cm013 Exercise

```
suppressPackageStartupMessages(library(tidyverse))
library(gapminder)
```

Saving Graphs to File

- Don't use the mouse
- Use `ggsave` for ggplot
    - Practice by saving the following plot to file:

```
p<- ggplot(mtcars, aes(hp, wt)) +
    geom_point()
ggsave("my_plot.png", p)
```

```
## Saving 6.5 x 4.5 in image
```

- Base R way: print plots "to screen", sandwiched between `pdf()`/`jpeg()`/`png()`... and `dev.off()`.
- Vector vs. raster: Images are stored on your computer as either *vector* or *raster*.
    - **Raster**: an `n` by `m` grid of pixels, each with its own colour. `jpeg`, `png`, `gif`, `bmp`.
    - **Vector**: represented as shapes and lines. `pdf`, `svg`.
    - For tips: "10 tips for making your R graphics look their best"".
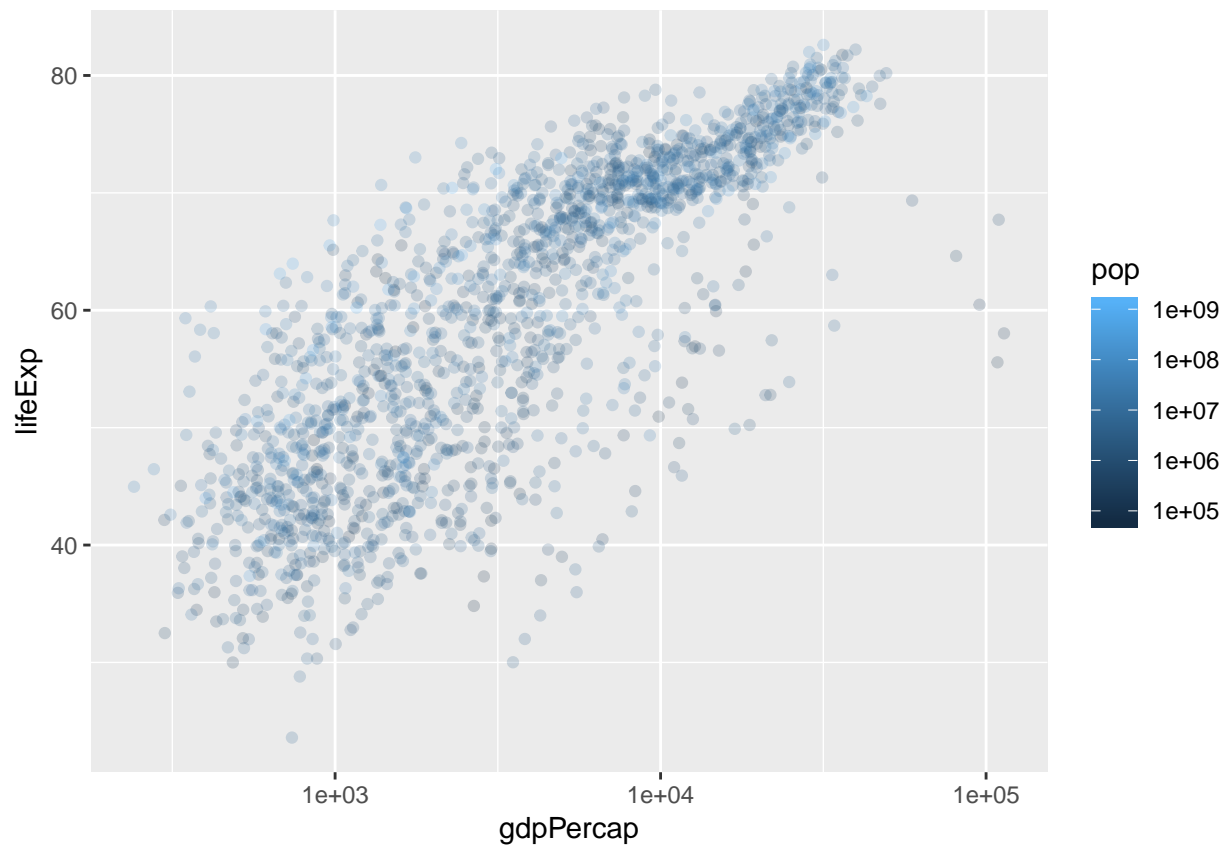
Scales; Colour

Scale functions in `ggplot2` take the form `scale_[aesthetic]_[mapping]()`.

Scale is one of the components of the grammar of graphics.

Let's first focus on the following plot:

```
p_scales <- ggplot(gapminder, aes(gdpPercap, lifeExp)) +
     geom_point(aes(colour=pop), alpha=0.2)
p_scales +
    scale_x_log10() +
    scale_colour_continuous(trans="log10")
```

