Operations With Raster Data I

HES 505 Fall 2022: Session 11

Matt Williamson

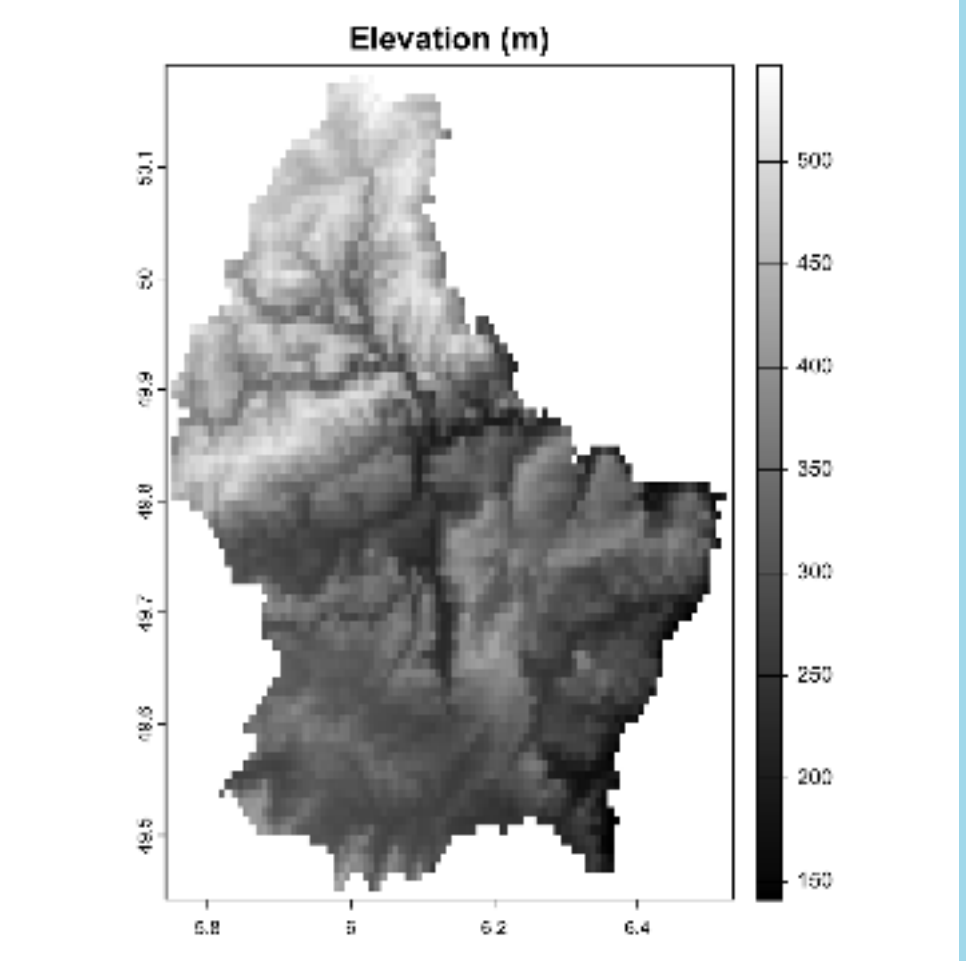
Today's Plan

Objectives

- By the end of today, you should be able to:
  - Evaluate logical conditions with raster data
  - Calculate different measures of raster data
  - Align rasters for spatial processing

Revisitng the Raster Data Model

- **Raster data** represent spatially continuous phenomena (`NA` is possible)
- Depict the alignment of data on a regular lattice (often a square)
  - Operations mimic those for `matrix` objects in `R`
- Geometry is implicit; the spatial extent and number of rows and columns define the cell size



Predicates and measures in `terra`

Extending predicates

- **Predicates**: evaluate a logical statement asserting that a property is TRUE
- `terra` does not follow the same hierarchy as `sf` so a little trickier

Unary predicates in `terra`

- Can tell us qualities of a raster dataset
- Many similar operations for `SpatVector` class (note use of `.`)

predicate	asks…
`is.lonlat`	Does the object have a longitude/latitude CRS?
`inMemory`	is the object stored in memory?
`is.factor`	Are there categorical layers?
`hasValues`	Do the cells have values?

