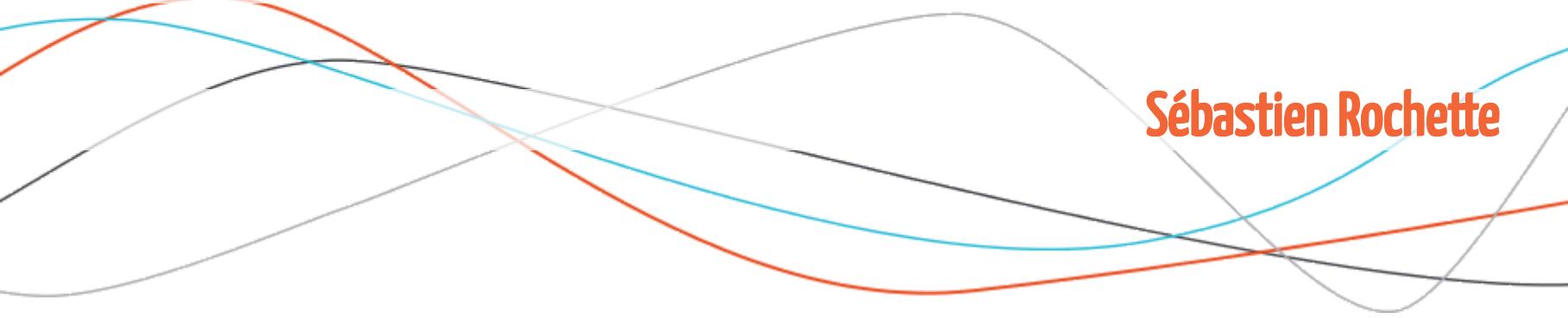


Everything but maps with spatial tools

SatRday Paris 2019



Sébastien Rochette



What are spatial data ?

Images of the world:

- Data associated with a position using coordinates
- Position on Earth is X/Y (long/lat): Earth is flat 🤦



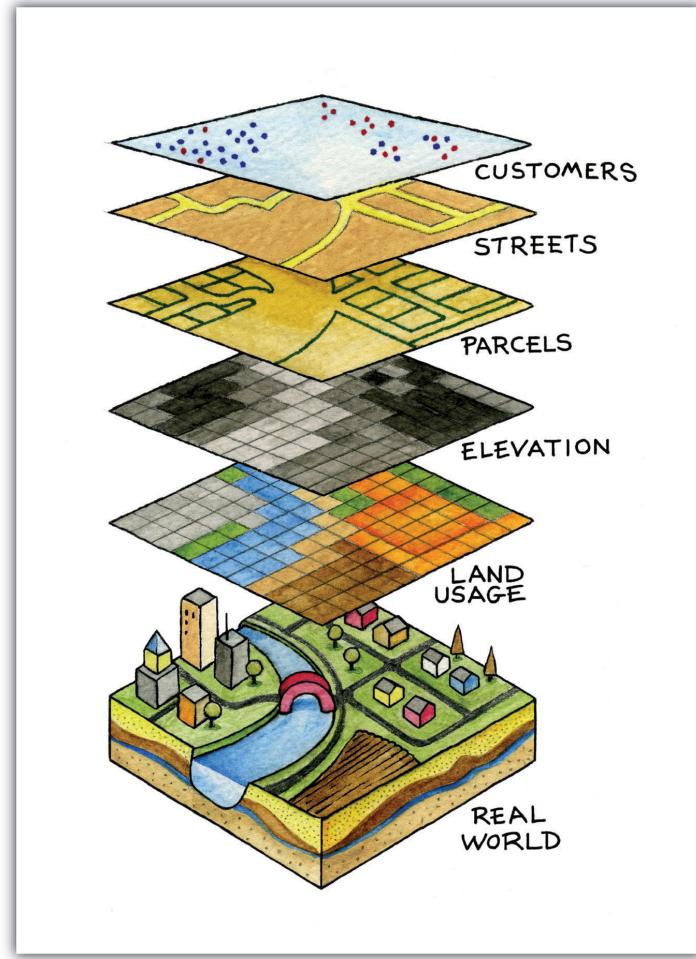


What are spatial data ?

Images of the world:

- Rasters: grids
- Vectors: points, lines, polygons

<https://2012books.lardbucket.org/books/geographic-information-system-basics/s11-02-multiple-layer-analysis.html>





I have a problem



I have a problem

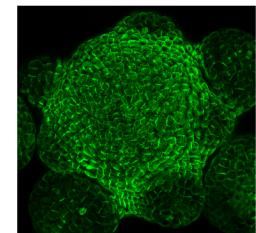
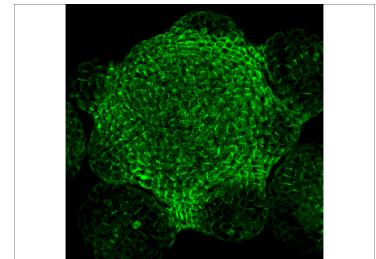
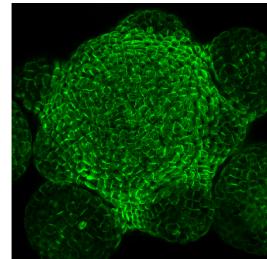
An image is a raster

