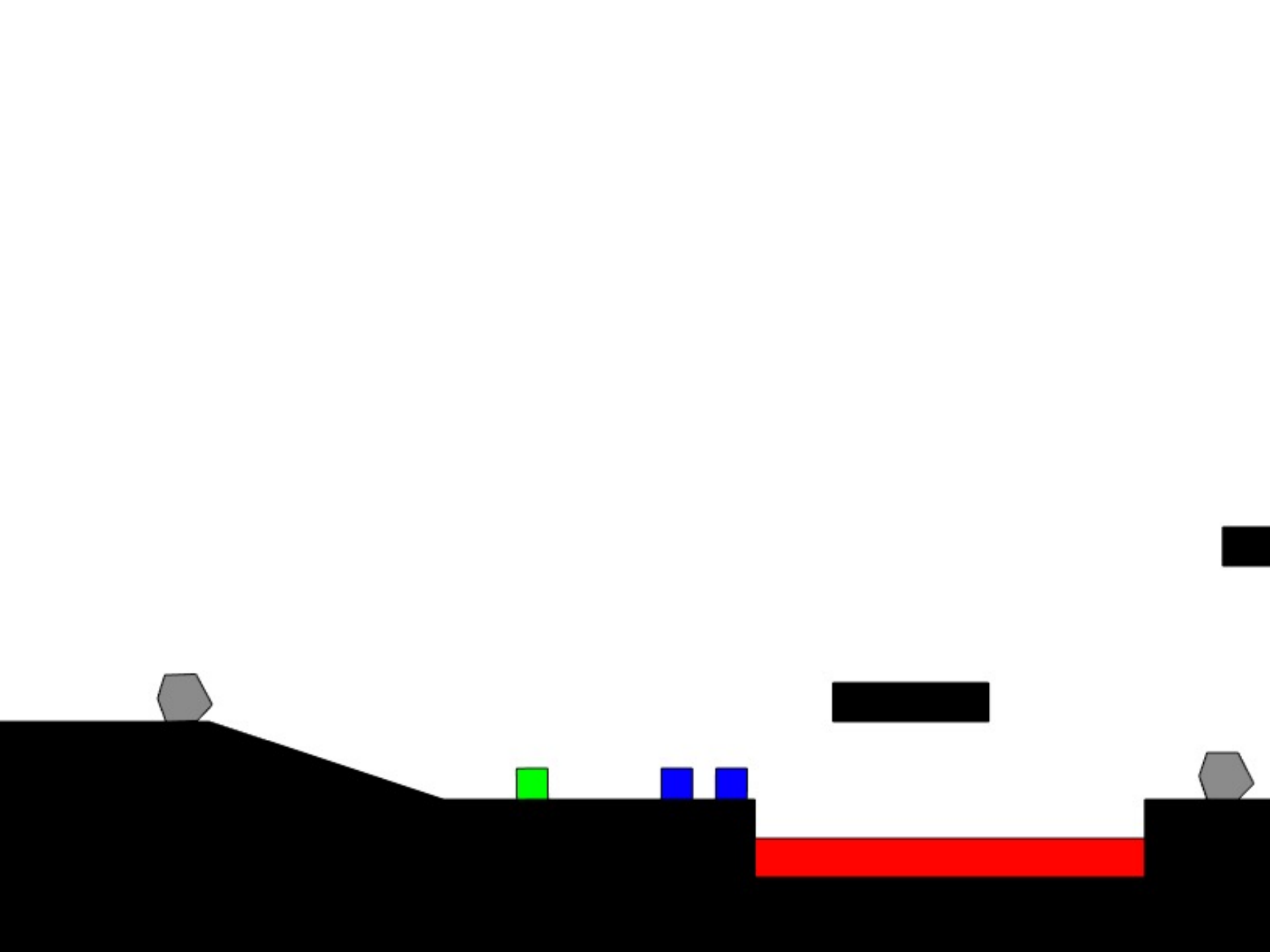
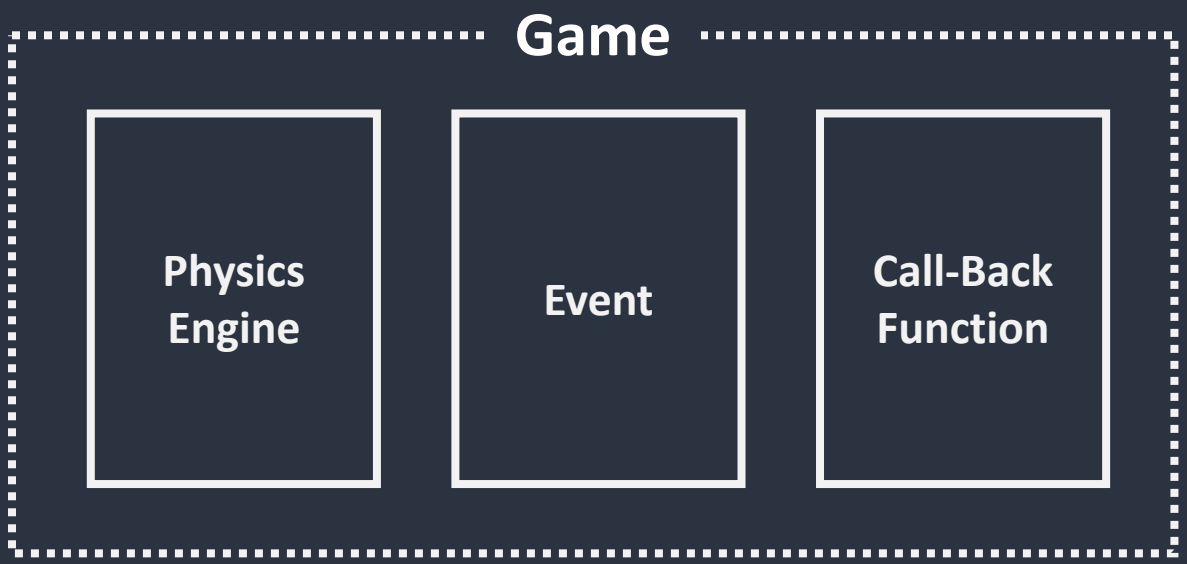
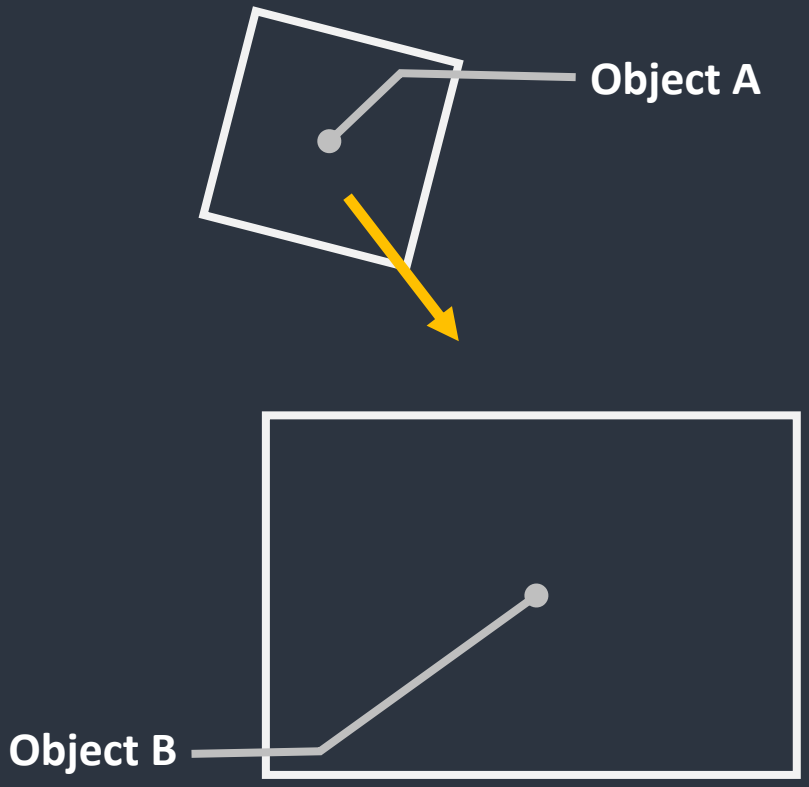
플랫포머 게임을 위한 2D 물리 엔진의 구현