Unary predicates in `terra`

- `global`: tests if the raster covers all longitudes (from -180 to 180 degrees) such that the extreme columns are in fact adjacent

```
r <- rast()
is.lonlat(r)
```

```
[1] TRUE
```

```
is.lonlat(r, global=TRUE)
```

```
[1] TRUE
```

- `perhaps`: If TRUE and the crs is unknown, the method returns TRUE if the coordinates are plausible for longitude/latitude

```
crs(r) <- ""
is.lonlat(r)
```

```
[1] NA
```

```
is.lonlat(r, perhaps=TRUE, warn=FALSE)
```

```
[1] TRUE
```

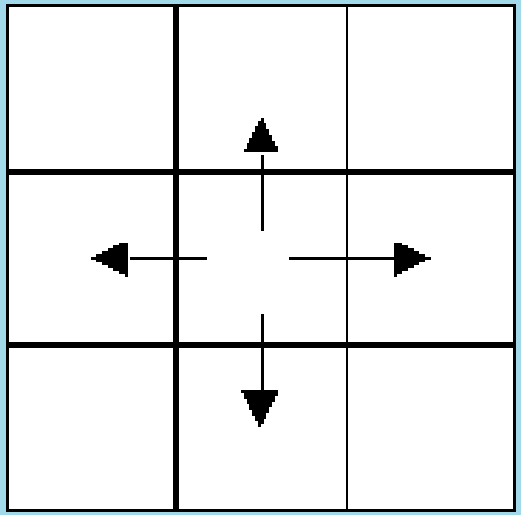
```
crs(r) <- "+proj=lcc +lat_1=48 +lat_2=33 +lon_0=-1
is.lonlat(r)
```

```
[1] FALSE
```

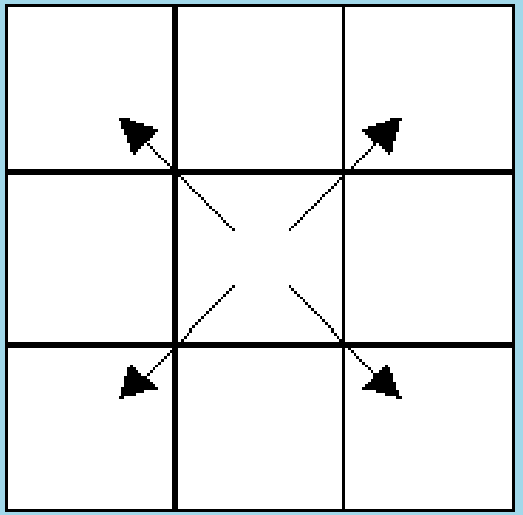
Binary predicates in `terra`

- Take exactly 2 inputs, return 1 matrix of cell locs where value is `TRUE`
- `adjacent`: identifies cells adajcent to a set of raster cells

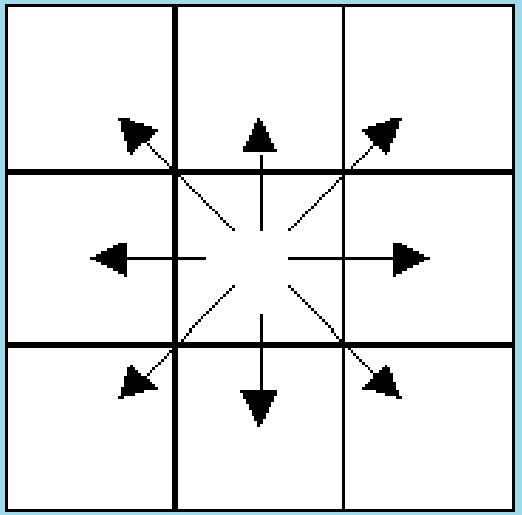
Rooks Case



Bishops Case



Queen's (Kings) Case



Unary measures in `terra`

- Slightly more flexible than `sf`
- One result for each layer in a stack

measure	returns
`cellSize`	area of individual cells
`expanse`	summed area of all cells
`values`	returns all cell values
`ncol`	number of columns
`nrow`	number of rows
`ncell`	number of cells
`res`	resolution
`ext`	minimum and maximum of x and y coords
`origin`	the orgin of a `SpatRaster`
`crs`	the coordinate reference system
`cats`	categories of a categorical raster

