UNIVERSITY OF TWENTE.

RESEARCH SOFTWARE FOR SPATIAL STATISTICS AND GEO-HEALTH

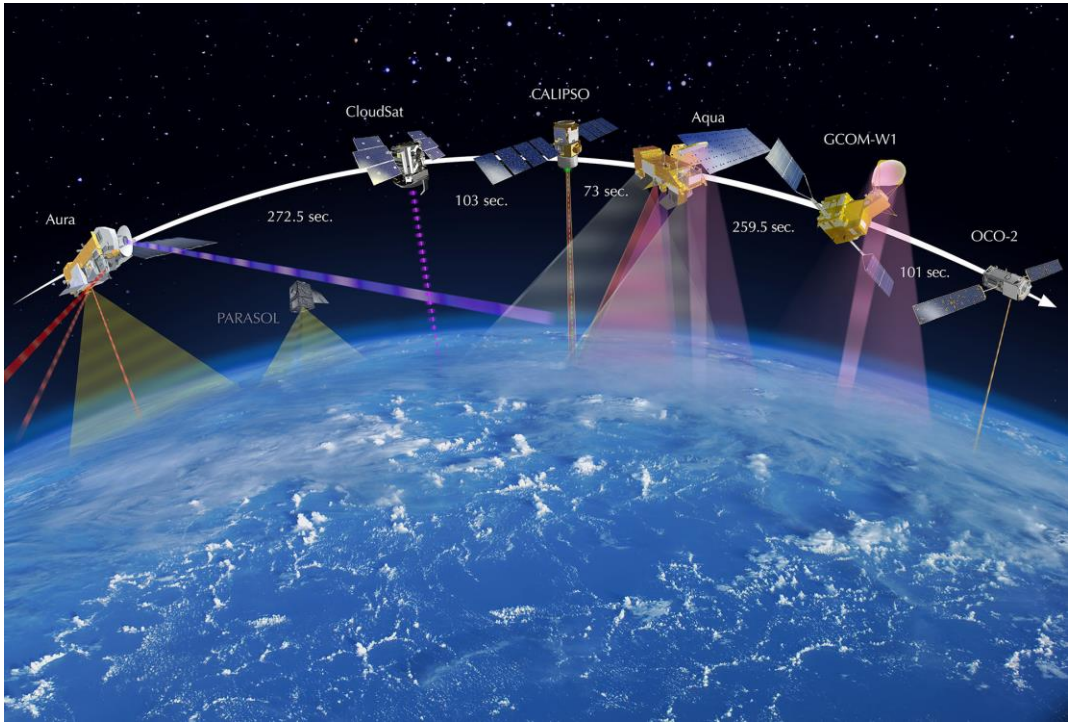
FRANK B OSEI

EARTH OBSERVATION SCIENCE

ITC FACULTY OF GEO-INFORMATION SCIENCE AND EARTH OBSERVATION

THE EOS DEPARTMENT

- The department of Earth Observation Systems (EOS) positions itself as a department of **science**, **covering core science as far as this is relevant for earth observation and data quality in relation to building on capacity**

