R / Python and Big Data; openEO

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Big Data Analytics & GIS September 21-22, Münster

Who am I?

- User, and contributor, of open source software since 1997
- Active member of the R community since 2003
- Professor at ifgi since 2007
- Editor for the Journal of Statistical Software, and Computers & Geosciences
- actively in search for the meaning of *open science*

Open Science (or: why I don't use ESRI software)

- transparency is a key pilar in science: everything needs to be questioned, all details need to be scrutinized
- in geoinformatics, an important component of research is the computational manipulations of data ("from data to information")
- only open source software fully discloses all details of scientific computation
- equivalent to how *open access* opens access to published text, *open source software* reveals the details of computational procedures underlying scientific findings
- ESRI's take on "open" (search: "ESRI's open vision"):
  - commit to interoperability
  - let users share open data and collaborate
  - promote open source software that binds to ESRI's software

  these goals are fine to engineer solutions, but not sufficient for open science

Reproducibility

- Reproducibility is an important aspect of scientific research, because the credibility of science is at stake when research is not reproducible (Pebesma/Nüst/Bivand 2012, Eos 93(16), 163-164).
- DFG guidelines of good scientific practice require researchers to be able to reproduce all findings at least 10 years after finishing each funded project
- in practice this means that along with a paper, we have to share and archive:
  - the data used
  - the code or scripts used
  - the runtime (OS, executables)
- this is not a problem, unless you use licensed software and proprietary OSs.

What can we do?

- use scripting languages; for data science: R, Python, Julia
- use literate programming (R Sweave / R markdown / Jupyter notebooks, etc.)
- reuse (open source) software that others use
- develop, and share, software that others benefit from
- publish methods, but also about software!

⇒ this all contributes to a shared understanding of science, and by that of our world

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Big data: what is it?

It is: ... big. Meaning: large in volume.

- it doesn't fit on your computer
- it doesn't fit on your large computer
- it takes long to summarize to small data
- it's hard to interact with
- most data you and I work with is not big.

Of the existing non-spatial solutions, what are they used for?

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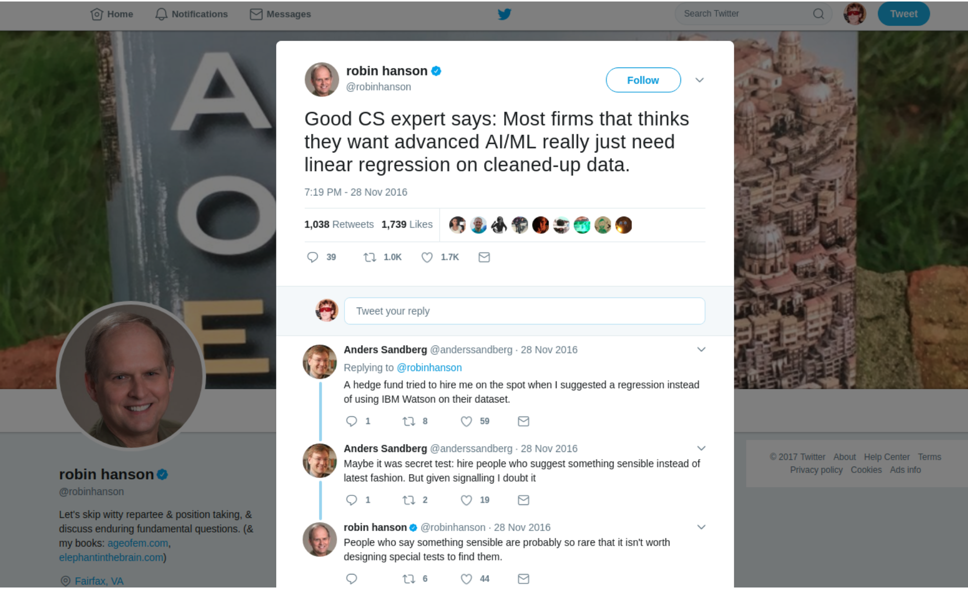
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robin hanson @robinhanson

Good CS expert says: Most firms that thinks they want advanced AI/ML really just need linear regression on cleaned-up data.

7:19 PM - 28 Nov 2016

1,038 Retweets 1,739 Likes

39 1.0K 1.7K

Anders Sandberg @anderssandberg · 28 Nov 2016

Replying to @robinhanson

A hedge fund tried to hire me on the spot when I suggested a regression instead of using IBM Watson on their dataset.

1 8 59

Anders Sandberg @anderssandberg · 28 Nov 2016

Maybe it was secret test: hire people who suggest something sensible instead of latest fashion. But given signalling I doubt it

1 2 19

robin hanson @robinhanson · 28 Nov 2016

People who say something sensible are probably so rare that it isn't worth designing special tests to find them.