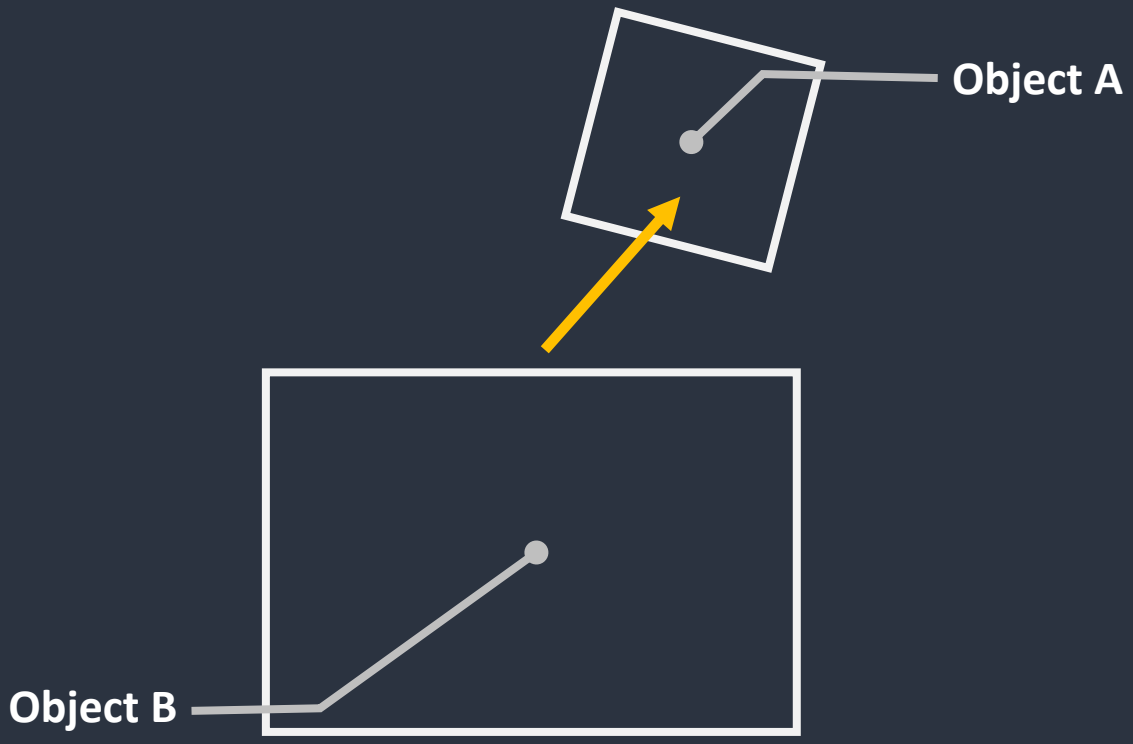
Game Structure



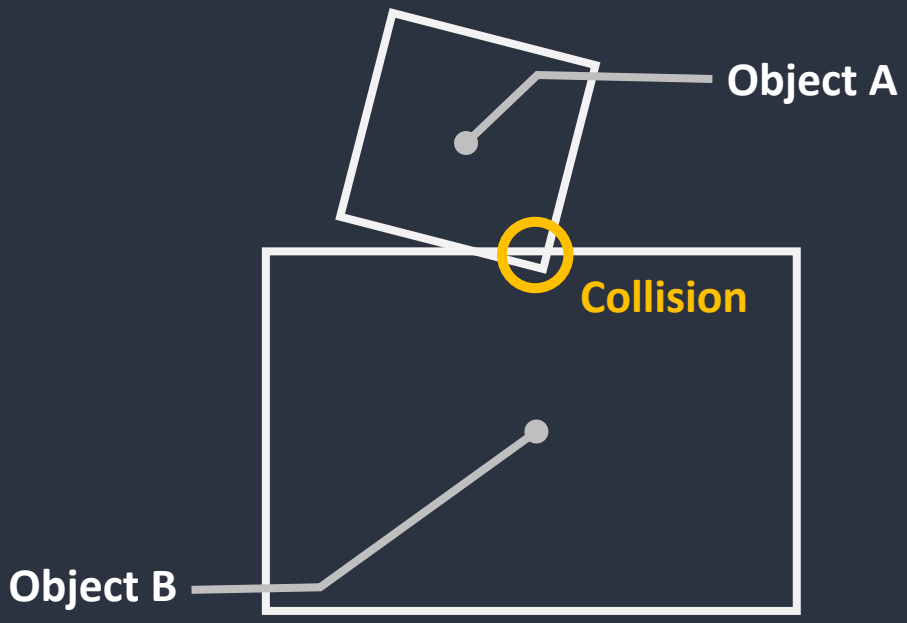
Physics Engine



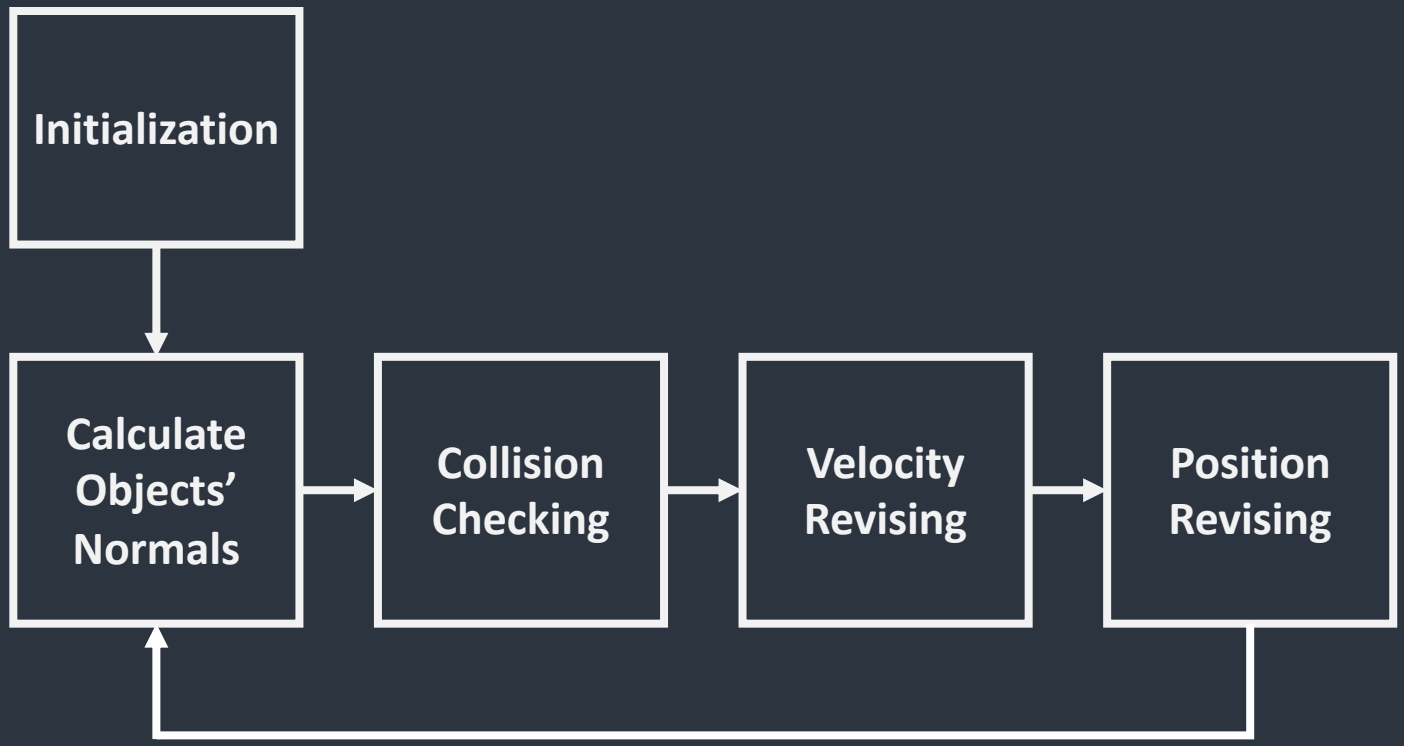
Physics Engine



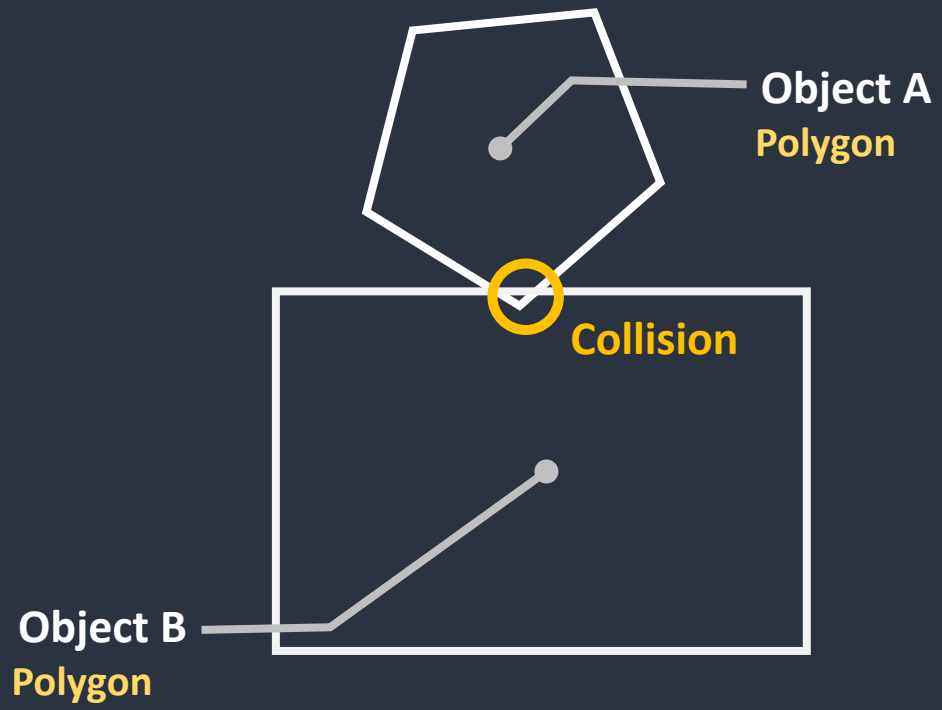
Physics Engine



Physics Engine Block Diagram

