Physical Path Planning using a Network of Learning Sensors: Experiments

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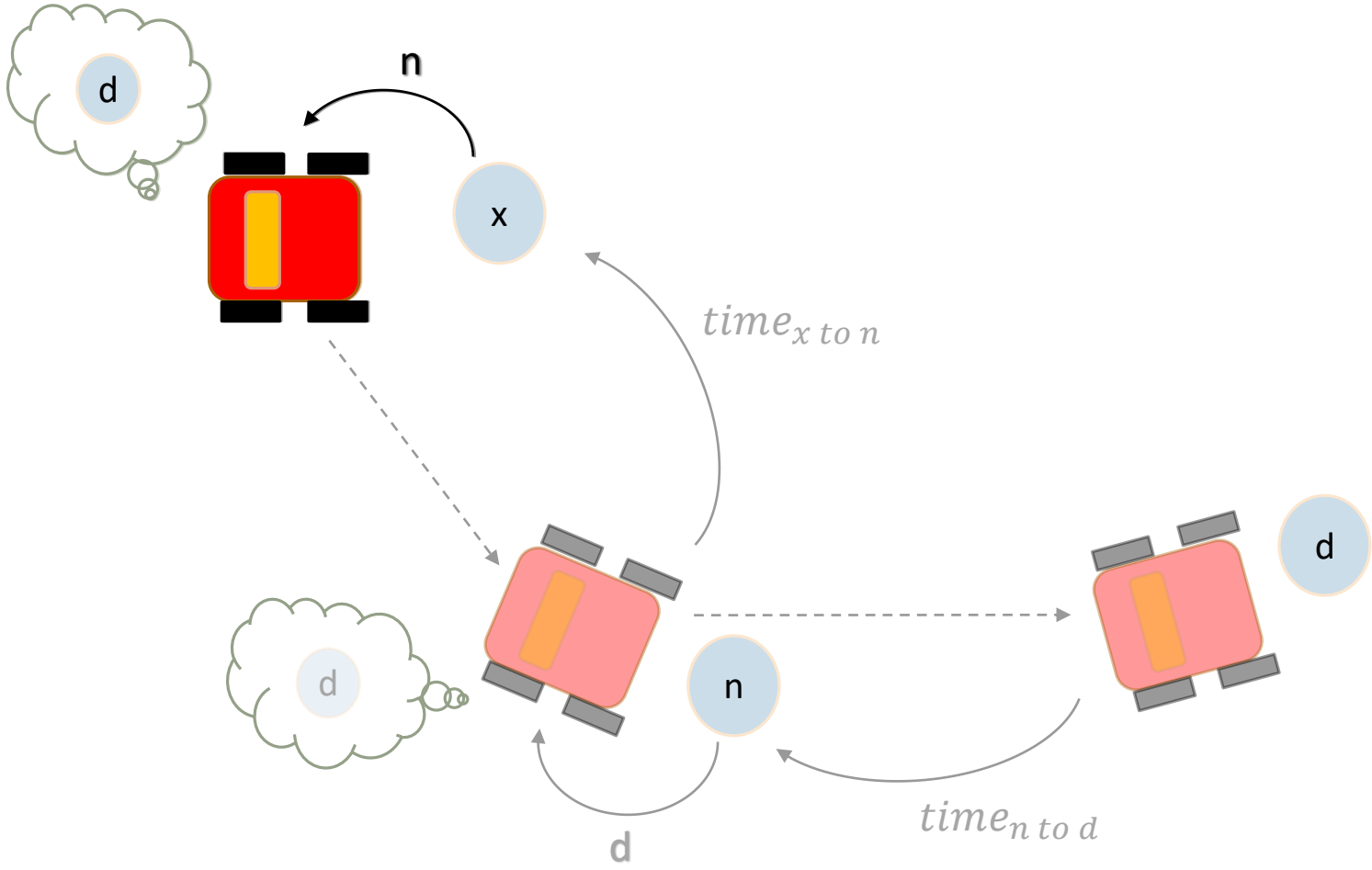
Swarm of Interacting Reinforcement Learners (SWIRLs)



