Algorithm *Preconditioned BiCGStab*

$\boldsymbol{r_0} = \boldsymbol{b} - \boldsymbol{A x_0}$

for $i = 1, 2, ...$ until convergence **do**

  if $i == 1$ **then**

    $\boldsymbol{p_i} = \boldsymbol{r_{i-1}}$

  else

    $\beta = \frac{\overbrace{(\bar{\boldsymbol{r}}_{\boldsymbol{0}}, \boldsymbol{r_{i-1}})}^{\delta_i}}{\underbrace{(\bar{\boldsymbol{r}}_{\boldsymbol{0}}, \boldsymbol{r_{i-2}})}_{\delta_{i-1}}} \cdot \frac{\alpha_{i-1}}{\omega_{i-1}}$

    $\boldsymbol{p_i} = \boldsymbol{r_{i-1}} + \beta(\boldsymbol{p_{i-1}} - \omega_{i-1} \underbrace{\boldsymbol{A}\widetilde{\boldsymbol{p}}_{\boldsymbol{i-1}}}_{\boldsymbol{v_{i-1}}})$ ▷ $\boldsymbol{p_i} \neq 0$

  end if

  $\widetilde{\boldsymbol{p}}_{\boldsymbol{i}} = \boldsymbol{M^{-1}} \boldsymbol{p_i} = \boldsymbol{M_U^{-1}} \boldsymbol{M_L^{-1}} \boldsymbol{p_i}$

  $\alpha_i = \frac{\overbrace{(\bar{\boldsymbol{r}}_{\boldsymbol{0}}, \boldsymbol{r_{i-1}})}^{\delta_i}}{(\bar{\boldsymbol{r}}_{\boldsymbol{0}}, \underbrace{\boldsymbol{A}\widetilde{\boldsymbol{p}}_{\boldsymbol{i}}}_{\boldsymbol{v_i}})}$

  $\boldsymbol{x_i} = \boldsymbol{x_{i-1}} + \alpha_i \widetilde{\boldsymbol{p}}_{\boldsymbol{i}}$

  $\boldsymbol{s} = \boldsymbol{r_{i-1}} - \alpha_i \underbrace{\boldsymbol{A}\widetilde{\boldsymbol{p}}_{\boldsymbol{i}}}_{\boldsymbol{v_i}}$

  check the convergence of $\boldsymbol{s}$. If converge, **return**

  $\widetilde{\boldsymbol{s}} = \boldsymbol{M_U^{-1}} \boldsymbol{M_L^{-1}} \boldsymbol{s}$

  $\omega_i = \frac{(\boldsymbol{A}\widetilde{\boldsymbol{s}}, \boldsymbol{s})}{(\boldsymbol{A}\widetilde{\boldsymbol{s}}, \underbrace{\boldsymbol{A}\widetilde{\boldsymbol{s}}}_{\boldsymbol{t}})}$ ▷ $omega \neq 0$

  $\boldsymbol{x_i} = \boldsymbol{x_i} + \omega_i \widetilde{\boldsymbol{s}}$

  $\boldsymbol{r_i} = \boldsymbol{s} - \omega_i \underbrace{\boldsymbol{A}\widetilde{\boldsymbol{s}}}_{\boldsymbol{t}}$

  check the convergence of $\boldsymbol{r_i}$. If converge, **return**

end for