## Optimal Control System Design Direct Methods: NLP Inirect Methods: PMP, CV Mathematics are not as BVP is difficult to solve · Much more effective · Insight about structure than direct methods ellegant as Indirect Methods of the solution Path constraints are difficult to handle · More effective in handling · No Insight about structure of the solution Initial guess for co any constraint state is needed · Powerfull NLP solvers · Problem is ill conditioned can be utilized · Not Robust · There exist well · Not doable for black established methods box functions Sequential: uSimultaneous: $u, \xi$ · Sparse NLP · Large number of defect constraints Smaller number of defect constraints $\cdot$ Need to perorm full simulation · Knowledge of state trajectory Mesh regridding is usually needed for each parameter perturbation Easily find feasible solution can be used in initialization and changes NLP dimesnion · Has problem when the system $\cdot$ Fast local convergence · Powerfull DAE solvers can be used · More difficult to find feasible is highly nonlinear or unstable · Effective for unstable systems solution · Effective for path and boundary · Low accuracy State derivative fucntion is needed constraint so does not work with data · Computationally inefficient driven models · Initial gauess for state trajectory can be utilized effectively and damps poor control initialization Single Shooting **Multiple Shooting** Single Step Pseudospectral · Less difficult to · Less accurate Coarse mesh can NLP inherits ill · Simple Better Convergence More Complex implement be used -conditioned · Finer mesh · Dynamics are Defect constraint Well – Condition dynamics should be used · More accurate always feasible is needed Good structure for · No defect constraint paralell computation is needed $\xi(t)$ $\xi(t)$ $\xi(t)'$ $\xi(t)$