- Read with {raster}, {terra} (=future of {raster} with C++) or {stars}
 - Rely on "GDAL" library: <https://gdal.org/>

```
img <- here:::here("satrday_paris_supp",
"Proj_2015-01-13_MBD_dis_indent_A_T0.png")
# raster
r_raster <- raster::stack(img)
raster:::plotRGB(r_raster)

# terra
r_png <- png::readPNG(img)
r_terra <- terra::rast(r_png)
pal <- colorRampPalette(c("black", "green"))(10)
image(r_terra, 2, col = pal, asp = 1)

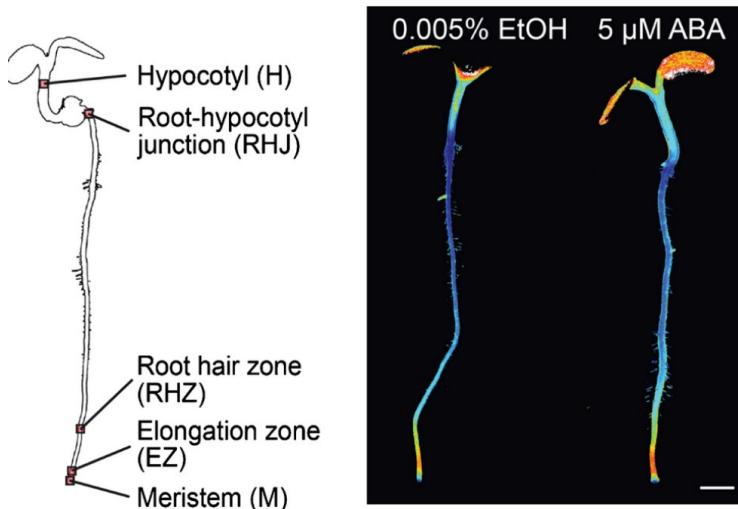
# stars
r_stars <- stars::read_stars(img)
stars:::image.stars(r_stars, rgb = 1:3)
```



Matrices are rasters

How to use geostatistical indices to compare matrices 1D+time correlation?

- Work with [cell biologist, Dr Rainer Waadt](#)
 - Imaging of calcium and abscisic acid signal in roots
 - Data from [Waad et al., 2017](#)
 - Data in Excel file (one column for each time step)

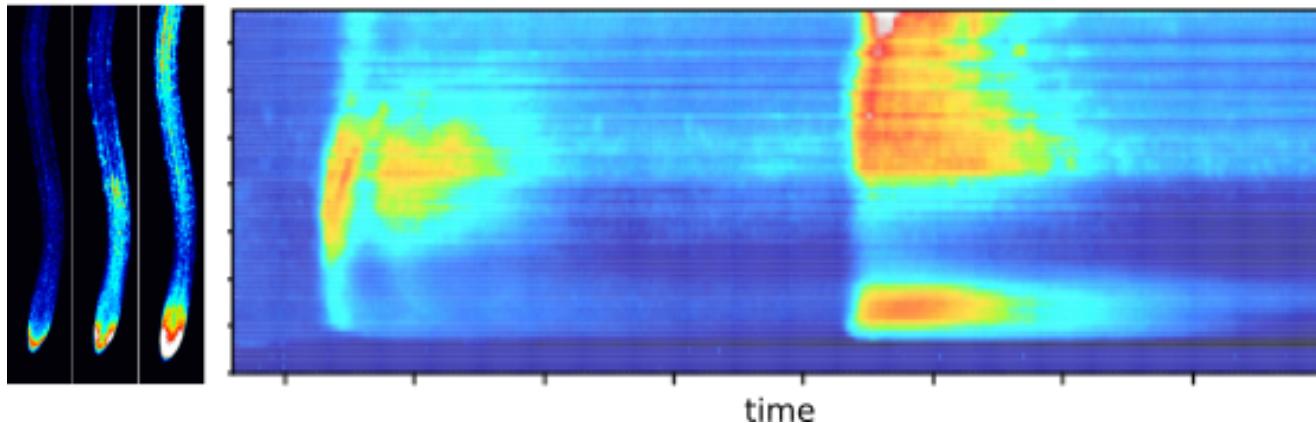


Waad, R. , Krebs, M. , Kudla, J. and Schumacher, K. (2017), Multiparameter imaging of calcium and abscisic acid and high-resolution quantitative calcium measurements using R-GECO1-mTurquoise in *Arabidopsis*. *New Phytol*, 216: 303-320. [doi:10.1111/nph.14706](https://doi.org/10.1111/nph.14706)

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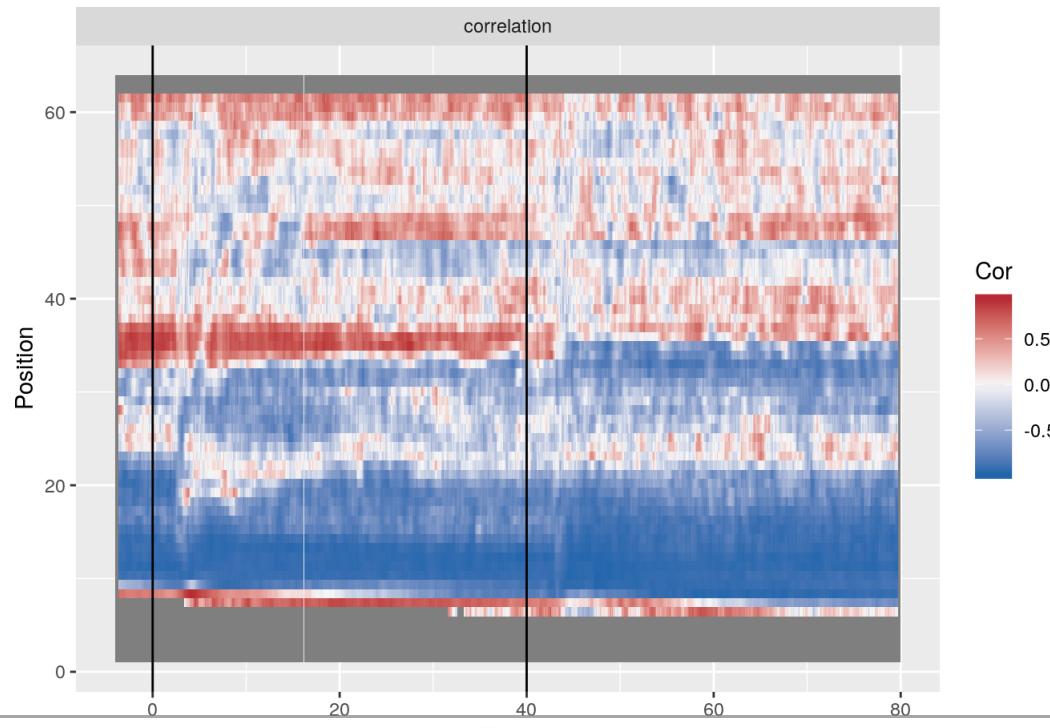
Waadt, R. , Krebs, M. , Kudla, J. and Schumacher, K. (2017), Multiparameter imaging of calcium and abscisic acid and high-resolution quantitative calcium measurements using R-GECO1-mTurquoise in Arabidopsis. *New Phytol*, 216: 303-320. doi:[10.1111/nph.14706](https://doi.org/10.1111/nph.14706)



Matrices are rasters

How to use geostatistical indices to compare matrices 1D+time correlation?