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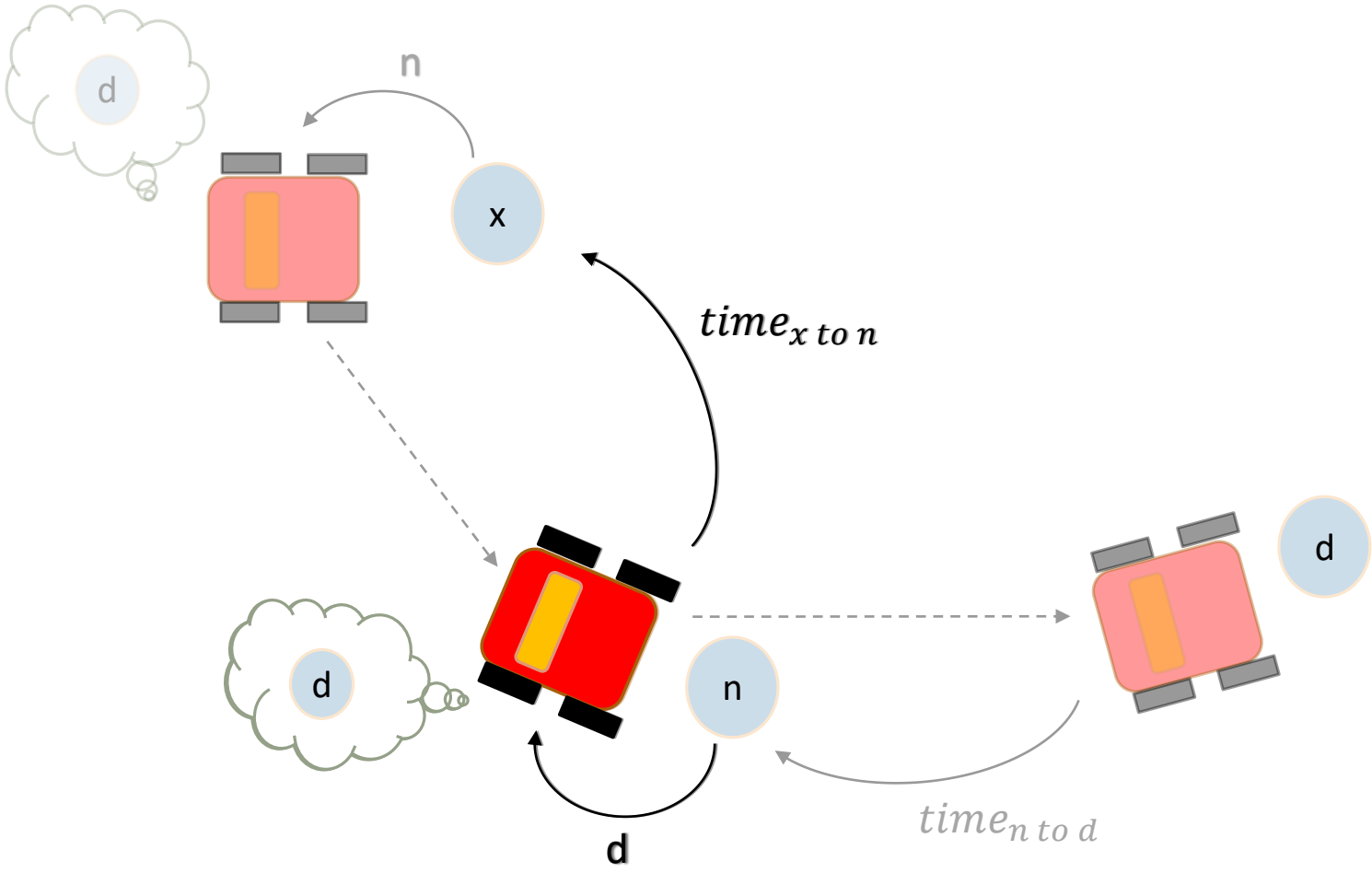

