Modelling trend: Part 2

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Hodrick-Prescott filter

HP filter

Assumption: no seasonality

Goal: smooth the data and obtain the trend

Basic idea: there are **two criteria**:

- smoothed data should be close to the real ones
- smoothed data should be actually *smooth*, small curvature of the resulting graph (not large fluctuations), measured by second derivative in the continuous case

We give weights to them and obtain the optimization problem (y_i are the data, $\tilde{y}_i$ are the fitted data, λ is the parameter):

$$\sum_{i=1}^{n}(y_i - \tilde{y}_i)^2 + \lambda \sum_{i=2}^{n-1}(\tilde{y}_{i+1} - 2\tilde{y}_i + \tilde{y}_{i-1})^2 \to \min_{\tilde{y}_1,\ldots,\tilde{y}_n}$$

HP filter in R

- Library `library(mFilter)`
- Then, for example `hpf1 <- hpfilter(data, freq=100)` where `freq` is our parameter λ
- Access to the fitted values (i.e., the trend): `hpf1$trend`

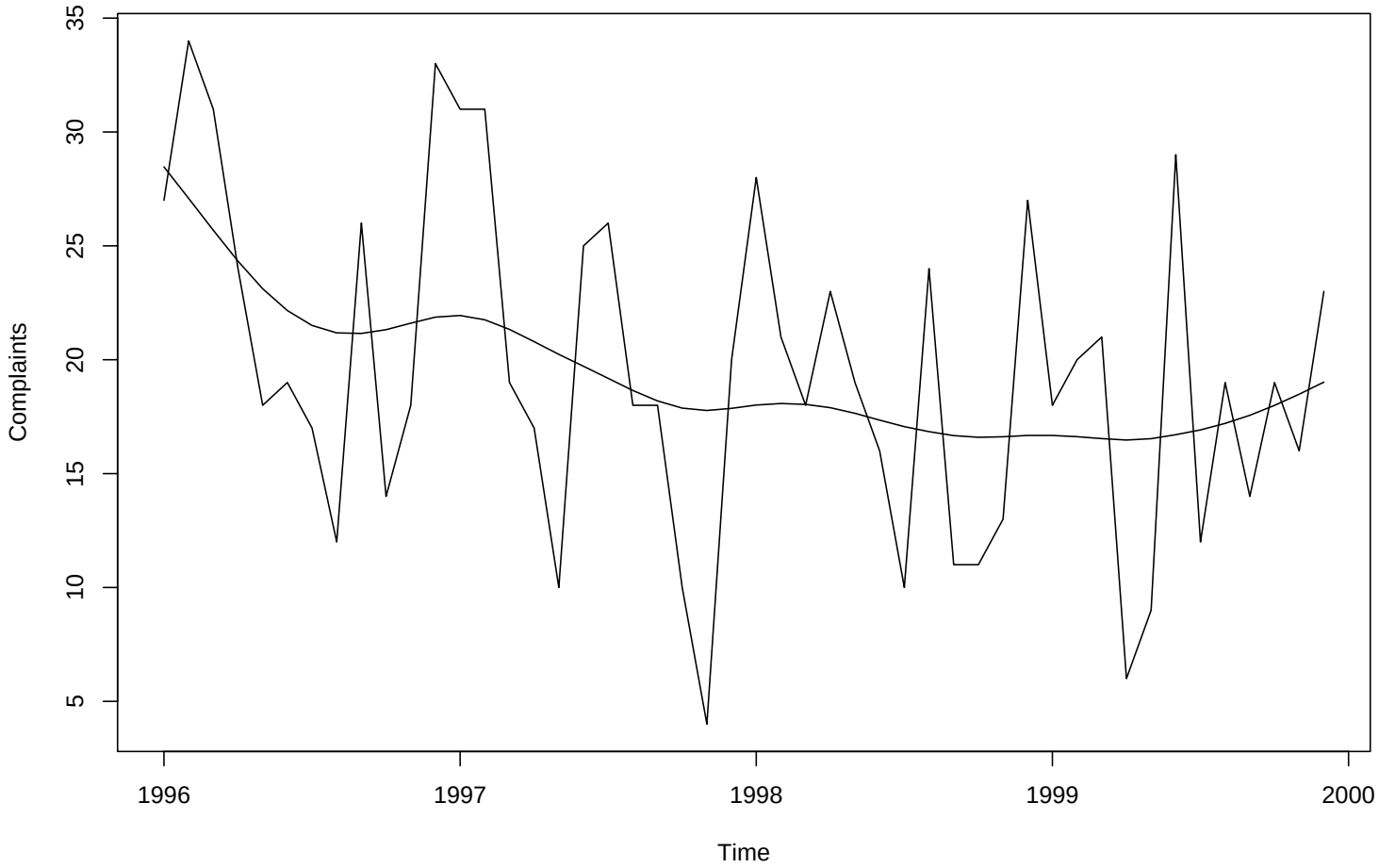
Example

Complaints to a motoring organization - data from the last week:

```
x <- read.table("motor.txt", col.names=c("Complaints"))
x <- ts(x, frequency=12, start=c(1996,1))
hpf1 <- hpfilter(x,freq=100)
plot(x); lines(hpf1$trend)
```

Try different λ, what is its effect?

