The viridis color palettes

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tl;dr

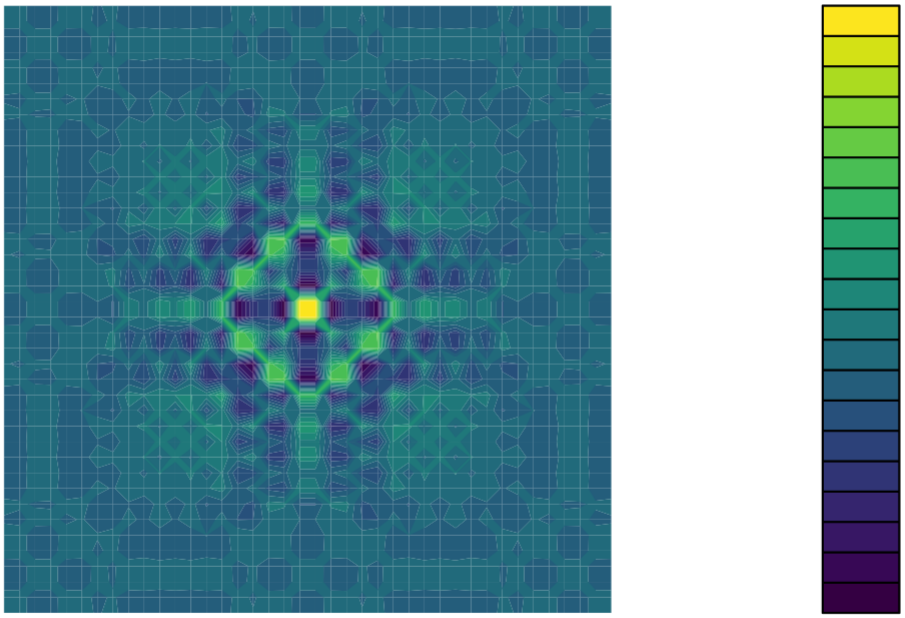
Use the color scales in this package to make plots that are pretty, better represent your data, easier to read by those with colorblindness, and print well in grey scale.

Install **viridis** like any R package:

```
install.packages("viridis")
library(viridis)
```

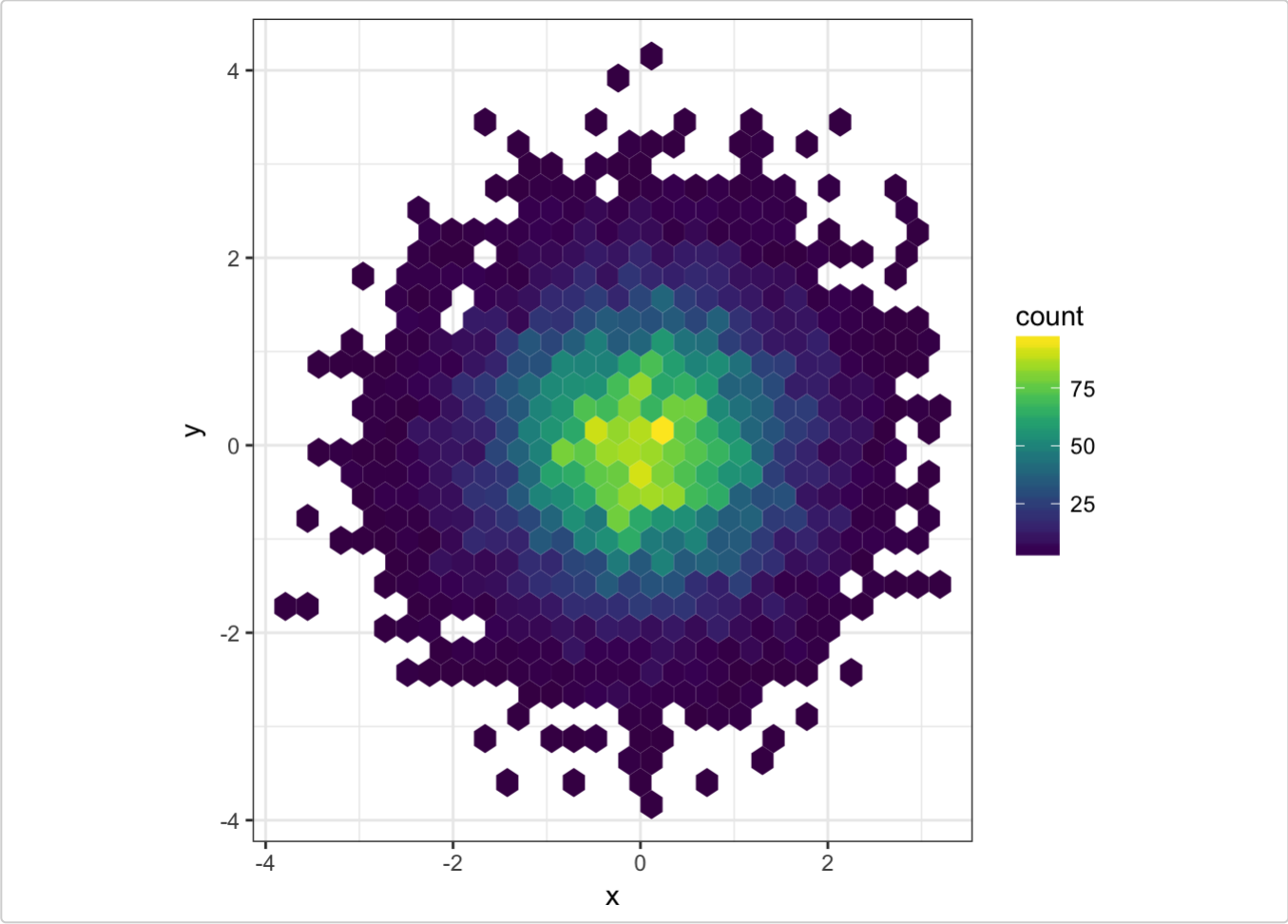
For base plots, use the `viridis()` function to generate a palette:

```
x <- y <- seq(-8*pi, 8*pi, len = 40)
r <- sqrt(outer(x^2, y^2, "+"))
filled.contour(cos(r^2)*exp(-r/(2*pi)),
               axes=FALSE,
               color.palette=viridis,
               asp=1)
```



For ggplot, use `scale_color_viridis()` and `scale_fill_viridis()`:

```
library(ggplot2)
ggplot(data.frame(x = rnorm(10000), y = rnorm(10000)), aes(x = x, y = y)) +
  geom_hex() + coord_fixed() +
  scale_fill_viridis() + theme_bw()
```



Introduction

The **viridis** package brings to R color scales created by Stéfan van der Walt and Nathaniel Smith for the Python **matplotlib** library.

