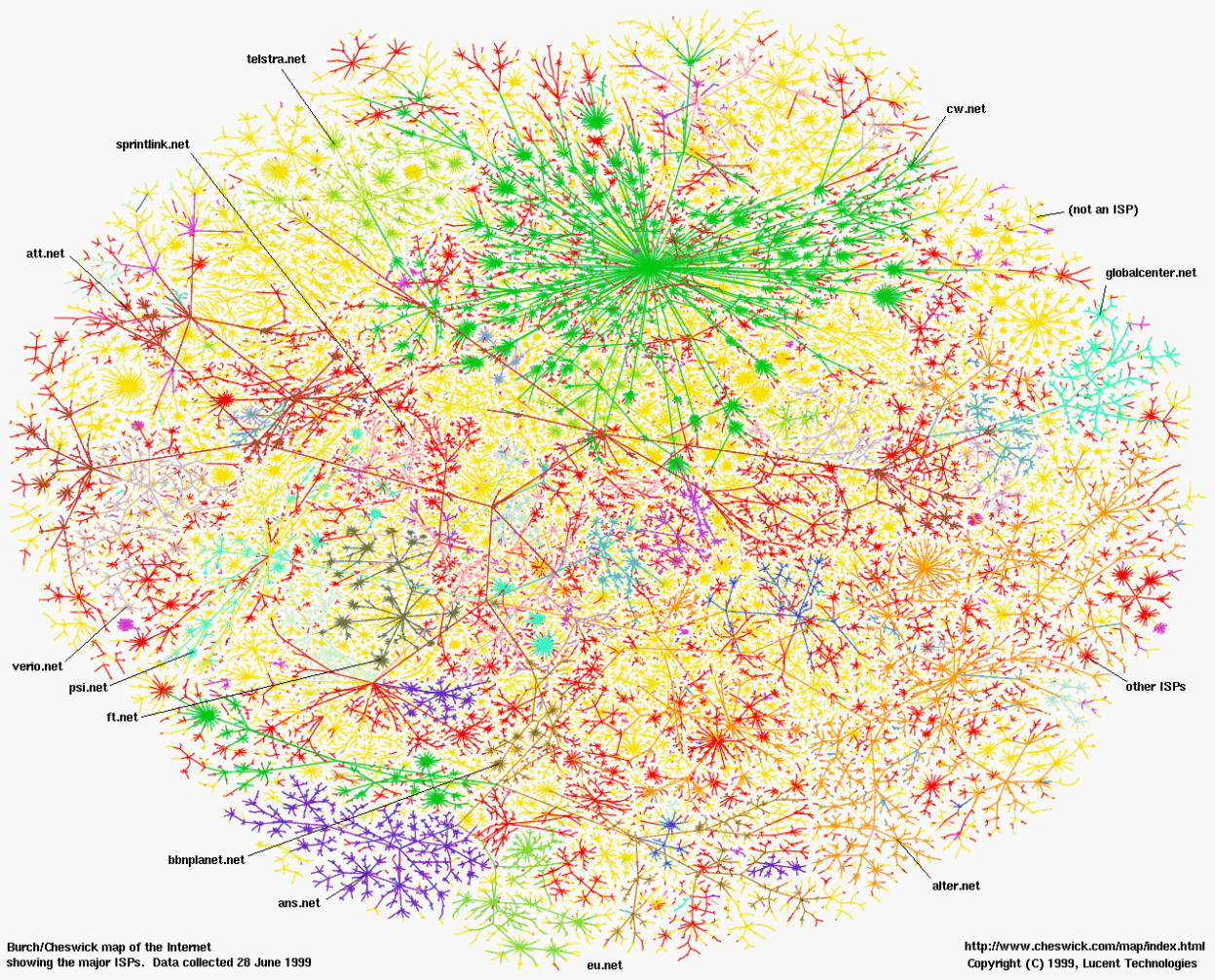
1000 km of fiber optic cable on the seafloor, connecting thousands of chemical, physical, and biological sensors



The Web

20+ billion web pages x 20KB = 400+TB

One computer can read 30-35 MB/sec from one disk => 4 months just to read the web



eScience is about the *analysis* of data

- The automated or semi-automated extraction of knowledge from massive volumes of data
  - There's simply too much of it to look at
  - But it's not just a matter of volume
- The Three V's of Big Data:
  - Volume: number of rows / objects / bytes
  - Variety: number of columns / dimensions / sources
  - Velocity: number of rows / bytes per unit time
- More V's:
  - *Veracity: Can we trust this data?*

Summary

- Science is in the midst of a generational shift from a data-poor enterprise to a data-rich enterprise
- Data analysis has replaced data acquisition as the new bottleneck to discovery

- What does this have to do with business?

Business is beginning to look a lot like science

- Acquire data aggressively and keep it around
- Hire data scientists
- Make empirical decisions