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A
Velocidades e Coeficientes das Redes D2Q9 e D3Q19

Wolf-Gladrow (Wolf-Gladrow, 2000) apresenta os valores de velocidades e coeficientes para as redes D2Q9 e D3Q19. Para a rede D2Q9 (A.1) as velocidades são as seguintes:

$$\begin{array}{llll} \mathbf{v}_0 = (0,0) & & & \\ \mathbf{v}_1 = (1,0)c & \mathbf{v}_2 = (0,1)c & \mathbf{v}_3 = (-1,0)c & \mathbf{v}_4 = (0,-1)c \\ \mathbf{v}_5 = (1,1)c & \mathbf{v}_6 = (-1,1)c & \mathbf{v}_7 = (-1,-1)c & \mathbf{v}_8 = (1,-1)c \end{array} \tag{A.1}$$

sendo $c = \frac{\Delta t}{\Delta x}$, e os coeficientes são dados por:

$$\begin{aligned} w_0 &= \frac{4}{9} \\ w_\alpha &= \frac{1}{9} \quad \alpha = 1,2,3,4 \\ w_\alpha &= \frac{1}{36} \quad \alpha = 5,6,7,8 \end{aligned} \tag{A.2}$$

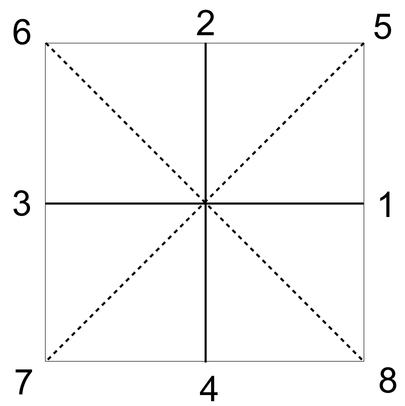

Figura A.1: Direção das velocidades discretas da rede D2Q9

Para a rede D3Q19 (fig. (A.2)) as velocidades e os coeficientes são os seguintes:

$$
\begin{array}{lll}
\mathbf{v}_0 = (0,0,0) & & \\
\mathbf{v}_1 = (1,0,0)c & \mathbf{v}_2 = (0,1,0)c & \mathbf{v}_3 = (0,0,1)c \\
\mathbf{v}_4 = (-1,0,0)c & \mathbf{v}_5 = (0,-1,0)c & \mathbf{v}_6 = (0,0,-1)c \\
\mathbf{v}_7 = (1,1,0)c & \mathbf{v}_8 = (0,1,1)c & \mathbf{v}_9 = (1,0,1)c \\
\mathbf{v}_{10} = (-1,-1,0)c & \mathbf{v}_{11} = (0,-1,-1)c & \mathbf{v}_{12} = (-1,0,-1)c \\
\mathbf{v}_{13} = (-1,1,0)c & \mathbf{v}_{14} = (0,-1,1)c & \mathbf{v}_{15} = (-1,0,1)c \\
\mathbf{v}_{16} = (1,-1,0)c & \mathbf{v}_{17} = (0,1,-1)c & \mathbf{v}_{18} = (1,0,-1)c
\end{array}
\tag{A.3}
$$

$$
\begin{aligned}
w_0 &= \frac{1}{3} \\
w_\alpha &= \frac{1}{18} \qquad \alpha = 1,2,3,4,5,6 \\
w_\alpha &= \frac{1}{36} \qquad \alpha = 7, ..., 18
\end{aligned}
\tag{A.4}
$$