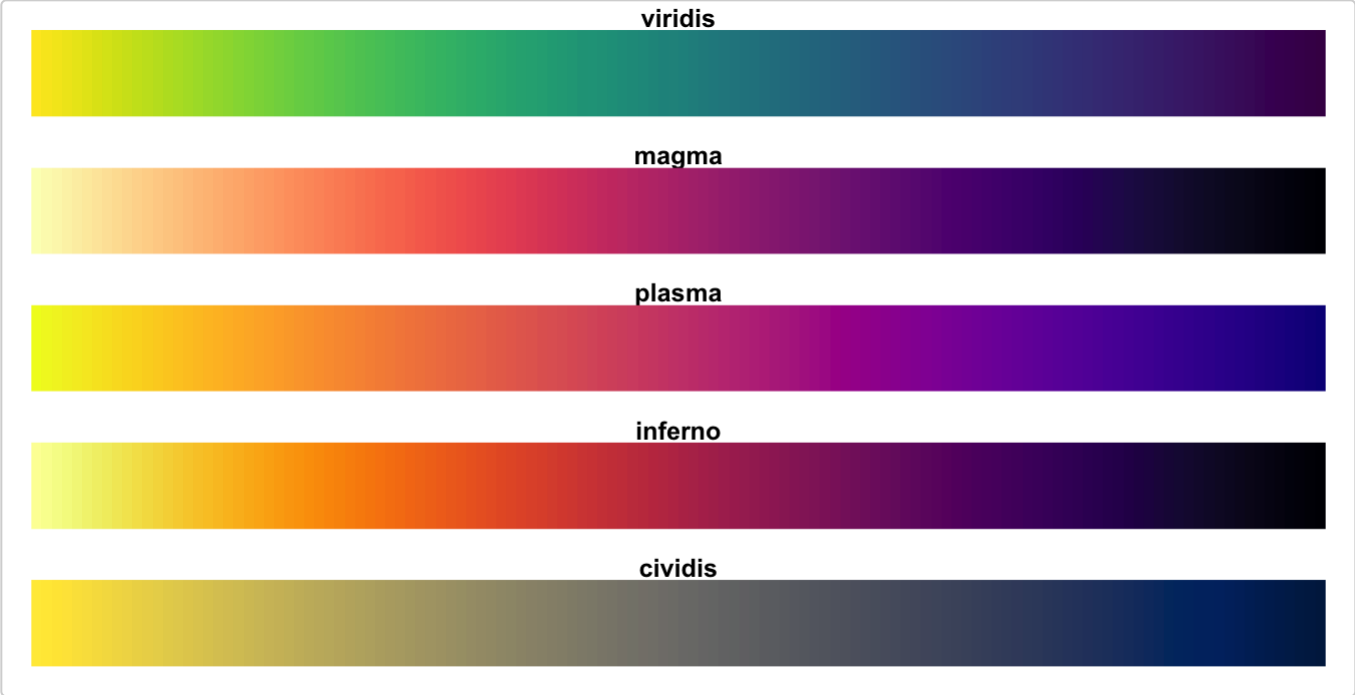
These color scales are designed to be:

- **Colorful**, spanning as wide a palette as possible so as to make differences easy to see,
- **Perceptually uniform**, meaning that values close to each other have similar-appearing colors and values far away from each other have more different-appearing colors, consistently across the range of values,
- **Robust to colorblindness**, so that the above properties hold true for people with common forms of colorblindness, as well as in grey scale printing, and
- **Pretty**, oh so pretty

If you want to know more about the science behind creating these color scales, van der Walt and Smith's talk at SciPy 2015 (YouTube) is quite interesting. On the project website you will find more details and a Python tool for creating other scales with similar properties.

