Appendices

- Appendix titles

Appendix A

This appendix includes tables of sample data sets.

- install knitr and open data that we want to create the tables of:
- example: European (Norway) puffins with Temperature values

1. Code for creating nice tables with kable and kableExtra packages

```
puffins_t <- read.csv("./data/puffins_temp.csv")

puffins_t <- puffins_t %>%
  rename("Year" = year, "Country list" = Country.list, "Population trend" = pop_trend,
         "ID" = id, "Mean max. T (°C)" = mean_tmax, "Mean min. T (°C)" = mean_tmin)
```

```
puffins_t %>%
  slice(1:10) %>%
  kable(digits = 2) %>%
  kable_styling(bootstrap_options = "striped", full_width = F,
                position = "center", font_size = 10) %>%
  add_header_above(c(" ", "EU puffins" = 2, " ", "Mean Temperatue (°C)" = 2)) %>%
  column_spec(3, color = "red", bold = T)  %>%
  column_spec(5:6, color = "green", bold = T) %>%
  row_spec(0, bold = T)  %>%
  group_rows("1970s", 1,2) %>%
  group_rows("1980s", 3,10)
```

	EU puffins			Mean Temperatue (°C)	
Year	**Country list**	**Population trend**	**ID**	**Mean max. T (°C)**	**Mean min. T (°C)**
1970s					
1979	Norway	**1.00**	8122	**8.23**	**3.95**
1979	Norway	**1.00**	2556	**8.23**	**3.95**
1980s					
1980	Norway	**0.00**	2555	**9.09**	**4.83**
1980	Norway	**0.00**	8126	**9.09**	**4.83**
1980	Norway	**0.80**	8122	**9.09**	**4.83**
1980	Norway	**0.00**	2553	**9.09**	**4.83**
1980	Norway	**0.83**	2556	**9.09**	**4.83**
1981	Norway	**0.20**	2555	**8.73**	**4.22**
1981	Norway	**0.29**	8126	**8.73**	**4.22**
1981	Norway	**0.88**	8122	**8.73**	**4.22**

- ADD PART AT THE END OF TUTORIAL: 'IT'S YOUR TURN!', where people can choose a different data set and play with the package kable etc.

Next: testing that page break works: (IT DOES! WOOT)

Appendix B

This appendix includes additional figures.

Second type of appendix: additional figures and graphs.

They can help calrify some summarised graphs from the main text; they can give more insight on a detailed section of explanation in the text.

Example: Norway puffins and relationship with temperature data. If on main text the comparison between puffin abundance and max/min T data have been presented (as follows), in the Appendix it could be useful to add the graphs obtained from calculating general climate data, as well as average of minimum and maximum temperature (always in °C).