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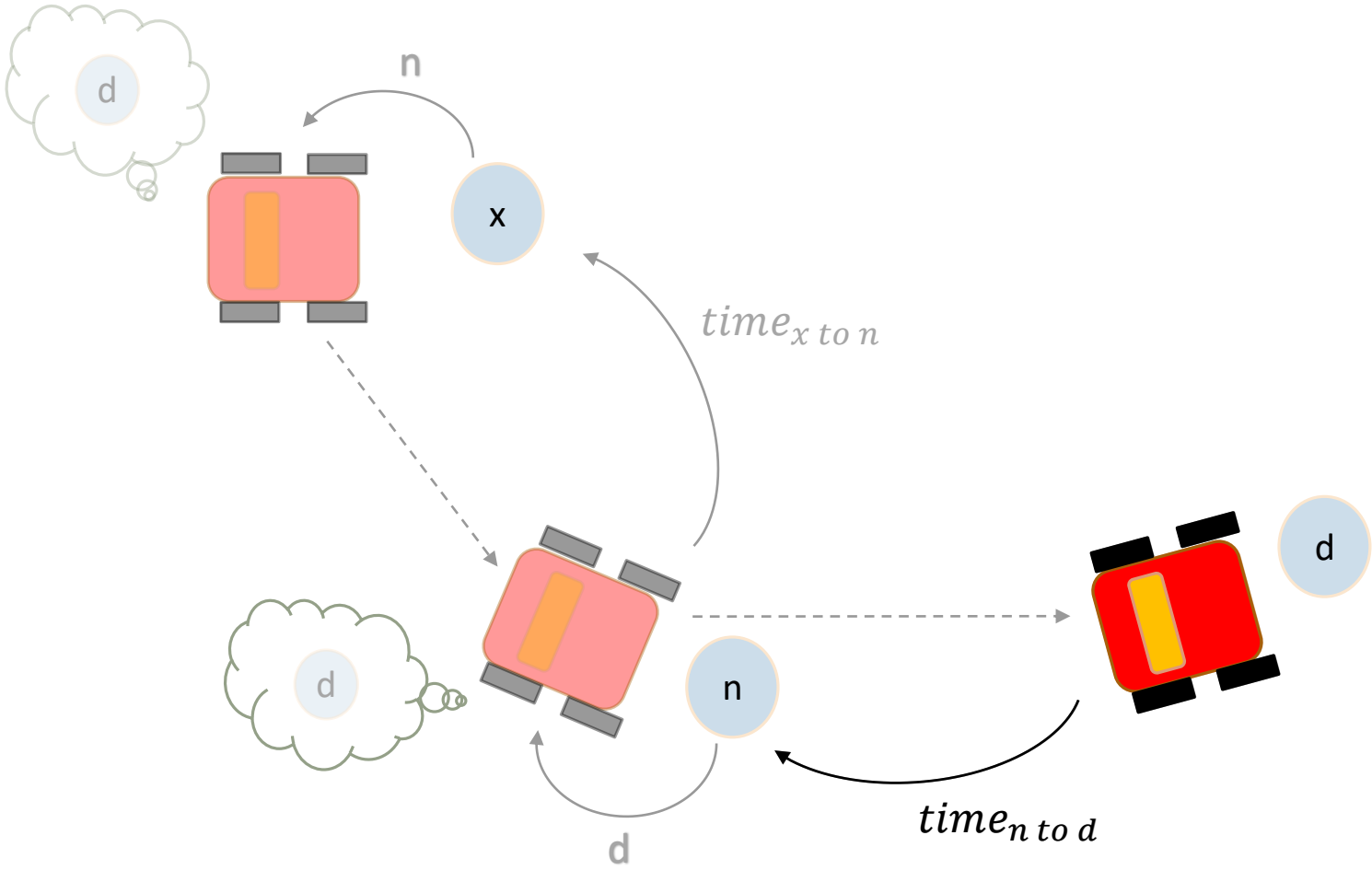
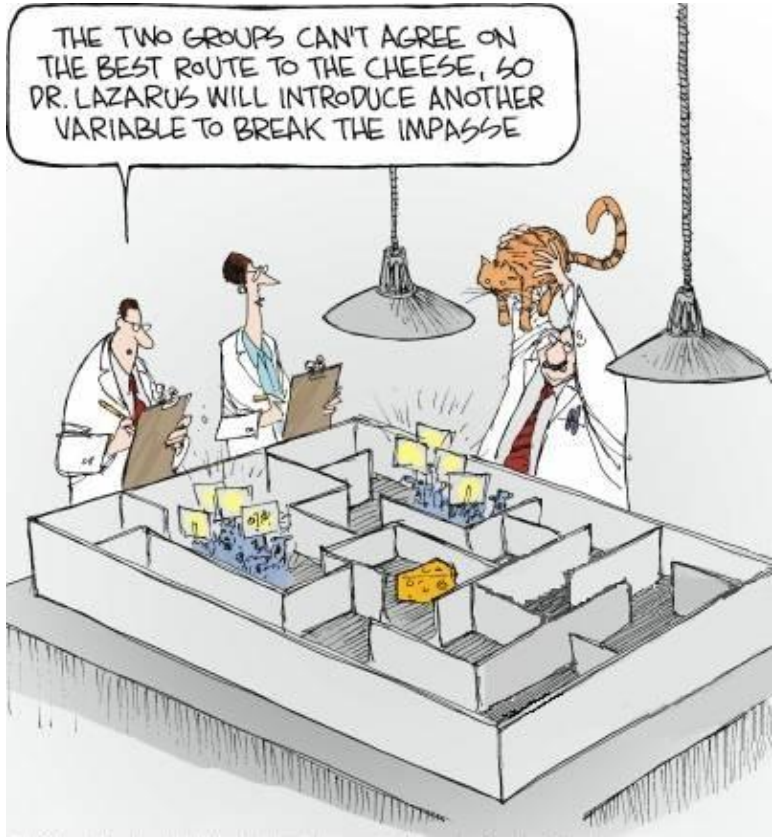


