DANMARKS TEKNINSKE UNIVERSITET

MATHEMATICAL SOFTWARE PROGRAMMING
Course number: 02635

Assignment 1

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Since everything will be implemented in c, I will start all index 1 number earlier given in the formulas in the assignment description, such that $\{1, 2, .., k\}$ will become $\{0, 1, .., k-1\}$ etc. This will be done without further notice.

Part 1

Documentation for the forward substitution, $fw : (n, \alpha, \mathbf{R}, \mathbf{b}) \rightarrow \mathbf{b}$, is given below.
Let an auxiliary variable, τ_k, be defined by:

$$\tau_k = \sum_{i=0}^{k-1} b_i \cdot R_{ik}, \qquad k \in \{0, 1, ..., n-1\}. \tag{1}$$

Let the only numerical consideration be division by zero which is handled by:

$$\exists k \in \{0, 1, ..., n-1\} \ : \ (\alpha + R_{kk} = 0) \quad \Rightarrow \quad \text{return -1} \tag{2}$$

Otherwise the result is given by:

$$b_k = \frac{b_k - \tau_k}{\alpha + R_{kk}} \quad \wedge \quad \text{return 0}, \qquad k \in \{0, 1, ..., n-1\}. \tag{3}$$

This was implemented in one for-loop, each time evaluating equation 1, 2, and 3 (τ_k was each time computed using a nested for-loop). Error testing was done by solving randomized data in Maple and comparing with the result computed by the function.

Part 2

First we check that the matrices R and C are defined and that their dimensions are equal by:

$$\nexists \mathbf{R} \ \vee \ \nexists \mathbf{C} \ \vee \ dim(\mathbf{R}) \neq dim(\mathbf{C}) \quad \Rightarrow \quad \text{return -2} \tag{4}$$

Now define an auxiliary variable, γ_{ki}, by:

$$\gamma_{ki} = \sum_{j=0}^{k-1} c_{ji} \cdot R_{jk}, \qquad k, i \in \{0, 1, ..., n-1\} \tag{5}$$

Now for $k \in \{0, 1, ..., n-1\}$ we compute the following iteratively:

$$(c_{ki} = c_{ki} - \gamma_{ki} \quad i \in \{0, 1, ..., n-1\}) \quad \wedge \tag{6}$$

$$fw(n, R_{kk}, \mathbf{R}, \mathbf{c}_k) = -1 \quad \Rightarrow \quad \text{return -1} \tag{7}$$

Otherwise,

$$\text{return 0} \tag{8}$$

This was implemented using nested for-loops for computing γ_{ki}, and using one for-loop for the last part for $k \in \{0, 1, ..., n-1\}$, each time computing c_{ki} using a nested for-loop for $i \in \{0, 1, ..., n-1\}$. Error testing was again done by solving randomly generated data in Maple and then comparing the results found in Maple with the result computed by the function. Testing of dimension errors and existence was done using manually generated data.