9. patchwork

Combining multiple plots into one figure

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```r
for (pkg in c("tidyverse", "gapminder", "showtext", "ggtext", "patchwork",
"cowplot")) {
  if (!require(pkg, character.only = TRUE)) install.packages(pkg)
}

showtext::showtext_opts(dpi = 300)
```

Scientific publications and presentations often require multiple related plots in a single figure - a bar chart next to a dumbbell plot, or a time series above a scatter plot. While `facet_wrap()` handles cases where the same plot type is repeated for different subsets, it cannot combine fundamentally different plot types or datasets. The {patchwork} package by Thomas Lin Pedersen fills this gap with an intuitive operator-based syntax for composing ggplot2 objects.

In this chapter we recreate the bar chart and dumbbell plot from Chapter 5 and combine them into multi-panel figures using patchwork's layout operators.

Setup

We reproduce the plots from Chapter 5. The code below is collapsed since it is a repetition of earlier material:

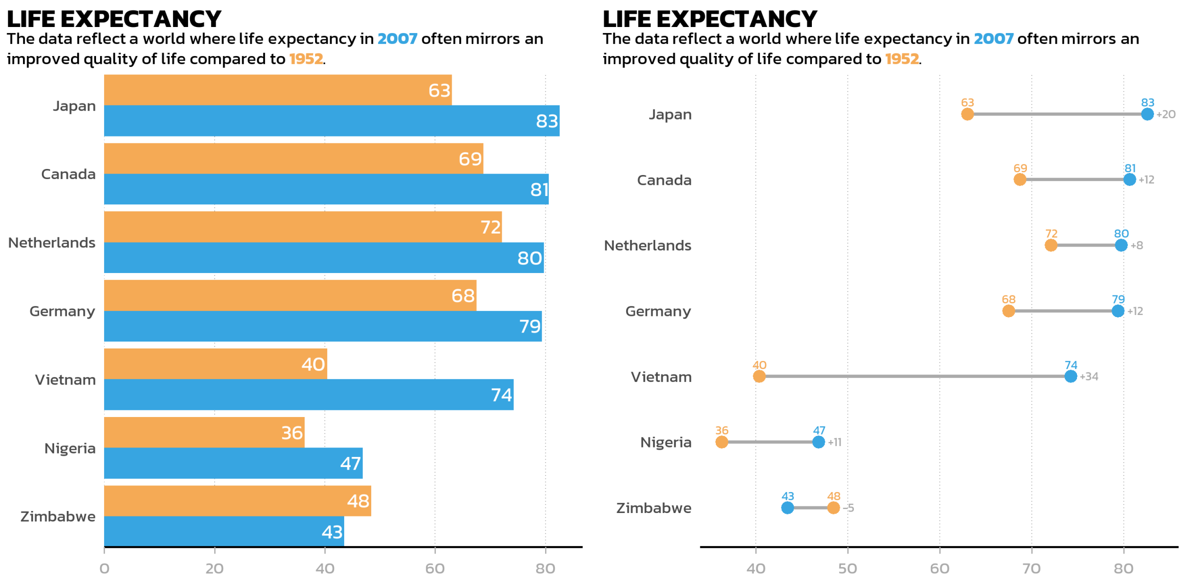
```r
sysfonts::font_add_google("Kanit", "kanit")
showtext::showtext_auto()

dat <- gapminder::gapminder %>%
  filter(year == 1952 | year == 2007) %>%
  filter(country %in% c(
    "Canada", "Germany", "Japan",
    "Netherlands", "Nigeria", "Vietnam", "Zimbabwe"
  )) %>%
  mutate(year = as.factor(year)) %>%
  droplevels()

sorted_countries <- dat %>%
  filter(year == "2007") %>%
  arrange(lifeExp) %>%
  pull(country) %>%
  as.character()

dat <- dat %>%
  mutate(country = fct_relevel(country, sorted_countries))

year_colors <- c("1952" = "#F7AA59", "2007" = "#37A9E1")

theme_nature <- function(base_size = 12) {
  theme_minimal(base_size = base_size) +
    theme(
      text = element_text(family = "kanit"),
      plot.title.position = "plot",
      plot.title = element_text(size = 15, face = "bold"),
      plot.subtitle = ggtext::element_textbox_simple(
        size = 10, margin = margin(0, 0, 10, 0)
      ),
      axis.line.y = element_blank(),
      axis.text.x = element_text(color = "#AAAAAA"),
      axis.ticks.x = element_line(color = "#AAAAAA", linewidth = 0.4),
      axis.ticks.length.x = unit(4, "pt"),
      axis.line.x = element_line(color = "black", linewidth = 0.6),
      legend.position = "top",
      legend.box.just = "left",
      legend.justification = "left",
      legend.title = element_text(face = "bold"),
      legend.key.size = unit(0.4, "cm"),
      legend.margin = margin(-5, 0, 0, 0),
      panel.grid.minor = element_blank(),
      panel.grid.major.y = element_blank(),
      panel.grid.major.x = element_line(
        linetype = "dotted", color = "#AAAAAA", linewidth = 0.3
      )
    )
}

long_subtitle <- "The data reflect a world where life expectancy in <b
style='color:#37A9E1;'>2007</b> often mirrors an improved quality of life compared
to <b style='color:#F7AA59;'>1952</b>."