Binary measures in `terra`

- Returns a matrix or `SpatRaster` describing the measure

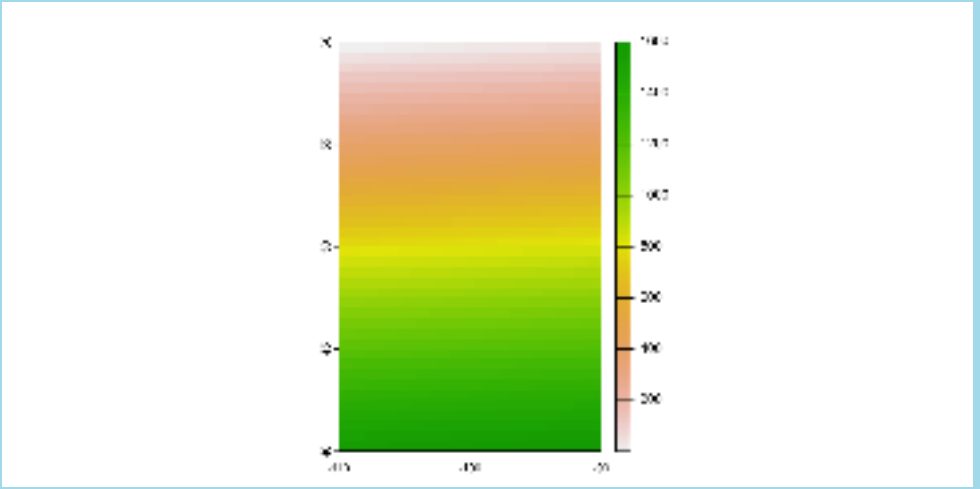
measure	returns
`distance`	shortest distance to non-NA or vector object
`gridDistance`	shortest distance through adjacent grid cells
`costDistance`	Shortest distance considering cell-varying friction
`direction`	azimuth to cells that are not `NA`

Aligning rasters

Projecting raster data

- Transformation from lat/long to planar CRS involves some loss of precision
- New cell values estimated using overlap with original cells
- Interpolation for continuous data, nearest neighbor for categorical data
- Equal-area projections are preferred; especially for large areas

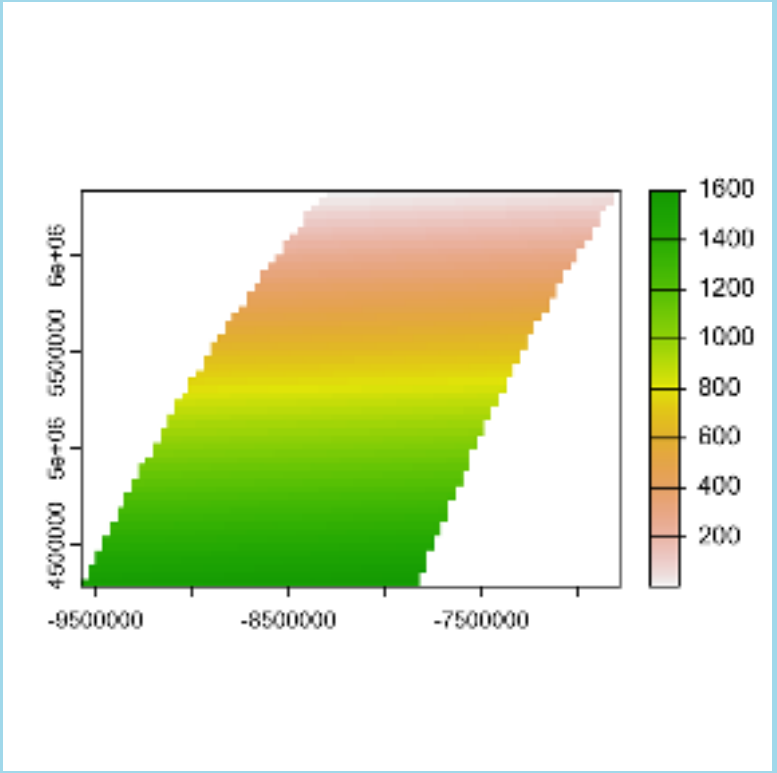
```
r <- rast(xmin=-110, xmax=-90, ymin=40, ymax=60, n
values(r) <- 1:ncell(r)
plot(r)
```