6 44

robin hanson @robinhanson

Let's skip witty repartee & position taking, & discuss enduring fundamental questions. (& my books: ageofem.com, elephantinthebrain.com)

Fairfax, VA

Spatial / spatiotemporal data

- most programming languages have built-in support for time data, but not for spatial data
- most statistical and ML methods assume *independent* observations: order of records in a table doesn't matter; many spatiotemporal methods cannot assume this
- is the algorithm embarrassingly parralel? CA: chunking-averaging (Matloff 2016, JSS 74(4)); map-reduce.
- non-trivial: image segmentation, watershed deliniation, routing through network, interacting agents (Th. Paschke)
- how to chunk: by pixel (time series), by time (scene collection), or both?

Python

- pandas: Python Data Analysis Library (`DataFrame`, time series)
- Dask: a flexible parallel computing library for analytic computing.
- GeoPySpark: a Python language binding library of the Scala library GeoTrellis.
- xarray: N-D labeled arrays and datasets (CDM, NetCDF; integrates well with Dask)
- general purpose; distributed community;
- `from osgeo import gdal`

Julia

- belongs in the data science scripting languages tripple “R - python - Julia”
- quite young
- learned from experiences in R and python
- emphasis on performance
- relatively little usage; research stage?

R

- R is a free software environment for statistical computing and graphics.
- oldest of the three; originally written for interactive analysis (REPL), rather than performance
- data in memory; upcoming ALTREP changes this
- R is extendible; on CRAN, over 11,000 extension packages
- most developers are users too
- CRAN task views of interest: HighPerformanceComputing, Spatial, SpatioTemporal, TimeSeries
- strong, friendly and centered community

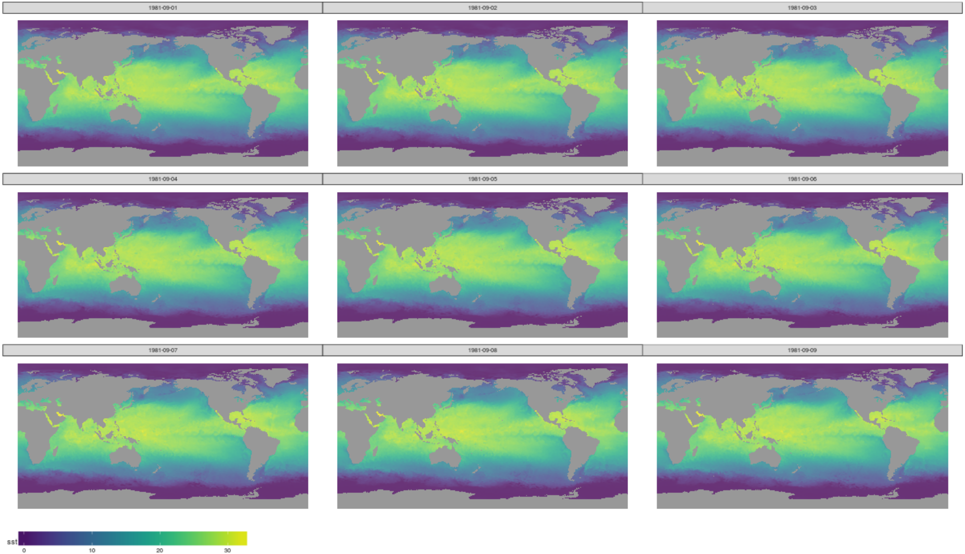
R for big data

- `dplyr`: interface to tabular data, internal, or external: PostgreSQL, MariaDB, MonetDB, Impala, Spark, Hyve, BigQuery, ... ; translates R expressions to SQL
- `matter` (BioConductor): a framework for rapid prototyping with binary data on disk
- `parallel`: multicore, multi-workstation (incl. MPI)
- (direct spark or hadoop interfaces)

... for big spatiotemporal data:

- `dplyr`: might work for spatial databases
- `SciDBR`, `scidb4geo`: interface to SciDB array database
- `raster`: data cube (3D) from (band/z/t) collection of tiles; on-disk
- `stars`: R Consortium funded project (under development; e.t.a. 2018); includes remote storage and computing
- openEO.org

```
> x
[1] "avhrr-only-v2.19810901.nc" "avhrr-only-v2.19810902.nc"
[3] "avhrr-only-v2.19810903.nc" "avhrr-only-v2.19810904.nc"
[5] "avhrr-only-v2.19810905.nc" "avhrr-only-v2.19810906.nc"
[7] "avhrr-only-v2.19810907.nc" "avhrr-only-v2.19810908.nc"
[9] "avhrr-only-v2.19810909.nc"
> (y = st_stars(x, quiet = TRUE))
stars object with 4 dimensions and 4 attributes
attribute(s):
 sst [degrees_C]   anom [degrees_C]   err [degrees_C]   ice [percentage]
 Min.   :-1.8      Min.   :-8.2       Min.   :0.1       Min.   :0
 1st Qu.: 1.4      1st Qu.:-0.5       1st Qu.:0.1       1st Qu.:1
 Median :14.3      Median : 0.0       Median :0.3       Median :1
 Mean   :13.7      Mean   :-0.1       Mean   :0.3       Mean   :1
 3rd Qu.:25.1      3rd Qu.: 0.4       3rd Qu.:0.3       3rd Qu.:1
 Max.   :33.9      Max.   : 5.6       Max.   :1.0       Max.   :1
 NA's   :3110850   NA's   :3110850    NA's   :3110850   NA's   :8094523
dimension(s):
     from   to     offset  delta                            refsys
x       1 1440          0   0.25 +proj=longlat +datum=WGS84 +no_defs
y       1  720         90  -0.25 +proj=longlat +datum=WGS84 +no_defs
time    1    9 1981-09-01 1 days                           POSIXct
zlev    1    1   0 meters     NA                                NA
```