# Bar chart
p_bar <- ggplot(data = dat) +
  aes(x = lifeExp, y = country, fill = fct_rev(year)) +
  geom_col(position = position_dodge()) +
  geom_text(
    mapping = aes(label = round(lifeExp), group = fct_rev(year)),
    position = position_dodge(width = 0.9),
    hjust = 1.1, color = "white", family = "kanit"
  ) +
  scale_y_discrete(name = NULL, expand = c(0, 0)) +
  scale_x_continuous(name = NULL, expand = expansion(mult = c(0, 0.05))) +
  scale_fill_manual(
    guide = "none", name = "Year",
    limits = names(year_colors), values = year_colors
  ) +
  labs(title = "LIFE EXPECTANCY", subtitle = long_subtitle) +
  theme_nature()

# Dumbbell plot
dat_wide <- dat %>%
  select(country, year, lifeExp) %>%
  pivot_wider(
    names_from = year, values_from = lifeExp, names_prefix = "year_"
  ) %>%
  mutate(
    max_x = pmax(year_2007, year_1952),
    diff = year_2007 - year_1952,
    diff_lab = sprintf("%+d", round(diff))
  )

p_dumbbell <- ggplot(data = dat) +
  aes(x = lifeExp, y = country, color = fct_rev(year)) +
  geom_segment(
    data = dat_wide,
    aes(x = year_1952, xend = year_2007, y = country, yend = country),
    color = "#AAAAAA", linewidth = 1
  ) +
  geom_point(size = 3) +
  geom_text(
    mapping = aes(label = round(lifeExp)),
    size = 2.5, vjust = -1, family = "kanit"
  ) +
  geom_text(
    data = dat_wide,
    mapping = aes(x = max_x, label = diff_lab),
    size = 2.5, hjust = 0,
    position = position_nudge(x = 1),
    color = "#AAAAAA", family = "kanit"
  ) +
  scale_color_manual(
    name = "Year", limits = c("1952", "2007"),
    values = year_colors, guide = "none"
  ) +
  scale_y_discrete(name = NULL) +
  scale_x_continuous(name = NULL) +
  labs(title = "LIFE EXPECTANCY", subtitle = long_subtitle) +
  theme_nature()

# Simple scatter plot for GDP
p_gdp <- ggplot(
  data = gapminder::gapminder %>% filter(year == 2007),
  aes(x = gdpPercap, y = lifeExp, size = pop, color = continent)
) +
  geom_point(alpha = 0.7) +
  scale_x_log10() +
  scale_size_continuous(guide = "none") +
  labs(x = "GDP per capita", y = "Life expectancy", color = "Continent") +
  theme_minimal(base_size = 12) +
  theme(text = element_text(family = "kanit"))
```

We now have three plot objects: `p_bar` (grouped bar chart), `p_dumbbell` (dumbbell plot), and `p_gdp` (scatter plot).

Combining plots

The simplest way to combine two plots is with the `+` operator. By default, patchwork arranges plots side by side:

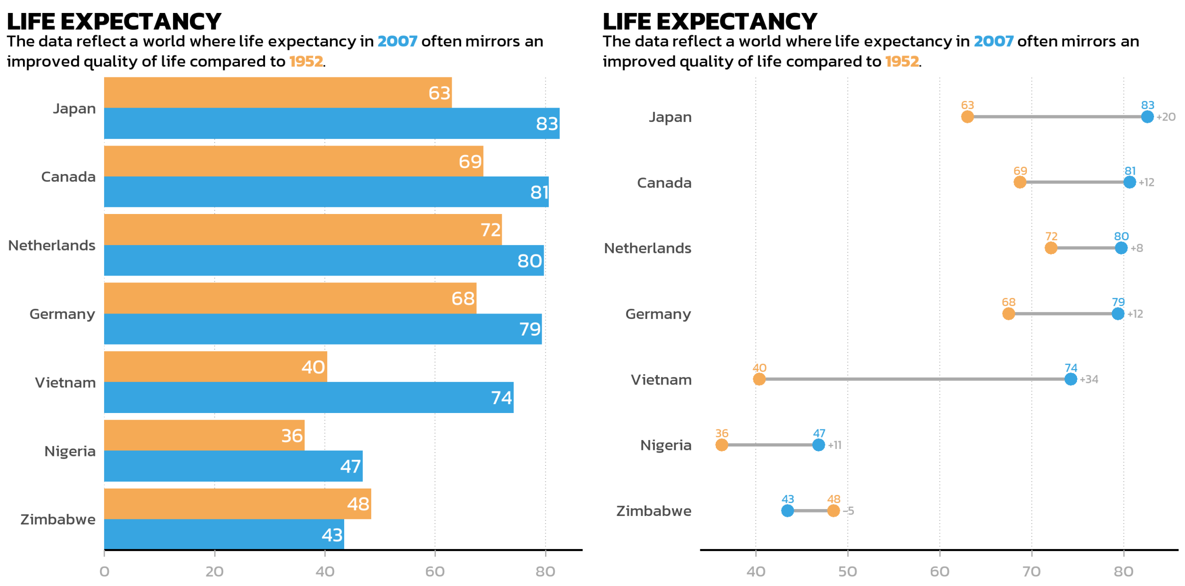
```
p_bar + p_dumbbell
```



Side by side: the `|` operator

The `|` operator is the explicit version of side-by-side arrangement. It behaves identically to `+` for two plots but makes the intent clearer in complex layouts:

```
p_bar | p_dumbbell
```



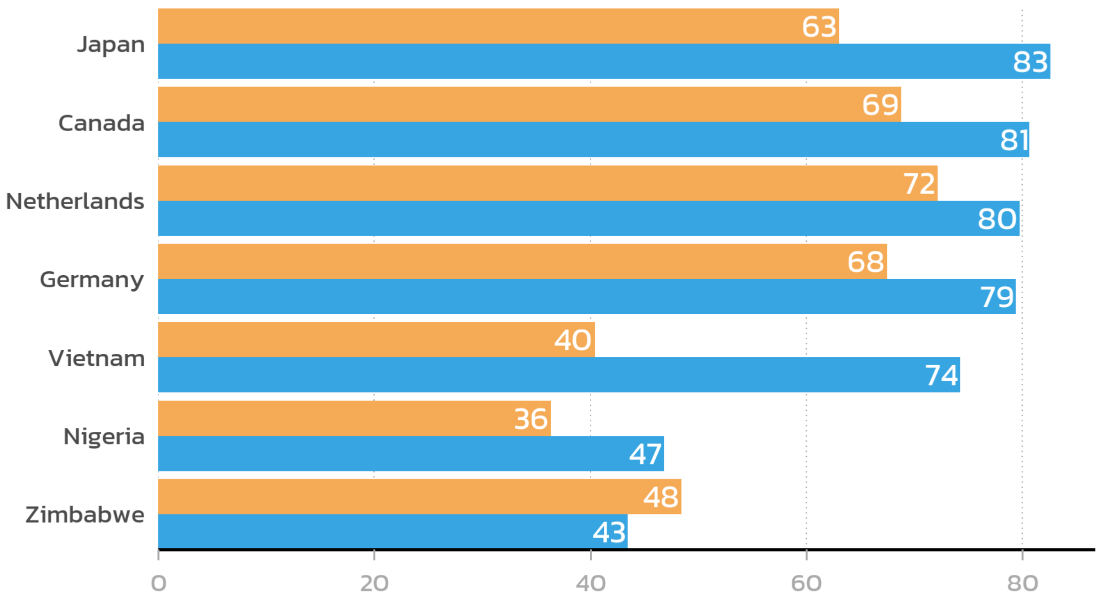
Stacked: the `/` operator

The `/` operator places plots on top of each other:

```
p_bar / p_dumbbell
```

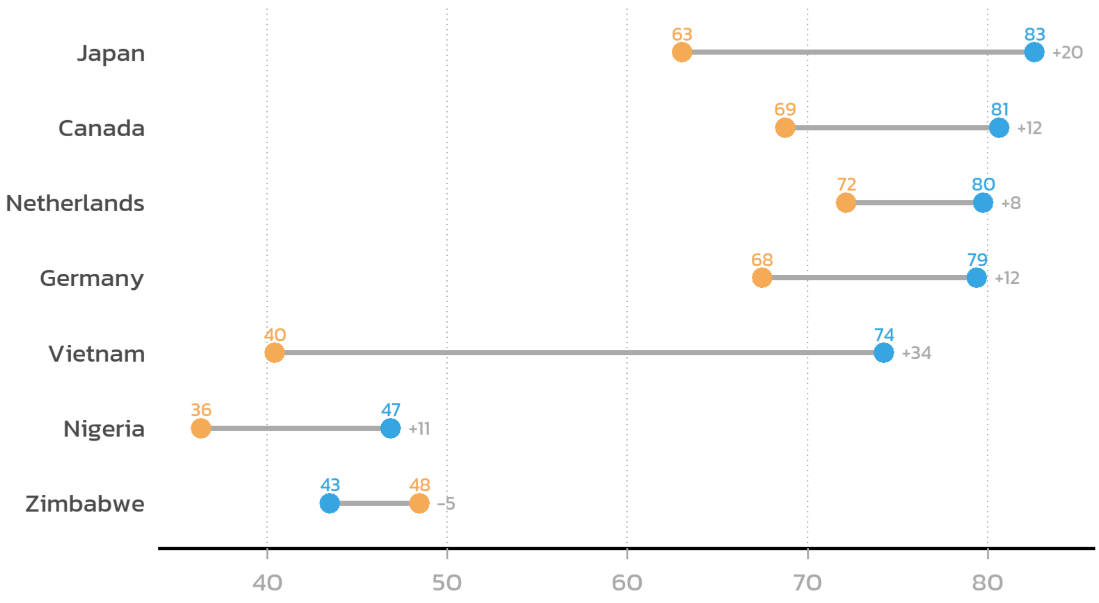
LIFE EXPECTANCY

The data reflect a world where life expectancy in **2007** often mirrors an improved quality of life compared to **1952**.



LIFE EXPECTANCY

The data reflect a world where life expectancy in **2007** often mirrors an improved quality of life compared to **1952**.



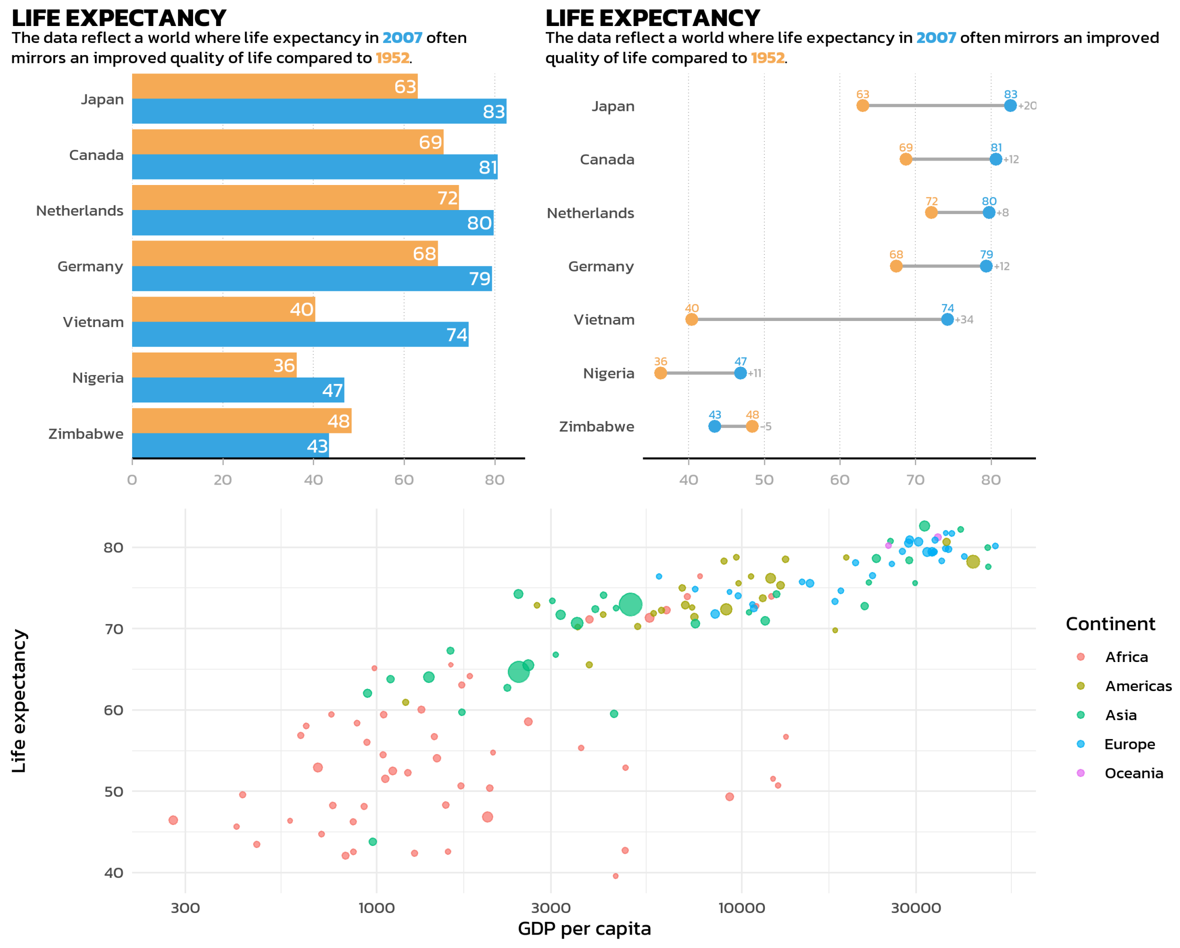
Operator precedence

When combining operators, **precedence matters**. The `/` operator (stacking) binds more tightly than `|` (side-by-side), so `p1 | p2 / p3` is interpreted as `p1 | (p2 / p3)` rather than `(p1 | p2) / p3`. The `+` operator has the lowest precedence of all. In practice, this means one should always use **parentheses** to make the intended layout explicit — relying on precedence rules leads to surprises.