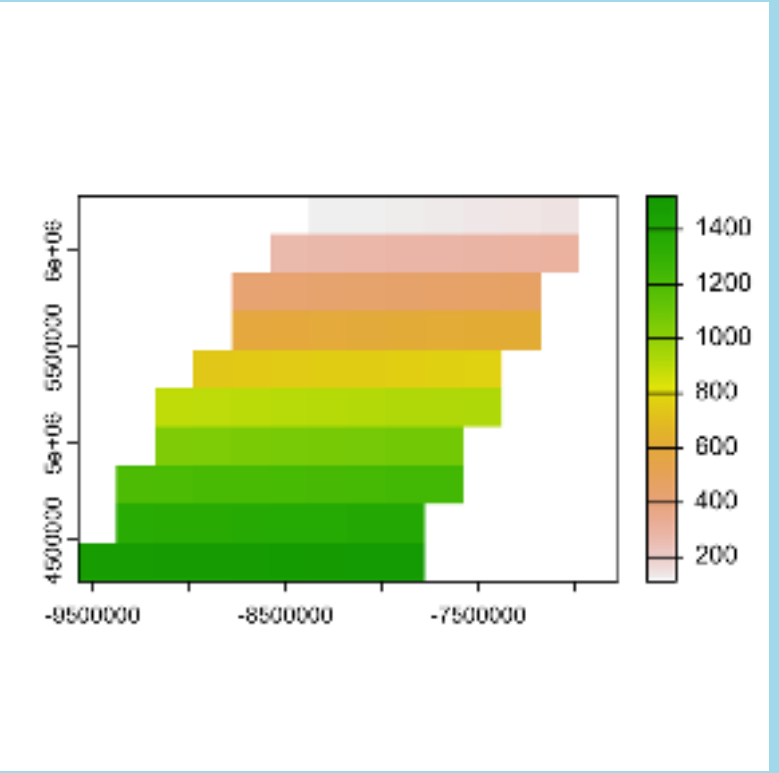
Projecting raster data

- simple method; alignment not guaranteed

```
1  newcrs <- "+proj=robin +datum=WGS8
2  pr1 <- terra::project(r, newcrs)
3  plot(pr1)
```



- providing a template to ensure alignment

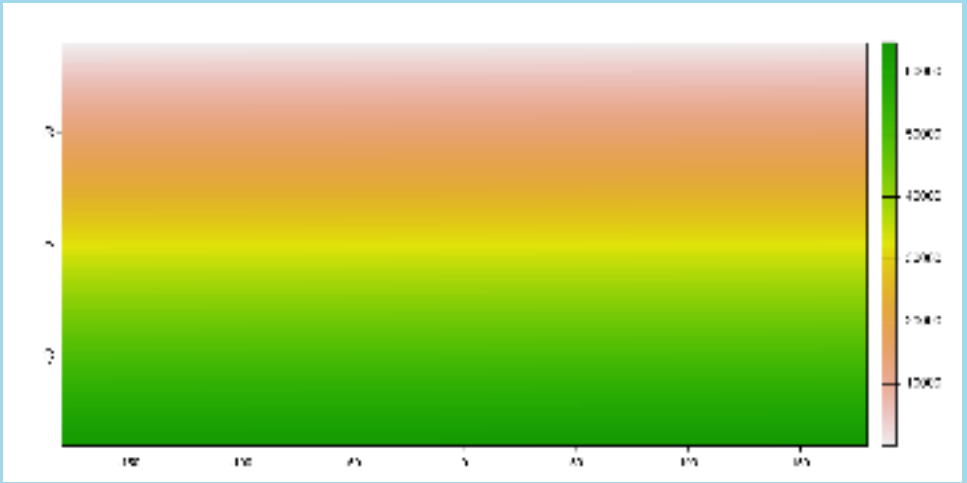


Changing resolutions

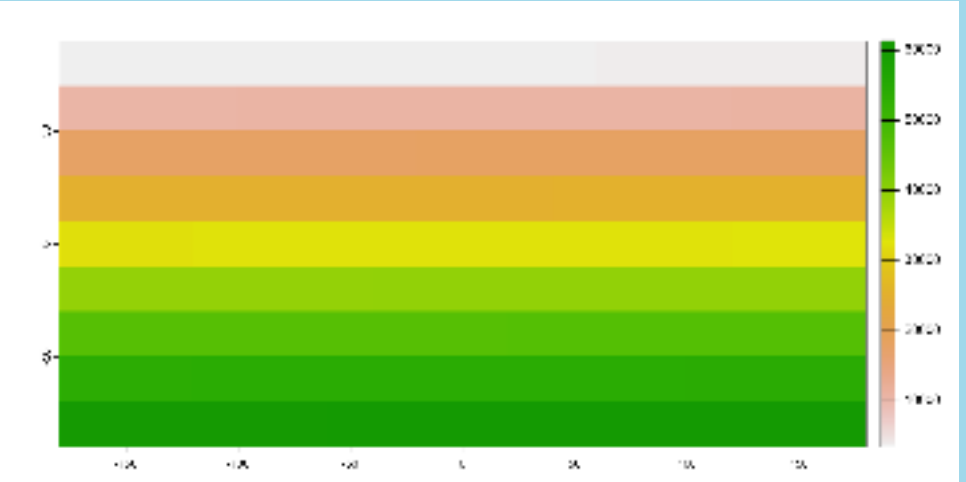
- `aggregate`, `disaggregate`, `resample` allow changes in cell size
- `aggregate` requires a function (e.g., `mean()` or `min()`) to determine what to do with the grouped values
- `resample` allows changes in cell size **and** shifting of cell centers (slower)

