

# Plotting Bessel functions

This simple example uses `numpy`, `scipy` and `Matplotlib` to produce a plot of the first six Bessel functions. Two plots are shown, one created by `Matplotlib` and a second created by LaTeX using the plotting package `pgfplots` and the data exported from `Matplotlib`.

If you are using macOS, you may need to use the `-Ppythonw` option when running `pylatex.sh`. This is a known problem with macOS and `Matplotlib`, see [https://matplotlib.org/faq/osx\\_framework.html](https://matplotlib.org/faq/osx_framework.html).

```
import numpy as np
import scipy.special as sp
import matplotlib.pyplot as plt

plt.matplotlib.rc('text', usetex = True)
plt.matplotlib.rc('grid', linestyle = 'dotted')
plt.matplotlib.rc('figure', figsize = (6.4,4.8)) # (width,height) inches

x = np.linspace(0, 15, 500)

for v in range(0, 6):
    plt.plot(x, sp.jv(v, x))

plt.xlim((0, 15))
plt.ylim((-0.5, 1.1))
plt.legend(('J0(x)', 'J1(x)', 'J2(x)',
           'J3(x)', 'J4(x)', 'J5(x)'), loc = 0)
plt.xlabel('$x$')
plt.ylabel('$J_n(x)$')
plt.grid(True)
plt.tight_layout(pad=0.5)

plt.savefig('example-04-fig.pdf')

# save the data for later use by pgfplots
np.savetxt('example-04.txt',list(zip(x,sp.jv(0,x),sp.jv(1,x),sp.jv(2,x),
                                   sp.jv(3,x),sp.jv(4,x),sp.jv(5,x))),
          fmt="% .10e")
```

