CPS: Medium: Collaborative Research: Collective Intelligence for Proactive Autonomous Driving
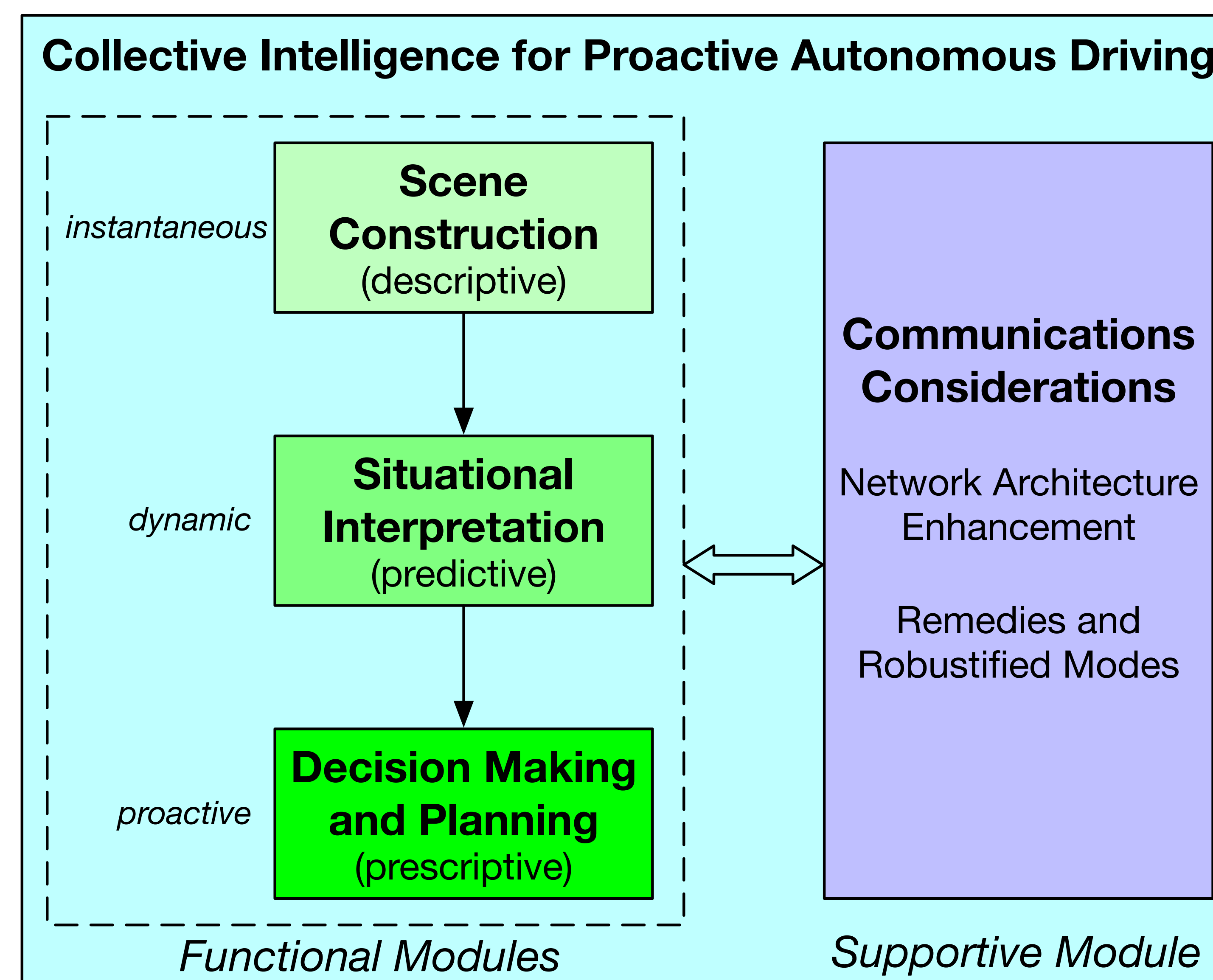
Introduction

❖ Transportation system: one of the most important infrastructure for our society

❖ Efforts along two paths: 1) improved intelligence for individual vehicles: from ADAS to autonomous driving; 2) enhanced infrastructure with intelligence and connectivity. **→ Can these two paths merge?**

❖ Passive mindset of autonomous driving **→ Can the autonomous vehicles be proactive?**

Scientific Impact:

❖ Studies on a highly dynamic complex CPS, including machine-machine and human-machine interactions

❖ Interdisciplinary research in signal processing, statistical learning, optimization, as well as communications and networking

Challenge:

❖ **Hybrid** system with mixed intelligence and/or connectivity

❖ **Heterogeneity** in information and actions

❖ High **complexity** and fast **dynamics**

❖ **Information sharing** requirements for cooperation

Collective Intelligence for Proactive Autonomous Driving

Functional Modules: Scene Construction (descriptive) — instantaneous; Situational Interpretation (predictive) — dynamic; Decision Making and Planning (prescriptive) — proactive

Supportive Module: Communications Considerations — Network Architecture Enhancement; Remedies and Robustified Modes

Solution: Proactive Driving with Collective Intelligence

❖ **Module 1: Scene construction**
  o Multi-modal multi-view sensing to exploit perspective diversity
  o Comprehensive, general and optimal scene construction

❖ **Module 2: Situational Interpretation**
  o Physics-level: cooperative tracking
  o Maneuver-level: behavioral characterization
  o Interaction-level: complex interactions with big hypothesis

❖ **Module 3: Decision Making and Planning**
  o Inter-vehicle impact map
  o Dual-layer game towards proactive driving

❖ **Supportive Module: Communications Considerations**
  o High-rate and low-latency communication support
  o Robustified modes of collective intelligence

Broader Impact:

❖ Next-generation intelligent transportation system design

❖ Combination of autonomous driving with traditional transportation system users

❖ Multi-disciplinary solution to large complex CPS in a holistic manner

❖ Software/Tool developed for data analytics in transportation systems

❖ New course developed and course updates

❖ Mentoring female engineering students for their graduate school applications