SWIRLs Implementations

- Sequential (SQ)
  - A **single thread** handles all processing
- Semi-Multi-Threaded (SMT)
  - Only **robots** run on **individual threads**
- Multi-Threaded (MT)
  - **Sensors** and **robots** run on **individual threads**

Experimental Variables

- No. of robots
- No. of sensors
- Estimate time
- Learning (on/off)
- Learning coefficient
- Minimum distance to arrive
- Robots max speed



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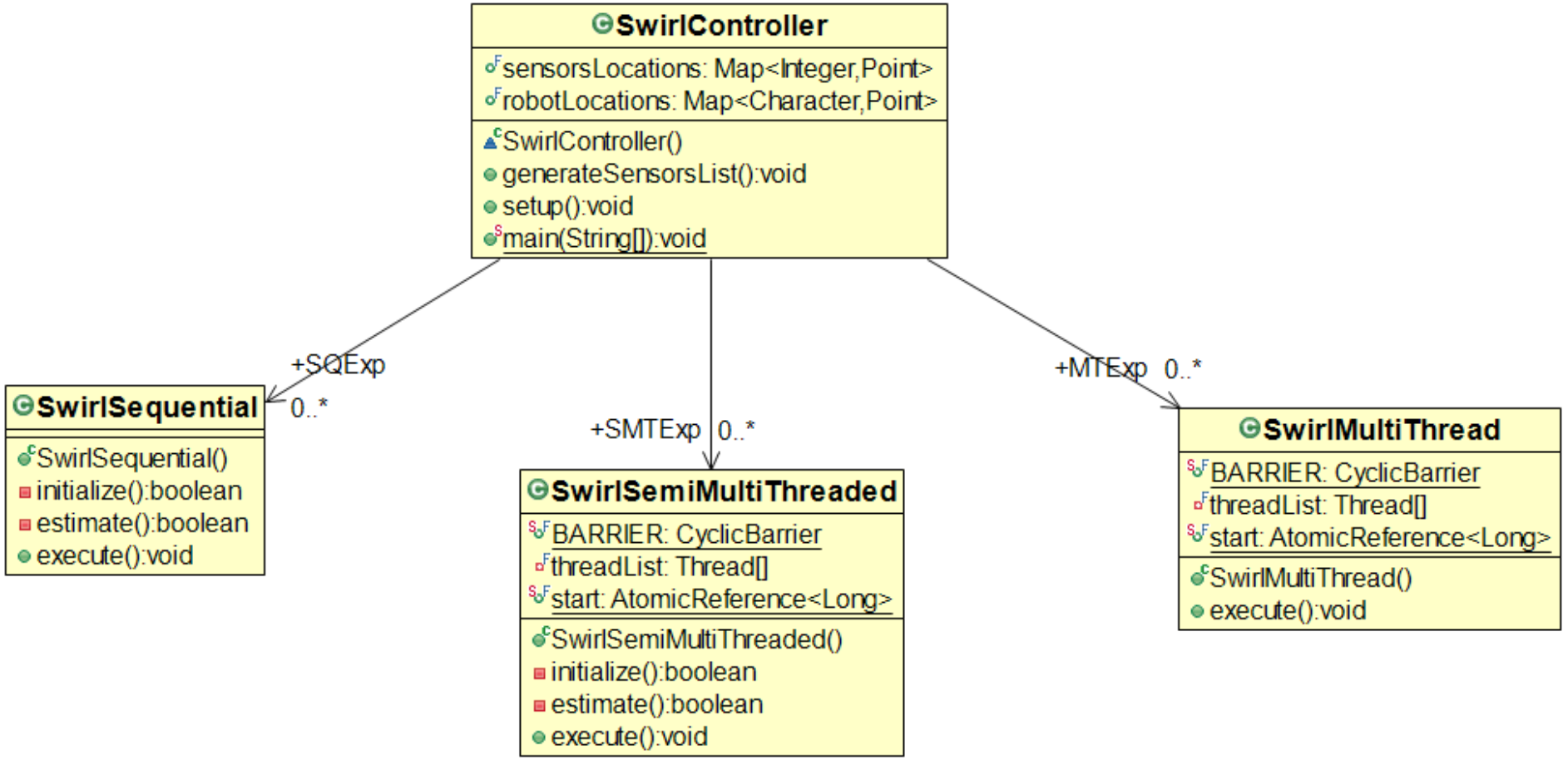
Software Setup