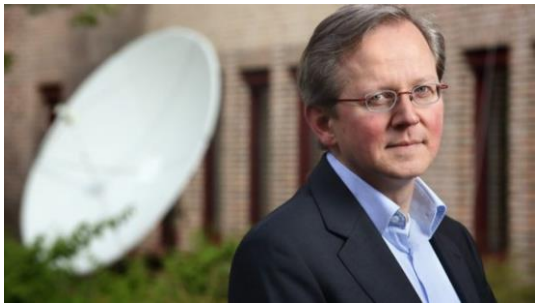


OUR RESEARCH GROUP LEADERS: THEY ARE AMIABLE

- **Spatial Statistics and Image analysis**
  Chair *Prof. dr. ir.* Alfred Stein

- **Geo-information Extraction with Sensor Systems**

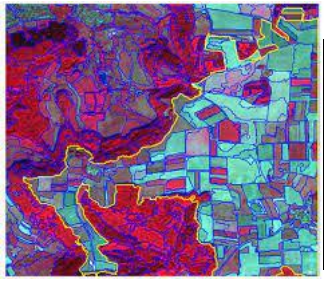
Chair *Prof. dr. ir.* George Vosselman

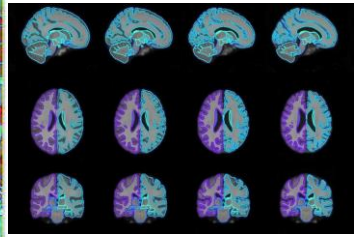


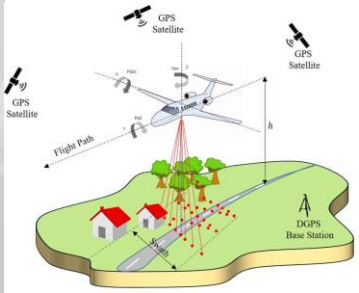
- **Geo-health**
  Chair *Prof. dr.* Justine Blanford

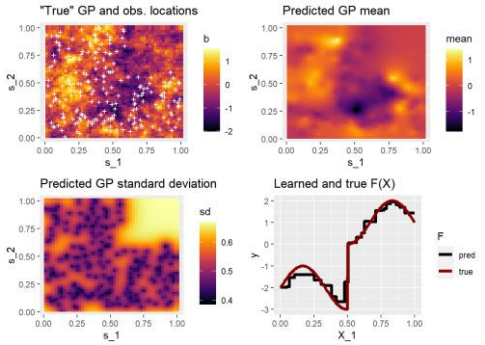
OUR KEY WORDS

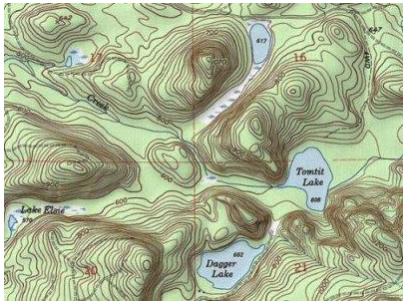
- Spatial statistics, photogrammetry, data quality, topographic mapping, air borne and mobile laser scanning, image analysis