The Color Scales

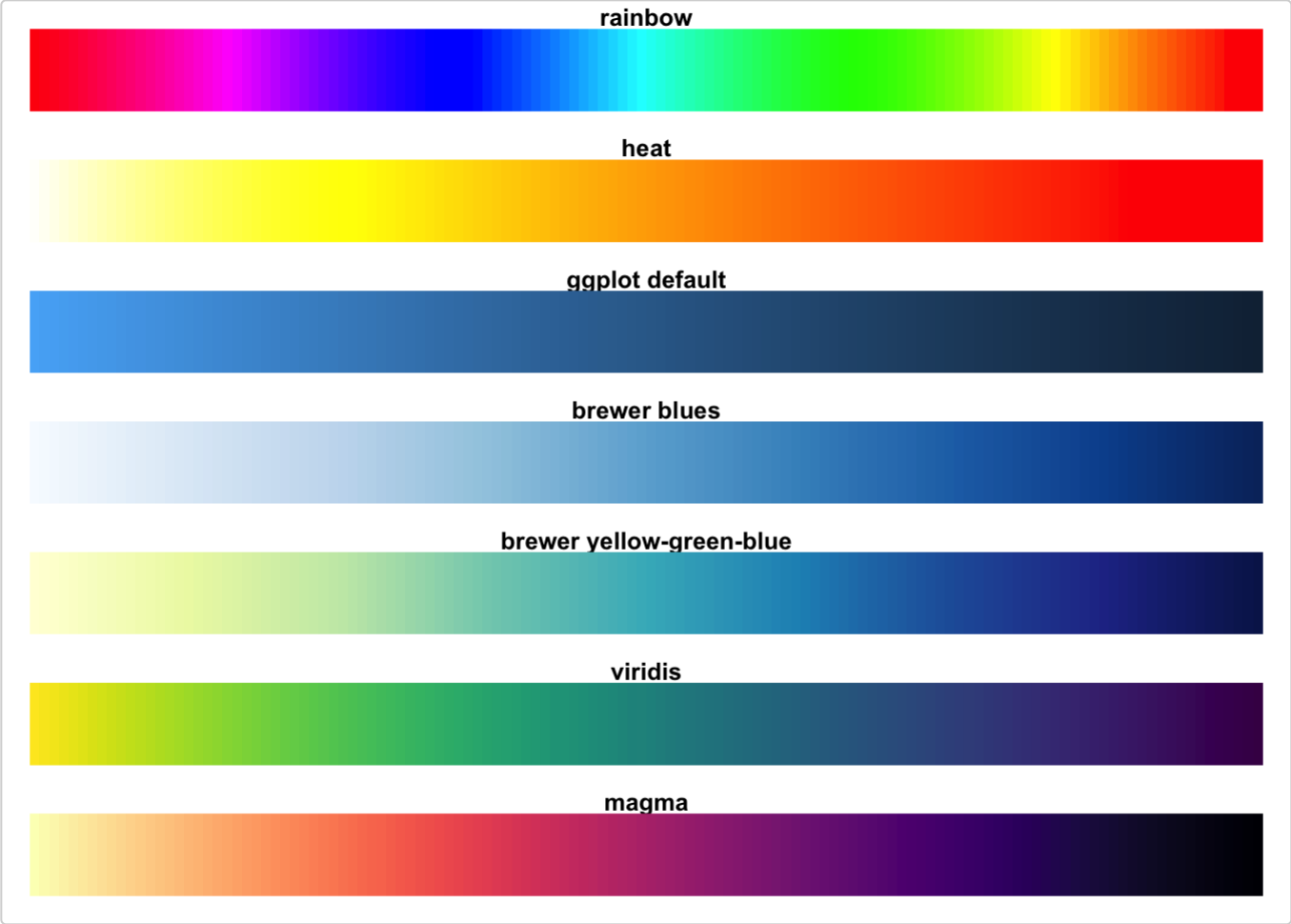
The package contains four color scales: "Viridis", the primary choice, and three alternatives with similar properties, "magma", "plasma", and "inferno."



Comparison

Let's compare the viridis and magma scales against these other commonly used sequential color palettes in R:

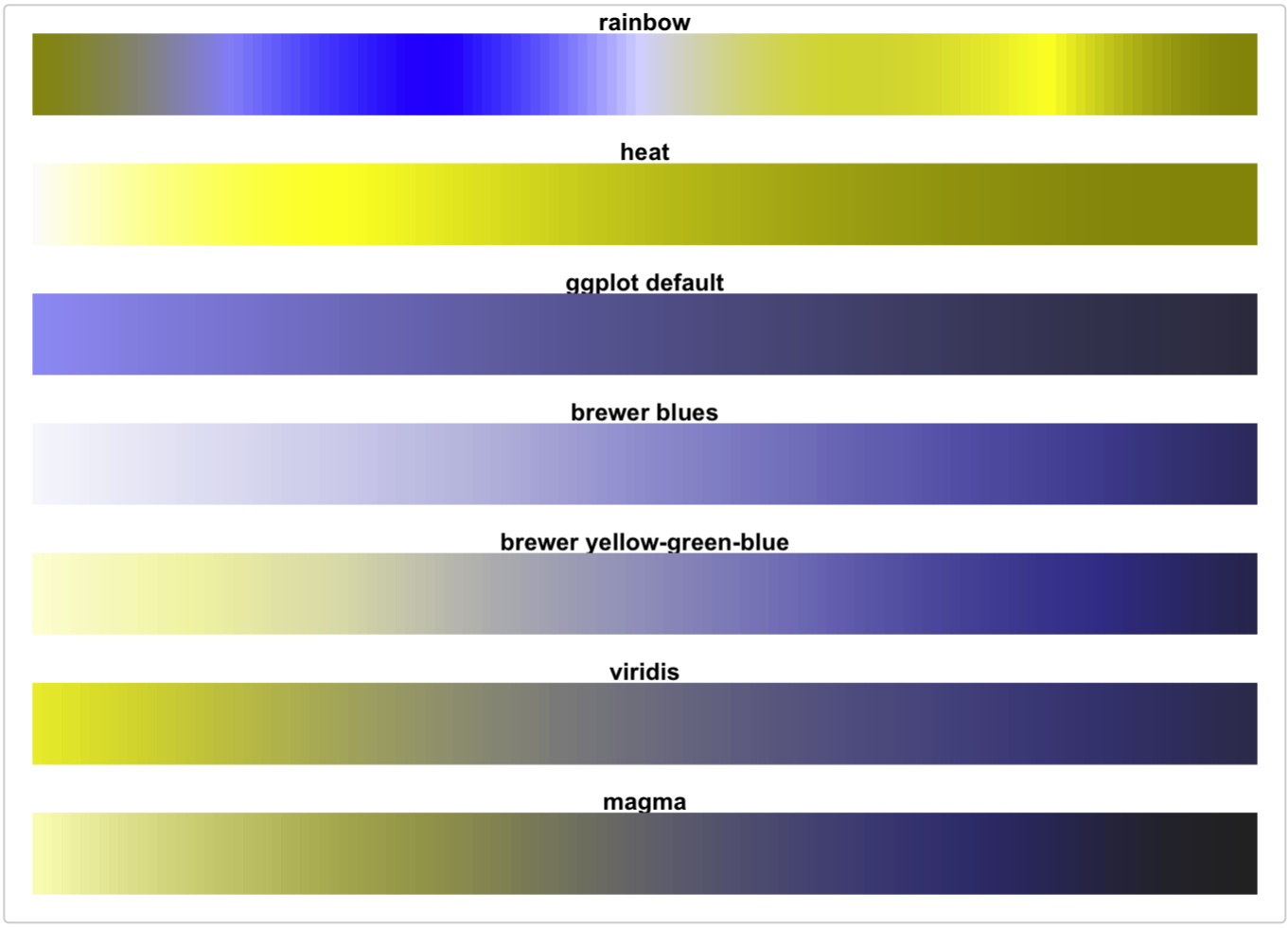
- Base R palettes: `rainbow.colors`, `heat.colors`, `cm.colors`
- The default **ggplot2** palette
- Sequential colorbrewer palettes, both default blues and the more viridis-like yellow-green-blue



It is immediately clear that the “rainbow” palette is not perceptually uniform; there are several “kinks” where the apparent color changes quickly over a short range of values. This is also true, though less so, for the “heat” colors. The other scales are more perceptually uniform, but “viridis” stands out for its large *perceptual range*. It makes as much use of the available color space as possible while maintaining uniformity.