Nesting layouts

Parentheses make the layout structure explicit and readable. For example, two plots side by side on top, with a third plot spanning the full width below:

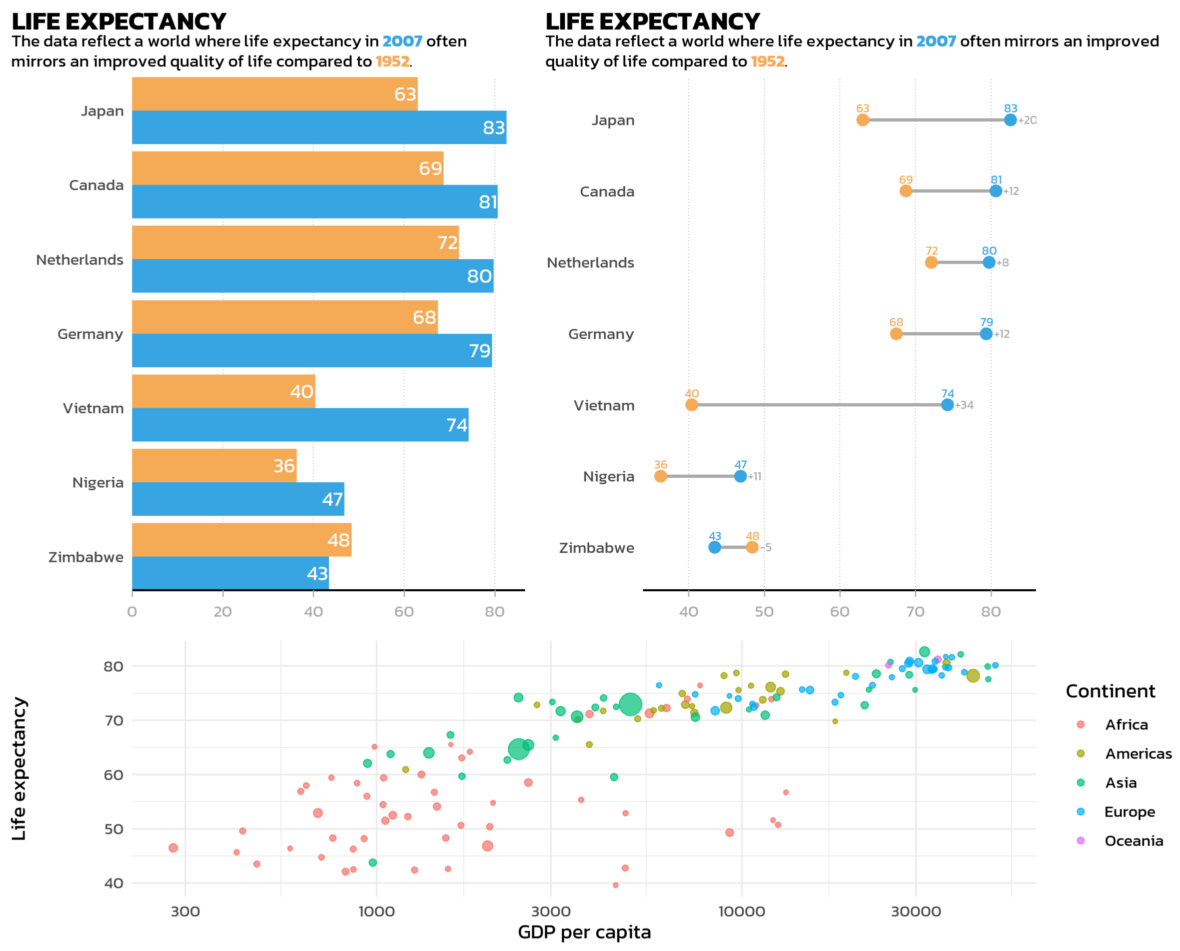
```r
(p_bar | p_dumbbell) / p_gdp
```



Layout control

The `plot_layout()` function provides fine-grained control over the arrangement:

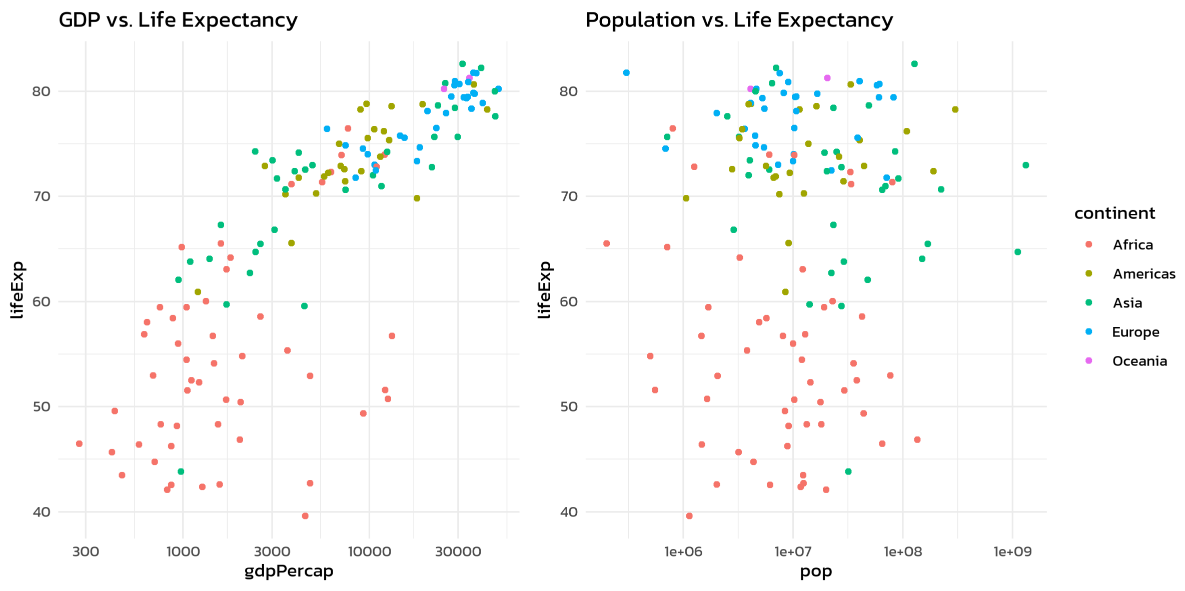
```r
(p_bar | p_dumbbell) / p_gdp +
  plot_layout(heights = c(2, 1))
```



Key arguments:

- `widths` and `heights`: Relative sizes of columns and rows. `heights = c(2, 1)` makes the top row twice as tall as the bottom row.
- `ncol` and `nrow`: Force a specific grid layout.
- `guides = "collect"`: Collects identical legends from all plots and shows them once. This is especially useful when multiple plots share the same color scale.