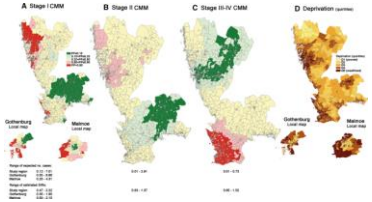






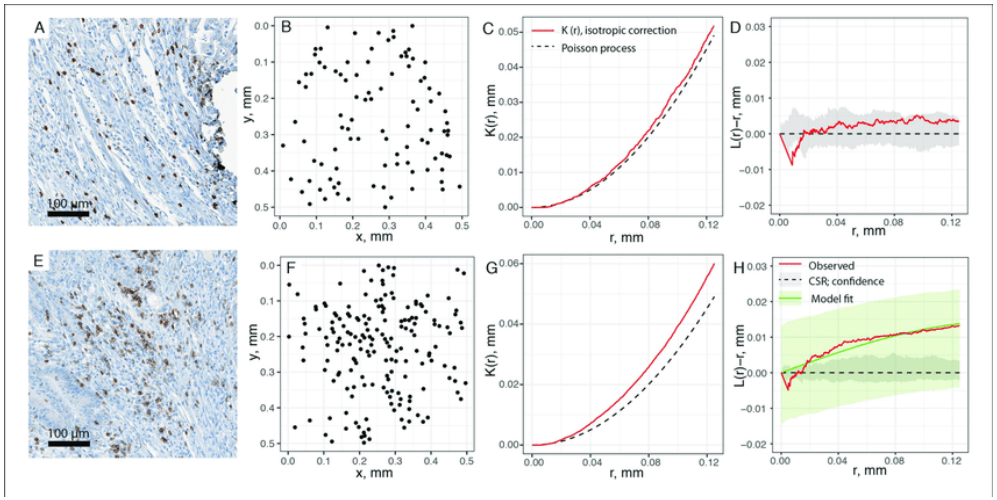






GeoHealth

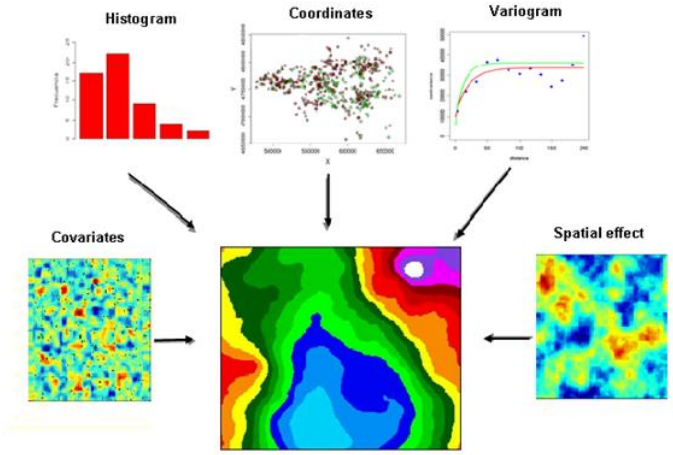
SPATIAL STATISTICS: EXPLORE, MODEL, AND PREDICT GEOGRAPHICALLY REFERENCED DATA



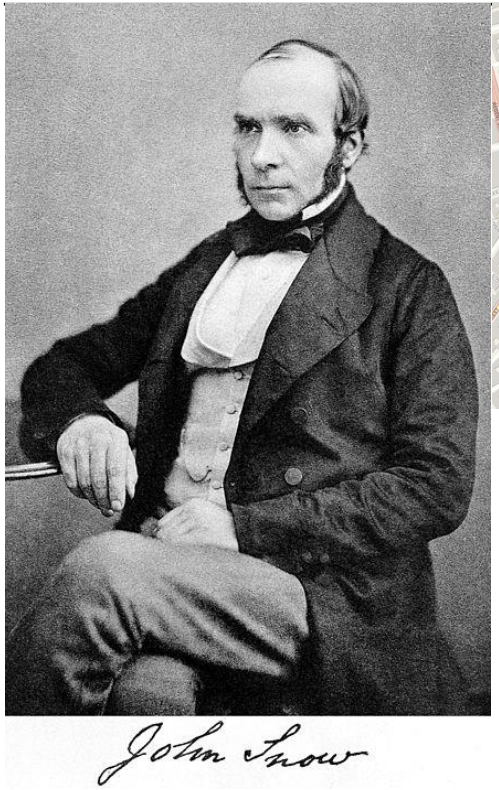
$$\hat{r}(s_0, t_0) = \boldsymbol{\mu} + \boldsymbol{\lambda}_{st}^T [\mathbf{r}(s,t) - \boldsymbol{\mu}]$$

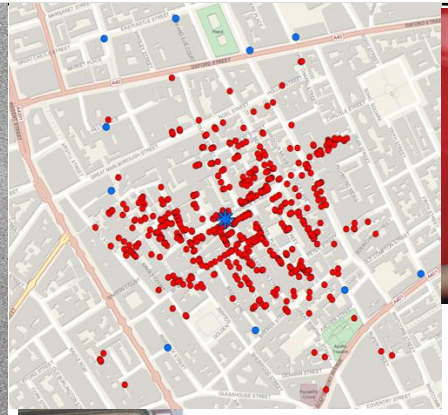
$$\begin{pmatrix} \boldsymbol{\lambda}_{st} \\ \psi \end{pmatrix} = \begin{pmatrix} \boldsymbol{\gamma}_{st,0} \\ 1 \end{pmatrix}^T \begin{pmatrix} \boldsymbol{\gamma}_{st} & 1 \\ 1^T & 0 \end{pmatrix}^{-1}$$

