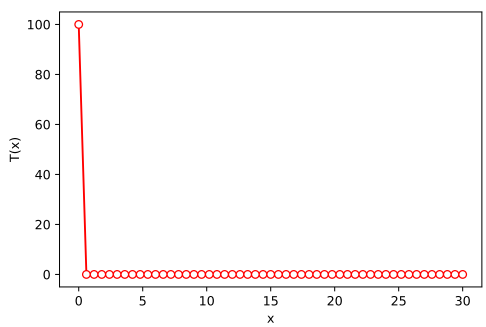
Stationary States of the Heat Equation

No code will be provided for this computer lab. Instead you are asked to write it all from scratch. Please save all notebooks for future use.

Stationary State of the 1D heat equation

Discretize the interval x=[0,L] in N sections using N+1 equally spaced points in order to solve the 1D heat equation with the boundary conditions T(x=0)=100 and T(x=L)=0 and the initial condition T(x>0)=0. *Please note that Python only understands the notation T[i] but not T(x=0), T(x=L), and T(x>0).*



(1) N=51 and L=30 are good values to start but your code should work for any N and L. First you need to decide which index *i* corresponds to point x=0 and which index corresponds to x=L. Then write two lines to code to set up a vector *T* to represent the specified initial conditions.

(2) Write the main, outer loop over different *iterations* to obtain the stationary state of the 1D heat equation. Please refer to lecture 12 on PDEs slide 25 and following if something is unclear.) Inside the main loop introduce a inner loop to update every temperature *in the interior* of the interval [0,L]. The update formula in the Jacobi method is

$$T_i^{new} = \tfrac{1}{2}\left[T_{i-1} + T_{i+1}\right]. \qquad (*)$$

(3) Before entering the inner loop introduce a second temperature vector T^{new}. Choose the correct command from the following three options: T^{new}=T and T^{new}=np.copy(T) and T^{new}[:]=T[:]. Then update the interior points of T^{new} according to (*) and copy the results in T^{new} back to T so that they are the starting temperatures for the next iteration.

(4) It may be useful to plot the temperature distribution in every iteration. We recommend:

```
plt.clf()
plt.plot(x,T, 'ro-',mfc='w')
plt.show()
plt.draw()
plt.pause(0.05)
```