Implementation of the FE-Assembling Algorithm:

Computation of $K_h^{(k)} = \begin{bmatrix} x & x \\ x & x \end{bmatrix}$, $\underline{f}_h^{(k)} = \begin{bmatrix} x \\ x \end{bmatrix}$ and assembling to $\tilde{K}_h = [\,\ddots\,]_{(N_h+1)\times(N_h+1)}$, $\underline{\tilde{f}}_h \in \mathbb{R}^{N_h+1}$;

Initiate: $\underline{\tilde{f}} := \underline{0}$, $\tilde{K} := 0$

FOR $k=1$ **STEP** 1 **UNTIL** N_h **DO** (Loop over all elements)

  FOR $\alpha=0$ **STEP** 1 **UNTIL** 1 **DO**

    BEGIN

      * compute $f_\alpha^{(k)} := \frac{h_k}{2} f(F_k(\xi_\alpha))$

      * determine $i := i(k,\alpha)$ Connectivity $K: i \leftrightarrow \alpha$

      * update $\tilde{f}_i := \tilde{f}_i + f_\alpha^{(k)}$

      FOR $\beta=0$ **STEP** 1 **UNTIL** 1 **DO**

        BEGIN

          * compute $K_{\alpha\beta}^{(k)} := \begin{cases} 1/h_k & \text{for } \alpha=\beta \\ -1/h_k & \text{for } \alpha\neq\beta \end{cases}$

          * determine $j := j(k,\beta)$ $\quad K: i \leftrightarrow \beta$

          * update $\tilde{K}_{ij} := \tilde{K}_{ij} + K_{\alpha\beta}^{(k)}$

        END

      ENDFOR

    END

  ENDFOR

ENDFOR

$\Rightarrow \underline{\tilde{f}}_h, \tilde{K}_h$ (without BC which will be incorporated in an extra loop over the boundary!)

$\Rightarrow$ Dirichlet: $x_0=a$ $u_0=g_0$ $\searrow$ $\tilde{f}_1 := \tilde{f}_1 + g_0/h_1$

Cancellation of the 0. row and column!

Robin: $x_N=1$: $-u'(1) = \alpha_1(u(1)-g_1)$

$\searrow$ $\tilde{K}_{NN} := \tilde{K}_{NN} + \alpha_1$, $\tilde{f}_N := \tilde{f}_N + \alpha_1 g_1$

$\Rightarrow \underline{f}_h \in \mathbb{R}^{N_h}$, $K_h \in \mathbb{R}^{N_h \times N_h}$: $\boxed{K_h \underline{u}_h = \underline{f}_h}$