1. Change the y-axis tick mark spacing to 10; change the colour spacing to include all powers of 10.

```
p_scales +
    scale_x_log10() +
    scale_colour_continuous(
        trans  = "log10",
        breaks = 10^(1:10) # vector of (10, 100, 1000, 10000, ...)
    ) +
    scale_y_continuous(breaks=1:10*10)
```
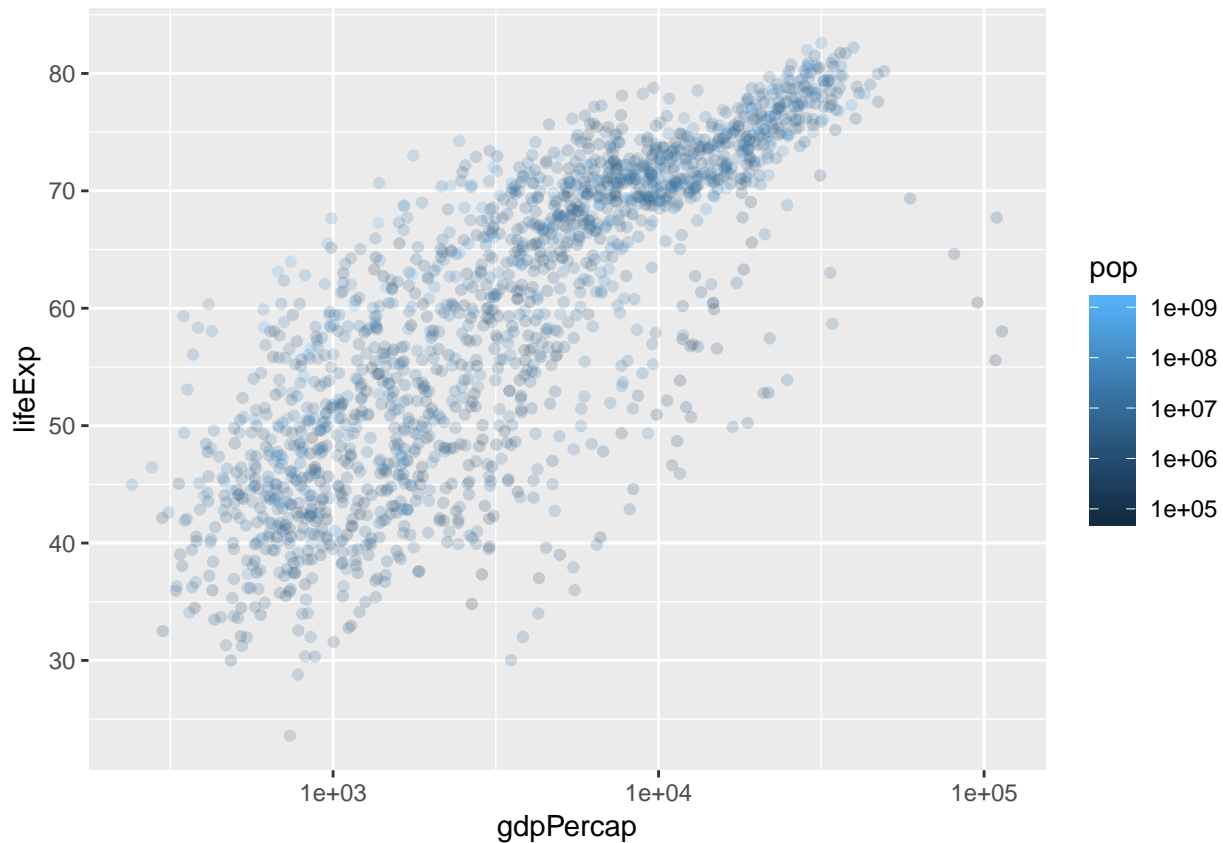
2. Specify `scales::*_format` in the `labels` argument of a scale function to do the following:
   - Change the x-axis labels to dollar format (use `scales::dollar_format()`)
   - Change the colour labels to comma format (use `scales::comma_format()`)

```
library(scales)
```

```
##
## Attaching package: 'scales'

## The following object is masked from 'package:purrr':
##
##     discard

## The following object is masked from 'package:readr':
##
##     col_factor
```

```
p_scales +
    scale_x_log10(labels=dollar_format()) +
    scale_colour_continuous(
        trans  = "log10",
        breaks = 10^(1:10),
        labels = comma_format()
    ) +
    scale_y_continuous(breaks=10*(1:10))
```
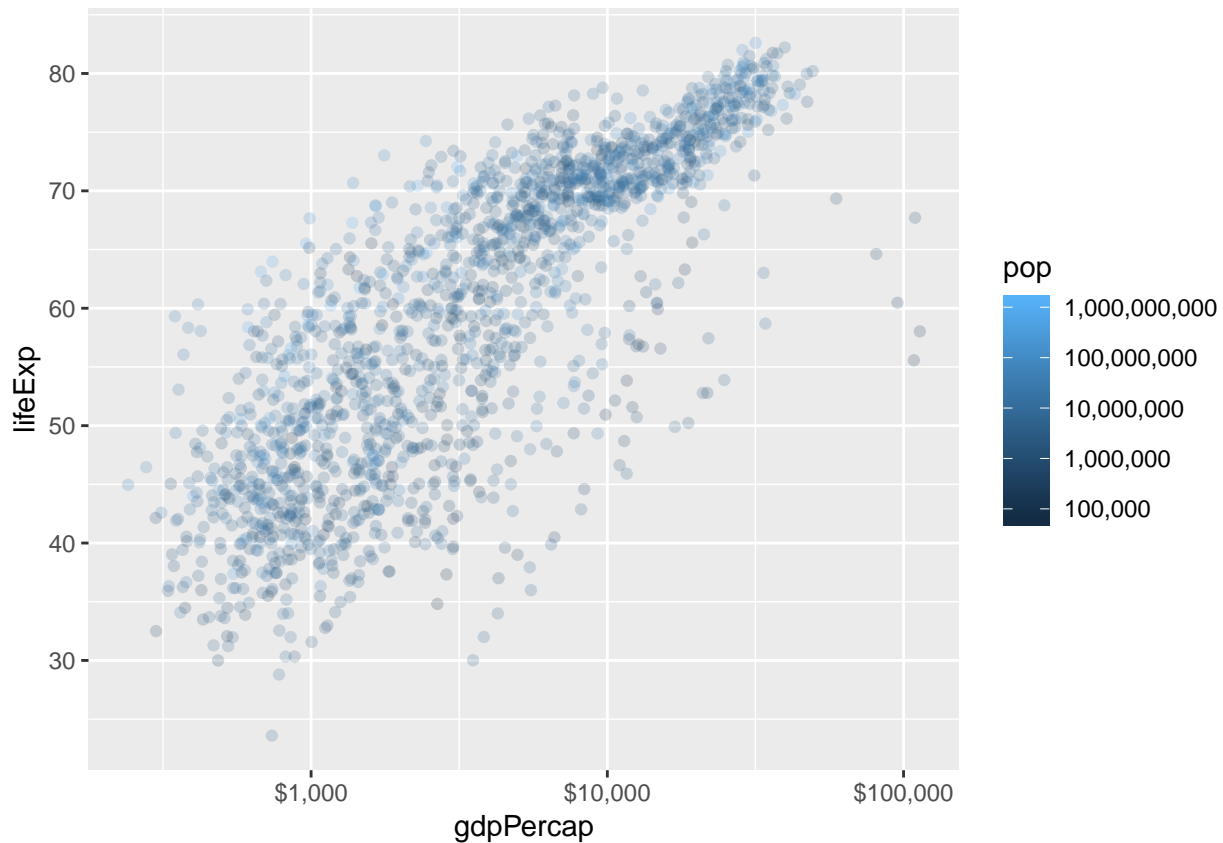
3. Use `RColorBrewer` to change the colour scheme.
   - Notice the three different types of scales: sequential, diverging, and continuous.

```
## All palettes the come with RColorBrewer:
RColorBrewer::display.brewer.all()
```
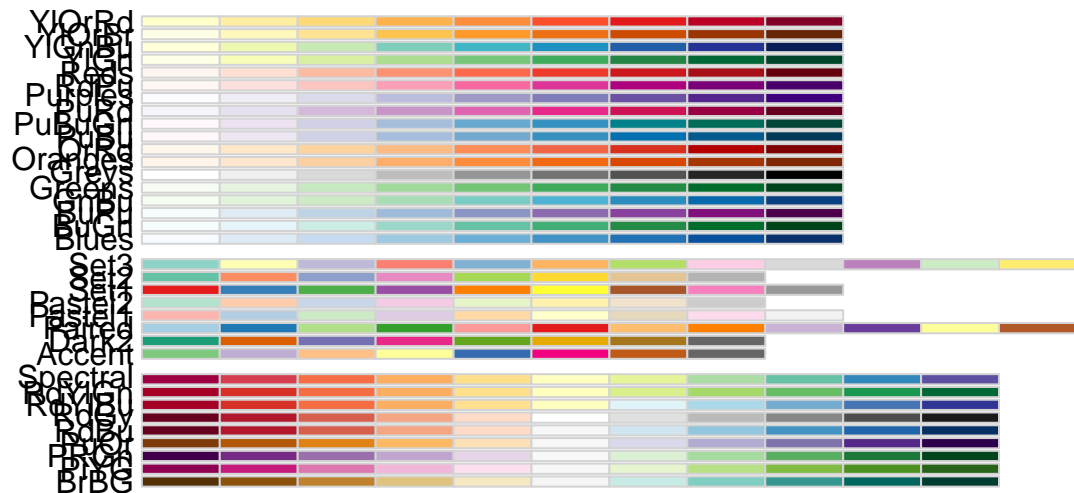


```
p_scales +
    scale_x_log10(labels=dollar_format()) +
    scale_color_distiller(
        trans   = "log10",
        breaks  = 10^(1:10),
        labels  = comma_format(),
```