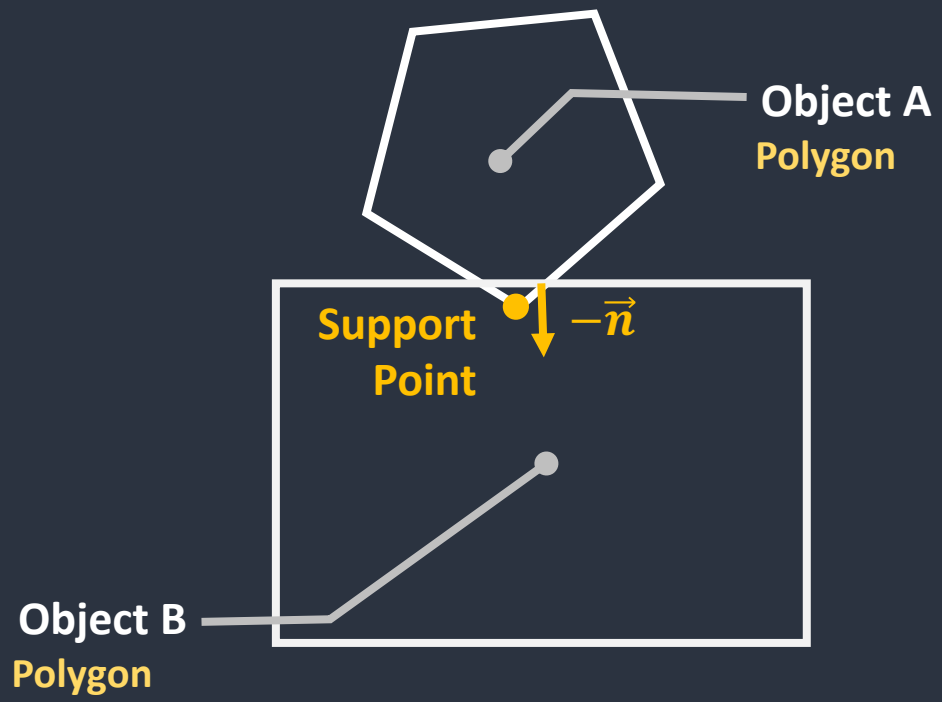


Physics Engine Collision Model



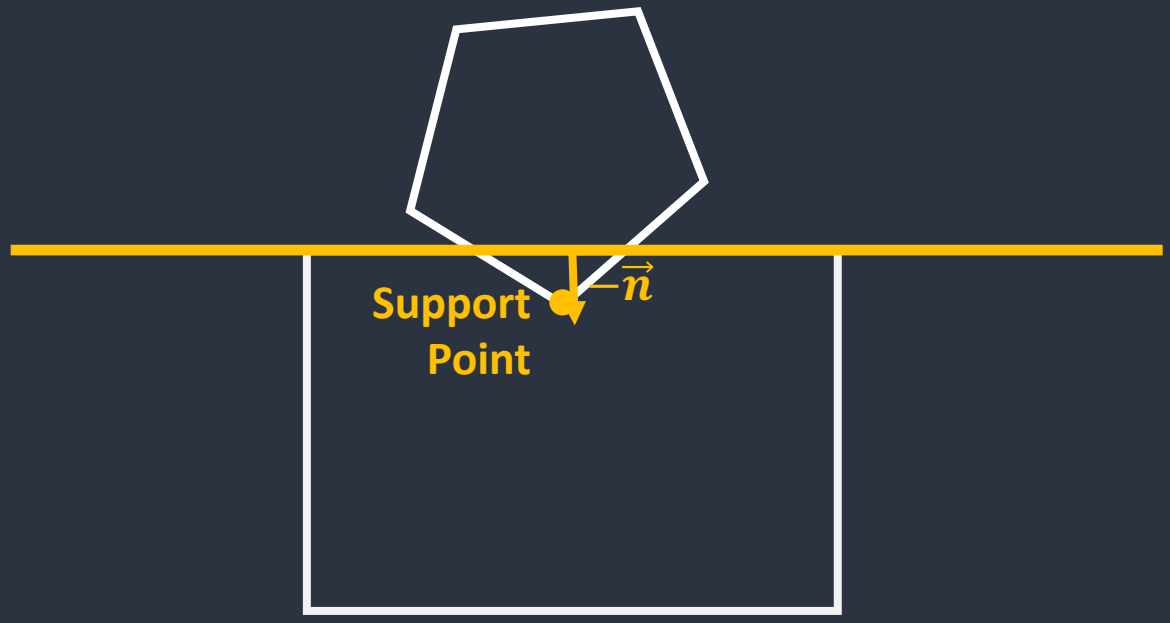
Physics Engine Collision Model

Support Point



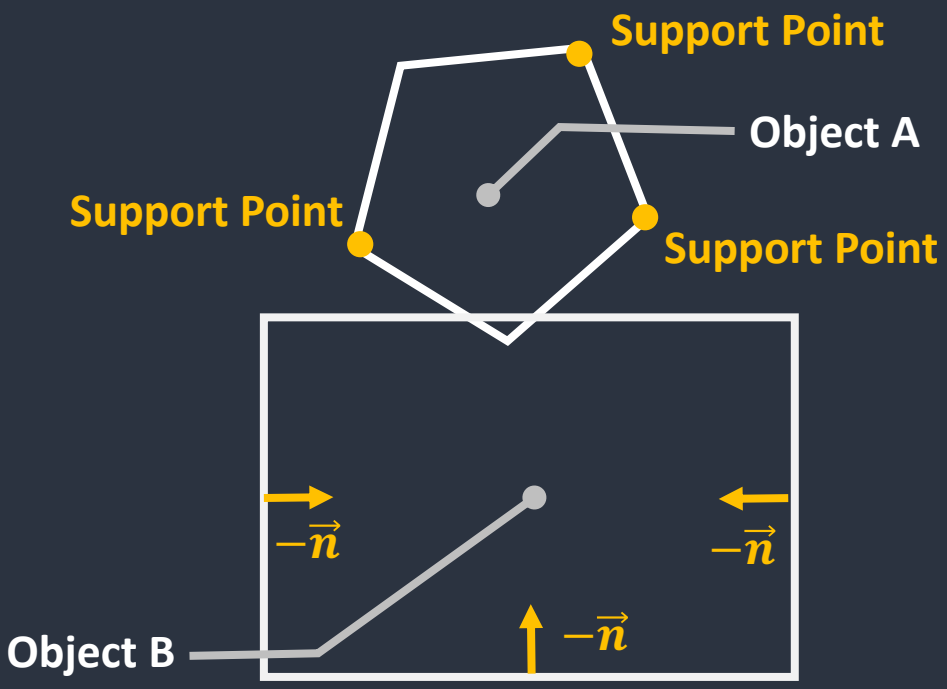
Physics Engine Collision Model

Support Point