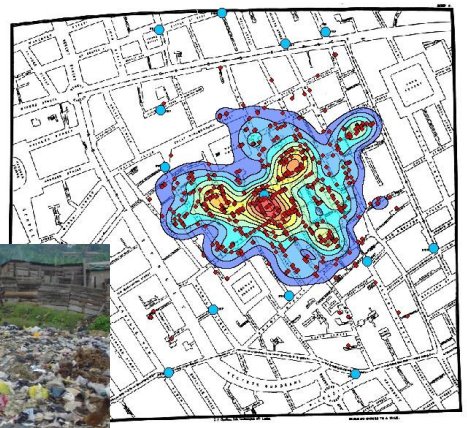
$$RMSE_{st} = \sqrt{\frac{1}{m \times T} \sum_{i=1}^{m} \sum_{j=1}^{T} [r(s_i, t_j) - \hat{r}(s_i, t_j)]^2}$$



GEO-HEALTH: EXPLORE, MODEL, AND PREDICT GEOGRAPHICALLY REFERENCED HEALTH DATA







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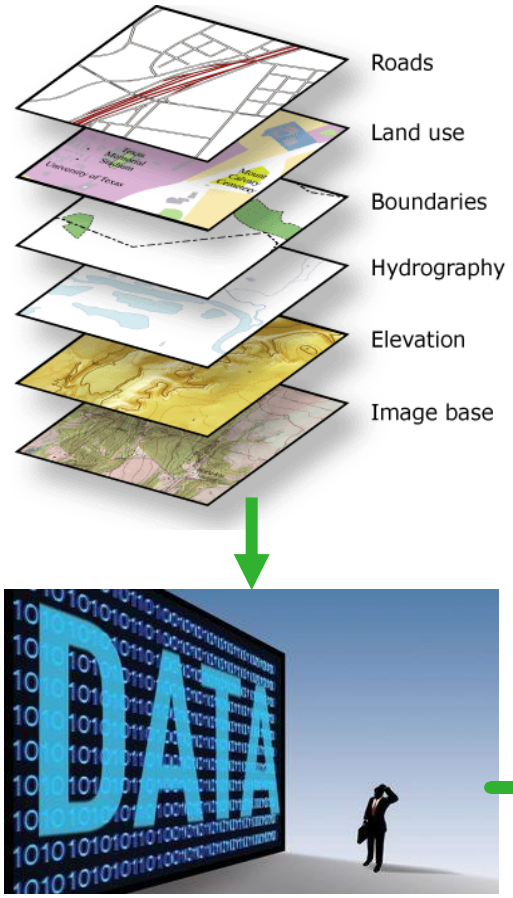
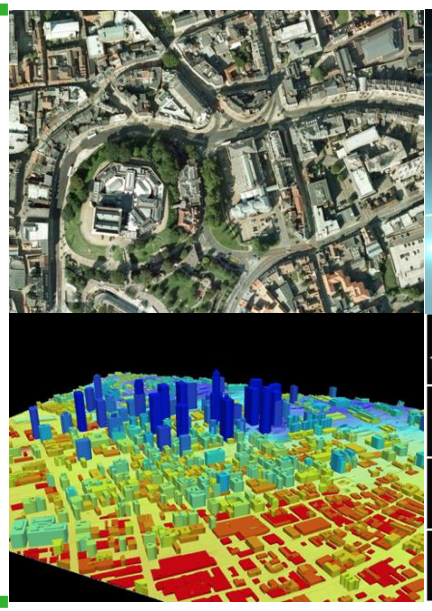
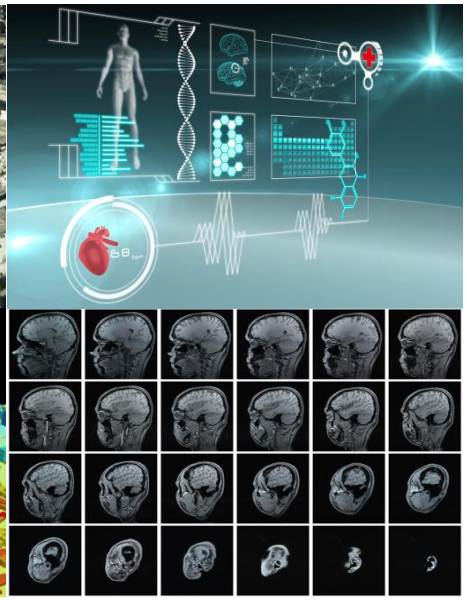
GEOSPATIAL DATA TO COMPLEMENT GEO-HEALTH