4

```
        palette = "Greens"
    ) +
    scale_y_continuous(breaks=10*(1:10))
```


4. Use `viridis` to change the colour to a colour-blind friendly scheme
   - Hint: add `scale_colour_viridis_c` (`c` stands for continuous; `d` discrete).
   - You can choose a palette with `option`.

```
p_scales +
    scale_x_log10(labels=dollar_format()) +
    scale_colour_viridis_c(
        trans   = "log10",
        breaks  = 10^(1:10),
        labels  = comma_format()
    ) +
    scale_y_continuous(breaks=10*(1:10))
```
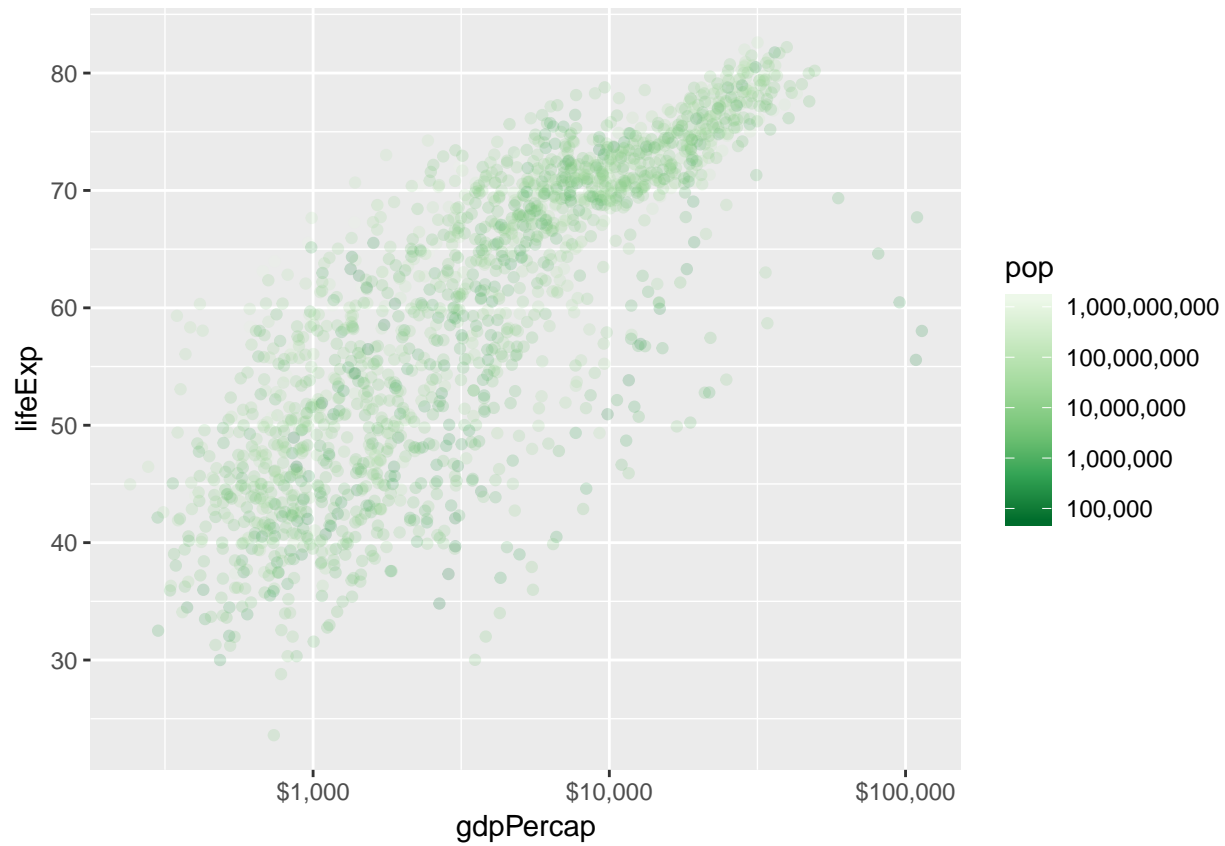
Theming