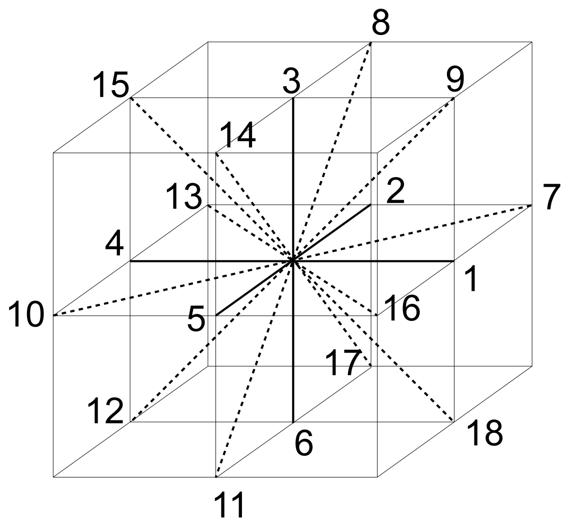

Figura A.2: Direção das velocidades discretas da rede D3Q19

B
Condição de Contorno de Pressão Prescrita

A condição de contorno de pressão prescrita implementada neste trabalho segue o esquema proposto por Zou e He (Zou e He, 1997). Considerando uma rede D2Q9, nos nós da entrada na figura (B.1) são impostos os valores $p = p_{in}$ e $u_y = 0$. Após a etapa de propagação são conhecidos os seguintes valores, nos nós da entrada: p_0, p_2, p_3, p_4, p_6, p_7. É necessario estabelecer as expressões para u_x, p_1, p_5, p_8. A partir das equações (2.48) e (2.49) tem-se:

$$p_{in} = p_0 + p_1 + p_2 + p_3 + p_4 + p_5 + p_6 + p_7 + p_8 \tag{B.1}$$

$$p_{in} u_x = c[p_1 + p_5 + p_8 - (p_3 + p_6 + p_7)] \tag{B.2}$$

$$0 = [p_2 + p_5 + p_6 - (p_4 + p_7 + p_8)] \tag{B.3}$$

Das equações (B.1) e (B.2) obtém-se:

$$u_x = c - \frac{c[p_0 + p_2 + p_4 + 2(p_3 + p_6 + p_7)]}{p_{in}} \tag{B.4}$$

O método proposto por Zou e He (Zou e He, 1997) admite que a regra de retorno ("bounce-back rule") é válida para a parte de não-equilíbrio: $p_1 - p_1^{eq} = p_3 - p_3^{eq}$. O que permite obter o valor de p_1:

$$p_1 = p_3 + \frac{2}{3} p_{in} \frac{u_x}{c} \tag{B.5}$$

Rearranjando as equações (B.2) e (B.3):

$$p_8 = p_{in} \frac{u_x}{c} + p_3 + p_6 + p_7 - p_1 - p_5 \tag{B.6}$$

$$p_5 = p_8 + p_4 + p_7 - p_2 - p_6 \tag{B.7}$$

Usando a equação (B.5) nas equações acima obtém-se as expressões para p_5 e p_8:

$$p_5 = p_7 - \frac{1}{2}(p_2 - p_4) + \frac{1}{6}p_{in}\frac{u_x}{c} \tag{B.8}$$

$$p_8 = p_6 + \frac{1}{2}(p_2 - p_4) + \frac{1}{6}p_{in}\frac{u_x}{c} \tag{B.9}$$

As equações (B.5), (B.8) e (B.9) são as necessárias para a imposição da pressão prescrita na entrada. A mesma metodologia é aplicada para se obter a condição de pressão prescrita na saída e para a condição de velocidade prescrita na entrada e saída.

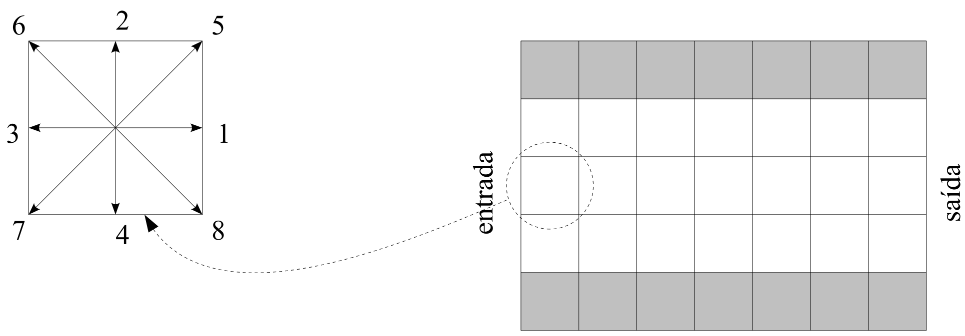

Figura B.1: Rede D2Q9