Challenges for Motion Planning

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Algorithmic Challenge: high DOF (still...)

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Adaptivity – How to Achieve it?

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• <u>Status:</u> Significant work for last decade (at least) on developing automatically adaptive methods, e.g., Hybrid PRM [Hsu et al'04], Feature Sensitive approaches [Morales et al'04]

•**Issue:** Despite progress, they are still hard to apply and require significant tuning

• <u>New Strategy:</u> Use ideas from parallel computing (partitioning, scheduling, load balancing) coupled with simpler planner [Jacobs, SC'11 ICRA'12,13, IROS'13]

- Subdivide planning space into regions
- Independently, plan motion in each region and then between adjacent regions
- Limits communication to adjacent regions





Uncertainty – Don't Give up on Planners

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- <u>Status:</u> Accounting for uncertainty is hard, but major progress, e.g., Kaebling/Lozano-Perez, Hsu, etc.
- <u>Still Issues:</u> require replanning, efficiency
- <u>Recent Progress</u>: FIRM (Feedback-based Information RoadMap) extends roadmap to belief space (don't need to replan) [Agha IROS'11,'12, ICRA'12, IJRR'13)





User Guided Planning

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• <u>Need:</u> Clear need for integrating planners & humans. Provide guidance/input that is difficult to quantify automatically and required for co-operation.

• **Issues:** Different type of information. Existing formalisms don't apply, e.g., measuring cost/complexity.



• <u>Some thoughts</u>: Can be synergistic – combine strengths of both. Human can provide guidance and reduce search space and planner does fine-grained planning.





Summary: Motion Planning Challenges for the next Generation

- Methods for extremely highdimensional systems
 - Multi-agent systems (simulation), molecules, SMA
- Adaptivity How to Achieve it?
 - Apply strategies from parallel & distributed processing and use simpler planning methods
- Uncertainty Don't give up on planners!
- User-Guided Planners: Integrating Planners & Humans
 - Take advantage of strengths of each



IROS 2011, San Francisco: Nancy, 4 current and 5 former students, and some of their students (4 grand students!) and their children (3)