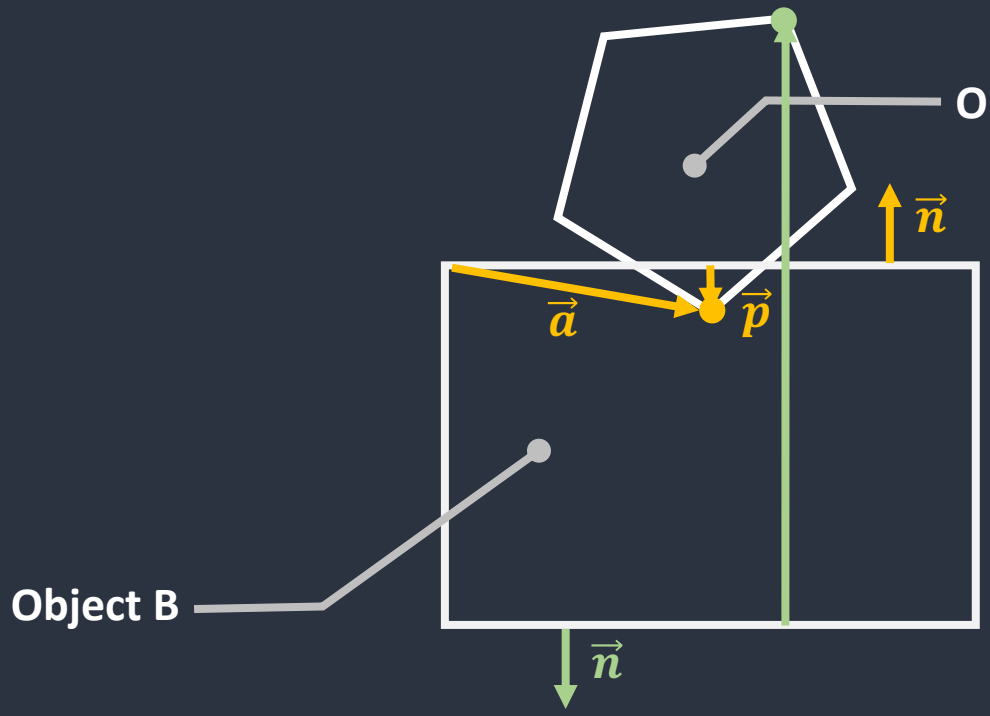
Physics Engine Collision Model

Support Point



Physics Engine Collision Model

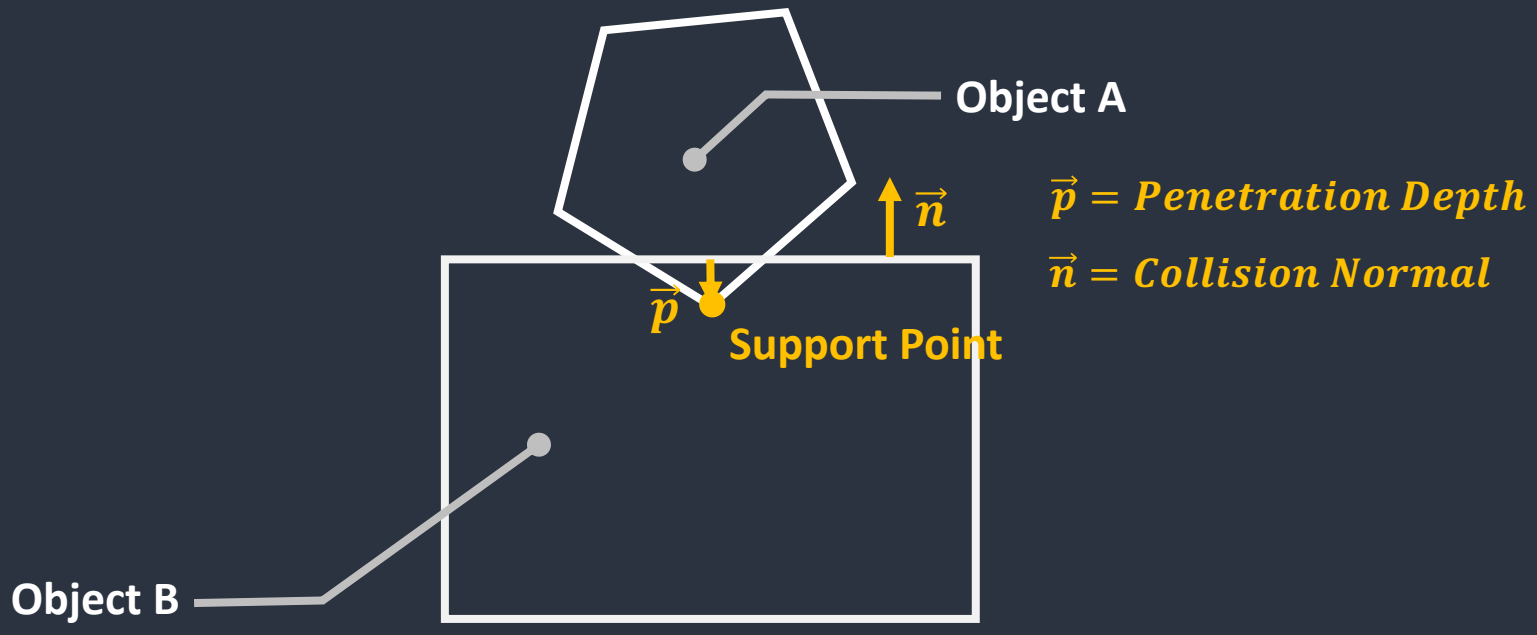
Support Point



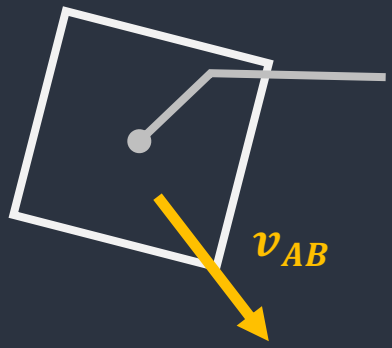
$$\vec{p} = max(\vec{a} \cdot \vec{n})$$

