I Dynamics

$$\underbrace{\begin{bmatrix} \mathbf{H} & -\mathbf{J}_c^\top \\ -\mathbf{J}_c & 0 \end{bmatrix}}_{\mathbf{K}} \underbrace{\begin{bmatrix} \ddot{\mathbf{q}} \\ \boldsymbol{\lambda} \end{bmatrix}}_{\boldsymbol{\nu}} = \underbrace{\begin{bmatrix} \mathbf{S}^\top \boldsymbol{\tau} + \mathbf{h} \\ \dot{\mathbf{J}}_c \dot{\mathbf{q}} \end{bmatrix}}_{\Psi}$$

$$\boxed{\boldsymbol{\nu} = \mathbf{K}^{-1} \Psi}$$

AD

II Conventional iLQR

$$\frac{\partial \boldsymbol{\nu}}{\partial \mathbf{q}} \quad \mathcal{O}(n^2)$$

AD

III Conventional DDP

$$\frac{\partial^2 \boldsymbol{\nu}}{\partial \mathbf{q}^2} \quad \mathcal{O}(n^3)$$

Contraction

$$\boldsymbol{\gamma}^\top \frac{\partial^2 \boldsymbol{\nu}}{\partial \mathbf{q}^2} \quad \mathcal{O}(n^3)$$