Changing resolutions: aggregate

```
1 r <- rast()
2 values(r) <- 1:ncell(r)
3 plot(r)
```



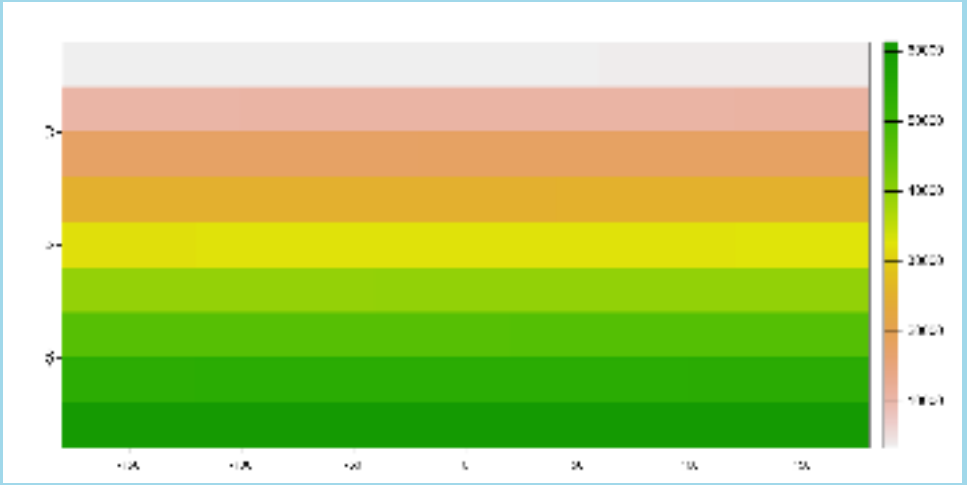
```
1 ra <- aggregate(r, 20)
2 plot(ra)
```



]

Changing resolutions: disagg

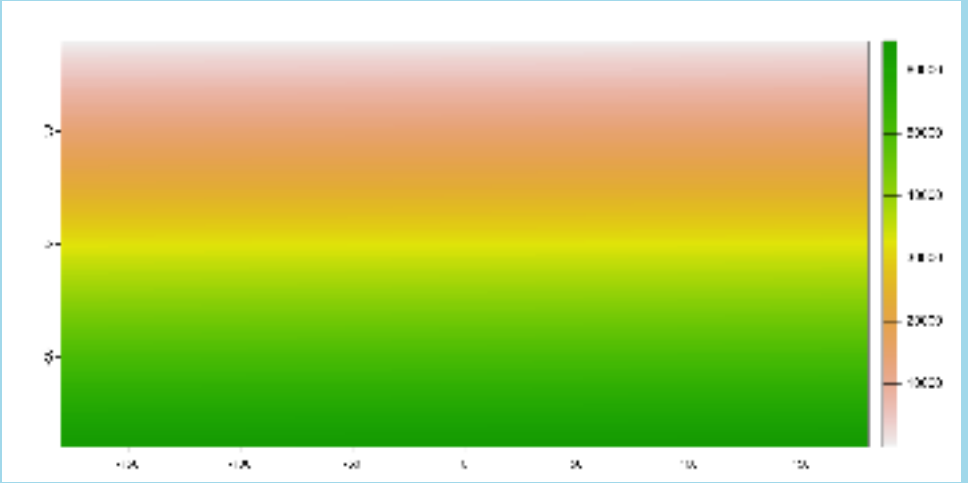
```
1 ra <- aggregate(r, 20)
2 plot(ra)
```



```
1 rd <- disagg(r, 20)
```