- Geography is the common attribute



Remote sensing data



Health care data

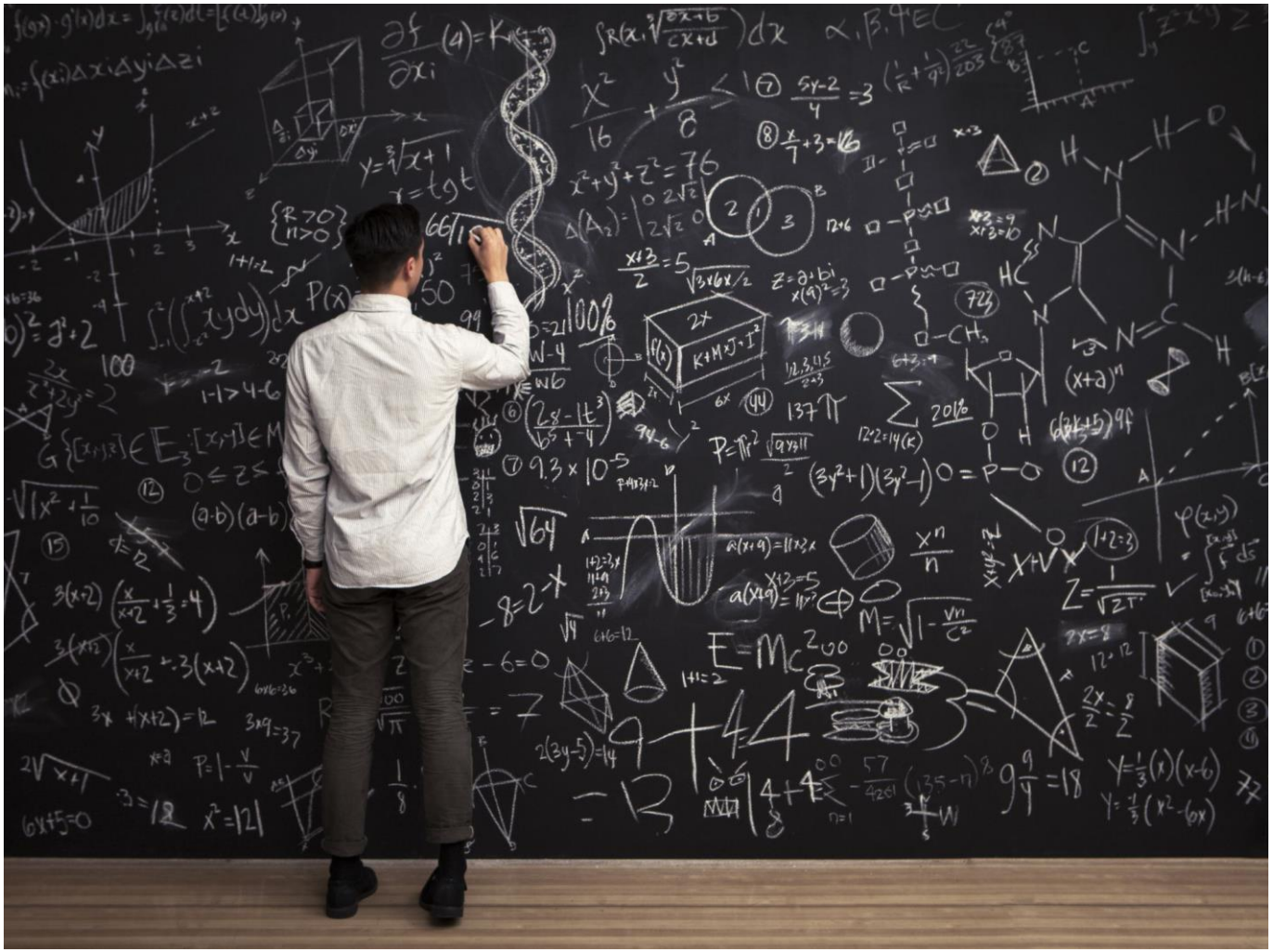
SPATIAL STATISTICS AS THE HUB OF GEO-HEALTH

GeoHealth

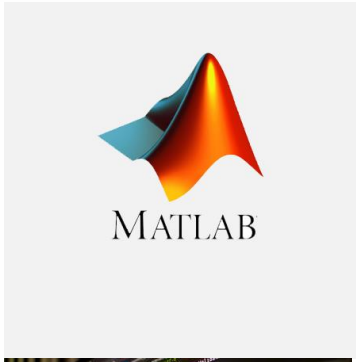
WHAT ANSWERS……

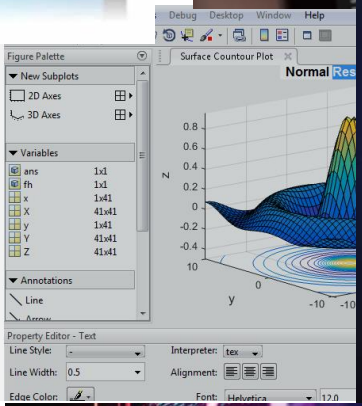
- **Spatial Statistics and Geo-Health** answers a lot of spatial and space-time epidemiological questions