- Transform each matrix as raster: `raster::raster/terra::rast`
 - Combine as `raster::stack/terra::rast`
- Correlation in space and time. `{raster/terra}::focal`
 - [Blog post on correlation between \(real\) rasters](#)





Microscopy images are rasters

How to use geostatistical indices to compare image fluorescence of plant cells?

- Work with [bio-image data scientist, Dr Marion Louveaux](#)
 - Shoot Apical Meristem of *Arabidopsis Thaliana*
 - Confocal microscopy live imaging
 - ROI manager of [ImageJ/Fiji](#)

<https://marionlouveaux.fr>

Louveaux, M., Rochette, S., Beauzamy, L., Boudaoud, A. and Hamant, O. (2016), The impact of mechanical compression on cortical microtubules in *Arabidopsis*: a quantitative pipeline. Plant J. Volume88, Issue2. 328-342.
[doi:10.1111/tpj.13290](https://doi.org/10.1111/tpj.13290)

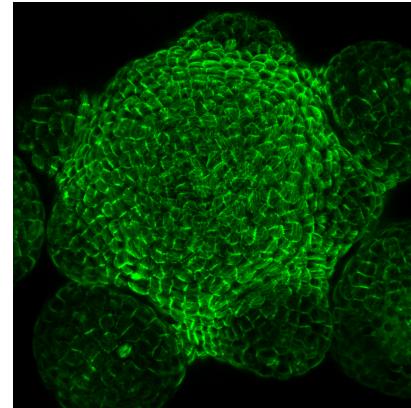
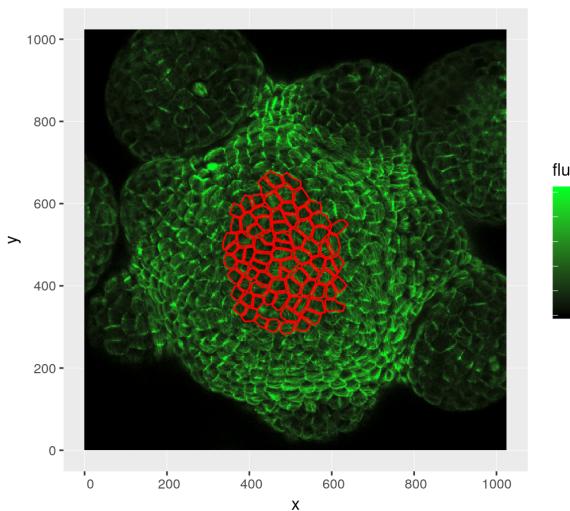


Image and ROI read in R

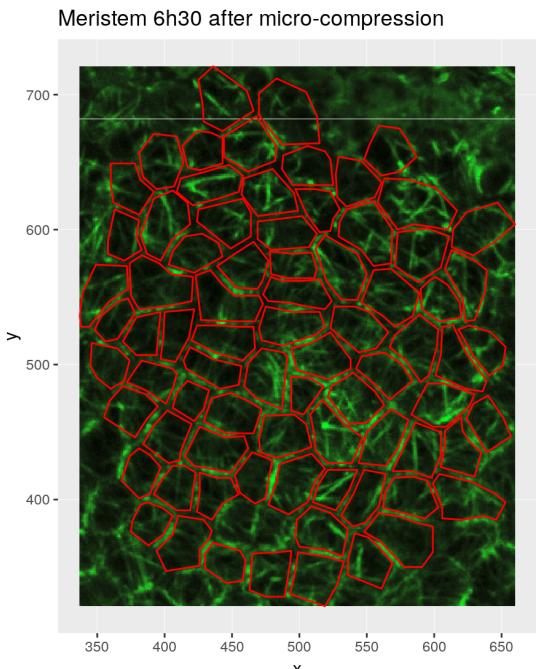
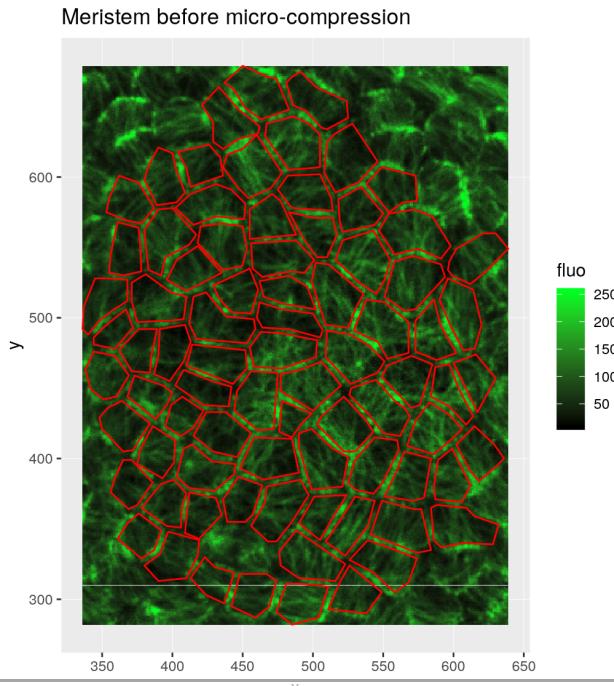




Microscopy images are rasters

How to use geostatistical indices to compare image fluorescence of plant cells?