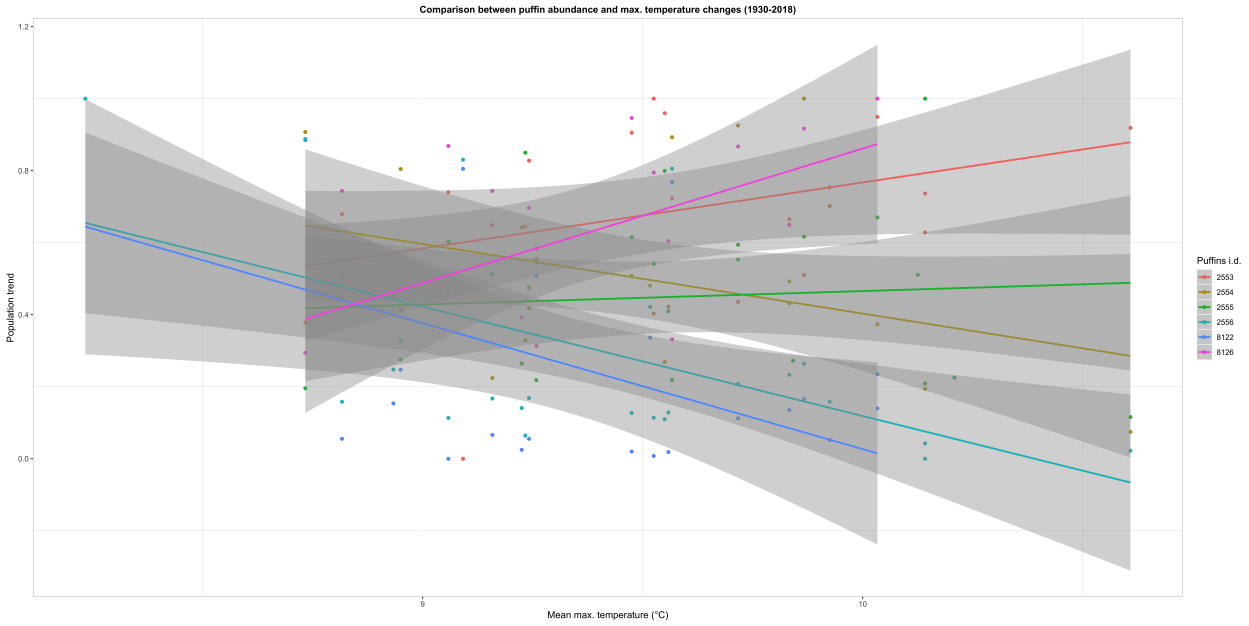


Figure 1: This is one of the figures in the main body of text.

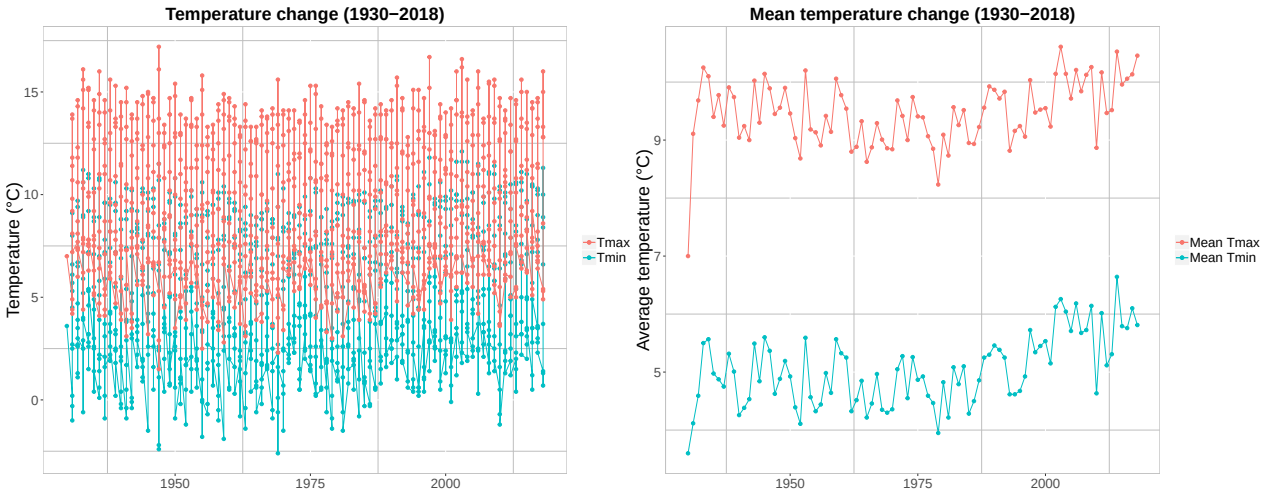
In the appendix, it is perhaps appropriate to add figures on climate trends, and average max and min temperatures. These graphs can be generated directly in the notebook by using the code chunks. Just as follows:

```
#if you want you can create the plot for climate data here:

climate_data <- read.csv("./data/Lerwick_temp_data.csv")
library(ggplot2)

# first graph for climate data (generic) ----
climate_plot <- ggplot(climate_data) +
  ggtitle("Temperature change (1930-2018)") +
  theme(plot.title = element_text(size = 20, hjust = 0.5, vjust = 0.5, face = "bold"),
        panel.background = element_rect(fill = "white"),
        panel.grid.minor = element_line(colour = "grey", size = 0.1 ),
        panel.border = element_rect(colour = "grey", fill = NA),
        axis.text = element_text(size=15),
        axis.title = element_text(size = 20),
        legend.text = element_text(size=15),
```

```
        legend.title = element_blank()) +
  ylab("Temperature (°C)") + xlab(" ") +
  geom_line(aes(x = year, y = tmin, colour = "tmin")) +
  geom_point(aes(x = year, y = tmin, colour = "tmin")) +
  geom_line(aes(x = year, y = tmax, colour = "tmax")) +
  geom_point(aes(x = year, y = tmax, colour = "tmax")) +
  scale_color_discrete(name = "Temp.", labels = c ("Tmax", "Tmin"))