Changing the look of a graphic can be achieved through the `theme()` layer.

There are "complete themes" that come with **ggplot2**, my favourite being `theme_bw` (I've grown tired of the default gray background, so `theme_bw` is refreshing).

1. Change the theme of the following plot to `theme_bw()`:

```
ggplot(iris, aes(Sepal.Width, Sepal.Length)) +
    facet_wrap(~ Species) +
    geom_point() +
    labs(x = "Sepal Width",
         y = "Sepal Length",
         title = "Sepal sizes of three plant species") +
    theme_bw()
```

Sepal sizes of three plant species
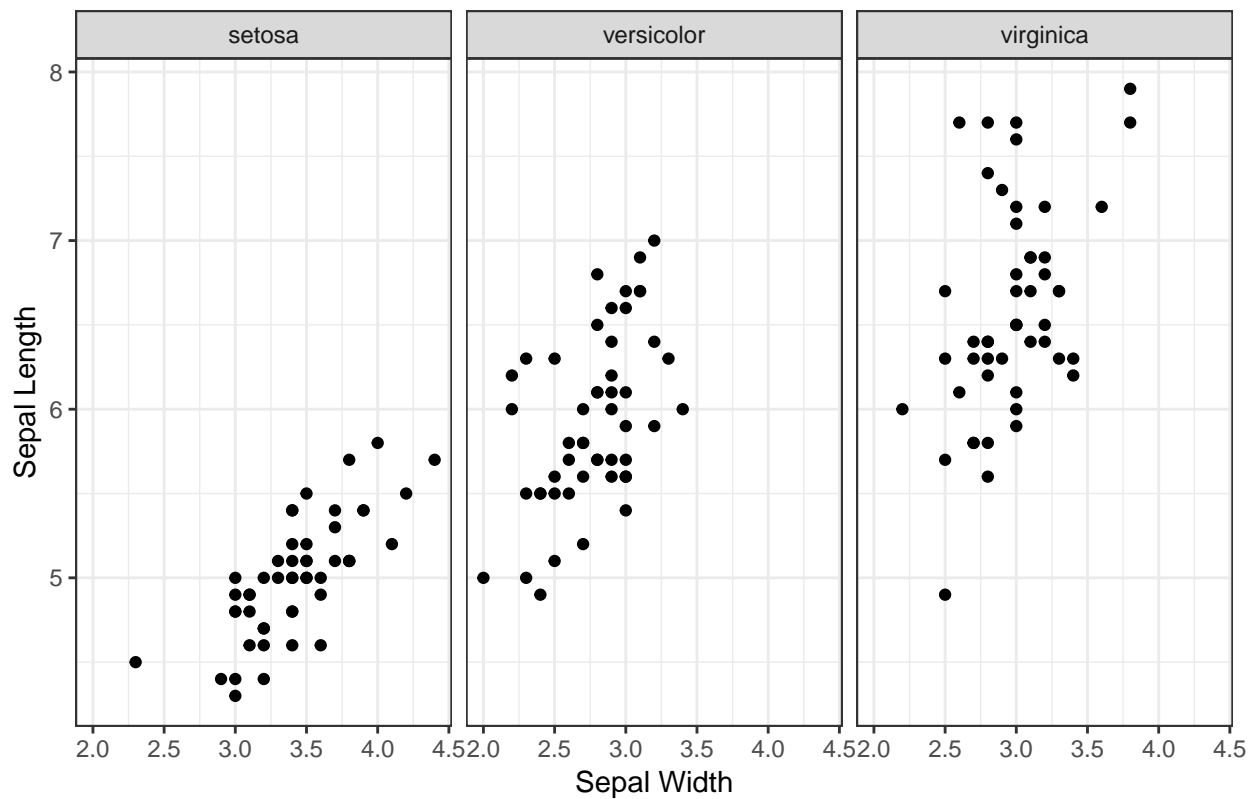
2. Then, change font size of axis labels, and the strip background colour. Others?

```r
ggplot(iris, aes(Sepal.Width, Sepal.Length)) +
    facet_wrap(~ Species) +
    geom_point() +
    labs(x = "Sepal Width",
        y = "Sepal Length",
        title = "Sepal sizes of three plant species") +
    theme_bw() +
    theme(axis.text = element_text(size = 16)  ,
        strip.background = element_rect(fill = "orange"),
        panel.background = element_rect(fill = "grey")) # change aspects of plot in theme()
```