- Read Fiji/imageJ ROI polygons: `RImageJROI`
 - Fork `statnmap/RImageJROI` to `{sf}`: `ijzip_as_sf`
- Calculate spatial autocorrelation indices (Moran, Geary): `raster::GearyLocal`
- Separate pixels for each `{sf}`-cell: `raster::extract`



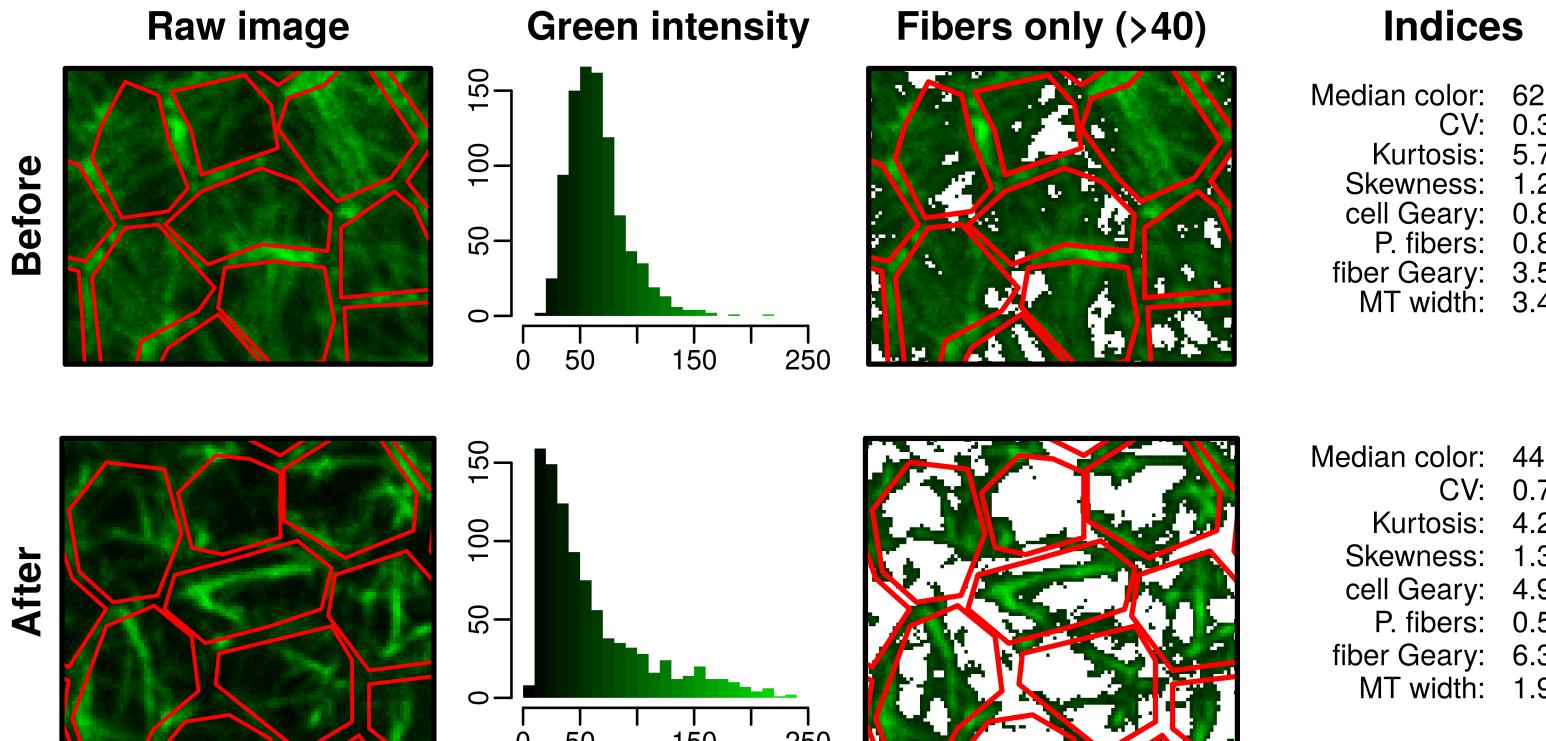


Microscopy images are rasters

How to use geostatistical indices to compare image fluorescence of plant cells?

- Compare indices through time
 - If needed with mask: {raster/terra}::mask

Louveaux et al. (2016)





Images user annotations are spatial data

How to gather and summarise user image annotations?

- Work with marine scientist, Dr Marjolaine Matabos
 - Images from the subsea geysers located at 1700 m depth in the Atlantic and Pacific Oceans
 - Deep-sea Spy project (<https://www.deepseaspy.com>, Ifremer)
 - Video game with public annotation



The image consists of three parts. The top right is a cartoon illustration of a yellow octopus swimming between grey rock formations. The middle right is a screenshot of a video feed from a submersible camera, showing a dark seabed with several orange circular annotations. The bottom right is a screenshot of a mobile application interface titled 'OBSERVATORY'. It shows a video stream of a seabed with orange annotations, a legend for species to look for (Buccinid snail, Polynoid worms, Spider crab, Pycnogonid, Zoarcid fish), and a guide for 'HOW TO ANNOTATE the Buccinid snail' with a diagram of a shell.

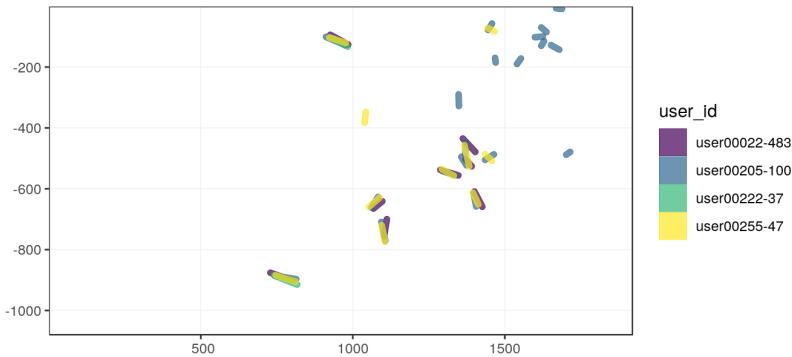


Images user annotations are spatial data

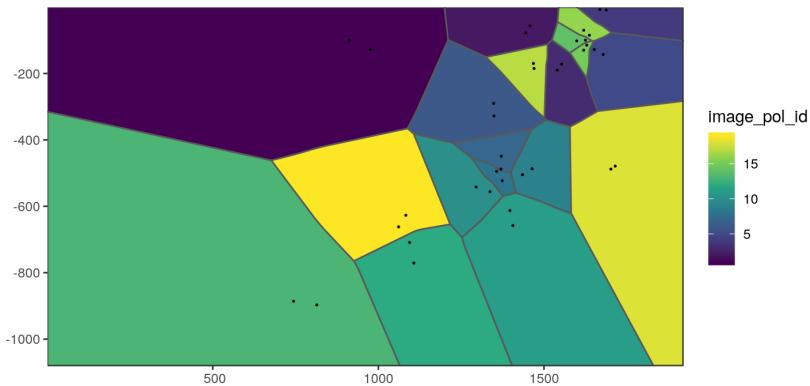
How to gather and summarise user image annotations?