TO GET THE ANSWERS REQUIRE A LOT OF COMPUTATIONS

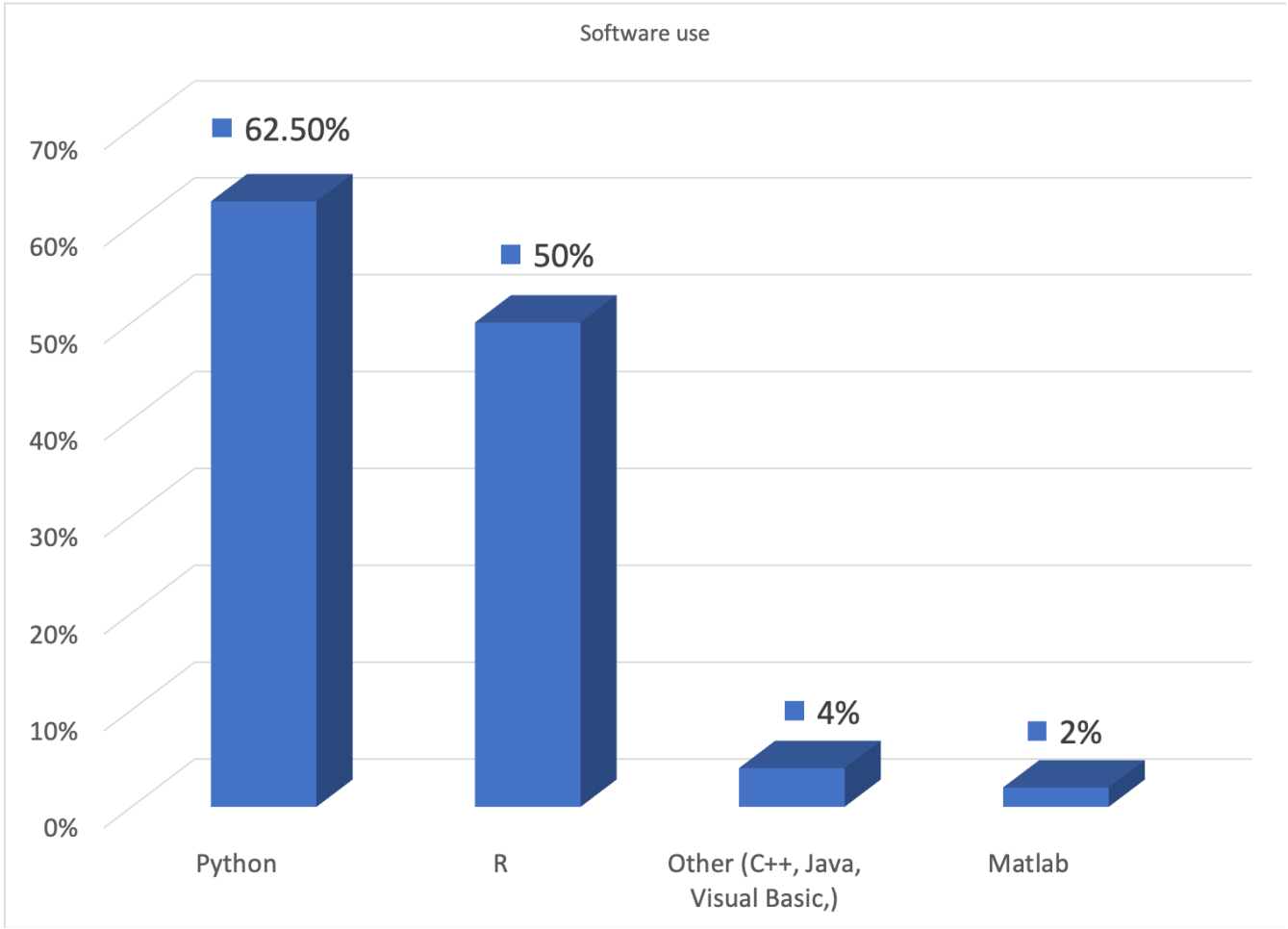


SOFTWARE USAGE





SOFTWARE USAGE (OVERLAPPING)AS AT 2021



SOFTWARE FOR SPATIAL STATISTICS AND GEO-HEALTH

GeoHealth

GeoDa™

SaTScan™
Software for the spatial, temporal, and space-time scan statistics

cran/rgdal
! This is a read-only mirror of the CRAN R package repository. rgdal — Bindings for the 'Geospatial' Data Abstraction...
1 Contributor 0 Issues 5 Stars 9 Forks
META CRAN

R spdep package

```
# Get the neighbours of each county
>eire.nb <- poly2nb(eireMap)
# Examine contiguity
>summary(eire.nb)
>plot(eire.nb, coordinates(eire), add=TRUE)
# Draw Eire with county names
>plot(eireMap)
>text(coordinates(eireMap),
   labels=as.character(eireMap$names), cex=0.4)
# You can check what a function does by using help.
# e.g. help(invisible)
```

pervouchine/
maptools