```r
p1 <- ggplot(gapminder::gapminder %>% filter(year == 2007),
  aes(x = gdpPercap, y = lifeExp, color = continent)) +
  geom_point() + scale_x_log10() + theme_minimal(base_size = 11) +
  theme(text = element_text(family = "kanit")) +
  labs(title = "GDP vs. Life Expectancy")

p2 <- ggplot(gapminder::gapminder %>% filter(year == 2007),
  aes(x = pop, y = lifeExp, color = continent)) +
  geom_point() + scale_x_log10() + theme_minimal(base_size = 11) +
  theme(text = element_text(family = "kanit")) +
  labs(title = "Population vs. Life Expectancy")

p1 + p2 + plot_layout(guides = "collect")
```

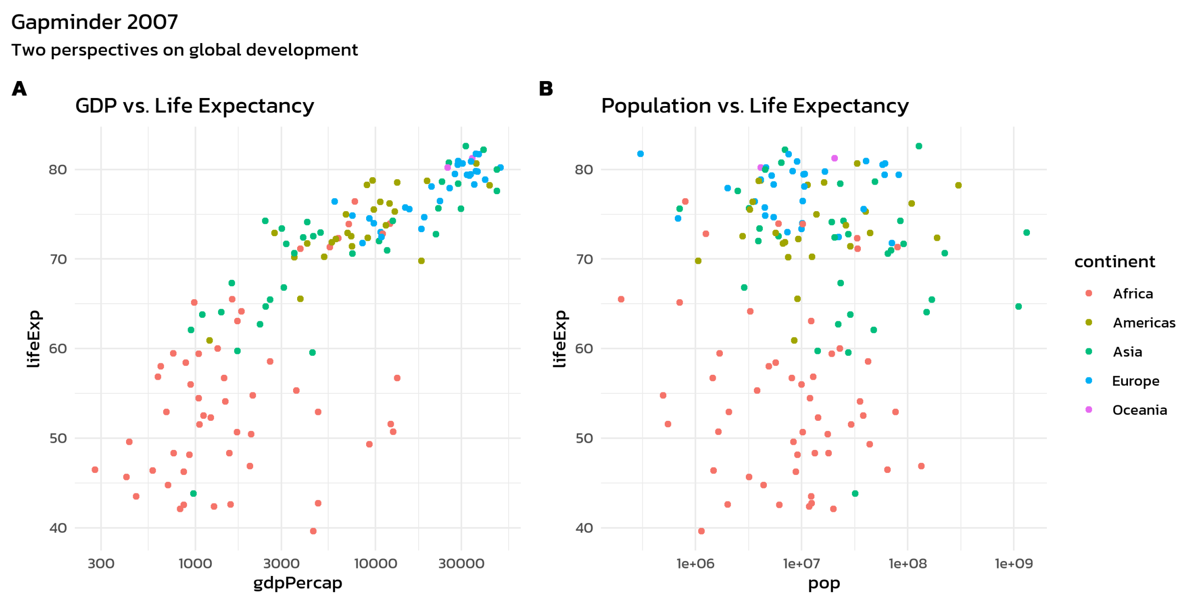


Without `guides = "collect"`, each plot would show its own continent legend - redundant and space-wasting.

Annotations

`plot_annotation()` adds titles, subtitles, captions, and automatic panel tags to the combined figure:

```
p1 + p2 +
  plot_layout(guides = "collect") +
  plot_annotation(
    title = "Gapminder 2007",
    subtitle = "Two perspectives on global development",
    tag_levels = "A"
  ) &
  theme(
    text = element_text(family = "kanit"),
    plot.tag = element_text(face = "bold")
  )
```



The `tag_levels` argument automatically labels panels as “A”, “B”, “C” (or “1”, “2”, “3”, “a”, “b”, “c”, “I”, “II”, “III”). This is essential for journal figures where panels need to be referenced in the text.

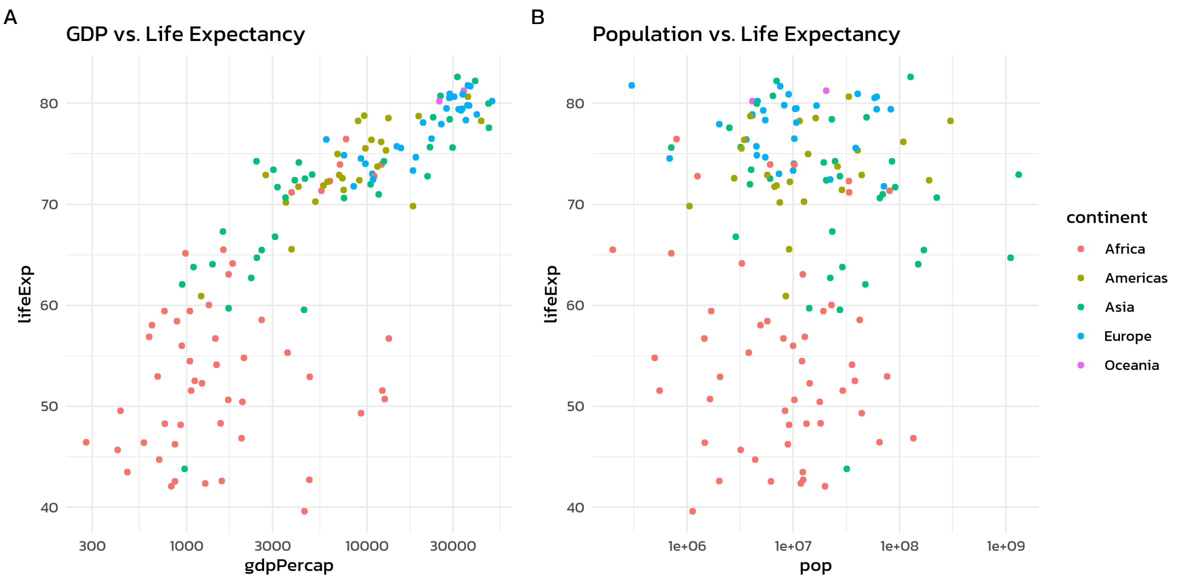
The `&` operator

Notice the `&` operator in the last example. This is one of patchwork’s most useful features:

- `+` adds a theme modification only to the **last** plot
- `&` applies a theme modification to **all** plots in the composition

This distinction matters when one wants to apply a consistent theme across all panels:

```
p1 + p2 +
  plot_layout(guides = "collect") +
  plot_annotation(tag_levels = "A") &
  theme_minimal(base_size = 11) &
  theme(text = element_text(family = "kanit"))
```



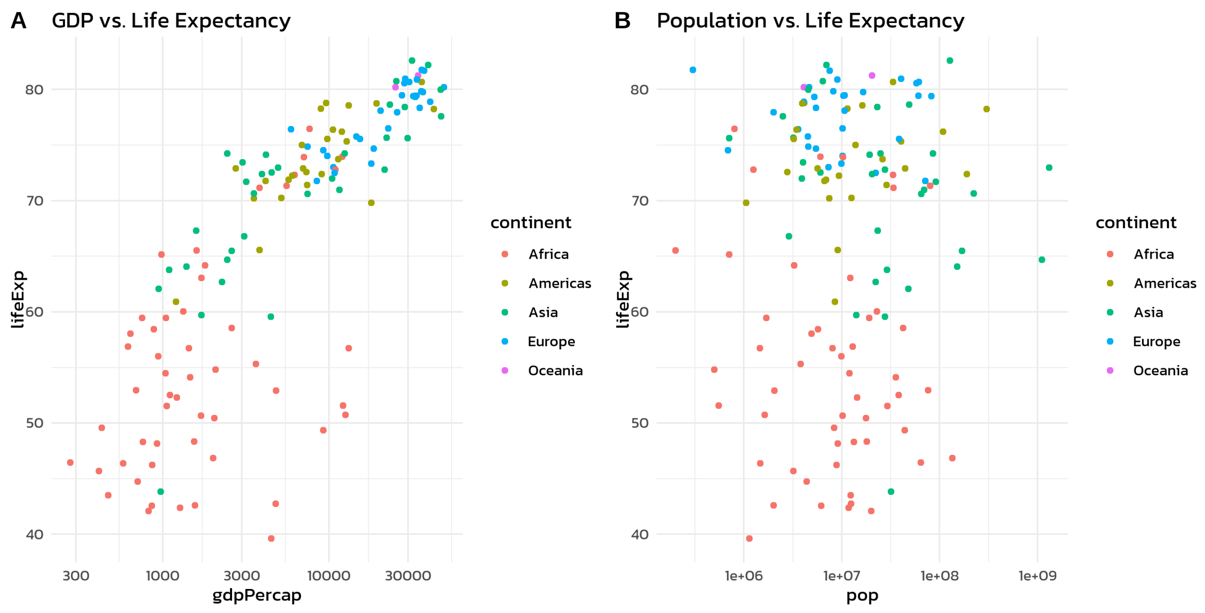
Beyond patchwork: cowplot

The {cowplot} package by Claus Wilke offers complementary functionality for combining plots. While patchwork excels at grid-based layouts with its operator syntax, cowplot shines in two specific areas: automatic panel labels and inset plots.

Basic grid with cowplot

The `cowplot::plot_grid()` function works similarly to patchwork’s `+` operator, but provides panel labels directly through the `labels` argument:

```
cowplot::plot_grid(p1, p2, labels = "AUTO")
```

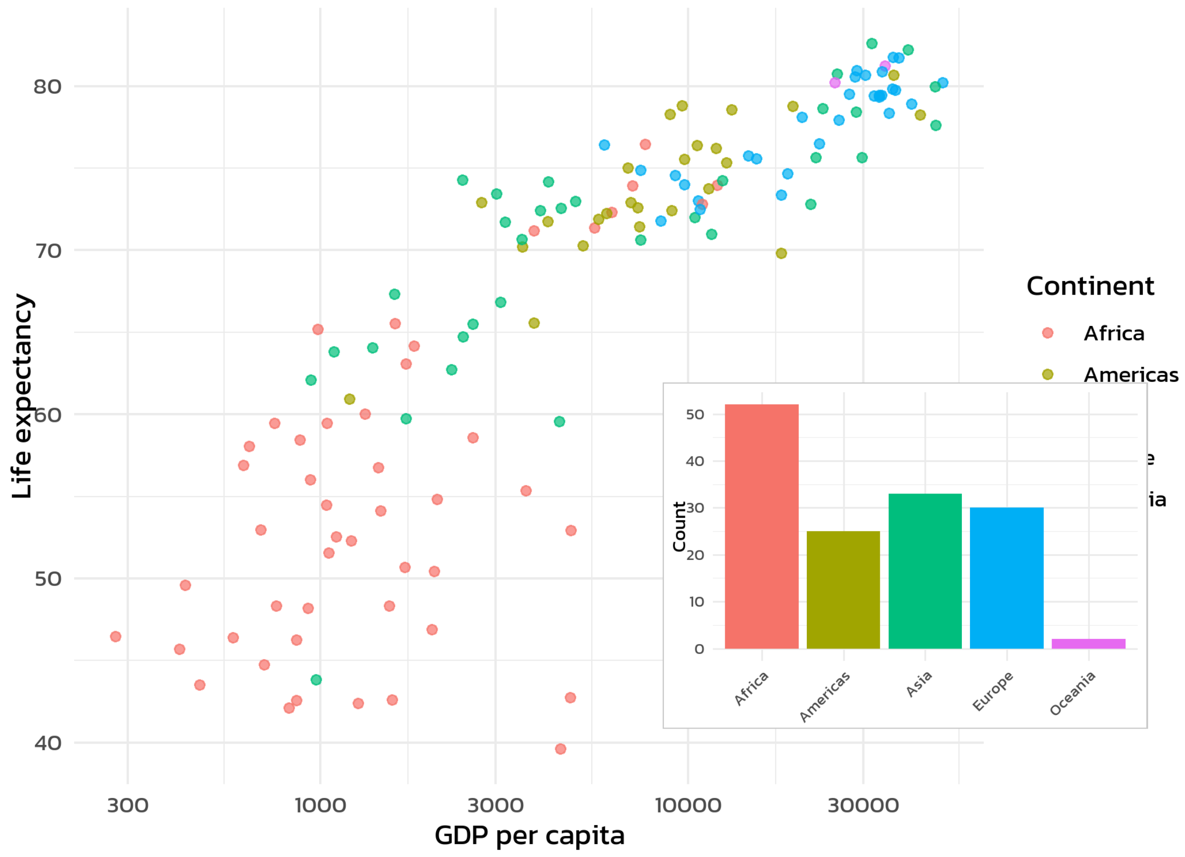


`labels = "AUTO"` generates uppercase labels (A, B, C, …), while `labels = "auto"` produces lowercase ones (a, b, c, …).

Inset plots

One feature that patchwork does not provide is placing a small plot *inside* a larger one - an inset plot. This is useful for showing a zoomed-in detail, a summary statistic, or a complementary view within the same figure. The `cowplot::ggdraw()` and `cowplot::draw_plot()` functions make this straightforward:

```r
dat_2007 <- gapminder::gapminder %>% filter(year == 2007)

p_main <- ggplot(dat_2007, aes(x = gdpPercap, y = lifeExp, color = continent)) +
  geom_point(alpha = 0.7) +
  scale_x_log10() +
  labs(x = "GDP per capita", y = "Life expectancy", color = "Continent") +
  theme_minimal(base_size = 12) +
  theme(text = element_text(family = "kanit"))

p_inset <- ggplot(dat_2007, aes(x = continent, fill = continent)) +
  geom_bar(show.legend = FALSE) +
  labs(x = NULL, y = "Count") +
  theme_minimal(base_size = 8) +
  theme(
    text = element_text(family = "kanit"),
    axis.text.x = element_text(angle = 45, hjust = 1),
    plot.background = element_rect(fill = "white", color = "grey80")
  )

cowplot::ggdraw(p_main) +
  cowplot::draw_plot(p_inset, x = 0.55, y = 0.15, width = 0.4, height = 0.4)
```



The `x`, `y`, `width`, and `height` arguments in `draw_plot()` use relative coordinates (0 to 1), where (0, 0) is the bottom-left corner. Adjusting these values positions and sizes the inset plot within the main figure.

For most multi-panel layouts, patchwork remains the better choice due to its cleaner syntax and automatic alignment. cowplot is worth reaching for when one needs inset plots or prefers the `plot_grid()` interface for simple side-by-side arrangements with automatic labels.

When to use facets vs. patchwork

Both tools create multi-panel figures, but they serve different purposes:

- **Facets** (`facet_wrap()`, `facet_grid()`): Same plot type, same data structure, split by a grouping variable. Axes are shared or individually scaled. Best for systematic comparisons within one dataset.
- **Patchwork**: Different plot types, different datasets, or different aesthetic mappings. Each panel is a fully independent ggplot. Best for combining complementary views of the data.

A good rule of thumb: if one can describe the panels as “the same plot for different groups”, use facets. If the panels show fundamentally different things, use patchwork.

Bibliography