HP filter in R



Choosing the smoothing parameter

Suggested values:

- $\lambda = 100$ for yearly data
- $\lambda = 1600$ for quarterly data
- $\lambda = 14400$ for monthly data

Try this for our data about complaints.

Application: Modelling the output gap

Potential GDP and the output gap

- **Potential GDP** - highest level sustainable over the long term
- **GDP gap** - difference between actual GDP or actual output and potential GDP

We will

- estimate the potential GDP using HP filter and compute the output gap (see, e.g. `https://www.imf.org/external/pubs/ft/wp/2008/wp08275.pdf`, p.6)
- compare it across countries

Getting the data

Libraries:

```
library(WDI); library(ggplot2)
```

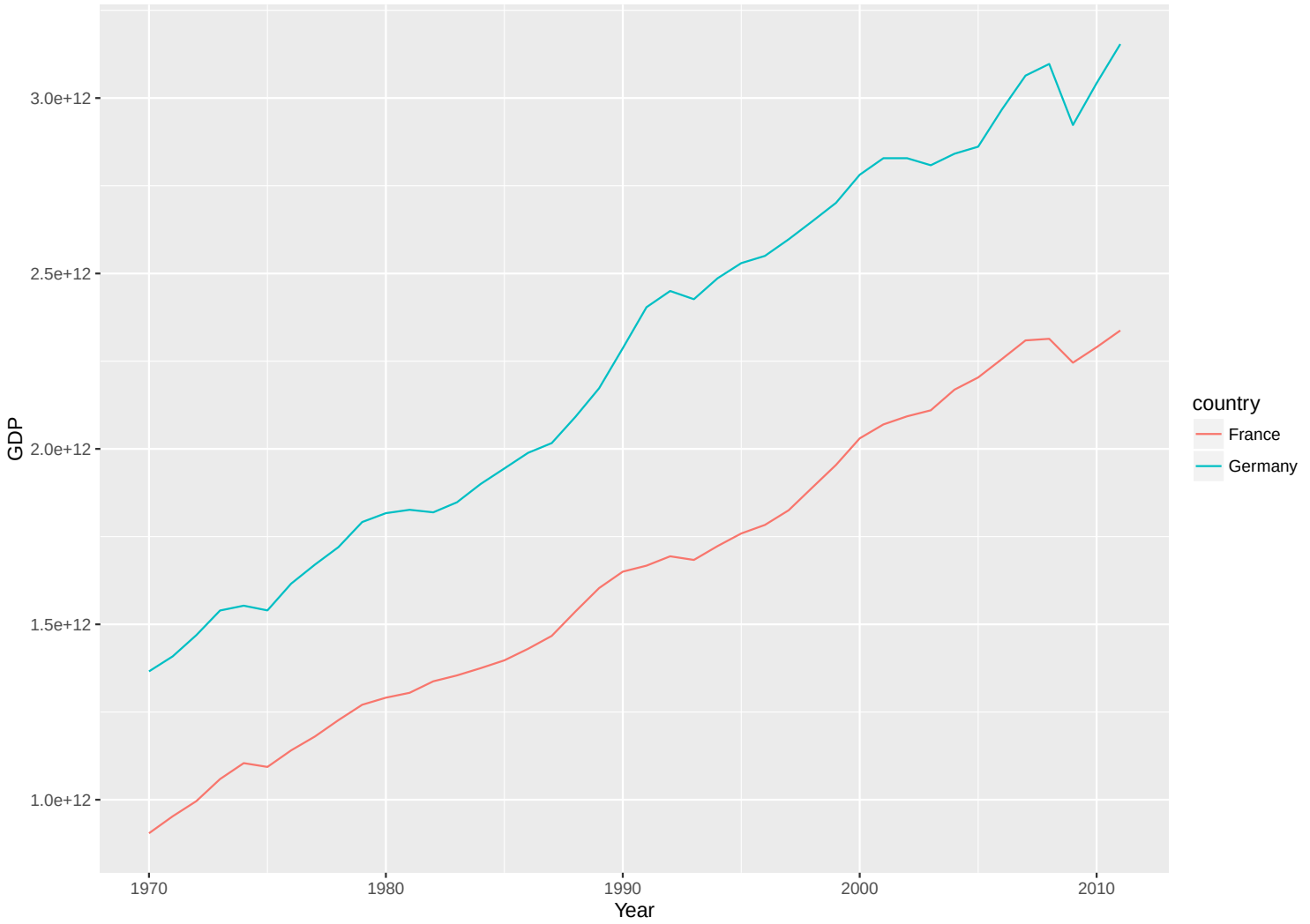
Data:

```
WDIsearch(string='NY.GDP.MKTP.KD', field="indicator")
```

```
##       indicator             name
## [1,] "NY.GDP.MKTP.KD"    "GDP (constant 2000 US$)"
## [2,] "NY.GDP.MKTP.KD.ZG" "GDP growth (annual %)"
```

```
data <- WDI(indicator='NY.GDP.MKTP.KD',
            country=c('DE','FR'), start=1970)
```

```
ggplot(data, aes(year, NY.GDP.MKTP.KD, color=country)) +
  geom_line() + xlab('Year') + ylab('GDP')
```



