Scientific Computing - Exercise Sheet 1

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1 Exercise

Notation:

(a) **Input**: $\mathbf{A} \in \mathbb{R}^{n \times n} \quad b, x_0 \in \mathbb{R}^n$

for i = 1,2,...,n **do**
  $h^{(0)} = \mathbf{A}x^{(0)}$
  $r^{(0)} = b - h^{(0)}$
  $p^{(0)} = r^{(0)}$
end for
for $k = 1, 2, \ldots$ **do**
  $\gamma_{(k-1)} = 0$
  $\beta_{(k-1)} = 0$
  $\delta_{(k-1)} = 0$
  $\zeta_{(k-1)} = 0$
  begin parallel private$(i, \gamma_{(k-1)}, \beta_{(k-1)}, \delta_{(k-1)}, \zeta_{(k-1)})$ **shared**$(A, r^{(k-1)}, p^{(k-1)}, h^{(k-1)})$
  reduce$(+ : \gamma_{(k-1)}, \beta_{(k-1)}, \delta_{(k-1)}, \zeta_{(k-1)})$
  for $i = 1, 2, \ldots, n$ **do**
    $h_i^{(k-1)} = \mathbf{A}p_i^{(k-1)}$
    $\gamma_{(k-1)} = \gamma_{(k-1)} + p_i^{(k-1)} h_i^{(k-1)}$
    $\beta_{(k-1)} = \beta_{(k-1)} + r_i^{(k-1)} r_i^{(k-1)}$
    $\delta_{(k-1)} = \delta_{(k-1)} + r_i^{(k-1)} h_i^{(k-1)}$
    $\zeta_{(k-1)} = \zeta_{(k-1)} + h_i^{(k-1)} h_i^{(k-1)}$
  end for
  end parallel
  $\alpha_{(k-1)} = \frac{\beta^{(k-1)}}{\gamma^{(k-1)}}$
  $\beta_{(k)} = \beta_{(k-1)} - 2\alpha_{(k-1)}\delta_{(k-1)} + \alpha_{(k-1)}^2 \zeta_{(k-1)}$
  begin parallel default(shared) private(i)
  for $i = 1, 2, \ldots, n$ **do**
    $x_i^{(k)} = x_i^{(k-1)} + \alpha_{(k-1)} p_i^{(k-1)}$
    $r_i^{(k)} = r_i^{(k-1)} - \alpha_{(k-1)} h_i^{(k-1)}$
    $p_i^{(k)} = r_i^{(k)} + \frac{\beta_{(k)}}{\beta_{(k-1)}} p_i^{(k-1)}$

28: **end for**
29: **end parallel**
30: **end for**

(b) Comment: We need a way to sum the result calculated on different processors: There needs to be a reduce operation.