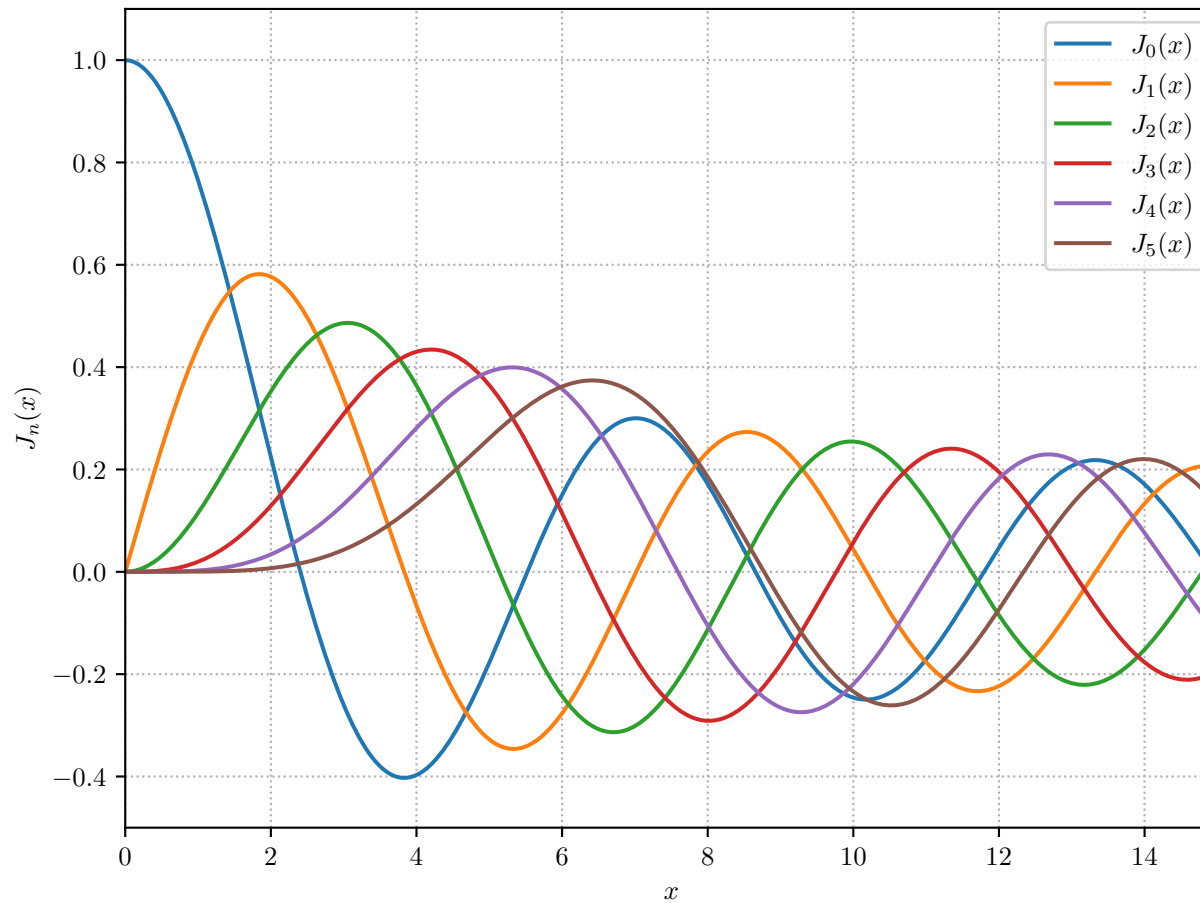


Figure 1: The first six Bessel functions.

```
\IfFileExists{example-04-fig.pdf}%
{\includegraphics[width=6.4in]
 {example-04-fig.pdf}}{Failed to create pdf plot.}
\captionof{figure}{The first six Bessel functions.}
```

## Using pgfplots

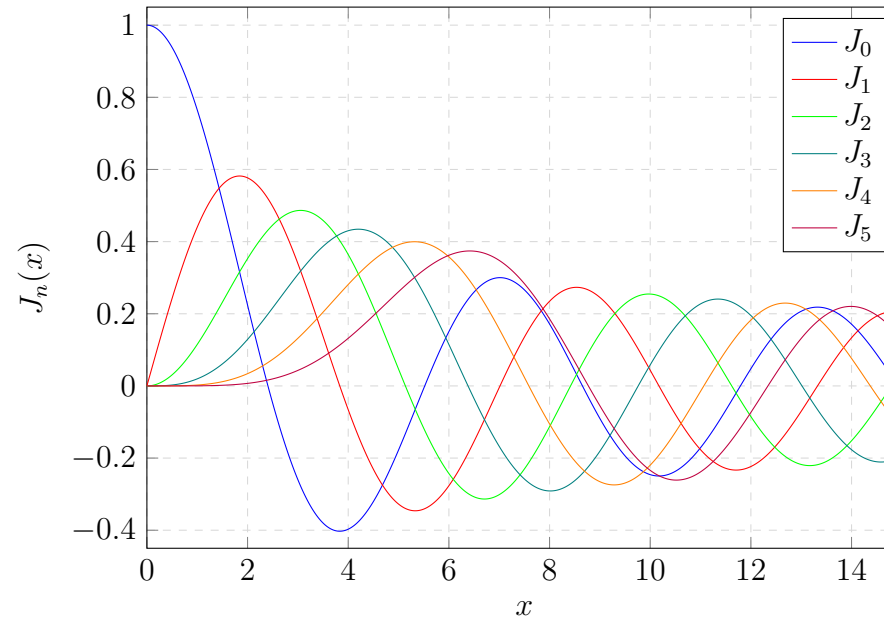


Figure 2: The first six Bessel functions.

```
\begin{tikzpicture} % requires \usepackage{pgfplots}
\begin{axis}
[xmin= 0.0, xmax=15.0,
ymin=-0.45, ymax=1.05,
xlabel=$x$, ylabel=$J_n(x)$,
grid=major, grid style={dashed,gray!30},
legend entries = {$J_0$, $J_1$, $J_2$, $J_3$, $J_4$, $J_5$}]
\addplot[blue] table [x index=0, y index=1]{example-04.txt};
\addplot[red] table [x index=0, y index=2]{example-04.txt};
\addplot[green] table [x index=0, y index=3]{example-04.txt};
\addplot[teal] table [x index=0, y index=4]{example-04.txt};
\addplot[orange] table [x index=0, y index=5]{example-04.txt};
\addplot[purple] table [x index=0, y index=6]{example-04.txt};
\end{axis}
\end{tikzpicture}
\captionof{figure}{The first six Bessel functions.} % requires \usepackage{caption}
```