Transformation of the data

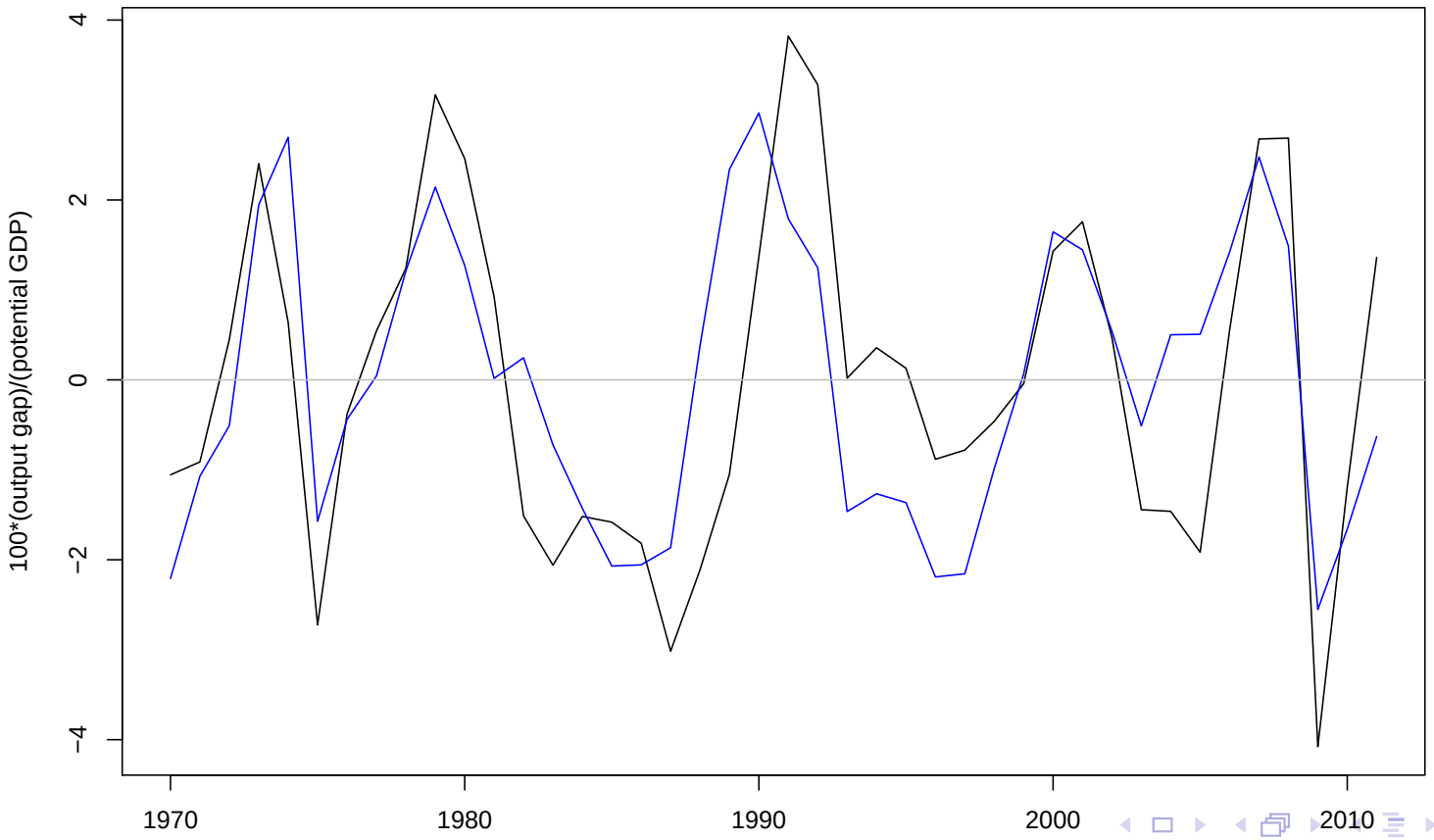
```
data <-  data[order(data$year),]

gdpDE <- subset(data, country=="Germany",
                select=NY.GDP.MKTP.KD)
gdpDE <- ts(gdpDE, start=1970)

gdpFR <- subset(data, country=="France",
                select=NY.GDP.MKTP.KD)
gdpFR <- ts(gdpFR, start=1970)
```

and now, for example:

```
hpDE <- hpfilter(gdpDE, freq=100, type="lambda")$trend
```

Output gap as a percentage of the potential GDP

Compute output gap as a percentage of the potential GDP and plot it together for the both countries.



Output gap as a percentage of the potential GDP

Compute the correlation between the values for these two countries.