ggsave("appendix_fig/climate_data.png", last_plot(),
       width = 20, height = 10, units = "in",
       dpi = 500)

# Second graph for mean max. and min. T (°C) ----

mean_t_data <- climate_data %>%
  group_by(year) %>%
  summarise(mean_tmax = mean(tmax),
            mean_tmin = mean(tmin)) %>%
  write_csv(file.path("mean_t_data.csv")) # new csv with mean t data

meant_plot <- ggplot(mean_t_data) +
  ggtitle("Mean temperature change (1930-2018)") +
  theme(plot.title = element_text(size = 20, hjust = 0.5, vjust = 0.5, face = "bold"),
        panel.background = element_rect(fill = "white"),
        panel.grid.minor = element_line(colour = "grey", size = 0.1 ),
        panel.border = element_rect(colour = "grey", fill = NA),
        axis.title = element_text(size = 20),
        axis.text = element_text(size = 15),
        legend.text = element_text(size = 15),
        legend.title = element_blank()) +
  ylab("Average temperature (°C)") + xlab(" ") +
  geom_line(aes(x = year, y = mean_tmin, colour = "mean_tmin")) +
  geom_point(aes(x = year, y = mean_tmin, colour = "mean_tmin")) +
  geom_line(aes(x = year, y = mean_tmax, colour = "mean_tmax")) +
  geom_point(aes(x = year, y = mean_tmax, colour = "mean_tmax")) +
  scale_color_discrete(name = "Temp.", labels = c ("Mean Tmax", "Mean Tmin"))

ggsave("appendix_fig/Mean_T.png", last_plot(),
       width = 20, height = 10,
       dpi = 500)
```