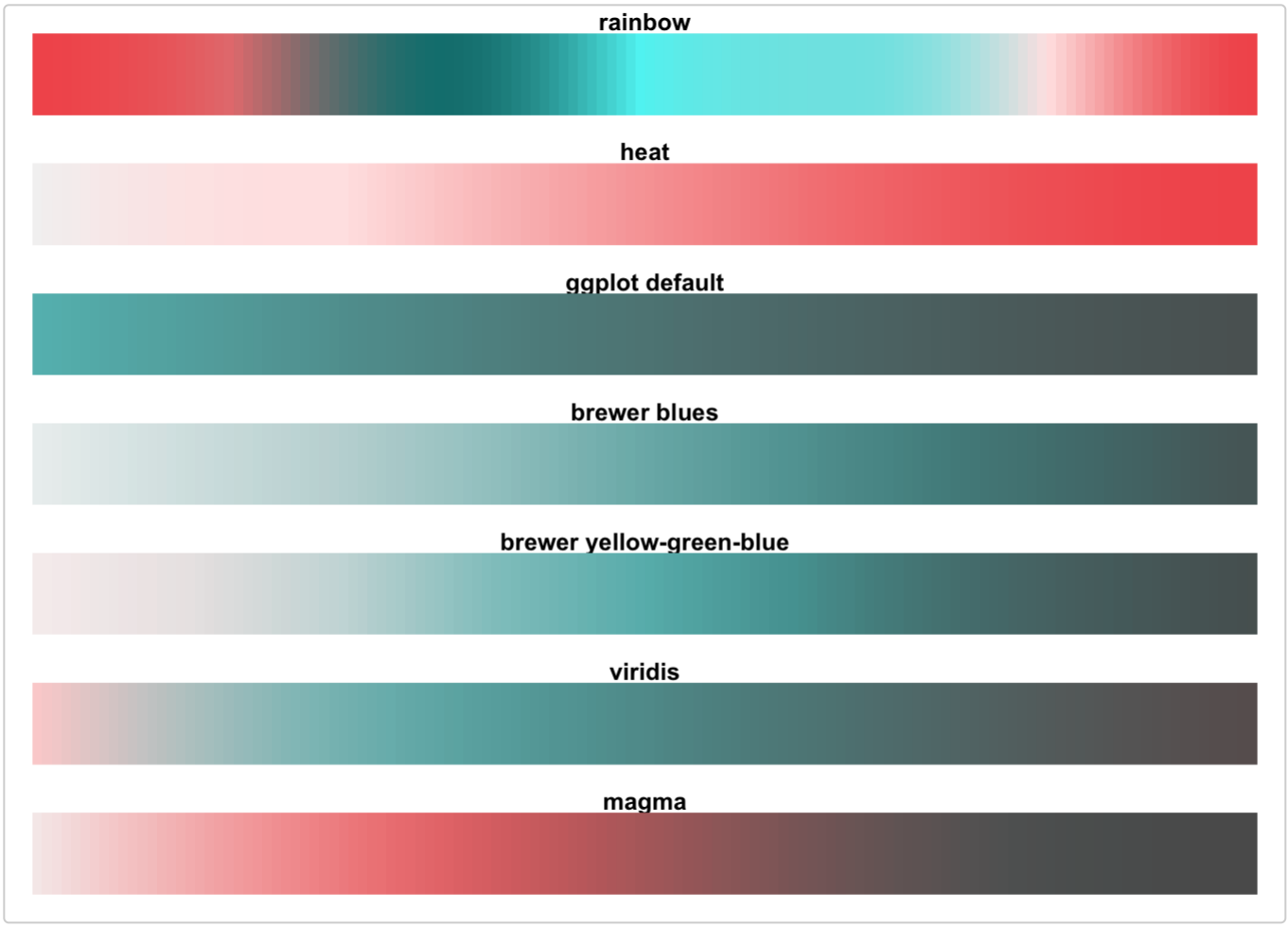
Now, let’s compare these as they might appear under various forms of colorblindness, which can be simulated using the **dichromat** package:

Green-Blind (Deuteranopia)



Red-Blind (Protanopia)

Blue-Blind (Tritanopia)