Physics Engine Collision Model

Support Point

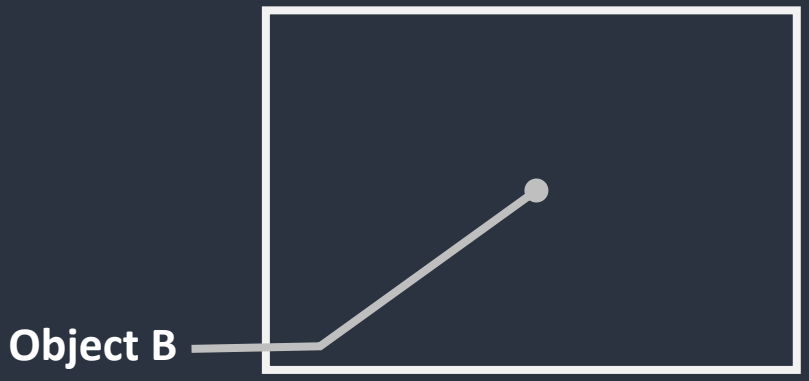


Physics Engine Velocity Revising

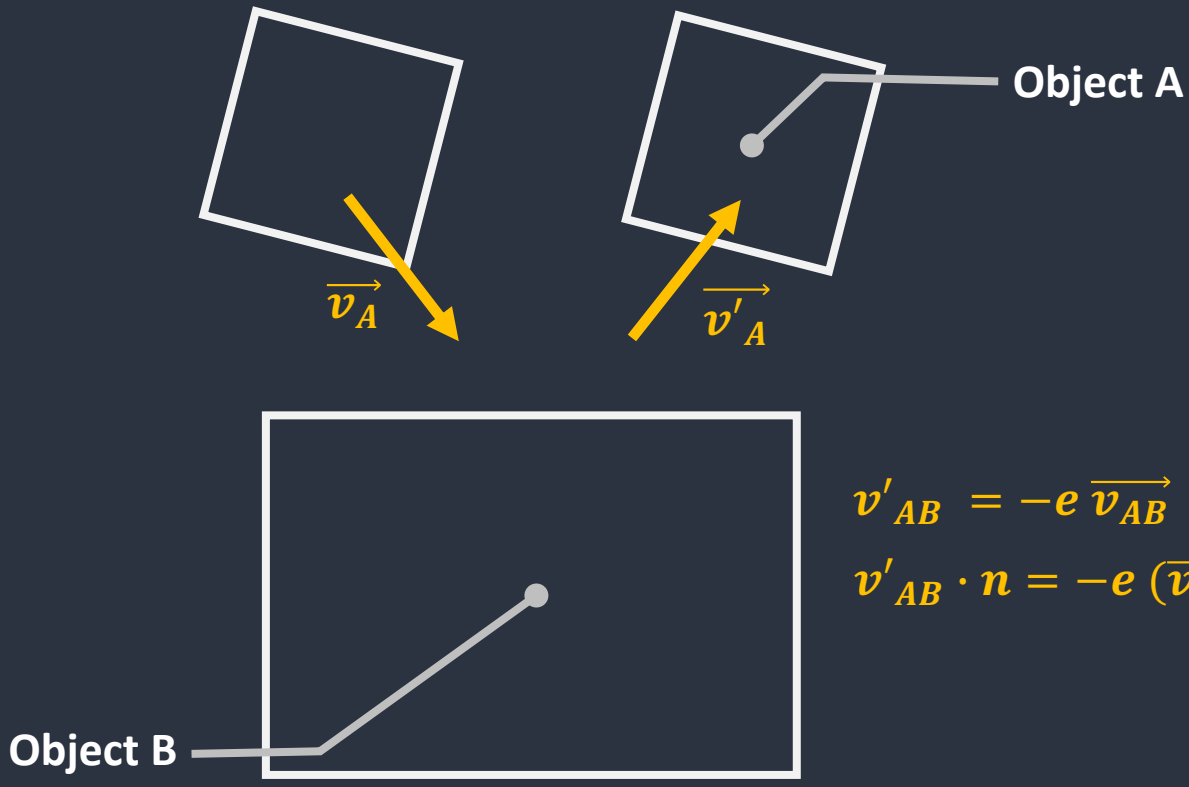


$$v_{AB} = v_B - v_A$$

$$v_{AB} \cdot n = (v_B - v_A) \cdot n$$



Physics Engine Velocity Revising



$$\overrightarrow{v'_{AB}} = -e\,\overrightarrow{v_{AB}}$$

$$\overrightarrow{v'_{AB}} \cdot n = -e\,(\overrightarrow{v_B} - \overrightarrow{v_A}) \cdot n$$

Physics Engine Velocity Revising

$$v'_{AB} \cdot n = -e\,(\overrightarrow{v_B} - \overrightarrow{v_A}) \cdot n$$

$$v' = v + \frac{j\,n}{m}$$

$$v'_A = v_A - \frac{j\,n}{m_A} \qquad v'_B = v_B + \frac{j\,n}{m_B}$$

$$v'_B - v'_A = (v_B + \frac{j\,n}{m_B}) - (v_A - \frac{j\,n}{m_A})$$

$$\left(v_B - v_A + \frac{j\,n}{m_A} + \frac{j\,n}{m_B}\right) \cdot n = -e(v_B - v_A) \cdot n$$

$$jn\left(\frac{1}{m_A} + \frac{1}{m_B}\right) \cdot n = -(e+1)(v_B - v_A) \cdot n$$

$$j = \frac{-(e+1)(v_B - v_A) \cdot n}{\left(\frac{1}{m_A} + \frac{1}{m_B}\right)}$$

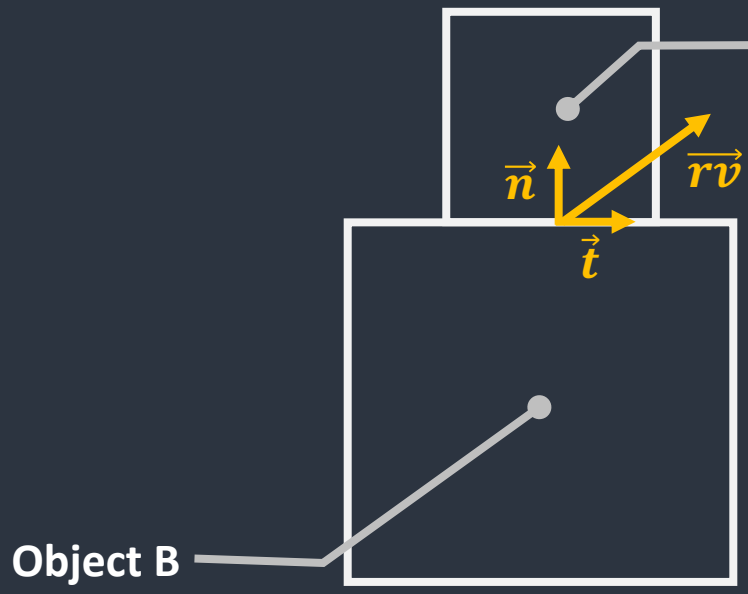
Physics Engine Velocity Revising

$$j = \frac{-(e+1)(v_B - v_A) \cdot n}{\left(\frac{1}{m_A} + \frac{1}{m_B}\right)} \ (impulse)$$