Sepal sizes of three plant species

Plotly

Consider the following plot:

```
(p <- gapminder %>%
    filter(continent != "Oceania") %>%
    ggplot(aes(gdpPercap, lifeExp)) +
    geom_point(aes(colour=pop), alpha=0.2) +
    scale_x_log10(labels=dollar_format()) +
    scale_colour_distiller(
        trans   = "log10",
        breaks  = 10^(1:10),
        labels  = comma_format(),
        palette = "Greens"
    ) +
    facet_wrap(~ continent) +
    scale_y_continuous(breaks=10*(1:10)) +
    theme_bw())
```
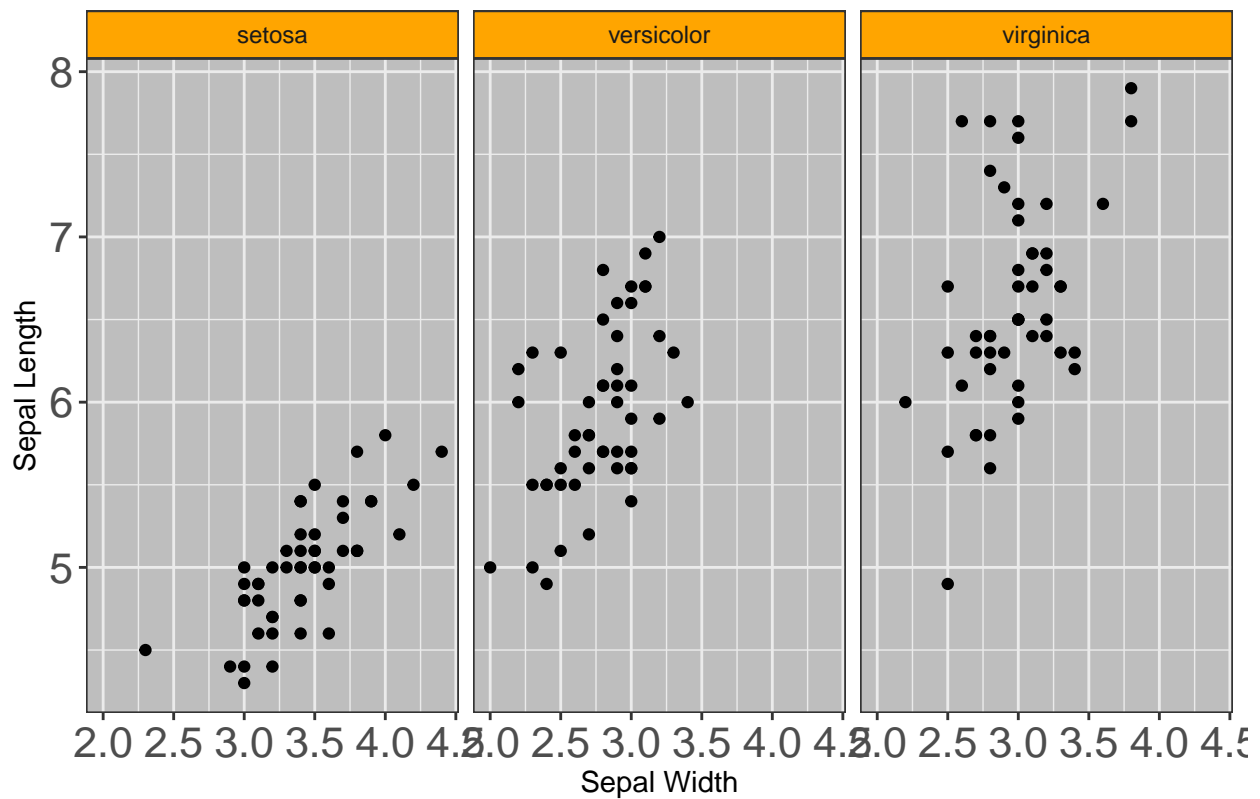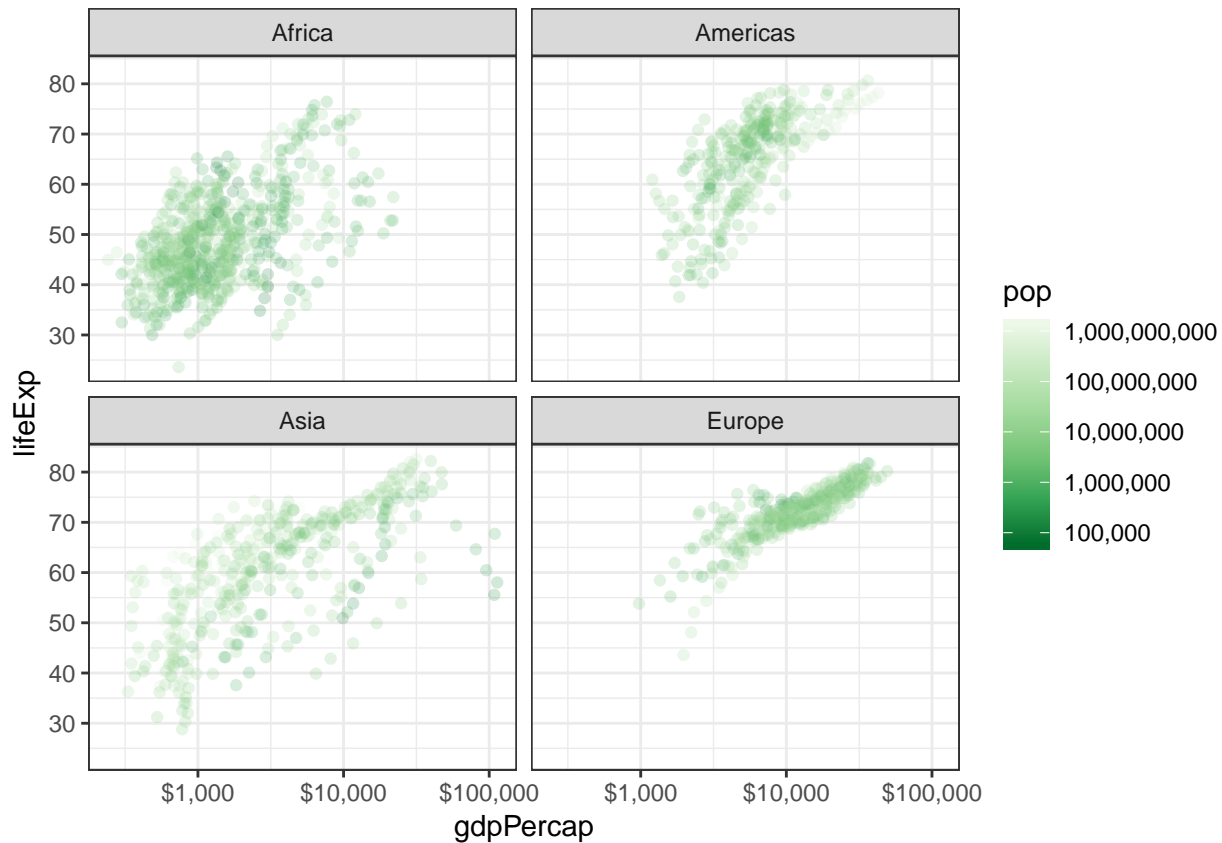
1. Convert it to a `plotly` object by applying the `ggplotly()` function:

```
library(plotly)
```

```
##
## Attaching package: 'plotly'
```

```
## The following object is masked from 'package:ggplot2':
##
##     last_plot
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following object is masked from 'package:graphics':
##
##     layout
```

```
ggplotly(p)
```