This package contains lift-over and other alignment tools
1 Contributor 0 Issues 0 Stars 0 Forks

CRAN R
The Comprehensive R Archive Network

cran/R2WinBUGS
! This is a read-only mirror of the CRAN R package repository. R2WinBUGS — Running 'WinBUGS' and 'OpenBUGS' from 'R'...
0 Contributors 0 Issues 2 Stars 2 Forks
META CRAN

cran/R2OpenBUGS
! This is a read-only mirror of the CRAN R package repository. R2OpenBUGS — Running OpenBUGS from R
1 Contributor 0 Issues 1 Star 1 Fork
META CRAN

SUSTAINABLE ????

- **Sustainable software**, also known as sustainable **Green software**, is **software that is designed, developed and implemented to limit energy consumption and have minimal environmental impact**.

Hard-sustainability
- Rack system workstation
- Common cooling room

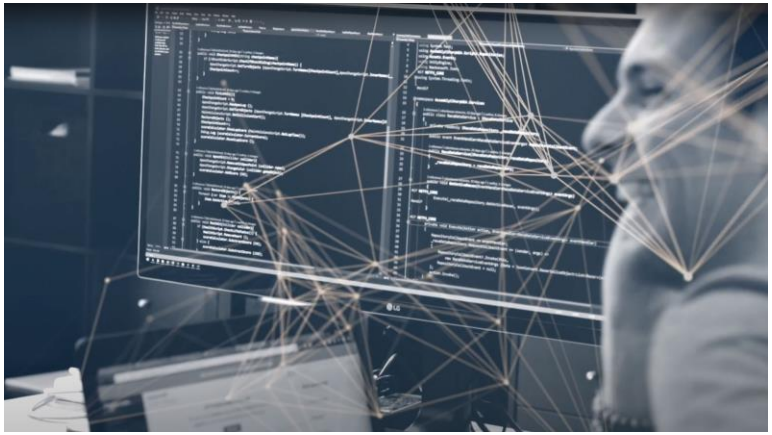
Soft-sustainability
- Optimized algorithms