$$v'_A = v_A - \frac{j\,n}{m_A} \ (velocity\ A)$$

$$v'_B = v_B + \frac{j\,n}{m_B} \ (velocity\ A)$$

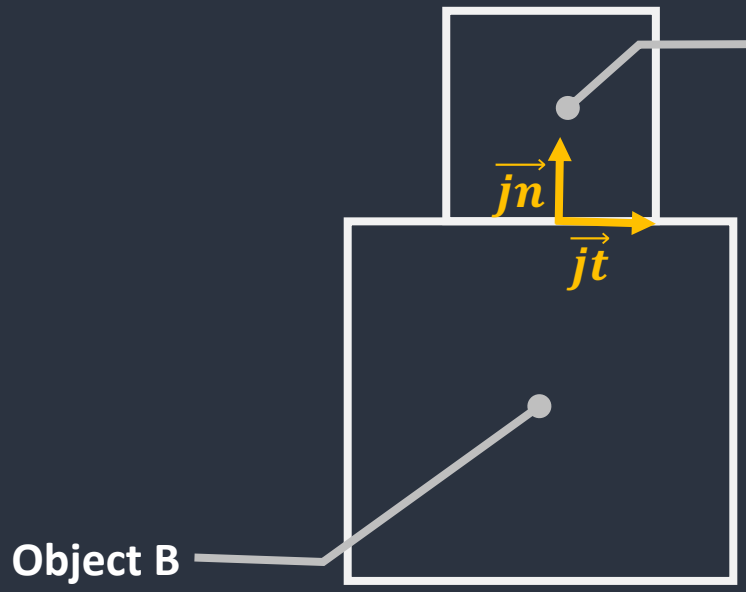
Physics Engine Friction



$$\vec{t} = (\vec{rv} - (\vec{rv} \cdot \vec{n})\vec{n})/t$$

$$\vec{jt} = \frac{-\vec{rv} \cdot \vec{n}}{\frac{1}{m_A} + \frac{1}{m_B}}$$

Physics Engine Friction



$$Static\ friction$$

$$F_f \leq \mu F_n \ -> \ jt \leq \mu_s\, jn$$

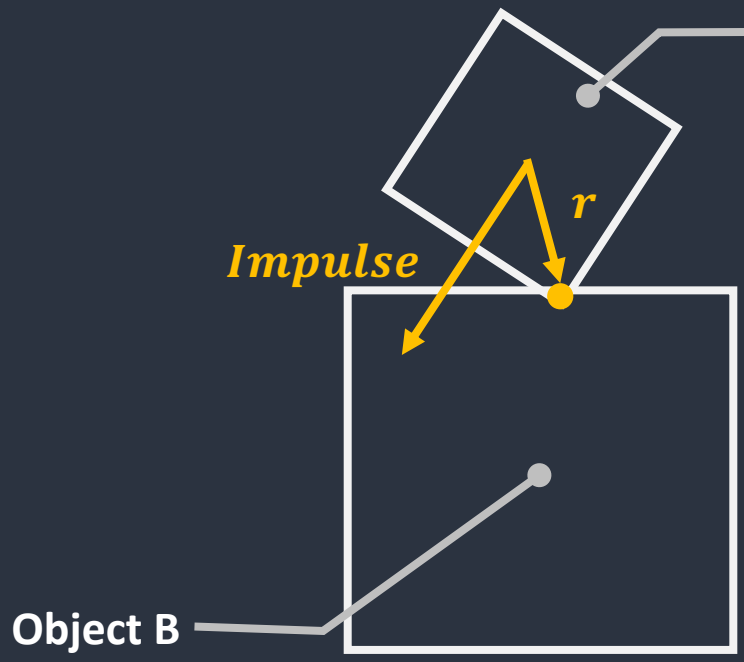
$$impulse = jt$$

$$Dynamic\ friction$$

$$otherwise$$

$$impulse = -jn * t * \mu_d$$

Physics Engine Torque



$$F = ma$$

$$\tau = I\alpha$$

$$r \times F = I\alpha$$

$$r \times F * dt = I\alpha * dt$$

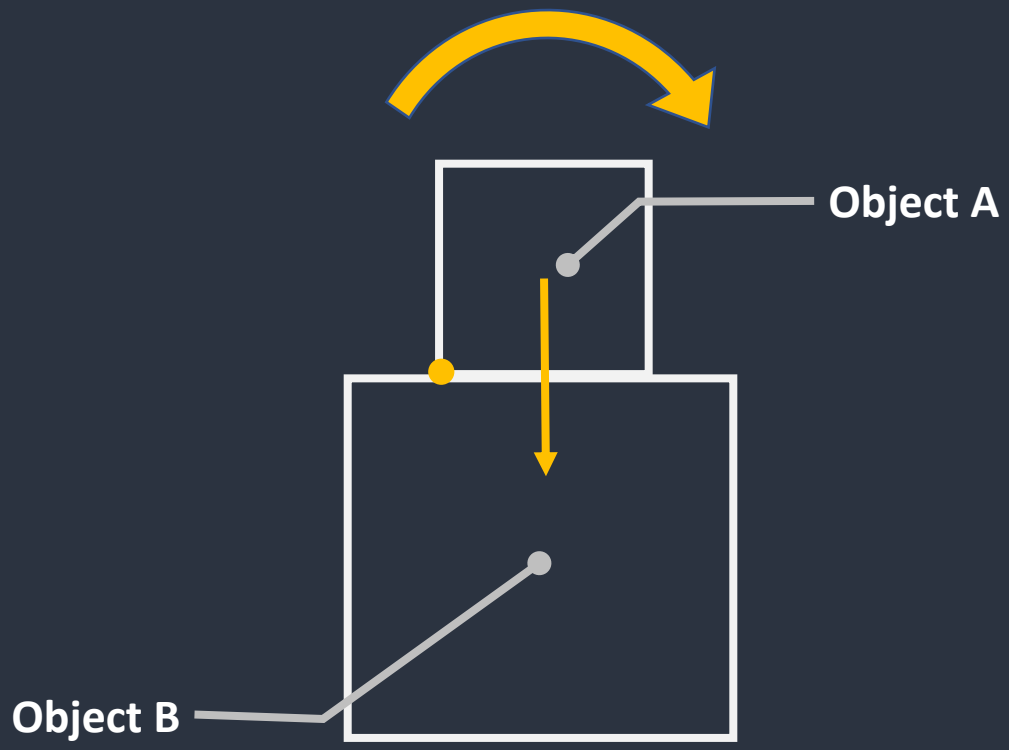
$$d\varpi = \frac{1}{I} r \times Impulse$$