Desaturated

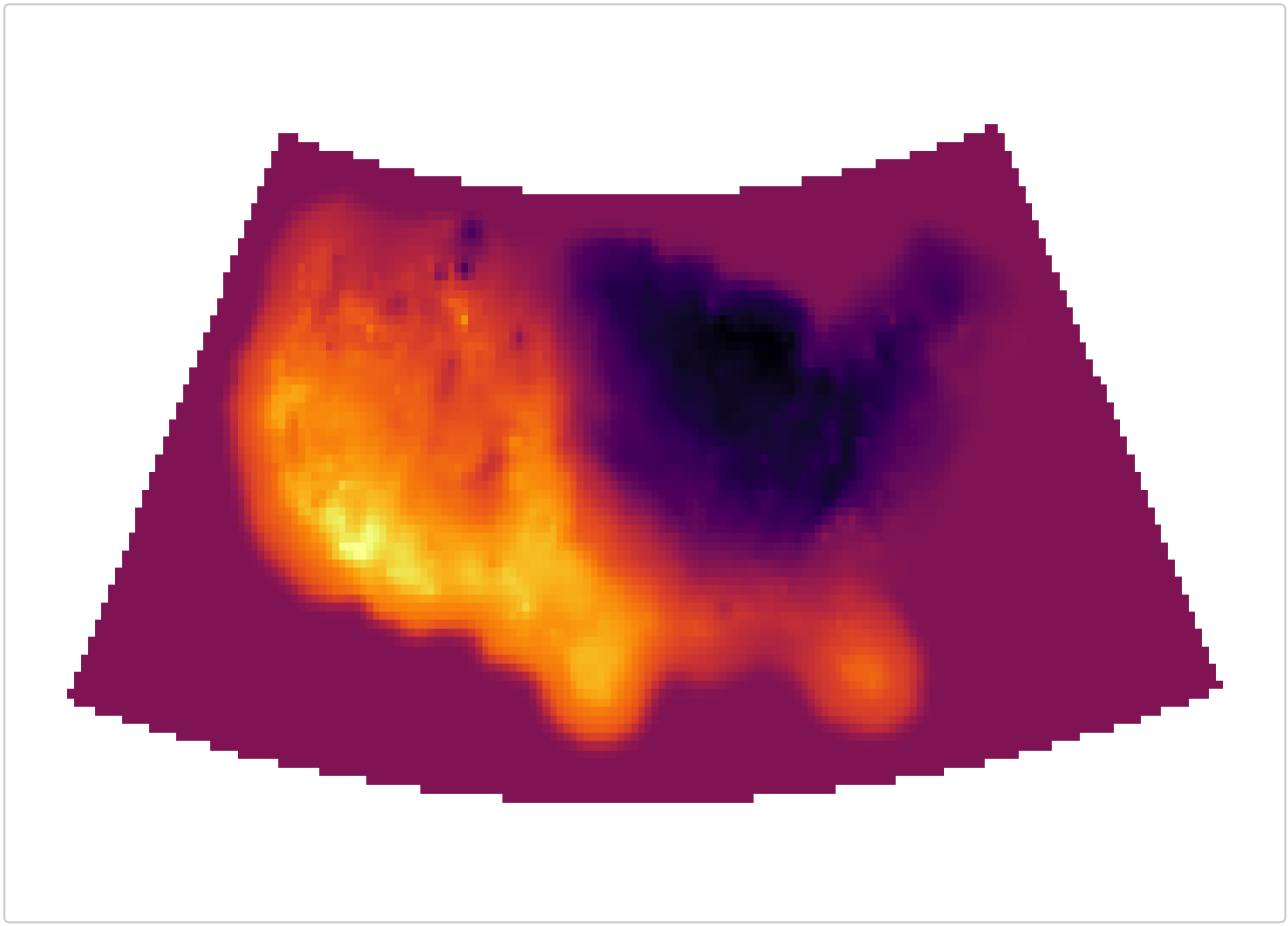
We can see that in these cases, “rainbow” is quite problematic - it is not perceptually consistent across its range. “Heat” washes out at bright colors, as do the brewer scales to a lesser extent. The ggplot scale does not wash out, but it has a low perceptual range - there’s not much contrast between low and high values. The “viridis” and “magma” scales do better - they cover a wide perceptual range in brightness in brightness and blue-yellow, and do not rely as much on red-green contrast. They do less well under tritanopia (blue-blindness), but this is an extrememly rare form of colorblindness.

Usage

The `viridis()` function produces the viridis color scale. You can choose the other color scale options using the `option` parameter or the convenience functions `magma()`, `plasma()`, and `inferno()`.

Here the `inferno()` scale is used for a raster of U.S. max temperature:

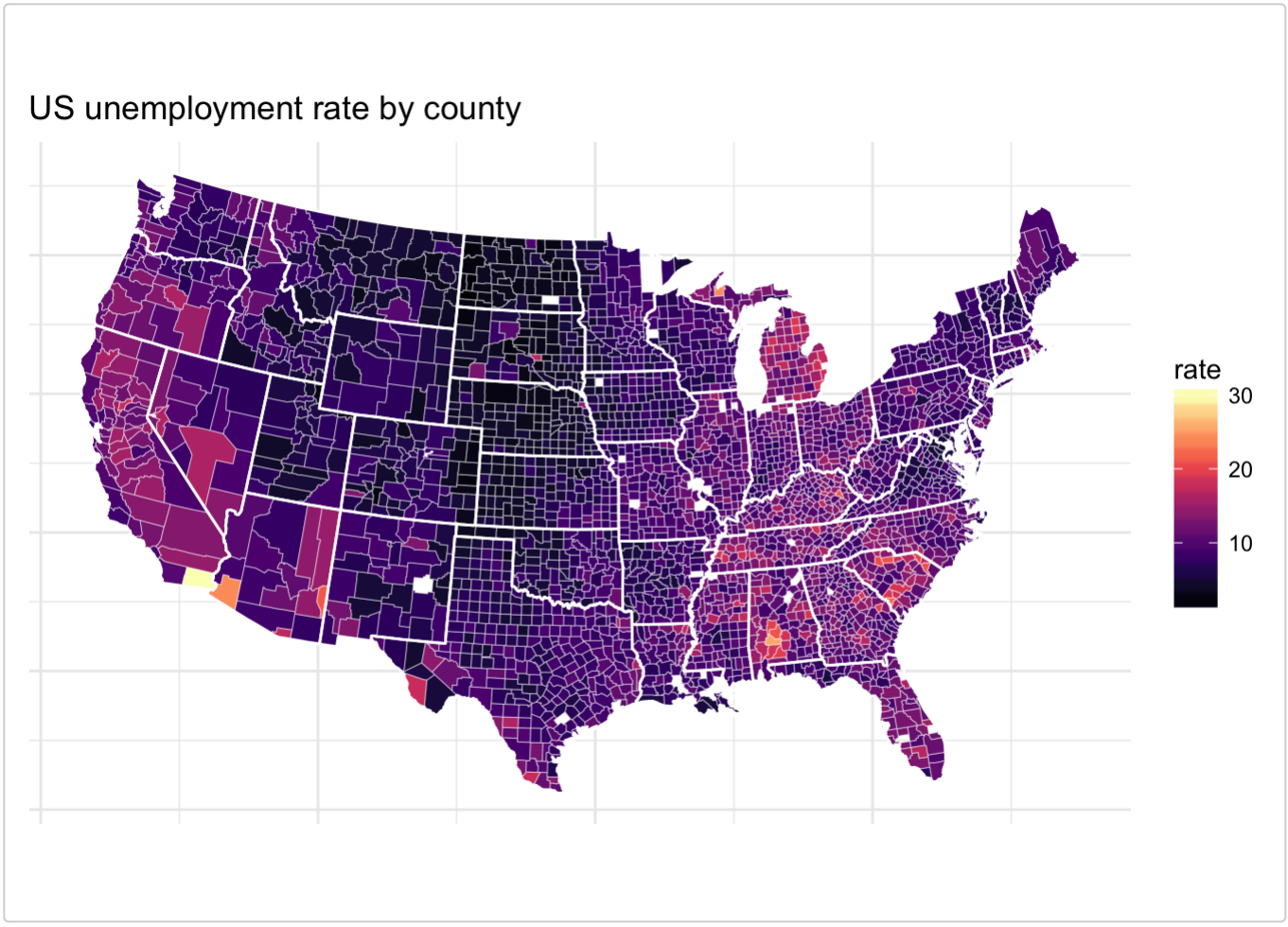
```
library(rasterVis)
library(httr)
par(mfrow=c(1,1), mar=rep(0.5, 4))
temp_raster <-
"http://ftp.cpc.ncep.noaa.gov/GIS/GRADS_GIS/GeoTIFF/TEMP/us_tmax/us.tmax_nohads_ll_20150219_float.tif"

try(GET(temp_raster,
        write_disk("us.tmax_nohads_ll_20150219_float.tif")), silent=TRUE)
us <- raster("us.tmax_nohads_ll_20150219_float.tif")
us <- projectRaster(us, crs="+proj=aea +lat_1=29.5 +lat_2=45.5 +lat_0=37.5 +lon_0=-96 +x_0=0 +y_0=0
+ellps=GRS80 +datum=NAD83 +units=m +no_defs")
image(us, col=inferno(256), asp=1, axes=FALSE, xaxs="i", xaxt='n', yaxt='n', ann=FALSE)
```



