



Coláiste na Tríonóide, Baile Átha Cliath
Trinity College Dublin
Ollscoil Átha Cliath | The University of Dublin



Autonomic Road Transport

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**MC Member (Ireland), COST Action TU1102:
Towards Autonomic Road Transport Support Systems**



Outline



- COST Action: Autonomic Road Transport Support Systems
 - Background, aims, objectives
 - Research/application areas
- My research – intelligent self-organising traffic control: an example of autonomic system
- Going forward
 - Research areas
 - Open research directions/questions

Trinity's Future Cities Centre



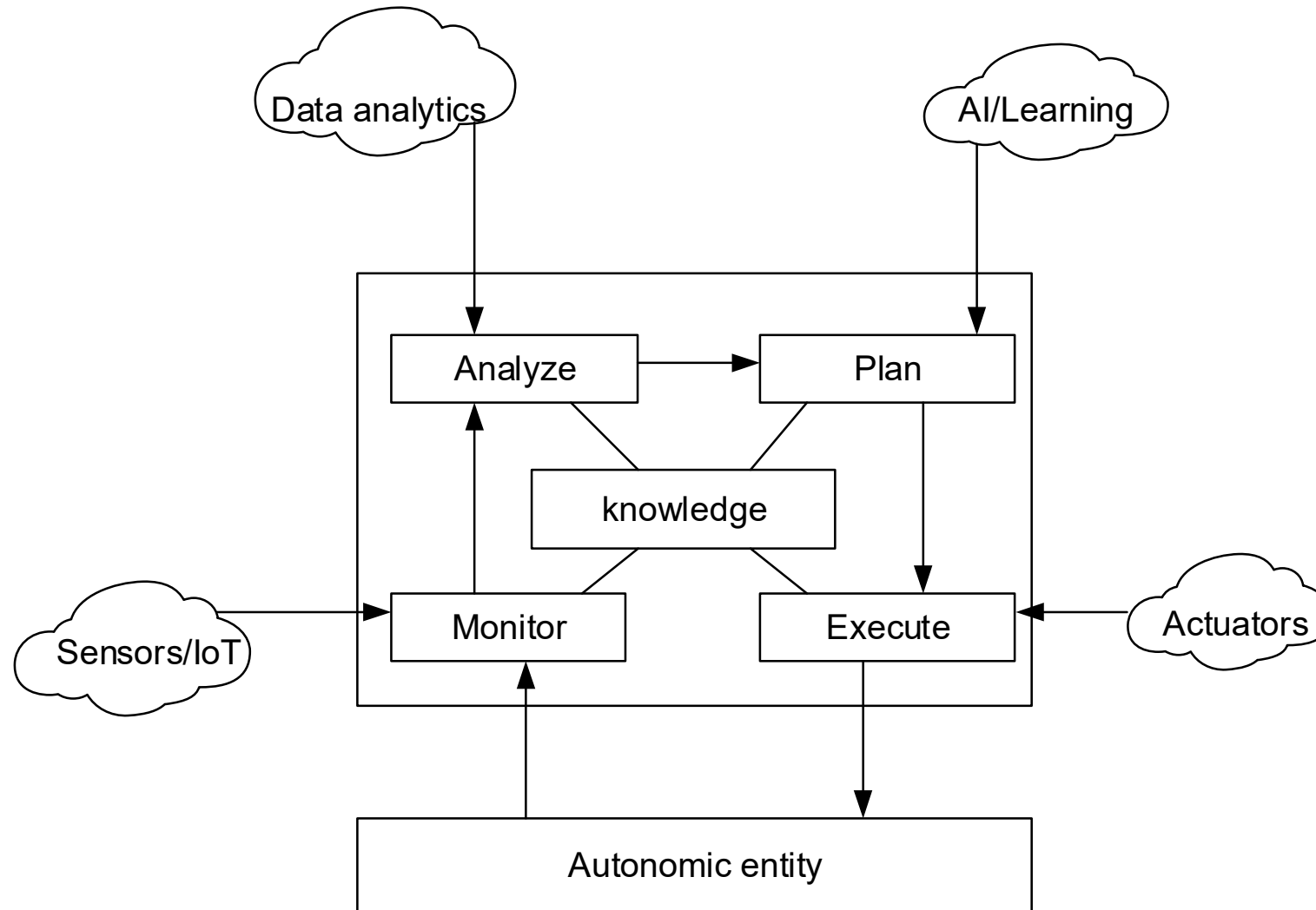
The research is supported by the application of **sensor, communication and analytical technological solutions to sustainability concerns** in urban infrastructure such as energy, water, waste management and transportation systems.