- Read database and extract spatial features (points, lines, polygons): {sf}
- Account for uncertain position
 - Rasterize voronoi separation of space of each individual:
`sf::st_voronoi,`
`raster::rasterize`

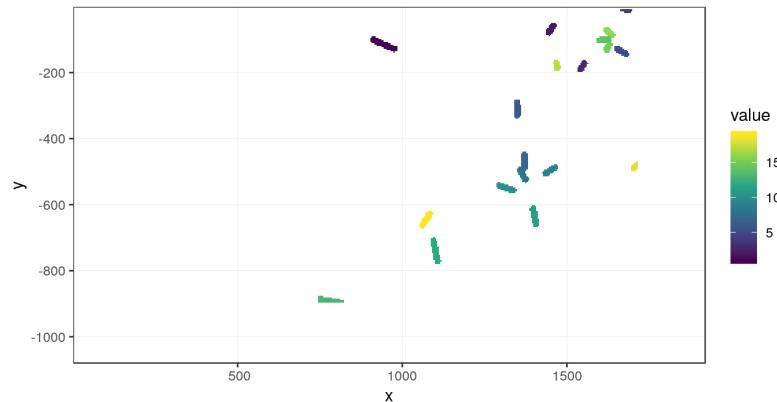
All users annotations for image 10681



Separate individuals observed by one user



Reduce space to reasonable uncertainty



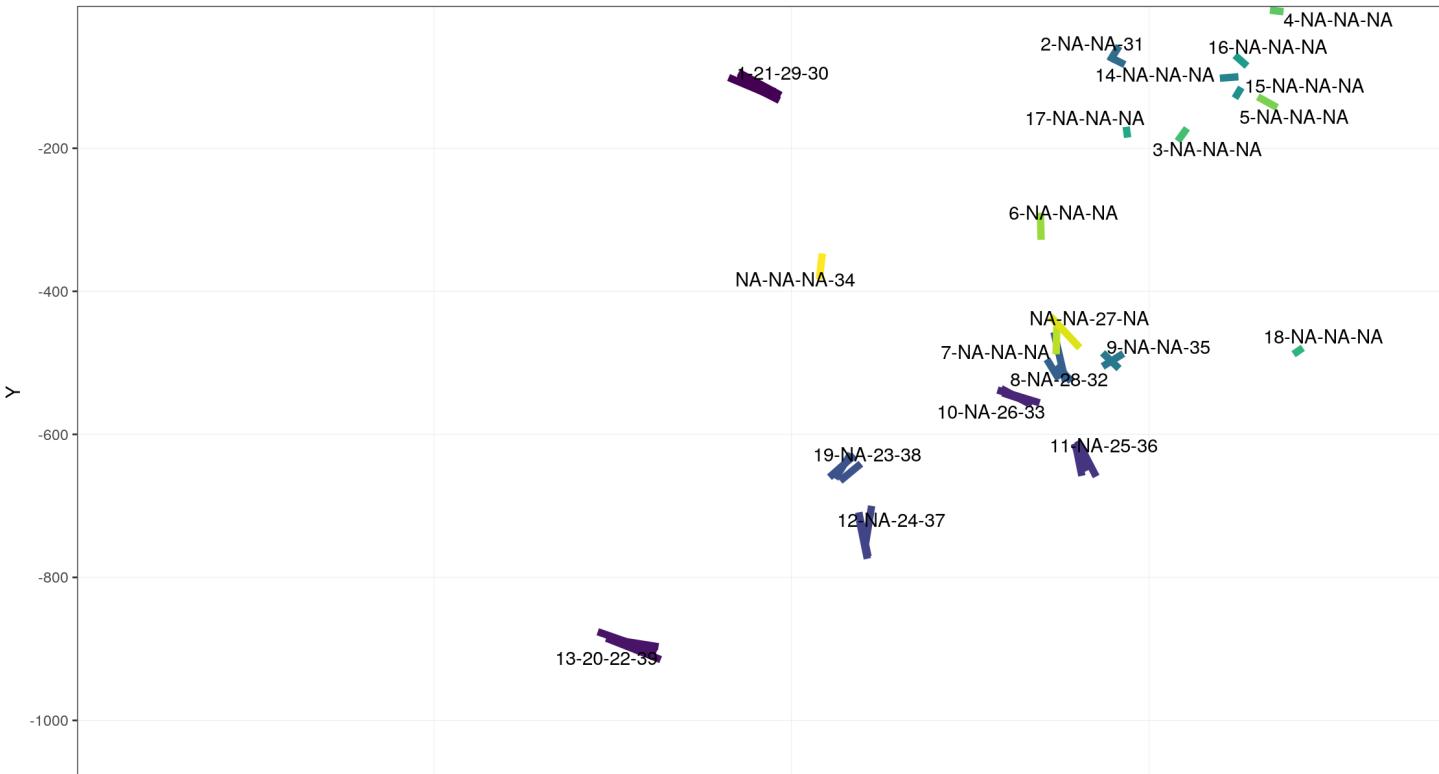


Images user annotations are spatial data

How to gather and summarise user image annotations?

- Super-impose rasters of users
- **Find individuals in common**

Identification of groups of marked individuals





Rasters are polygons

How to render interactive grid quickly?