Physics Engine Torque

$$T = \begin{pmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{pmatrix}$$

$$position' = T(point - position) - position$$

Physics Engine Collision Problem



Physics Engine Collision Problem

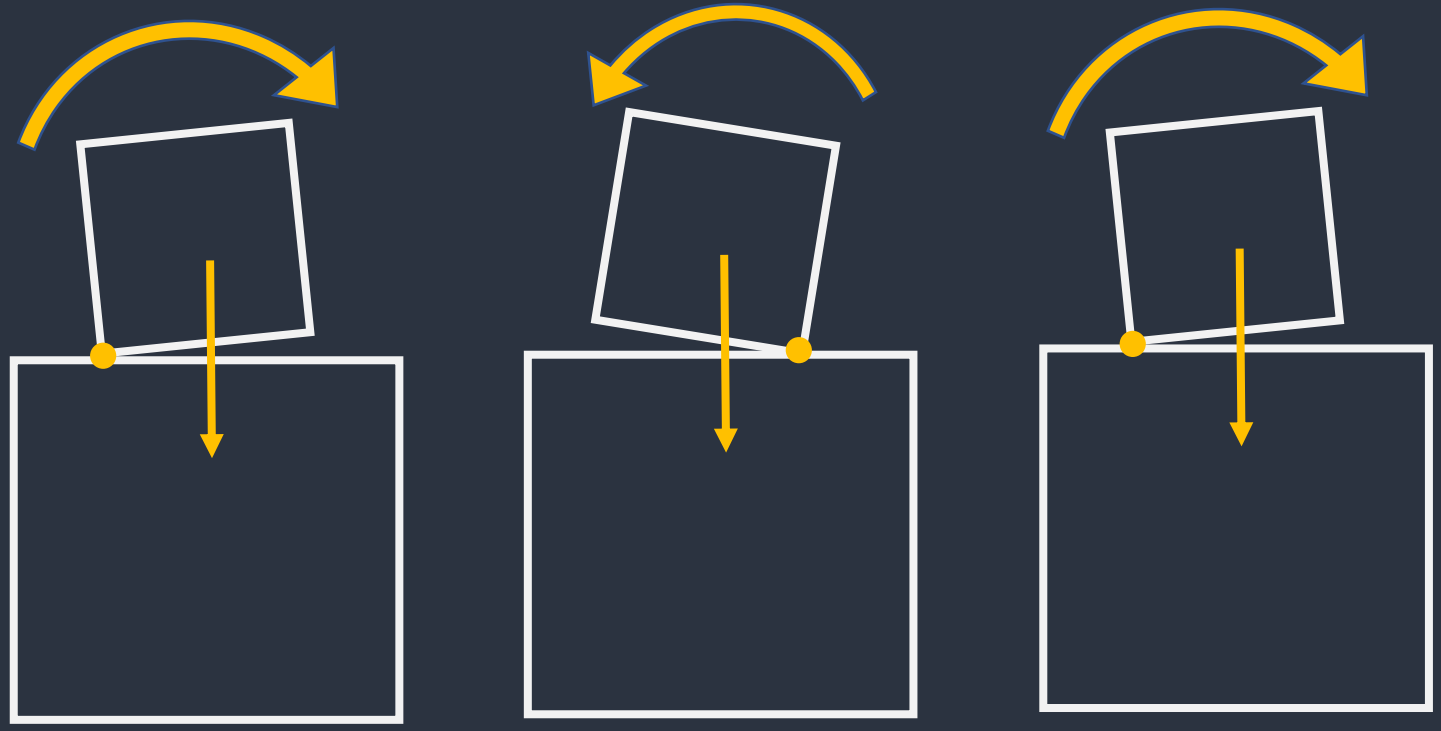
$\varpi = +1$

