Areal Data: Rasters

HES 505 Fall 2023: Session 9

Matt Williamson

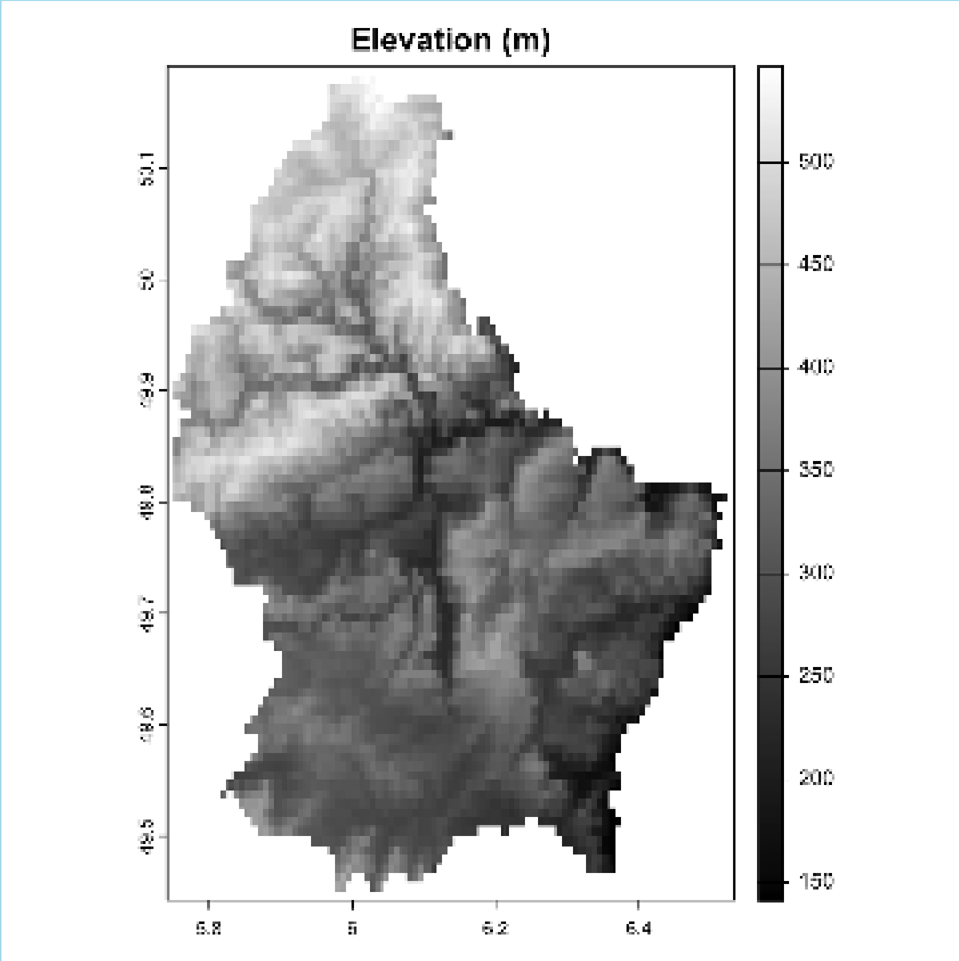
Today's Plan

By the end of today, you should be able to:

- Access the elements that define a raster
- Build rasters from scratch using matrix operations and `terra`
- Evaluate logical conditions with raster data
- Calculate different measures of raster data

Revisiting the Raster Data Model

- **Vector data** describe the "exact" locations of features on a landscape (including a Cartesian landscape)
- **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



Rasters with `terra`

- syntax is different for `terra` compared to `sf`
- Representation in `Environment` is also different
- Can break pipes, **Be Explicit**

