Discrete Global Grids
what they are – how to use them

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Not to worry about projections
Equal-sized cells/bins for stats
Fast neighbour-cell addressing
(Anything you might use geohashing for)

What do we want?
Distortion: Tissot’s Indicatrix
Sinusoidal
Cassini
Winkel III
Lambert Conformal Conic
Lambert Conformal Conic
Problematic Spatial Indices

(Mapzen.com)
Discrete global grid system evaluation criteria as proposed by Goodchild (1994) and modified by Kimerling et al. (1999)

1. Areal cells constitute a complete tiling of the globe, exhaustively covering the globe without overlapping
2. Areal cells have equal areas
3. Areal cells have the same topology
4. Areal cells have the same shape
5. Areal cells are compact
6. Edges of cells are straight in a projection
7. The midpoint of an arc connecting two adjacent cells coincides with the midpoint of the edge between the two cells
8. The points and areal cells of the various resolution grids which constitute the grid system form a hierarchy which displays a high degree of regularity
9. A single areal cell contains only one grid reference point
10. Grid reference points are maximally central within areal cells
11. Grid reference points are equidistant from their neighbors
12. Grid reference points and areal cells display regularities and other properties which allow them to be addressed in an efficient manner
13. The grid system has a simple relationship to the latitude and longitude graticule
14. The grid system contains grids of any arbitrary defined spatial resolution
Polyhedra
Orientation
Partitioning
Transformation

Design Choices
Design Choice: Polyhedra
(van Wijk 2008)
Design Choice: Polyhedra
(Hafner and Zitko)
Design Choice: Orientation
(Barnes, in-progress – almost done!)
Design Choice: Orientation
(Barnes, in-progress – almost done!)
Design Choice: Partition
(Barnes)
Design Choice: Partition
(Tor Stensola, CBM/Kavli Institute)
Design Choice: Partition
(Sahr et al 2003)
Work needed: Partitioning/Addressing

(Oom et al 2004)
Design Choice: Transformation

(Kimerling 1999)
Design Choice: Transformation
(Kimerling 1999)
Design Choice: Transformation  
(Kimerling 1999)
An Alternative Grid Idea

(Kimerling 1999)
Design Choice: Transformation

(Kimerling 1999)
Design Choice: Transformation

(Kimerling 1999)
ISEA3H
Icosahedral
Snyder Equal Area
Aperture-3
Hexagonal

Design Decision
#include libraries

library(dggridR)
library(dplyr)

# Construct a global grid with cells approximately 1000 miles across
dggs <- dgconstruct(spacing=1000, metric=FALSE, resround='down')

# Load included test data set
data(dgquakes)

# Get the corresponding grid cells for each earthquake epicenter (lat-long pair)
dgquakes$cell <- dgGEO_to_SEQNUM(dggs, dgquakes$lon, dgquakes$lat)$seqnum

# Get the number of earthquakes in each cell
quakecounts <- dgquakes %>% group_by(cell) %>% summarise(count=n())

# Get the grid cell boundaries for cells which had quakes
grid <- dgcellstogrid(dggs, quakecounts$cell, frame=TRUE, wrapcells=TRUE)
# Update the grid cells' properties to include the number of earthquakes
# in each cell
grid <- merge(grid, quakecounts, by.x = "cell", by.y = "cell")

# Make adjustments so the output is more visually interesting
grid$count <- log(grid$count)
cutoff <- quantile(grid$count, 0.9)
grid <- grid %>% mutate(count = ifelse(count > cutoff, cutoff, count))

# Get polygons for each country of the world
countries <- map_data("world")
Plot everything on a flat map

```r
p <- ggplot() +
  geom_polygon(data=countries, aes(x=long, y=lat, group=group), fill=NA, color="black") +
  geom_polygon(data=grid, aes(x=long, y=lat, group=group, fill=count), alpha=0.4) +
  geom_path (data=grid, aes(x=long, y=lat, group=group), alpha=0.4, color="white") +
  scale_fill_gradient(low="blue", high="red")

p
```
dggridR: Using a DGG
Replot on a spherical projection

```r
p+coord_map("ortho", orientation = c(-38.49831, -179.9223, 0))+
  xlab('') + ylab('') +
  theme(axis.ticks.x = element_blank()) +
  theme(axis.ticks.y = element_blank()) +
  theme(axis.text.x = element_blank()) +
  theme(axis.text.y = element_blank()) +
  ggtitle('Your data could look like this')
```
dggridR: Using a DGG
library(webglobe)

# Construct a webglobe
wg <- webglobe(immediate=FALSE)
wg <- wg + wgpolygondf(grid, alpha=0.6)
wg
webglobe: Using a DGG
Examples
(Kranstauber et al 2015)
Examples
(Kranstuber et al 2015)
Examples
(Sabokbar et al 2014)


Bibliography
github.com/r-barnes/dggridR
github.com/r-barnes/webglobe
www.discreteglobalgrids.org
healpix.sourceforge.net
www.pyxisinnovation.com
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