Algorithm 1 DTF

Input: tensor with missing values $\mathcal{X}$, positions of missing values $\mathcal{P}$,
number of component R;
Output: predicted probability of missing pairs $\mathbf{y}'$;

function PREDICT($\mathbf{a}^f$,$\mathbf{b}^f$,$\mathbf{c}^f$,$\{\mathbf{W}_d\}$, $\{\mathbf{b}_d\}$):
    $y' \leftarrow$ forwardprop($\mathbf{a}^f$,$\mathbf{b}^f$,$\mathbf{a}^f$,$\{\mathbf{W}_d\}$, $\{\mathbf{b}_d\}$);
    return y' ▷ Feature vectors $\mathbf{a}^f$,$\mathbf{b}^f$,$\mathbf{c}^f$
end

function TRAIN($[\![\mathbf{A},\mathbf{B},\mathbf{C}]\!]$):
    $\{\mathbf{W}_d\} \leftarrow$ init_glorot_uniform($\{\mathbf{W}_d\}$);
    $\{\mathbf{b}_d\} \leftarrow \{\mathbf{0}\}$;
    for *epoch* $\leftarrow 1$ **to** *maxepoch* **do**
        $\left\{\frac{\partial F}{\partial \mathbf{W}_d}\right\} \leftarrow 0$, $\left\{\frac{\partial F}{\partial \mathbf{b}_d}\right\} \leftarrow 0$;
        for i $\leftarrow$ *mini_batch_indices* **do**
            $\mathbf{y}'^{(i)} \leftarrow$ forwardprop($\mathbf{a}^{(i)}$, $\mathbf{b}^{(i)}$,$\mathbf{c}^{(i)}$,$\{\mathbf{W}_d\}$, $\{\mathbf{b}_d\}$)
            $\left\{\frac{\partial F}{\partial \mathbf{W}_d}\right\}, \left\{\frac{\partial F}{\partial \mathbf{b}_d}\right\} \leftarrow \left\{\frac{\partial F}{\partial \mathbf{W}_d}\right\}, \left\{\frac{\partial F}{\partial \mathbf{b}_d}\right\}$ + backprop($\mathbf{a}^{(i)}$,
            $\mathbf{b}^{(i)}, \mathbf{c}^{(i)}, \mathbf{y}^{(i)}, \left\{\frac{\partial F}{\partial \mathbf{W}_d}\right\}, \left\{\frac{\partial F}{\partial \mathbf{b}_d}\right\}$);
        end
        $\{\mathbf{W}_d\}$,$\{\mathbf{b}_d\} \leftarrow$ RMSProp($\{\mathbf{W}_d\}$,$\{\mathbf{b}_d\}$,$\left\{\frac{\partial F}{\partial \mathbf{W}_d}\right\}, \left\{\frac{\partial F}{\partial \mathbf{b}_d}\right\}$);
    end
    return $\{\mathbf{W}_d\}$,$\{\mathbf{b}_d\}$; ▷ The parameters of deep neural network
end

procedure MODEL:
    $[\![\mathbf{A},\mathbf{B},\mathbf{C}]\!] \leftarrow$ CP-WOPT($\mathcal{X}$,$\mathcal{P}$,R); ▷ Tensor factorization
    $\{\mathbf{W}_d\}$,$\{\mathbf{b}_d\} \leftarrow$ TRAIN($[\![\mathbf{A},\mathbf{B},\mathbf{C}]\!]$,$\{\mathbf{W}_d\}$,$\{\mathbf{b}_d\}$);
    $\mathbf{y}' \leftarrow$ [ ]; ▷ Vector to collect the predicting result
    for i $\leftarrow$ *test_set_indices* **do**
        $y'^{(i)} \leftarrow$ TEST($\mathbf{a}^{(i)}, \mathbf{b}^{(i)}, \mathbf{c}^{(i)}, \{\mathbf{W}_d\}, \{\mathbf{b}_d\}$);
        $\mathbf{y}' \leftarrow \mathbf{y}'$.append($y'^{(i)}$);
    end
    return $\mathbf{y}'$
end