

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Gaoyuan Liu**

The public defense will take place on **Thursday 13th November 2025 at 4 pm** in the **Green Room** (U-Residence, VUB Main Campus)

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HYBRID SOLUTIONS FOR BEHAVIOR PLANNING IN ROBOTIC MANIPULATION

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Abstract of the PhD research

Planning robot behavior is a central challenge in enabling robots to perform useful tasks. Existing methods often emphasize a single capability, such as collision avoidance, logical sequencing, or data-driven learning, whereas real-world applications require a combination of these abilities. This dissertation investigates how hybrid planning methods can enhance the effectiveness and efficiency of robotic systems across diverse tasks. We developed several such methods, including a safe reinforcement learning framework that reduces collision risks during training and improves human-robot collaboration; a synergistic approach that combines learning-based actions with structured planning to improve performance in cluttered manipulation; a mechanism that integrates logic-based planning with learned skills to expand action capabilities in a table rearrangement task; and a robotic pruning system that leverages motion planning and precise control to achieve agile and accurate movements among intricate branches. All methods are validated in both the simulation environment and on physical trials. Collectively, these contributions demonstrate that hybrid planning not only increases robustness and versatility but also advances robots toward reliable deployment in real-world environments.