2. You can save a plotly graph locally as an html file. Try saving the above:
   - NOTE: plotly graphs don't seem to show up in Rmd *notebooks*, but they do with Rmd *documents*.

```
# p %>%
#     ggplotly() %>%
#     htmlwidgets::saveWidget("cm013-exercise_files/plotly.html")
```

3. Run this code to see the json format underneath:

```
p %>%
    ggplotly() %>%
    plotly_json()
```

```
## {
##   "data": [
##     {
##       "x": [3.38899023661283, 3.47913979306149, 3.40667928226323, 3.51148118797499, 3.62145295412403,
##       "y": [43.077, 45.685, 48.303, 51.407, 54.518, 58.014, 61.368, 65.799, 67.744, 69.152, 70.994,
##       "text": ["pop: 6.967526<br />gdpPercap:    2449.0082<br />lifeExp: 43.07700", "pop: 7.011607<br
##       "type": "scatter",
##       "mode": "markers",
##       "marker": {
##         "autocolorscale": false,
##         "color": ["rgba(140,207,137,1)", "rgba(142,208,139,1)", "rgba(144,209,140,1)", "rgba(147,210
##         "opacity": 0.2,
##         "size": 5.66929133858268,
##         "symbol": "circle",
##         "line": {
##           "width": 1.88976377952756,
##           "color": ["rgba(140,207,137,1)", "rgba(142,208,139,1)", "rgba(144,209,140,1)", "rgba(147,2
##         }
##       },
##       "hoveron": "points",
##       "showlegend": false,
##       "xaxis": "x",
##       "yaxis": "y",
##       "hoverinfo": "text",
##       "frame": null
##     },
##     {
##       "x": [3.77168410638546, 3.83612504242298, 3.85328233225476, 3.90595516552978, 3.97511176153781
##       "y": [62.485, 64.399, 65.142, 65.634, 67.065, 68.481, 69.942, 70.774, 71.868, 73.275, 74.34, 75
##       "text": ["pop: 7.252294<br />gdpPercap:    5911.3151<br />lifeExp: 62.48500", "pop: 7.292490<br
##       "type": "scatter",
##       "mode": "markers",
##       "marker": {
##         "autocolorscale": false,
##         "color": ["rgba(154,214,149,1)", "rgba(156,215,151,1)", "rgba(158,216,153,1)", "rgba(160,216
##         "opacity": 0.2,
##         "size": 5.66929133858268,
##         "symbol": "circle",
##         "line": {
##           "width": 1.88976377952756,
##           "color": ["rgba(154,214,149,1)", "rgba(156,215,151,1)", "rgba(158,216,153,1)", "rgba(160,2
##         }
##       },
##       "hoveron": "points",
##       "showlegend": false,
##       "xaxis": "x2",
##       "yaxis": "y",
##       "hoverinfo": "text",
##       "frame": null
##     },
```

```
##      {
##        "x": [2.89178565070639, 2.91426540541726, 2.93100030340142, 2.92230867688807, 2.86922063087752
##        "y": [28.801, 30.332, 31.997, 34.02, 36.088, 38.438, 39.854, 40.822, 41.674, 41.763, 42.129, 4
##        "text": ["pop: 6.925587<br />gdpPercap:    779.4453<br />lifeExp: 28.80100", "pop: 6.965716<br
##        "type": "scatter",
##        "mode": "markers",
##        "marker": {
##          "autocolorscale": false,
##          "color": ["rgba(138,206,135,1)", "rgba(140,207,137,1)", "rgba(142,208,139,1)", "rgba(145,209
##          "opacity": 0.2,
##          "size": 5.66929133858268,
##          "symbol": "circle",
##          "line": {
##            "width": 1.88976377952756,
##            "color": ["rgba(138,206,135,1)", "rgba(140,207,137,1)", "rgba(142,208,139,1)", "rgba(145,20
##          }
##        },
##        "hoveron": "points",
##        "showlegend": false,
##        "xaxis": "x",
##        "yaxis": "y2",
##        "hoverinfo": "text",
##        "frame": null
##      },
##      {
##        "x": [3.20440655935692, 3.28831278714121, 3.36415478275528, 3.44094006865781, 3.52027677612856
##        "y": [55.23, 59.28, 64.82, 66.22, 67.69, 68.93, 70.42, 72, 71.581, 72.95, 75.651, 76.423, 66.8
##        "text": ["pop: 6.108124<br />gdpPercap:   1601.0561<br />lifeExp: 55.23000", "pop: 6.169235<br
##        "type": "scatter",
##        "mode": "markers",
##        "marker": {
##          "autocolorscale": false,
##          "color": ["rgba(87,181,102,1)", "rgba(92,183,104,1)", "rgba(97,185,107,1)", "rgba(101,188,109
##          "opacity": 0.2,
##          "size": 5.66929133858268,
##          "symbol": "circle",
##          "line": {
##            "width": 1.88976377952756,
##            "color": ["rgba(87,181,102,1)", "rgba(92,183,104,1)", "rgba(97,185,107,1)", "rgba(101,188,1
##          }
##        },
##        "hoveron": "points",
##        "showlegend": false,
##        "xaxis": "x2",
##        "yaxis": "y2",
##        "hoverinfo": "text",
##        "frame": null
##      },
##      {
##        "x": [3],
##        "y": [30],
##        "name": "99_cf8fe1fdb84eaed8dd26ad0d87dd3617",
##        "type": "scatter",
##        "mode": "markers",
```

```