The code above has created the data sets used in to filter the climate data and the averages from the main, raw data set. Below is the reproduction of these figures in the notebook. NOTE: the figures which are produced through R must be called within a code chunk.

```
climate_plot
meant_plot
```



In case the figures were already existing and saved within the main repo, this could be done by calling within a code chunk:

```
img_appendix<-list.files("appendix_fig/", pattern = ".png", full.names = TRUE)
include_graphics(img_appendix)
```

However, with this method is harder to control and change figure size so as to have them both aligned. (Perhaps can show what happens by attempting it.) It is suggested to create the figures within the chunk, as manipulation becomes easier. Plus, it follows idea of transparency and, in sharing the html/pdf output of the notebook, whoever has access to it can see the code behind the figures or tables produced.

Figure 2: Additional images in Appendix B

Appendix C

This appendix includes the code used in the main body of text.

This chunk of code allows to take all the code used from the main body of text and join it into a single chunk, as below:

```
library(tidyverse)
library(reshape2)
library(ggplot2)

# Living planet data
LPI <- read_csv("./data/LPIdata_Feb2016.csv")

# Climate data
climate_data <- read_csv("./data/Lerwick_temp_data.csv")

# Puffins data transformation
LPI <- LPI %>%
  gather(key = "year", value = "population", select = 26:70) %>%
  mutate(binomial_id = paste(Genus, Species, id, sep = "_")) %>%
  filter(population >= 0) %>%
  group_by(binomial_id) %>%
  mutate(max_year = max(year), min_year = min(year),
         lengthyear = as.integer(max_year) - as.integer(min_year),
         pop_trend = (population - min(population))/(max(population) - min(population))) %>%
  ungroup()

# European puffins only

eu_puffins <- filter(LPI, Genus == "Fratercula", Species == "arctica",
         `Country list` !="Russian Federation") %>%
  select(`Country list`, year, pop_trend, id)  %>%
  group_by(id) %>%
  filter(length(year)>10)

# Mean T

mean_t_data <- climate_data %>%
  group_by(year) %>%
  summarise(mean_tmax = mean(tmax),
            mean_tmin = mean(tmin))

# Merging EU puffins and mean T

puffin_temp <- merge(eu_puffins, mean_t_data)

# Select values to correlate
corpuffin_temp <- puffin_temp %>%
  select(id, year, mean_tmax, mean_tmin, pop_trend) %>%
  spread(key = "id", value = "pop_trend") %>%
  drop_na()

# Correlation
```

```r
cormat <- round(cor(corpuffin_temp[, c(2:9)]),2) %>%
  melt()

# Puffins EU (Norway)
ggplot(eu_puffins, aes(x = year, y = pop_trend,
                colour = as.factor(id))) +
       geom_line(group = "id") +
       geom_point() +
  ggtitle("European puffins population trends (1930-2018)") +
  theme(plot.title = element_text(hjust = 0.5, vjust = 0.5, face = "bold"),
        panel.background = element_rect(fill = "white"),
        panel.grid.minor = element_line(colour = "grey", size = 0.1 ),
        panel.border = element_rect(colour = "grey", fill = NA)) +
  ylab("Population trends") +
  xlab("Years") +
  labs(colour = "ID")

ggsave("./main_fig/pop_tmin.png", last_plot(),
       width = 20, height = 10,
       dpi = 500) #saved fifth plot

# Compare Puffin populations with temperature

  # Max temps
ggplot(puffin_temp) +
  ggtitle("Comparison between puffin abundance and max. temperature changes (1930-2018)") +
  theme(plot.title = element_text(hjust = 0.5, vjust = 0.5, size = 11, face = "bold"),
        panel.background = element_rect(fill = "white"),
        panel.grid.minor = element_line(colour = "grey", size = 0.1 ),
        panel.border = element_rect(colour = "grey", fill = NA)) +
  scale_colour_discrete(name = "Puffins i.d.") +
  xlab("Mean max. temperature (°C)") + ylab("Population trend") +
  geom_point(aes(x = mean_tmax, y = pop_trend,
                 colour = as.factor(id))) +
  geom_smooth(aes(x = mean_tmax, y = pop_trend,
                  colour = as.factor(id)),
              method = 'lm')

  # Min temps
ggplot(puffin_temp) +
  ggtitle("Comparison between puffin abundance and min. temperature changes (1930-2018)") +
  theme(plot.title = element_text(hjust = 0.5, vjust = 0.5, size = 11, face = "bold"),
        panel.background = element_rect(fill = "white"),
        panel.grid.minor = element_line(colour = "grey", size = 0.1 ),
        panel.border = element_rect(colour = "grey", fill = NA)) +
  scale_colour_discrete(name = "Puffins i.d.") +
  xlab("Mean min. temperature (°C)") + ylab("Population trend") +
  geom_point(aes(x = mean_tmin, y = pop_trend,
                 colour = as.factor(id))) +
  geom_smooth(aes(x = mean_tmin, y = pop_trend,
                  colour = as.factor(id)),
              method = 'lm')
# Correlation mat
```

```
ggplot(cormat,
       aes(x = Var1, y = Var2, fill = value)) +
  ggtitle("Correlation mat of population trends") +
  theme(plot.title = element_text(hjust = 0.5, vjust = 0.5,
                                  size = 11, face = "bold")) +
          geom_tile()
```

As you can see, all the code used in the main text, that we hid, is now visible here!

Great job!