



INTERNATIONAL UNIVERSITY OF SARAJEVO

TUTORIAL 5 MATH205 NUMERICAL ANALYSIS SPRING 2019

1. There is a file `airpollution.m` on the resource page. The file contains a data-set of measured pollution (concentration of PM10 particles) in Sarajevo during 24 hours one day last winter. The file contains MATLAB code that approximates the measured values using trigonometric (sine and cosine) functions as the base functions.
 - a) Plot the pollution using `scatter`! Plot the approximation together with the original data (use `hold on` to display several graphs on one figure).
 - b) Calculate the standard deviation of the approximation that uses trigonometric functions!
 - c) Now try to approximate the data set with third-, fifth- and ninth-order polynomial! Use the MATLAB command `polyfit` to do this! Plot the solutions in the same graph (different color – type `plot(xx,yy,'r')` for red color, 'g'-green, 'k'-black, 'm'-magenta etc...) Calculate the standard deviation of the approximations and tell which fit is best! Does the graph also suggest the same answer?

2. Try to fit some other nonlinear functions to the air pollution data-set instead of trivial polynomials. Using the code below, try to fit the data with functions like

$$f(t) = a_0 + a_1 * \exp(-a_2 * t),$$

$$f(t) = a_1 * \cos(o*t) + a_2 * \sin(o*t)...$$

Try to come up with a function that will represent data well. Apart from the code below, try also using the MATLAB command `fit` with different options.

```
f = @(a) fitSr(t,y,a);
a = fminsearch(f,[0.1 0.1 0.1])

% Plot a curve f(t) = a1 + exp(-a2*t) * sin(a3*t)
tt = linspace(0,24,300)';
yy = a(1) + exp(-a(2)*tt).*sin(a(3)*tt);

plot(t,y,'o',tt,yy,'-','linewidth',2)
```

Make a separate file `fitSr.m` that calculates the residuals

```
function S = fitSr(t,y,a)
phi = a(1) + exp(-a(2).*t).*sin(a(3).*t);
S = sum((y-phi).^2);
```

Try using different functions to see which one fits best... Finally, try to implement the function

$$f(t) = a_1 \exp\left(-\left(\frac{t-t_1}{\sigma_1}\right)^2\right) \left(1 + \operatorname{erf}(d_1(t-t_1))\right) + \\ a_2 \exp\left(-\left(\frac{t-t_2}{\sigma_2}\right)^2\right) \left(1 + \operatorname{erf}(d_2(t-t_2))\right)$$

Where the erf (error function) is an in-built MATLAB function you do not need to specify. As starting guess use $a_1 = a_2 = 1$, $t_1 = 2$, $t_2 = 8$, $\sigma_1 = \sigma_2 = 4$, $d_1 = d_2 = 1$.

Finally, try also using the MATLAB command `fit` to fit the data.