Rasters by Construction

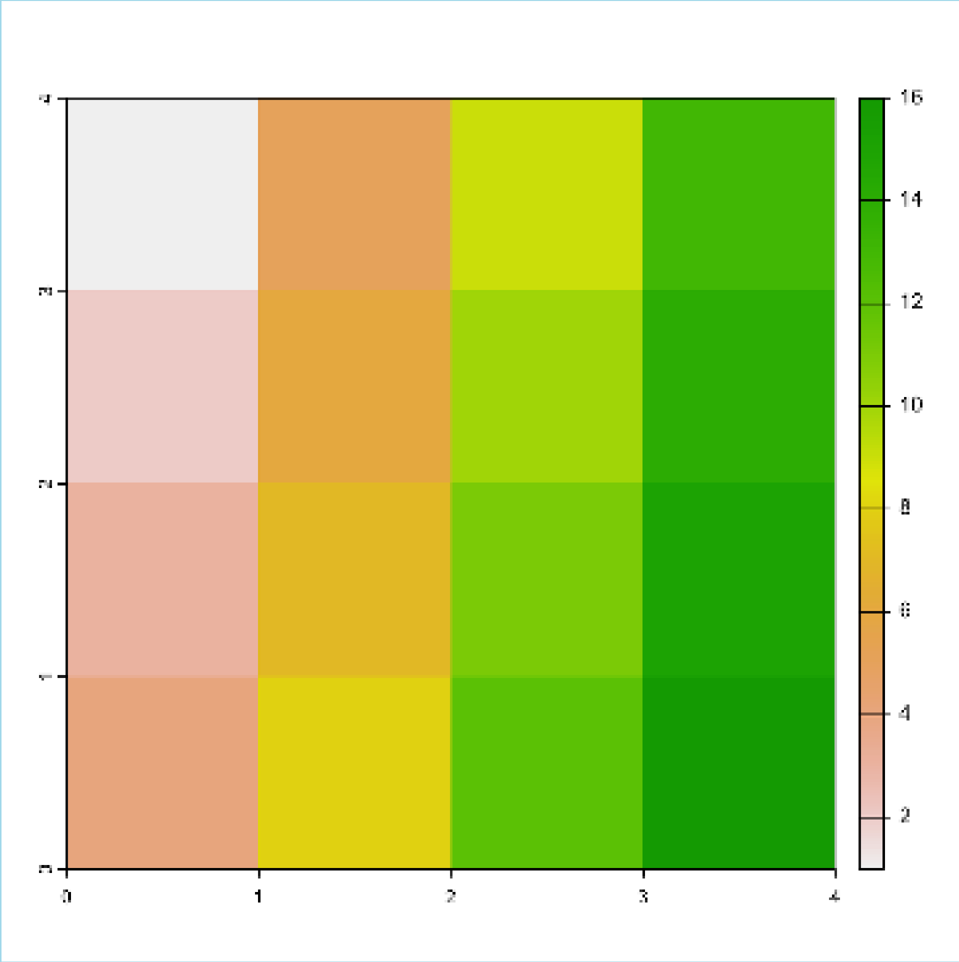
Rasters by Construction

```r
mtx <- matrix(1:16, nrow=4)
mtx
```

```
     [,1] [,2] [,3] [,4]
[1,]    1    5    9   13
[2,]    2    6   10   14
[3,]    3    7   11   15
[4,]    4    8   12   16
```

```r
rstr <- terra::rast(mtx)
rstr
```

```
class       : SpatRaster
dimensions  : 4, 4, 1  (nrow, ncol,
nlyr)
resolution  : 1, 1  (x, y)
extent      : 0, 4, 0, 4  (xmin,
xmax, ymin, ymax)
coord. ref. :
source(s)   : memory
name        : lyr.1
min value   :     1
max value   :    16
```



