**Algorithm 3** Efficient implementation of SVP, $\mathcal{K} = \{\mathbb{R}, \mathbb{C}\}$

**Require:** $\|\boldsymbol{\mathcal{A}}\|,\ u_0 \in \mathcal{K}^{m\times r},\ v_0 \in \mathcal{K}^{n\times r},\ d_0 \in \mathcal{K}^r$
**Require:** Function $\texttt{A} : (u, d, v) \mapsto \boldsymbol{\mathcal{A}}(u \operatorname{diag}(d) v^H)$
**Require:** Function $\texttt{At} : (\mathbf{z}, w) \mapsto \boldsymbol{\mathcal{A}}^*(\mathbf{z}) w$
**Require:** Function $\texttt{At}^H : (\mathbf{z}, w) \mapsto (\boldsymbol{\mathcal{A}}^*(\mathbf{z}))^H w$

$\mu \leftarrow 4/\|\boldsymbol{\mathcal{A}}\|^2$
$v_{-1} \leftarrow 0,\ u_{-1} \leftarrow 0,\ d_{-1} \leftarrow 0$
**for** $i = 0, 1, \ldots$ **do**
    Compute $\beta_i$ // See text
    $u_y \leftarrow [u_i, u_{i-1}],\ v_y \leftarrow [v_i, v_{i-1}]$
    $d_y \leftarrow [(1+\beta)d_i, -\beta_i d_{i-1}]$ // $\mathbf{Y}_{i+1} = (1+\beta_i)\mathbf{X}_i - \beta_i \mathbf{X}_{i-1}$
    $\mathbf{z} \leftarrow A(u_y, d_y, v_y)$ // Compute the residual
    Define the functions
    $h : w \mapsto u_y \operatorname{diag}(d_y) v_y^H w - \mu \texttt{At}(\mathbf{z}, w)$
    $h^H : w \mapsto v_y \operatorname{diag}(d_y) u_y^H w - \mu \texttt{At}^H(\mathbf{z}, w)$
    $(u_{i+1}, d_{i+1}, v_{i+1}) \leftarrow \texttt{RandomizedSVD}(h, h^H, r)$
**end for**
**return** $X \leftarrow u_i d_i v_i^H$ // If desired