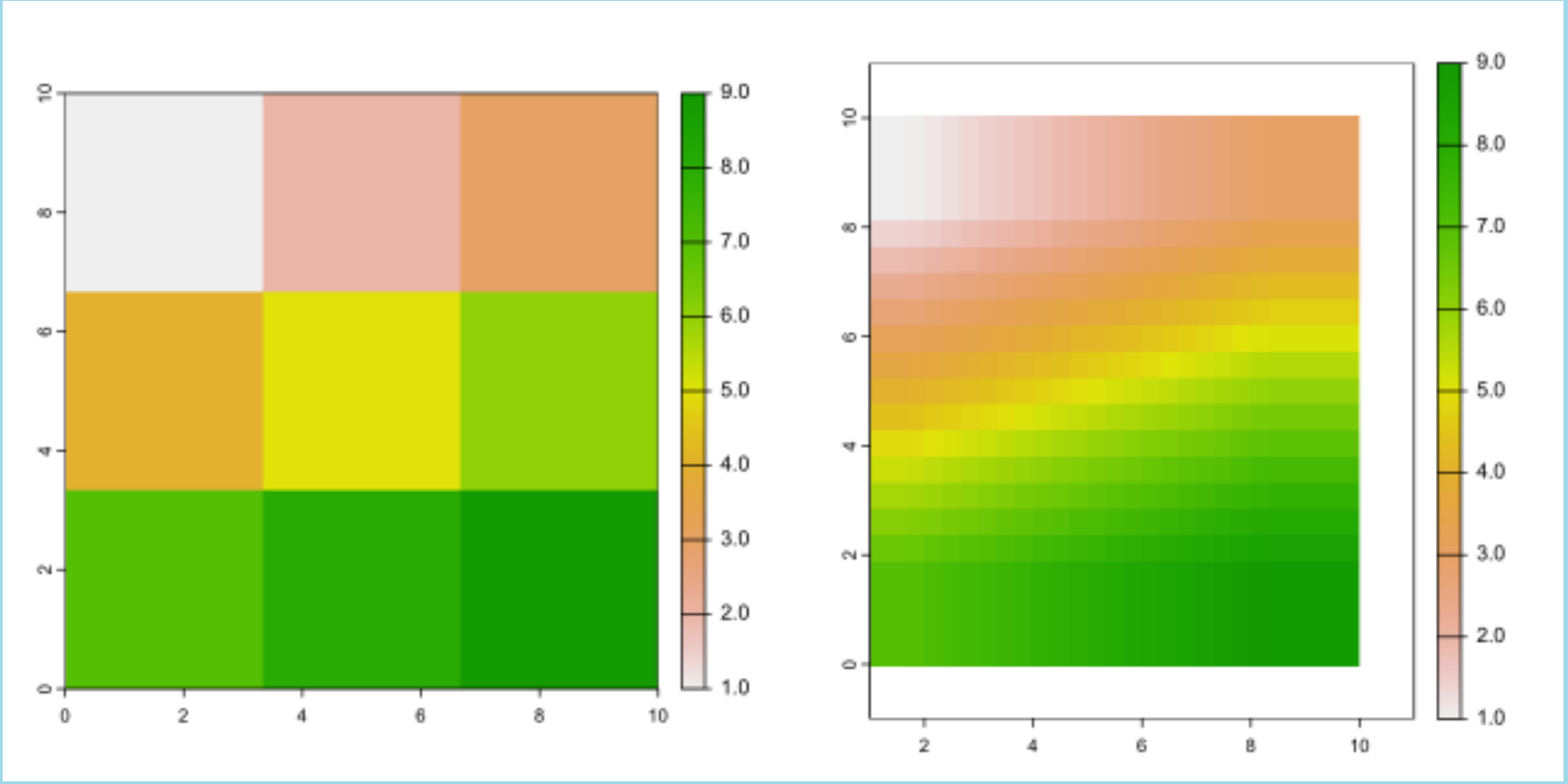
```
|---------|---------|---------|------
---|
===
```

```
1 plot(rd)
```



Changing Resolutions: resample

```
r <- rast(nrow=3, ncol=3, xmin=0, xmax=10, ymin=0, ymax=10)
values(r) <- 1:ncell(r)
s <- rast(nrow=25, ncol=30, xmin=1, xmax=11, ymin=-1, ymax=11)
x <- resample(r, s, method="bilinear")
```



On Weds

- Transformations of data and coverage
- Raster math
- Cell-based functions