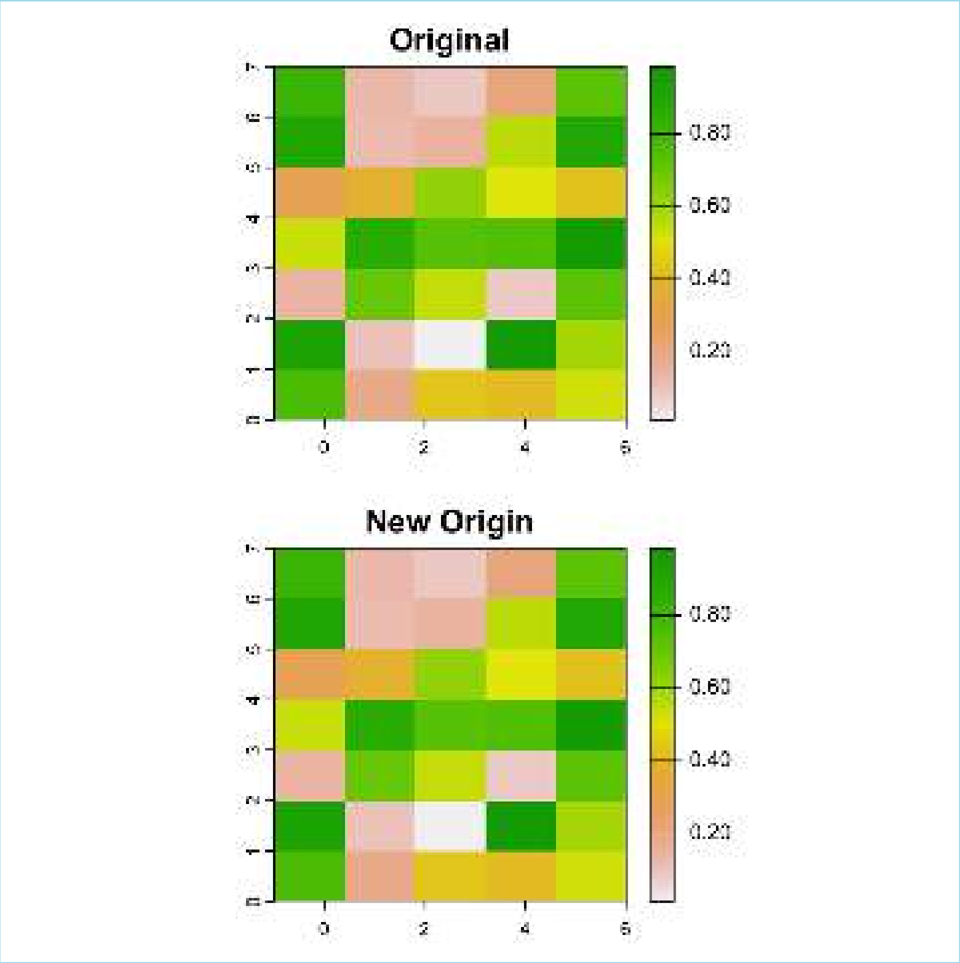
Rasters by Construction: Origin

- Origin defines the location of the intersection of the x and y axes

```
r <- rast(xmin=-4, xmax = 9.5, ncc
r[] <- runif(ncell(r))
origin(r)
```

```
[1] 0.05 0.00
```

```
r2 <- r
origin(r2) <- c(2,2)
```



Rasters by Construction: Resolution

- Geometry is implicit; the spatial extent and number of rows and columns define the cell size
- **Resolution** (`res`) defines the length and width of an individual pixel

```
r <- rast(xmin=-4, xmax = 9.5,
            ncols=10)
res(r)
```

```
[1] 1.35 1.00
```

```
r2 <- rast(xmin=-4, xmax = 5,
            ncols=10)
res(r2)
```

```
[1] 0.9 1.0
```

```
r <- rast(xmin=-4, xmax = 9.5,
            res=c(0.5,0.5))
ncol(r)
```

```
[1] 27
```

```
r2 <- rast(xmin=-4, xmax = 9.5,
            res=c(5,5))
ncol(r2)
```

```
[1] 3
```

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)
```

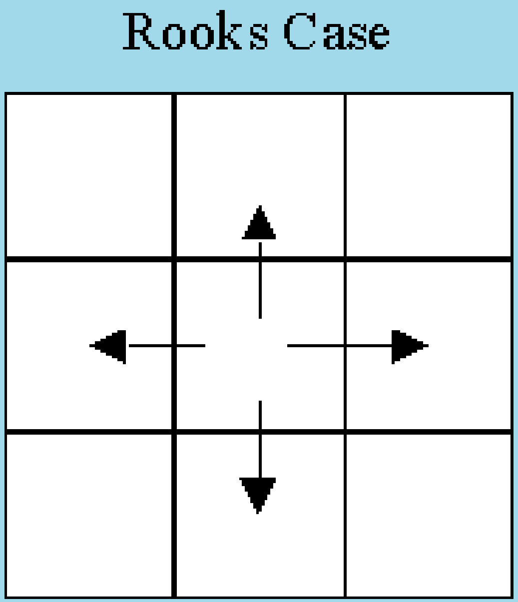
```
[1] TRUE
```

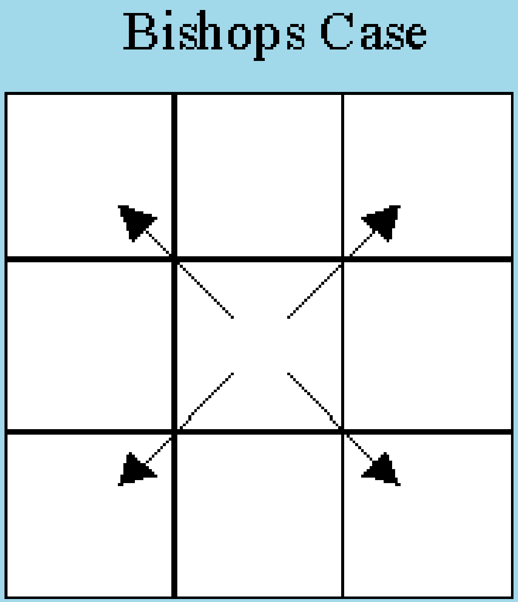
```
crs(r) <- "+proj=lcc +lat_1=48 +lat_2=33 +lon_0=-1
is.lonlat(r)
```

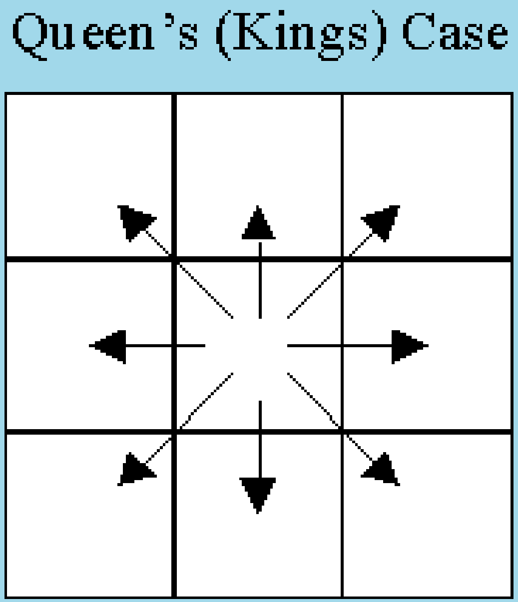
```
[1] FALSE
```

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







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`