Ballistic integration

$$s(t+1) = s(t) + dt\ v(t) + \frac{dt^2}{2} a(t) \tag{1}$$

$$v(t+1) = v(t) + dt\ a(t) \tag{2}$$

$$a(t) = \frac{2}{dt^2}\Big(s(t+1) - s(t) - dt\ v(t)\Big) \tag{3}$$

$$a(t) = \frac{1}{dt}\Big(v(t+1) - v(t)\Big) \tag{4}$$

Final Model

$$v(t+1) = v(t) + c_1 a(t) + c_2 a(t-1) \tag{5}$$

$$s(t+1) = s(t) + dt\ v(t) + c_3 a(t) + c_4 a(t-1) \tag{6}$$

$$a(k) = -\overline{c}_1 a(k-1) + \overline{c}_2\big(v(k+1) - v(k)\big) \tag{7}$$

$$a(k) = -\overline{c}_3 a(k-1) + \overline{c}_4\big(s(k+1) - s(k) - dt\ v(k)\big) \tag{8}$$

Final Model in matrix notation (For linear regression)

$$\begin{bmatrix} a(t) \\ a(t) \end{bmatrix} = \begin{bmatrix} -a(t-1) & v(t+1) - v(t) & 0 & 0 \\ 0 & 0 & -a(t-1) & s(t+1) - s(t) - dt\ v(t) \end{bmatrix} \begin{bmatrix} \overline{c}_1 \\ \overline{c}_2 \\ \overline{c}_3 \\ \overline{c}_4 \end{bmatrix} \tag{9}$$