1981-09-01
1981-09-02
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ArcGIS-R bridge

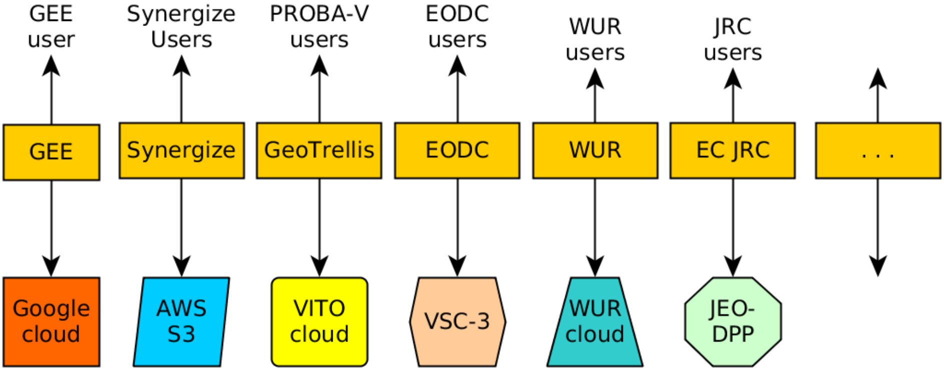
- R is (mostly) GPL, how can closed source software link to it?
- (ESRI's) lawyers say it's a gray zone, but think it is all right (...)
- Why doesn't ArcGIS bridge to TERR (Tibco Enterprise R Runtime)? Customers don't like to pay for that.
- If you contribute to R-ArcGIS bridge functions, you contribute to ESRI, and not to Open Science

openEO.org

A Common, Open Source Interface between Earth Observation Data Infrastructures and Front-End Applications

- H2020 project funded under call EO-2-2017: EO Big Data Shift
- Oct 2017 – Sept 2020.
- TU Wien (Coordinates), ifgi, WUR, VITO, EODC, Mundialis, Sinergise, EURAC Research, Solenix, JRC, (Google)
- background: EO data are too large to download
- we all work on the same satellite imagery, but how do R/python/javascript users access these?
- heterogeneity: choosing one cloud platform is such an investment that nobody validates outcomes against another
- choosing a set of abstractions (data models) and interfaces (processes), implement use cases against different backends
- side effect: makes cloud offerings comparable, in terms of data, functionality and costs

`http://r-spatial.org/2016/11/29/openeo.html`


GEE user
Synergize Users
PROBA-V users
EODC users
WUR users
JRC users
GEE
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GeoTrellis
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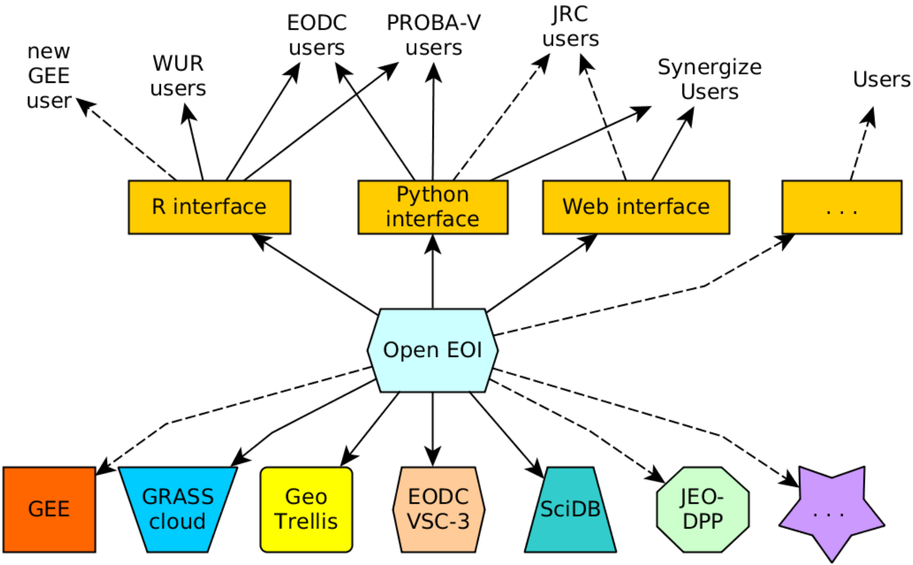
AWS S3
VITO cloud
VSC-3
WUR cloud
JEO-DPP


new GEE user
WUR users
EODC users
PROBA-V users
JRC users
Synergize Users
Users
R interface
Python interface
Web interface
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Open EOI
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GRASS cloud
Geo Trellis
EODC VSC-3
SciDB
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