- *Confidential work...*
 - Let's find an equivalent case !
- Imagine: "The World largest waffle"
 - How to explore the quantity of chocolate in each square ?
- Interactive plot in a ShinyApp
 - Millions of cells
 - Quick print and easy exploration

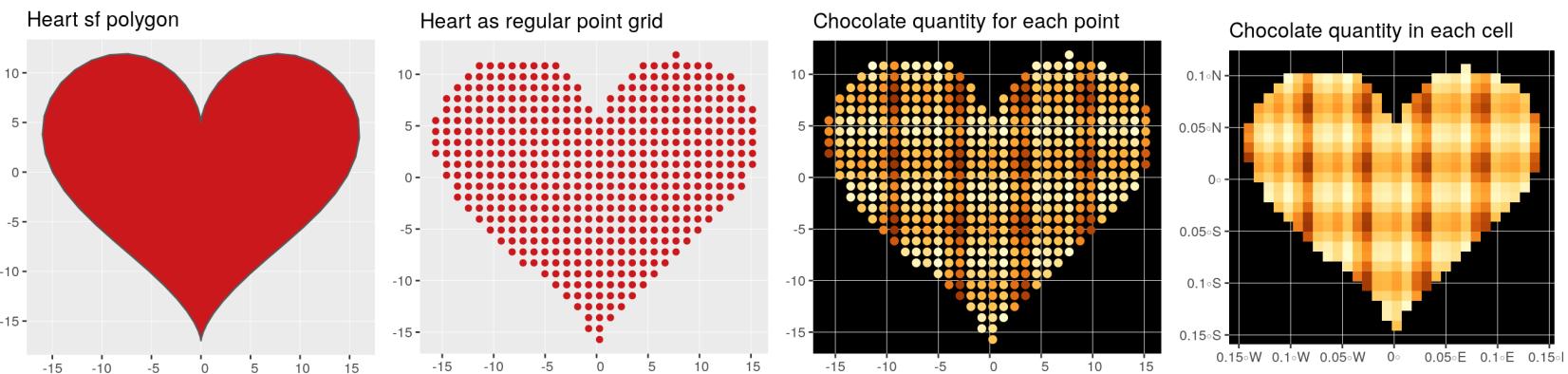




Rasters are polygons (waffles too...)

How to render interactive grid quickly?

- Build a heart polygon waffle with {sf}
 - Create regular grid from polygon:
`st_sample`
 - Generate more or less chocolate
 - Create polygon grid with correct
`crs` to avoid deformation on leaflet



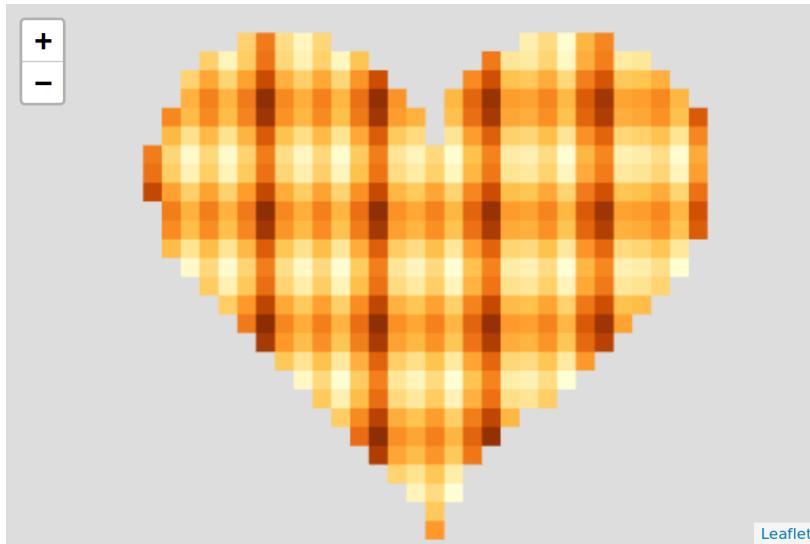


Rasters are polygons (waffles too...)

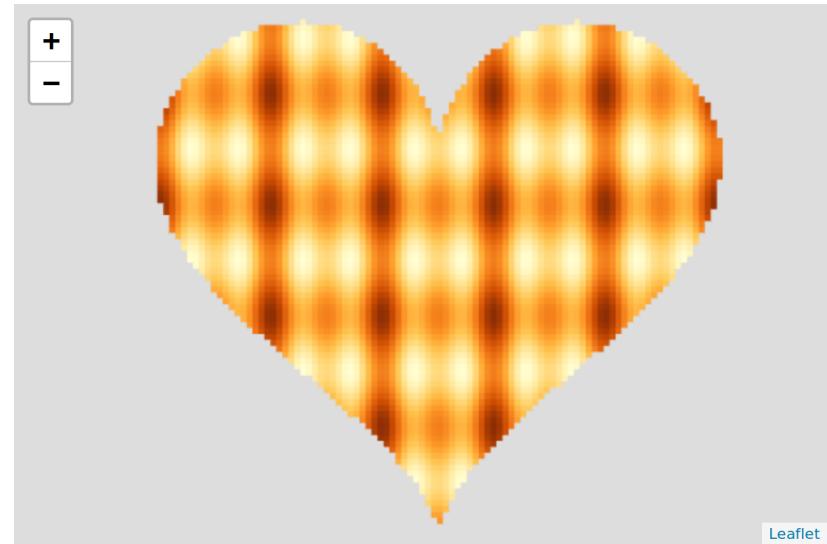
How to render interactive grid quickly?

- Build a heart polygon waffle with {sf}
 - Create regular grid from polygon: `st_sample`
 - Generate more or less chocolate
 - Create polygon grid with correct `crs` to avoid deformation on leaflet
 - Quick print with {leafgl} (prev. `{leaflet.glyph}`): `addGlPolygons`

Low resolution leaflet polygons



High resolution leaflet polygons

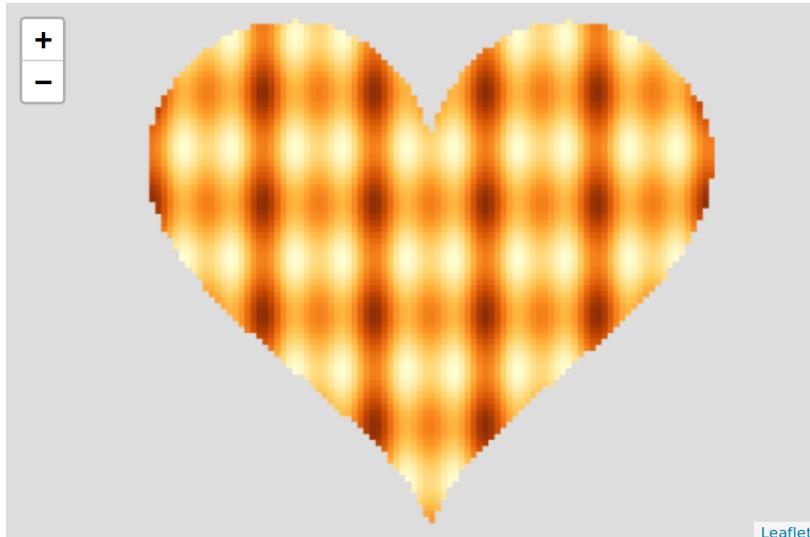




Rasters are polygons (waffles too...)