##         "opacity": 0,
##         "hoverinfo": "none",
##         "showlegend": false,
##         "marker": {
##           "color": [0, 1],
##           "colorscale": [
##             [0, "#006D2C"],
##             [0.0526315789473684, "#107B36"],
##             [0.105263157894737, "#1D8941"],
##             [0.157894736842105, "#28974B"],
##             [0.210526315789474, "#35A556"],
##             [0.263157894736842, "#49AD5F"],
##             [0.31578947368421, "#5AB668"],
##             [0.368421052631579, "#6BBF71"],
##             [0.421052631578947, "#79C67A"],
##             [0.473684210526316, "#85CC84"],
##             [0.526315789473684, "#91D18D"],
##             [0.578947368421053, "#9CD797"],
##             [0.631578947368421, "#A7DCA1"],
##             [0.684210526315789, "#B1E0AA"],
##             [0.736842105263158, "#BBE4B4"],
##             [0.789473684210526, "#C5E8BE"],
##             [0.842105263157894, "#CFECC9"],
##             [0.894736842105263, "#D9F0D3"],
##             [0.947368421052631, "#E3F4DE"],
##             [1, "#EDF8E9"]
##           ],
##           "colorbar": {
##             "bgcolor": "rgba(255,255,255,1)",
##             "bordercolor": "transparent",
##             "borderwidth": 1.88976377952756,
##             "thickness": 23.04,
##             "title": "pop",
##             "titlefont": {
##               "color": "rgba(0,0,0,1)",
##               "family": "",
##               "size": 14.6118721461187
##             },
##             "tickmode": "array",
##             "ticktext": ["100,000", "1,000,000", "10,000,000", "100,000,000", "1,000,000,000"],
##             "tickvals": [0.0510764059940825, 0.281389815946806, 0.511703225899529, 0.742016635852253, (
##             "tickfont": {
##               "color": "rgba(0,0,0,1)",
##               "family": "",
##               "size": 11.689497716895
##             },
##             "ticklen": 2,
##             "len": 0.5
##           }
##         },
##         "xaxis": "x",
##         "yaxis": "y",
##         "frame": null
##       }
```

```
##   ],
##   "layout": {
##     "margin": {
##       "t": 38.2425164890918,
##       "r": 7.30593607305936,
##       "b": 40.5073566717402,
##       "l": 37.2602739726027
##     },
##     "plot_bgcolor": "rgba(255,255,255,1)",
##     "paper_bgcolor": "rgba(255,255,255,1)",
##     "font": {
##       "color": "rgba(0,0,0,1)",
##       "family": "",
##       "size": 14.6118721461187
##     },
##     "xaxis": {
##       "domain": [0, 0.488291769113687],
##       "automargin": true,
##       "type": "linear",
##       "autorange": false,
##       "range": [2.24867743229327, 5.18872279335025],
##       "tickmode": "array",
##       "ticktext": ["$1,000", "$10,000", "$100,000"],
##       "tickvals": [3, 4, 5],
##       "categoryorder": "array",
##       "categoryarray": ["$1,000", "$10,000", "$100,000"],
##       "nticks": null,
##       "ticks": "outside",
##       "tickcolor": "rgba(51,51,51,1)",
##       "ticklen": 3.65296803652968,
##       "tickwidth": 0.66417600664176,
##       "showticklabels": true,
##       "tickfont": {
##         "color": "rgba(77,77,77,1)",
##         "family": "",
##         "size": 11.689497716895
##       },
##       "tickangle": -0,
##       "showline": false,
##       "linecolor": null,
##       "linewidth": 0,
##       "showgrid": true,
##       "gridcolor": "rgba(235,235,235,1)",
##       "gridwidth": 0.66417600664176,
##       "zeroline": false,
##       "anchor": "y2",
##       "title": "",
##       "titlefont": {
##         "color": "rgba(0,0,0,1)",
##         "family": "",
##         "size": 14.6118721461187
##       },
##       "hoverformat": ".2f"
##     },
```

```
##      "annotations": [
##        {
##          "text": "gdpPercap",
##          "x": 0.5,
##          "y": -0.0524268560798241,
##          "showarrow": false,
##          "ax": 0,
##          "ay": 0,
##          "font": {
##            "color": "rgba(0,0,0,1)",
##            "family": "",
##            "size": 14.6118721461187
##          },
##          "xref": "paper",
##          "yref": "paper",
##          "textangle": -0,
##          "xanchor": "center",
##          "yanchor": "top",
##          "annotationType": "axis"
##        },
##        {
##          "text": "lifeExp",
##          "x": -0.0362955157475705,
##          "y": 0.5,
##          "showarrow": false,
##          "ax": 0,
##          "ay": 0,
##          "font": {
##            "color": "rgba(0,0,0,1)",
##            "family": "",
##            "size": 14.6118721461187
##          },
##          "xref": "paper",
##          "yref": "paper",
##          "textangle": -90,
##          "xanchor": "right",
##          "yanchor": "center",
##          "annotationType": "axis"
##        },
##        {
##          "text": "Africa",
##          "x": 0.244145884556843,
##          "y": 1,
##          "showarrow": false,
##          "ax": 0,
##          "ay": 0,
##          "font": {
##            "color": "rgba(26,26,26,1)",
##            "family": "",
##            "size": 11.689497716895
##          },
##          "xref": "paper",
##          "yref": "paper",
##          "textangle": -0,
```

```