The package also contains color scale functions for **ggplot** plots: `scale_color_viridis()` and `scale_fill_viridis()`. As with `viridis()`, you can use the other scales with the `option` argument in the `ggplot` scales. Here the “magma” scale is used for a cloropleth map of U.S. unemployment:

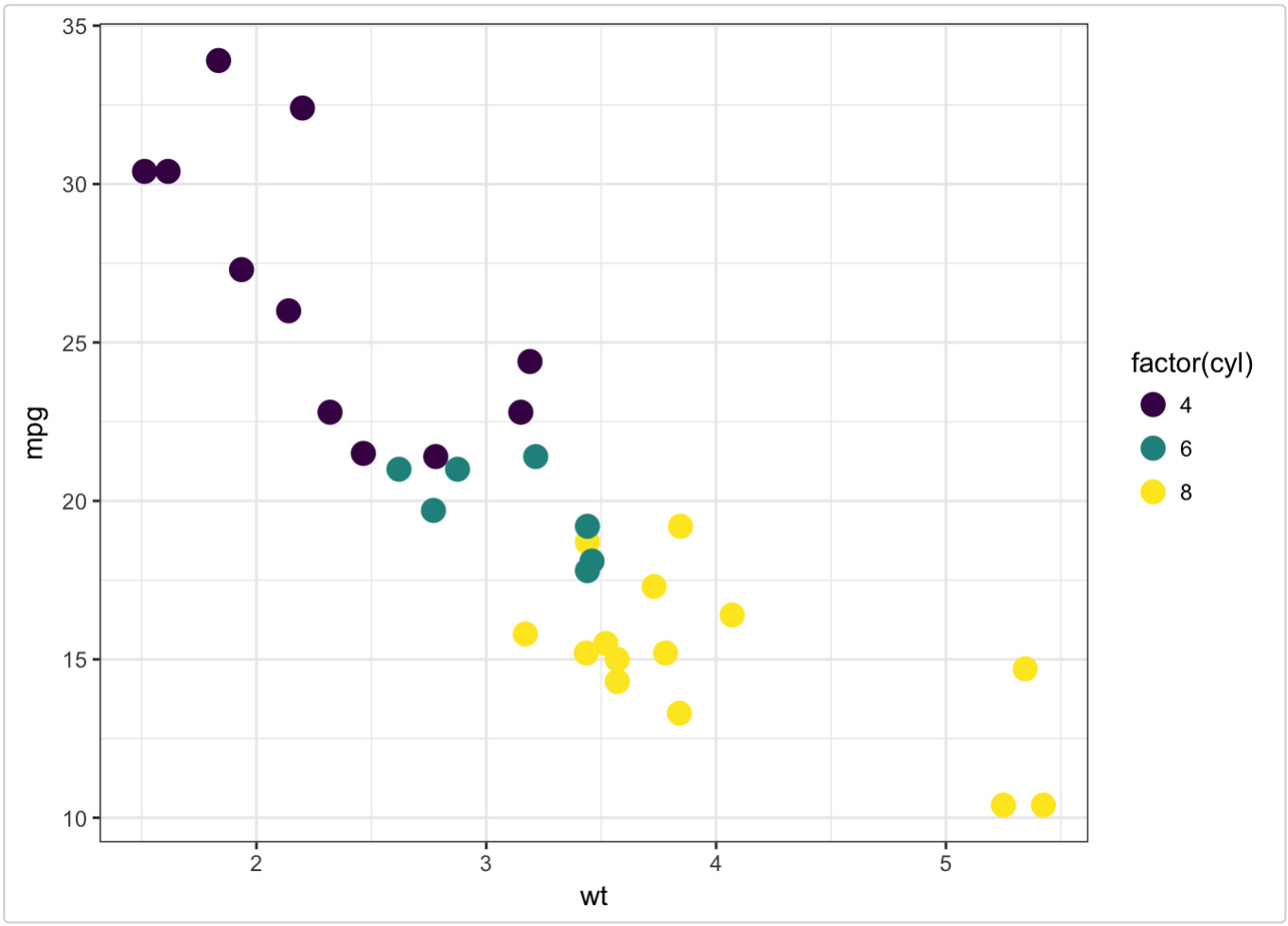
```
unemp <- read.csv("http://datasets.flowingdata.com/unemployment09.csv",
                  header = FALSE, stringsAsFactors = FALSE)
names(unemp) <- c("id", "state_fips", "county_fips", "name", "year",
                  "?", "?", "?", "rate")
unemp$county <- tolower(gsub(" County, [A-Z]{2}", "", unemp$name))
unemp$county <- gsub("^(.*) parish, ..$","\\1", unemp$county)
unemp$state <- gsub("^.*([A-Z]{2}).*$", "\\1", unemp$name)

county_df <- map_data("county", projection = "albers", parameters = c(39, 45))


##
## Attaching package: 'maps'


## The following object is masked _by_ '.GlobalEnv':
##
##     unemp
```

```
names(county_df) <- c("long", "lat", "group", "order", "state_name", "county")
county_df$state <- state.abb[match(county_df$state_name, tolower(state.name))]
county_df$state_name <- NULL

state_df <- map_data("state", projection = "albers", parameters = c(39, 45))

choropleth <- merge(county_df, unemp, by = c("state", "county"))
choropleth <- choropleth[order(choropleth$order), ]

ggplot(choropleth, aes(long, lat, group = group)) +
  geom_polygon(aes(fill = rate), colour = alpha("white", 1 / 2), size = 0.2) +
  geom_polygon(data = state_df, colour = "white", fill = NA) +
  coord_fixed() +
  theme_minimal() +
  ggtitle("US unemployment rate by county") +
  theme(axis.line = element_blank(), axis.text = element_blank(),
        axis.ticks = element_blank(), axis.title = element_blank()) +
  scale_fill_viridis(option="magma")
```