How to render interactive grid quickly?

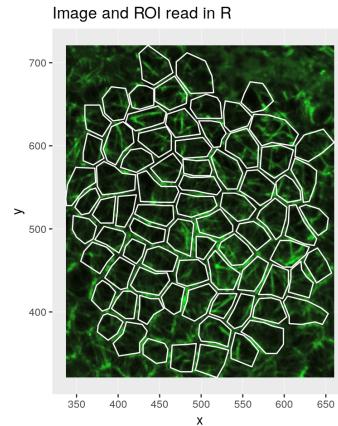
- Build a heart polygon waffle with {sf}
 - Create regular grid from polygon: `st_sample`
 - Generate more or less chocolate
 - Create polygon grid with correct `crs` to avoid deformation on leaflet
 - Quick print with {leafgl} (*prev.* `{leaflet.glyph}`): `addGlPolygons`



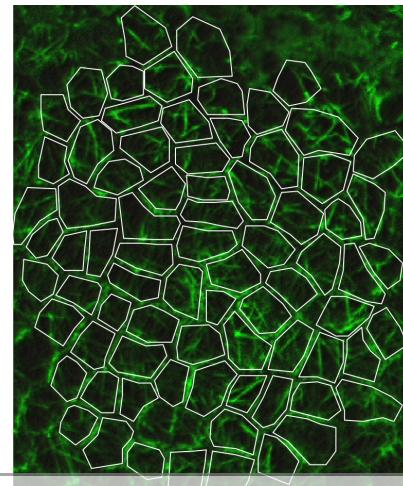


Images are 3D elevation data

- Rasters are commonly used for terrain elevation
- Imagine images as 3D elevation data
- Transform rasters and sf object into `{rayshader}` visualisation
 - 2D with overlay layer and polygons:
`plot_map`



Plot rayshaded raster with overlay

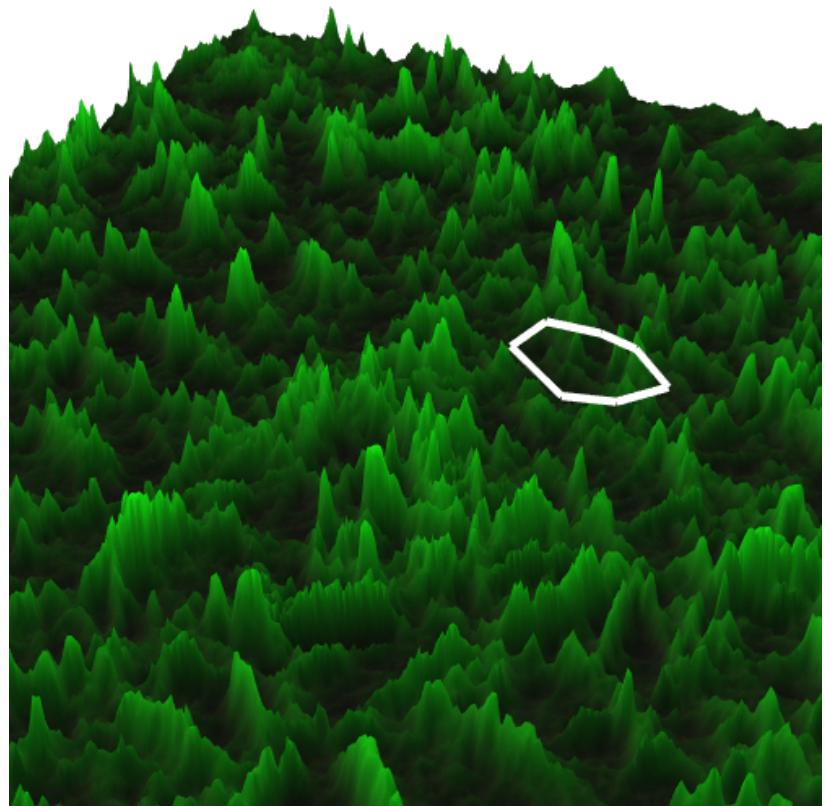


Rochette S. (2016, Aug. 02). "Rshiny expert image comparison app".
Retrieved from
<https://statnmap.com/2016-08-02-rshiny-expert-image-comparison-app/>.
Rochette S. (2018, Oct. 28). "Play with spatial tools on 3D cells images".
Retrieved from
<https://statnmap.com/2018-10-28-play-with-spatial-tools-on-3d-cells-images/>.



Images are 3D elevation data

- Rasters are commonly used for terrain elevation
- Imagine images as 3D elevation data
- Transform rasters and sf object into `{rayshader}` visualisation
 - 3D with overlay layer and polygons:
`plot_3d + lines3d`