$d\varpi = \frac{1}{I}\, r \times Impulse < 0$

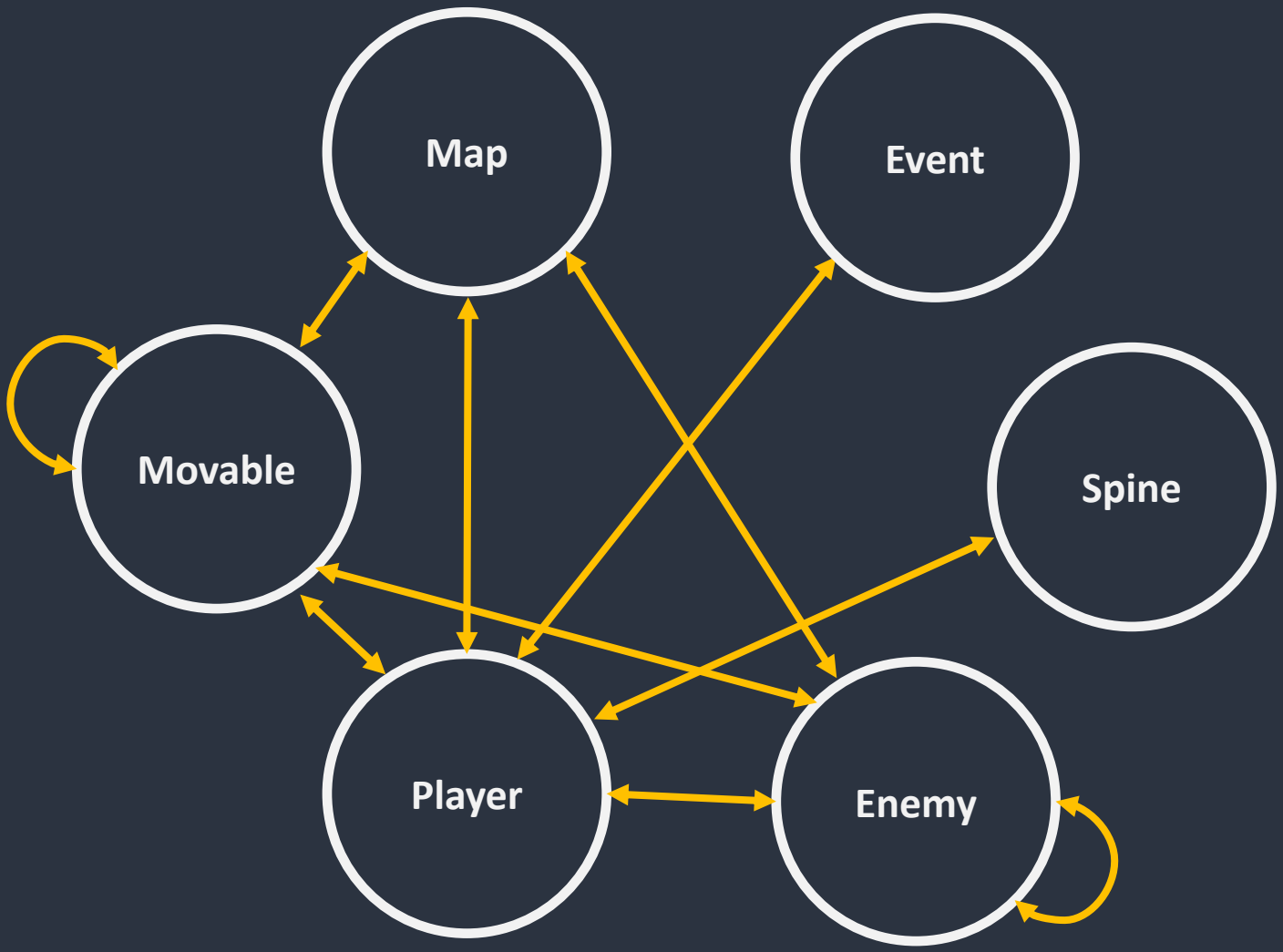
$\varpi = -1$

otherwise.

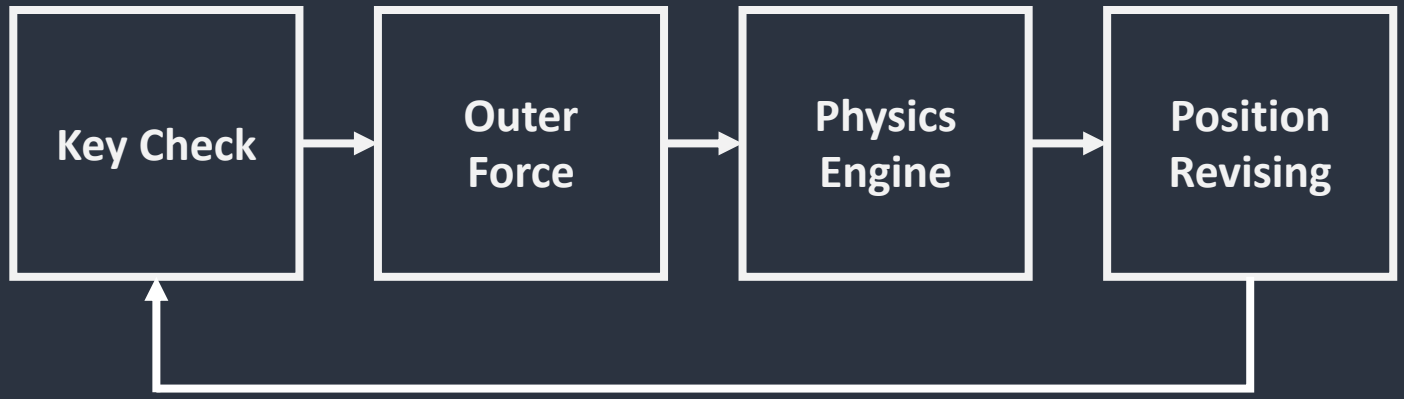
$d\varpi = \frac{1}{I}\, r \times Impulse$



Physics Engine



Game Design Moving Process



Game Design Event Calling