##           "xanchor": "center",
##           "yanchor": "bottom"
##         },
##         {
##           "text": "Americas",
##           "x": 0.755854115443157,
##           "y": 1,
##           "showarrow": false,
##           "ax": 0,
##           "ay": 0,
##           "font": {
##             "color": "rgba(26,26,26,1)",
##             "family": "",
##             "size": 11.689497716895
##           },
##           "xref": "paper",
##           "yref": "paper",
##           "textangle": -0,
##           "xanchor": "center",
##           "yanchor": "bottom"
##         },
##         {
##           "text": "Asia",
##           "x": 0.244145884556843,
##           "y": 0.45602908844918,
##           "showarrow": false,
##           "ax": 0,
##           "ay": 0,
##           "font": {
##             "color": "rgba(26,26,26,1)",
##             "family": "",
##             "size": 11.689497716895
##           },
##           "xref": "paper",
##           "yref": "paper",
##           "textangle": -0,
##           "xanchor": "center",
##           "yanchor": "bottom"
##         },
##         {
##           "text": "Europe",
##           "x": 0.755854115443157,
##           "y": 0.45602908844918,
##           "showarrow": false,
##           "ax": 0,
##           "ay": 0,
##           "font": {
##             "color": "rgba(26,26,26,1)",
##             "family": "",
##             "size": 11.689497716895
##           },
##           "xref": "paper",
##           "yref": "paper",
##           "textangle": -0,
```

```
##         "xanchor": "center",
##         "yanchor": "bottom"
##       }
##     ],
##     "yaxis": {
##       "domain": [0.54397091155082, 1],
##       "automargin": true,
##       "type": "linear",
##       "autorange": false,
##       "range": [20.6488, 85.5532],
##       "tickmode": "array",
##       "ticktext": ["30", "40", "50", "60", "70", "80"],
##       "tickvals": [30, 40, 50, 60, 70, 80],
##       "categoryorder": "array",
##       "categoryarray": ["30", "40", "50", "60", "70", "80"],
##       "nticks": null,
##       "ticks": "outside",
##       "tickcolor": "rgba(51,51,51,1)",
##       "ticklen": 3.65296803652968,
##       "tickwidth": 0.66417600664176,
##       "showticklabels": true,
##       "tickfont": {
##         "color": "rgba(77,77,77,1)",
##         "family": "",
##         "size": 11.689497716895
##       },
##       "tickangle": -0,
##       "showline": false,
##       "linecolor": null,
##       "linewidth": 0,
##       "showgrid": true,
##       "gridcolor": "rgba(235,235,235,1)",
##       "gridwidth": 0.66417600664176,
##       "zeroline": false,
##       "anchor": "x",
##       "title": "",
##       "titlefont": {
##         "color": "rgba(0,0,0,1)",
##         "family": "",
##         "size": 14.6118721461187
##       },
##       "hoverformat": ".2f"
##     },
##     "shapes": [
##       {
##         "type": "rect",
##         "fillcolor": "transparent",
##         "line": {
##           "color": "rgba(51,51,51,1)",
##           "width": 0.66417600664176,
##           "linetype": "solid"
##         },
##         "yref": "paper",
##         "xref": "paper",
```

```
##          "x0": 0,
##          "x1": 0.488291769113687,
##          "y0": 0.54397091155082,
##          "y1": 1
##        },
##        {
##          "type": "rect",
##          "fillcolor": "rgba(217,217,217,1)",
##          "line": {
##            "color": "rgba(51,51,51,1)",
##            "width": 0.66417600664176,
##            "linetype": "solid"
##          },
##          "yref": "paper",
##          "xref": "paper",
##          "x0": 0,
##          "x1": 0.488291769113687,
##          "y0": 0,
##          "y1": 23.37899543379,
##          "yanchor": 1,
##          "ysizemode": "pixel"
##        },
##        {
##          "type": "rect",
##          "fillcolor": "transparent",
##          "line": {
##            "color": "rgba(51,51,51,1)",
##            "width": 0.66417600664176,
##            "linetype": "solid"
##          },
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##        },
```

```
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```

```
##            },
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##        "autorange": false,
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##        "tickvals": [3, 4, 5],
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##        "autorange": false,
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##        "tickmode": "array",
```

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```

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##         },
##         "click": "function(gd) { \n        // is this being viewed in RStudio?\n        if (location
##       }
##     ],
##     "cloud": false
##   },
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##       "colour": {},
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##     }
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##     "selected": {
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##     },
##     "debounce": 0
##   },
##   "base_url": "https://plot.ly"
## }
```

4. Check out code to make a plotly object from scratch using `plot_ly()` – scatterplot of gdpPercap vs lifeExp.
    - Check out the cheat sheet.

```r
plot_ly(gapminder,
        x = ~gdpPercap,
        y = ~lifeExp,
        type = "scatter",
        mode = "markers",
        opacity = 0.2) %>%
    layout(xaxis = list(type = "log"))
```

5. Add population to form a z-axis for a 3D plot:

```r
plot_ly(gapminder,
        x = ~gdpPercap,
        y = ~lifeExp,
        z = ~pop,
        type = "scatter3d",
        mode = "markers",
```

```
        opacity = 0.2)
```