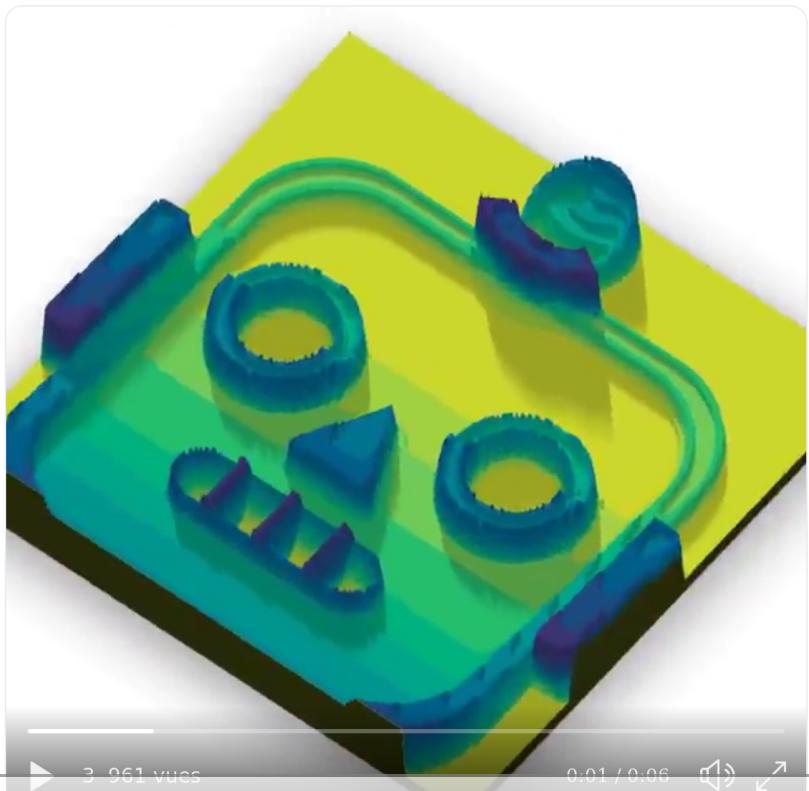
Rochette S. (2016, Aug. 02). "Rshiny expert image comparison app". Retrieved from <https://statnmap.com/2016-08-02-rshiny-expert-image-comparison-app/>.
Rochette S. (2018, Oct. 28). "Play with spatial tools on 3D cells images". Retrieved from <https://statnmap.com/2018-10-28-play-with-spatial-tools-on-3d-cells-images/>.



Images are 3D elevation data

- Extract elevation using `{isoband}`
- Rayshade this with `@rayshaderbot` !

<https://twitter.com/rayshaderbot>



3 961 vues

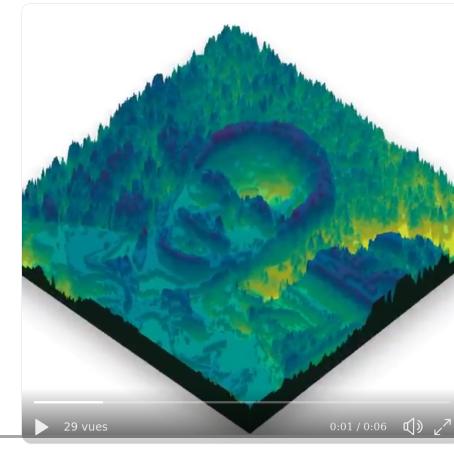
0:01 / 0:06 🔍 ↗

<https://twitter.com/rayshaderbot/status/1092308191100012800>
s=19



▶ 29 vues

0:00 / 0:06 🔍 ↗



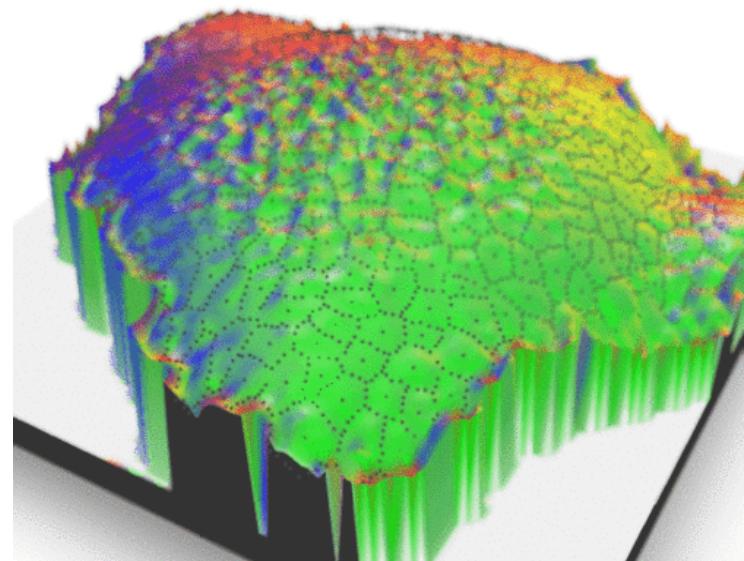
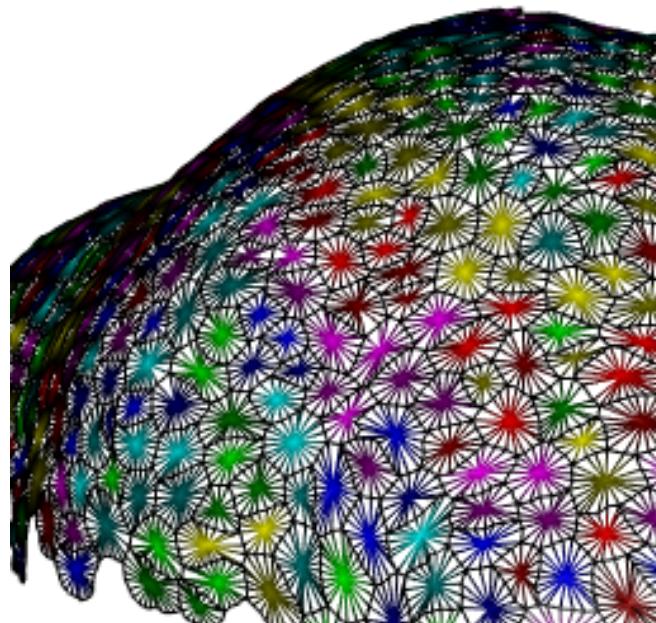
▶ 29 vues

0:01 / 0:06 🔍 ↗



3D mesh are raster elevation data

- Read .ply mesh 3D files: {mgx2r} `read_mgxPly`
- Interpolate surface based on vertices
- Rayshade this !



<https://statnmap.com/2018-10-28-play-with-spatial-tools-on-3d-cells-images>



3D mesh are raster elevation data

- Go further ?





Do you also see rasters everywhere?

- Matrices are rasters
- Images are rasters
- Image annotations are spatial polygons
- Rasters are polygons
- Images are 3D elevation data



Thank you for your attention

See more:

- statnmap.com
- marionlouveaux.com
- rtask.thinkr.fr
- deepseaspy.com
- rayshader.com