The ggplot functions also can be used for discrete scales with the argument `discrete=TRUE`.

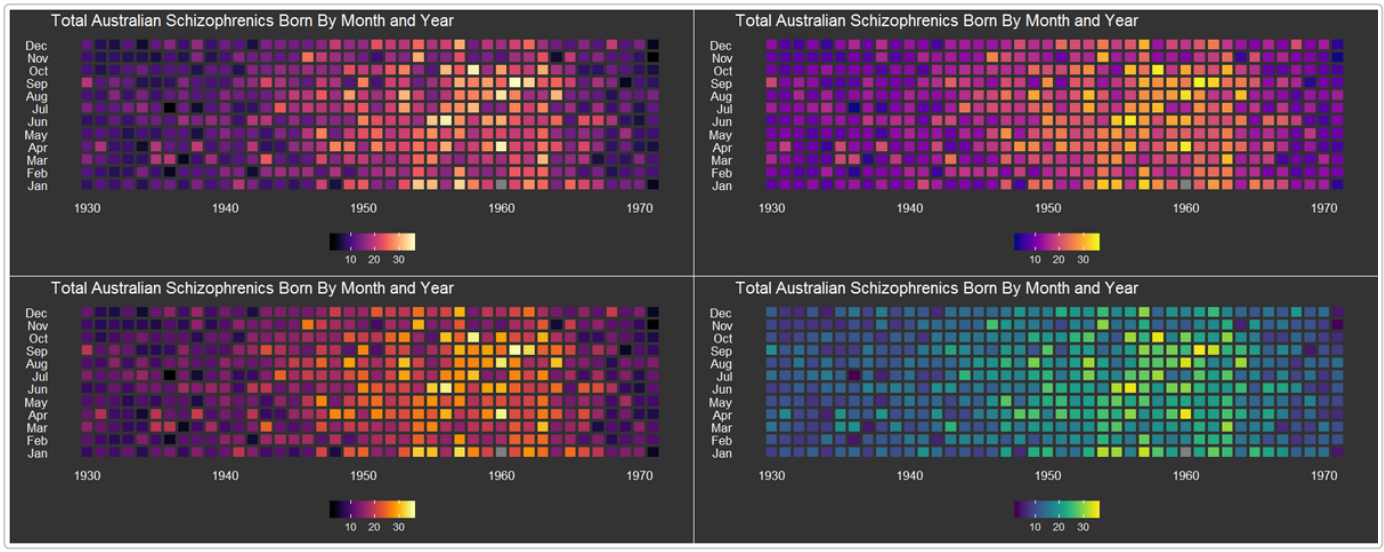
```
p <- ggplot(mtcars, aes(wt, mpg))
p + geom_point(size=4, aes(colour = factor(cyl))) +
    scale_color_viridis(discrete=TRUE) +
    theme_bw()
```



