$$\text{state} = (x, v)$$

$$\frac{dx}{dt} = v$$

$$\frac{dv}{dt} = F/m = a$$

$$F_{ij} = -G m_i m_j \frac{\vec{r}_{ij}}{|r^3|} = -G m_i m_j \frac{\hat{r}_{ij}}{|r_{ij}|^3}$$

$$a_{ji} = -G m_j \frac{\vec{r}_{ij}}{|r^3|}$$

$$a_i = \sum_{j \neq i} -G m_j \frac{\vec{r}_{ij}}{|r_{ij}|^3}$$