HARDWARE SUSTAINABILITY: OUR CONTRIBUTION

- Hard-sustainability: computer rack at UT data center
  - a physical chassis that can house multiple computers or servers simultaneously.
  - Reduces space
  - Same cooling for multiple computers
  - Shift the burden of management from academic staff

SOFTWARE SUSTAINABILITY: OUR CONTRIBUTION

- **As a department**
- *Bringing the pieces together*
  - Software Engineer: From 1-6-2017 until 31-5-2019.



- **As individual scientist**
  - *Optimize code to reduce computation cost and time*
  - *Optimize data (parameterize data)*

```
for (j=1; j<=4,j++)
{
      a[j]=3;
      a[j]=a[j]*2*h;
};
for (k=1;k<=4;k++)
{
      b[k]=6;
      b[k]=b[k]+3*k*k;
};
```

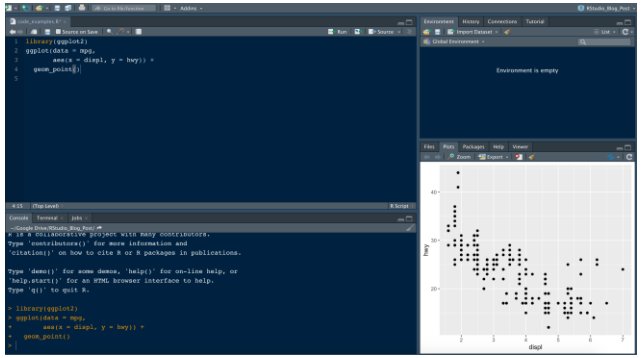
For instance, The **Cholesky decomposition** (**Cholesky factorization)** is roughly twice as efficient as the LU decomposition for solving systems of linear equations.

A FOCUS ON R

- Is **R** sustainable?
- **R** is a **FREE SOFTWARE** environment for statistical computing and graphics. It compiles and runs on a wide variety of UNIX platforms, Windows and MacOS

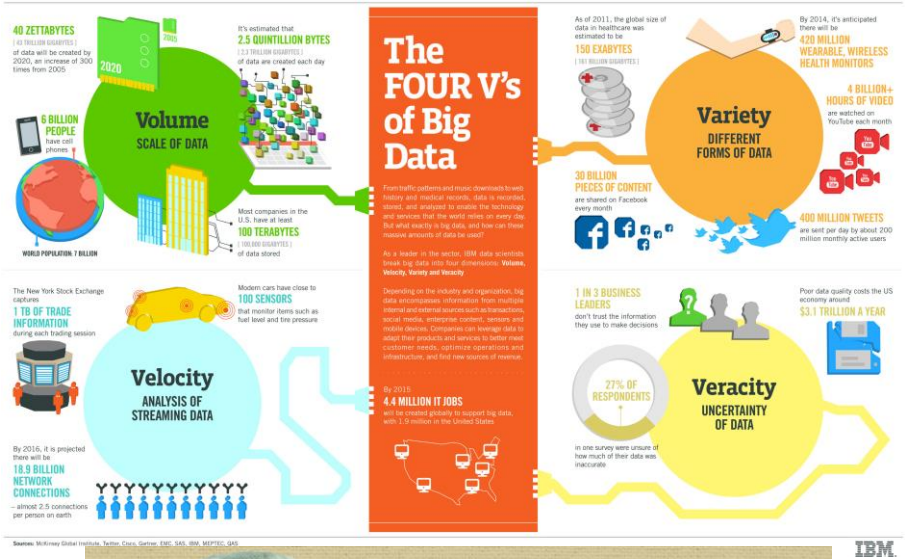
- **RStudio** is an integrated development environment for R
- **CRAN** is a network of ftp and web servers around the world that store identical, up-to-date, versions of code and documentation for R

- **R or Python?**
  - Let's discuss latter



IS THE FUTURE SUSTAINABLE ???

Big data is here; opportunity or setback



BUT

Thank You