Autonomic systems



- COST Action: Towards Autonomic Road Transport Support Systems (ARTS)
 - 2011-2016
 - 24 countries
 - Transport studies, computer science, engineering experts
- Autonomic computing: self-managed computing systems with a minimum of human interference
 - Term derived from the body's autonomic nervous system, which controls key functions without conscious awareness or involvement
- Self-managing:
 - Self-configuring, Self-healing, Self-optimizing, Self-protecting

Autonomic control – MAPE loop



Autonomic Road Transport Support Systems (ARTS)



- Make all aspects of transport support/Intelligent Transport Systems autonomic, e.g.,
 - Intelligent navigation
 - Automatic number plate recognition
 - Urban traffic control
 - Vehicular networking
 - Motorway traffic control
 - Electric vehicle flow/charging management
 - Incident prediction/detection/management
 - etc

Autonomic systems: underlying techniques

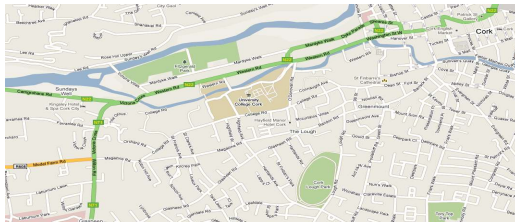
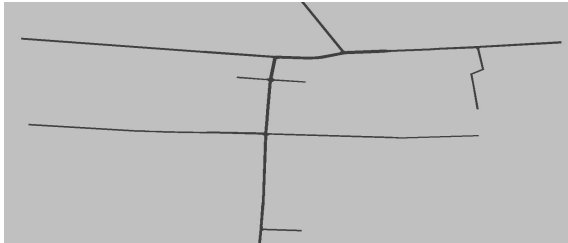


- Artificial intelligence
 - Rule-based systems, automated planning, domain modelling and knowledge engineering, evolutionary computation, machine learning ...
- Multi-agent systems
 - Self-organisation and emergence, collaboration, learning
- Game-theory
 - Cooperative games, non-cooperative games
- etc

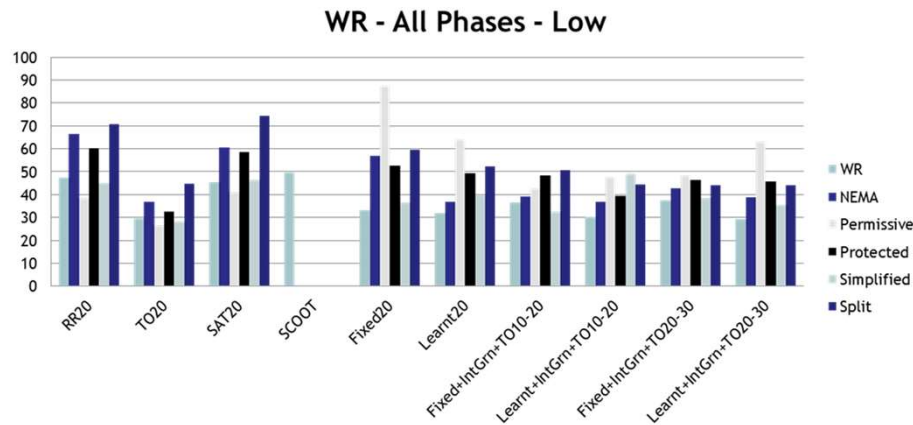
COST Action Outputs/Resources

- ARTS Vocabulary on www.cost-arts.org
- Book: Autonomic Road Transport Support Systems, Editors: McCluskey, Th.L., Kotsialos, A., Müller, J.P., Klügl, F., Rana, O., Schumann, R., Springer/Birkhauser, 2016
- 2 ARTS Competitions – demos of autonomic systems, e.g.,
 - Automated Planning for Traffic Signals Control
 - Proactive Re-Routing of Urban Traffic based on Traffic Flow Forecasts
 - Autonomic fault-adaptive state estimation and sensor-fault detection in road traffic systems
- Roadmap- Future research directions for ARTS community
 - <https://helios.hud.ac.uk/cost/roadmap.php>

