

### Class Exercise 1

Estimate the parameters  $k_1, k_2$  and  $k_3$ , of the chemical reaction ODE system below. Initial conditions and data(only for A) are given in the code.

$$\begin{aligned}\frac{d[A]}{dt} &= -k_1[A][B] - k_2[A][C] - k_3[A][D] \\ \frac{d[B]}{dt} &= -k_1[A][B] \\ \frac{d[C]}{dt} &= +k_1[A][B] - k_2[A][C] \\ \frac{d[D]}{dt} &= +k_2[A][C] - k_3[A][D] \\ \frac{d[E]}{dt} &= +k_3[A][D] \\ \frac{d[F]}{dt} &= k_1[A][B] + k_2[A][C] + k_3[A][D].\end{aligned}$$

### Class Exercise 2

Estimate the parameters of the nonlinear model  $y = \frac{1}{1+\exp(-(\theta_1+\theta_2x))}$  . Use both `fminsearch` and `lsqcurvefit`. Data is provided in the code.

### Class Exercise 3

Estimate the parameters of the nonlinear model  $y = \frac{1}{\exp(\theta_1+\theta_2x^2)}$  using the data below. Use both `fminsearch` and `lsqcurvefit`.

```
x = [5 7 11 12 15 17 19]';  
y = [0.93 0.91 0.84 0.82 0.76 0.71 0.66]';
```

Use initial guess of parameters as `theta_init = [0.1 0.5];`

### Class Exercise 4

Fit the ODE model parameters  $a, b$  and  $c$  below to the data provided in ODE1\_data.mat using fminsearch optimizer.

$$\begin{aligned}\frac{dx}{dt} &= x + ay - z \\ \frac{dy}{dt} &= x + z \\ \frac{dz}{dt} &= bx - by + cz\end{aligned}$$

using the initial conditions  $x(0)=1$ ,  $y(0)=2$ , and  $z(0)=3$ . Use initial guess of parameters as `abc_init = [10 30 7]`;

### Class Exercise 5

Estimate the parameters of the nonlinear model  $y = \frac{x}{\theta_1 + \theta_2 x}$  using the data below. Use both fminsearch and lsqcurvefit.

```
data.xdata = [1:3:9, 11 14 19 21 23]';
data.ydata = [0.13 0.24 0.27 0.29 0.30 0.31 0.31 0.31]';
```

Use initial guess of parameters as `theta_init = [100 50]`;

### Class Exercise 6

Fit the parameters  $r, a, s, b$  of the predator-prey system of ODE below to the data provided in ODE\_data.mat using fminsearch optimizer.

$$\begin{aligned}\frac{dN_p}{dt} &= rN_p - aN_pN_h \\ \frac{dN_h}{dt} &= -sN_h + bN_pN_h\end{aligned}$$

using the initial conditions for prey and predator given as  $N_p(0)=40$ ,  $N_h(0)=9$ . Use initial guess of parameters as `param_init = [0.2 0.025 0.02 0.01]`;