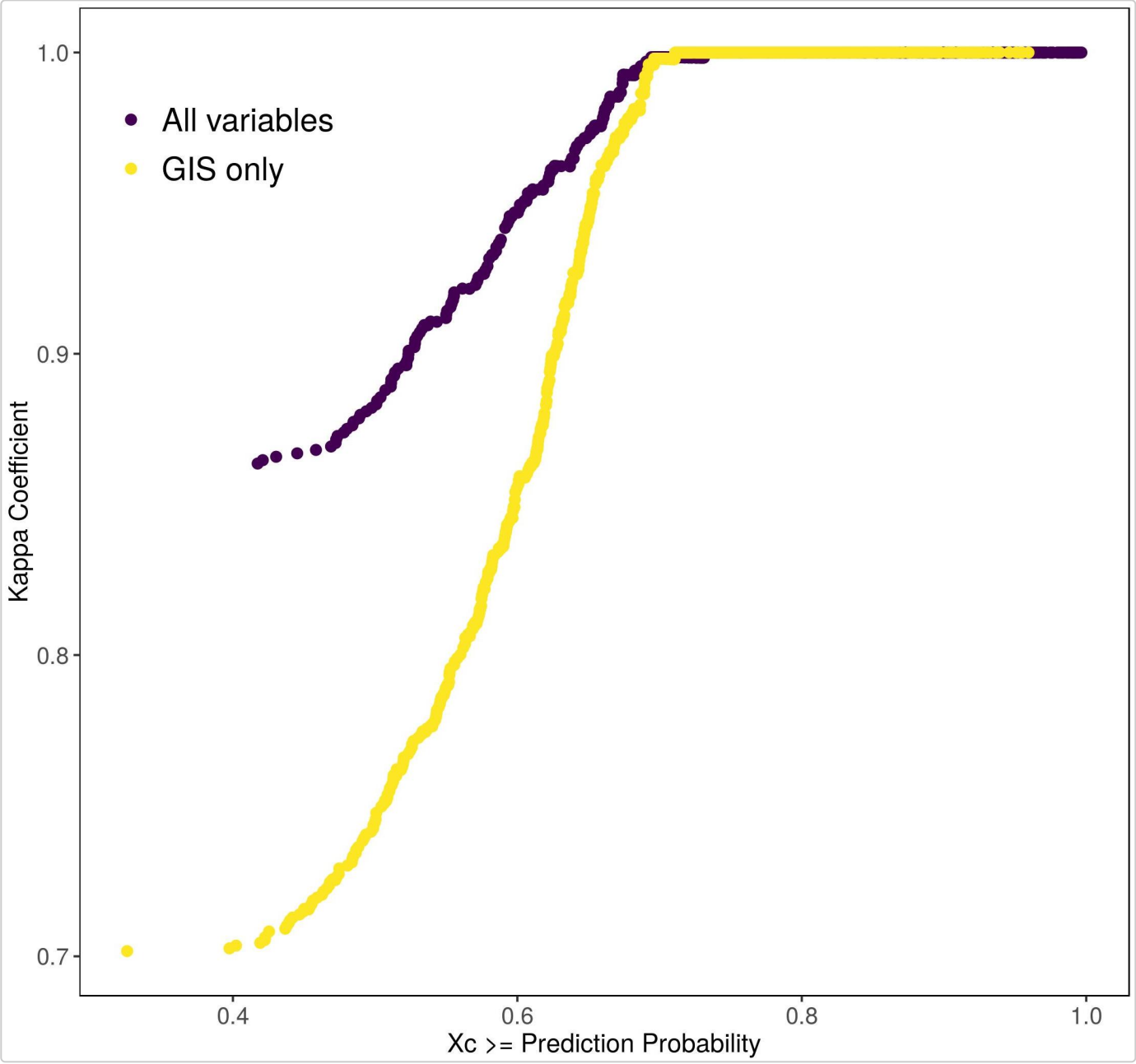
Gallery

Here are some examples of viridis being used in the wild:

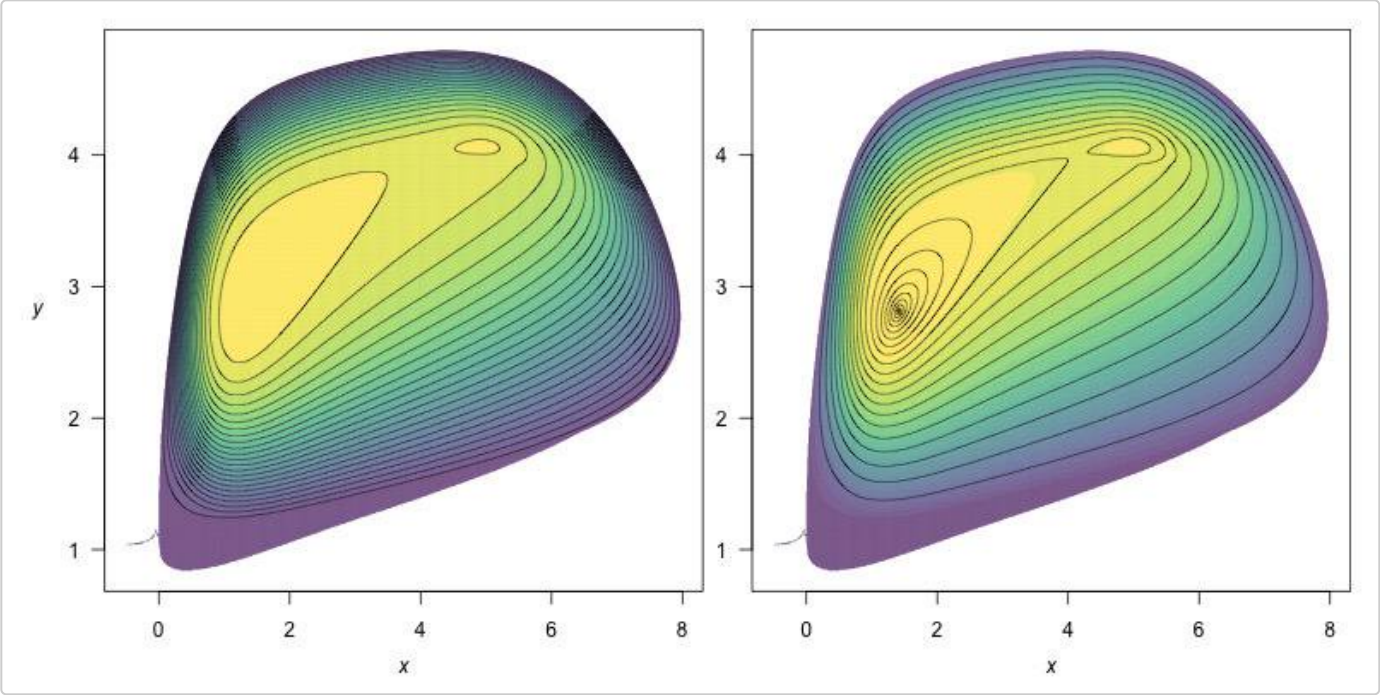
James Curley uses **viridis** for matrix plots (Code):



Jeff Hollister uses the viridis as a discrete categorical scale (Code):



Christopher Moore created these contour plots of potential in a dynamic plankton-consumer model:


y
x
x