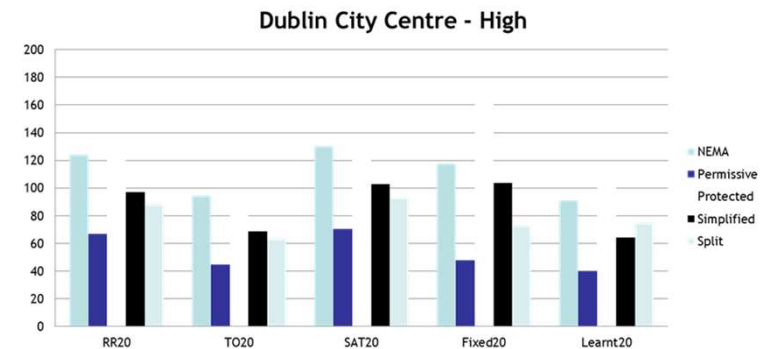
REALT: Real-Time Adaptive Learning-Based Urban Traffic Control



REALT either
outperforms or performs
on par with historical
SCOOT settings,
SCATS-like simulation,
round robin



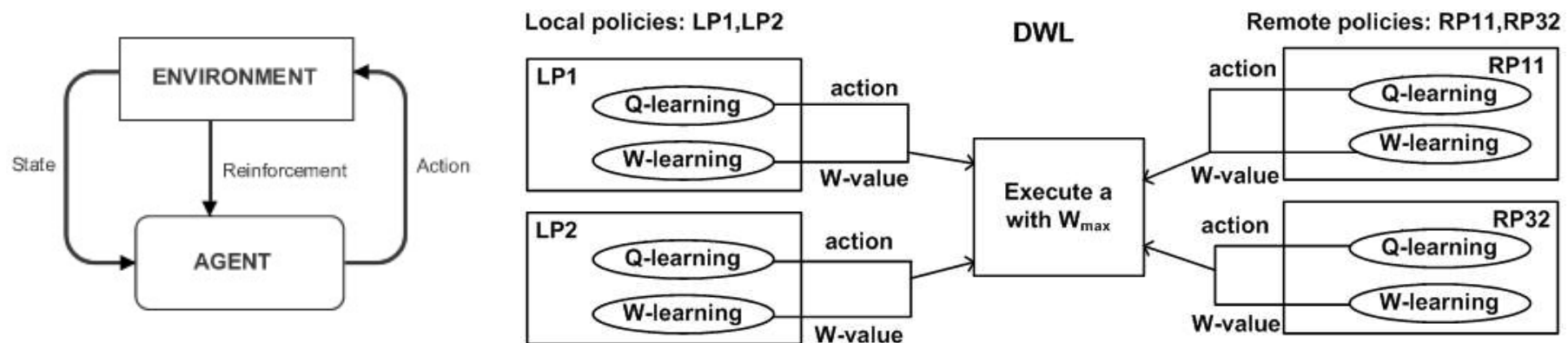
Cork City Centre Simulation



Dublin City Centre Simulation

REALT: Underlying science

- Distributed W-Learning – multi-agent multi-policy learning algorithm that enables collaboration between heterogeneous intelligent agents
 - Uses reinforcement learning – Q-learning and W-Learning
 - Multiple heterogeneous policies on each agent
 - Multiple heterogeneous agents collaborating with each other
 - Each agent learns how its actions affect its neighbours
 - Each agents learns the degree of collaboration with other agents



<http://www.dsg.cs.tcd.ie/FutureCities/SmartInfrastructure/SmartUrbanTrafficControl>

Future Research (1 of 2)

- Research on furthering underlying techniques that are used to enable self-* properties of autonomic systems
- E.g., Machine Learning
 - Autonomous cars themselves need to learn
 - Urban traffic control – traffic lights need to learn
 - Mobility as a Service (MaaS) – learning both on user end (learn habits and preferences) and provider end (learn optimal actions based on estimated demand)
 - Incentivize/influence consumer decisions, i.e., demand-side management

Future Research (2 of 2)

- Integration of various intelligent/autonomous/autonomic systems
 - Shared autonomous vehicles within MaaS solutions
 - Autonomous vehicles cooperate with traffic lights/traffic management systems to influence traffic flows
- Look at autonomous vehicles and transport systems as a part of an overall city ecosystem
 - Interdisciplinary research
 - Impact of autonomous cars on urban design, impact of autonomous cars/MaaS on inclusivity etc.



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Thank you.

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Future Cities: The Trinity Centre for Smart and Sustainable Cities

Trinity College Dublin

<http://www.tcd.ie/futurecities/research/mobility/>

<http://www.dsg.cs.tcd.ie/FutureCities/SmartInfrastructure/SmartUrbanTrafficControl>

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