Hardware Setup

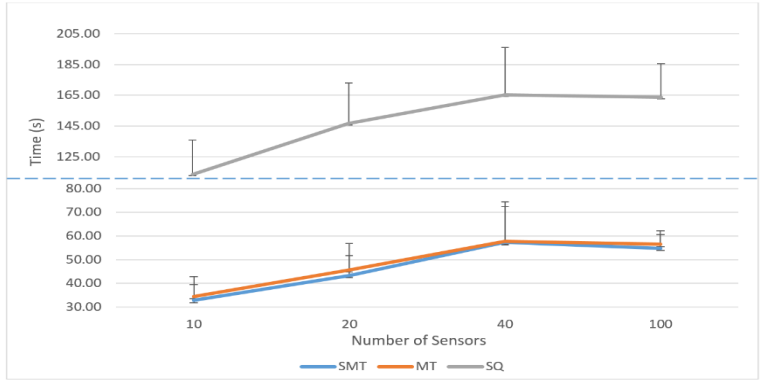
	MTL	IPX
Processor	Intel Xeon Processor E7-4860s	Intel Xeon Processor X5650
No. of Cores	40	24
No. Threads	40	24
Frequency	2.26 GHz	2.67 GHz
Memory	64 GB	24GB
OS	Red Hat Enterprise Linux Server release 5.11 (Carthage)	Ubuntu 14.04
JRE	1.7.0	1.7.0

Measuring Performance

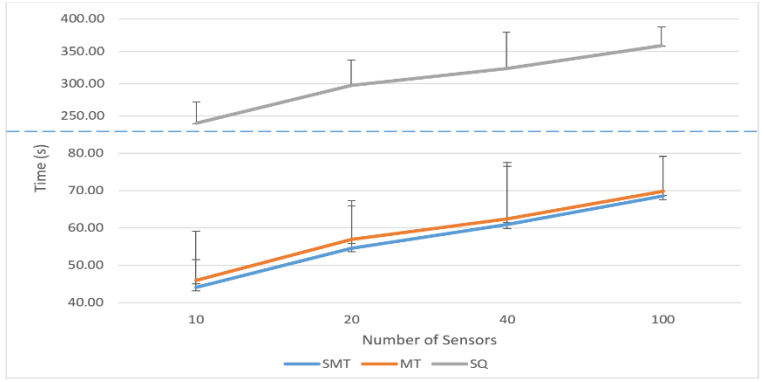
- **Response time** of each method
  - The total time of completion of a task
- Experiments 1-3 were run on MTL
- Experiments 4-5 were run on IPX

Experiment 1: Best Response time

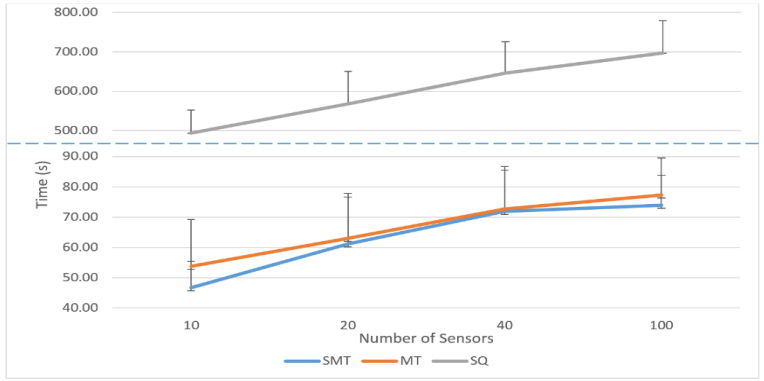
5 Robots



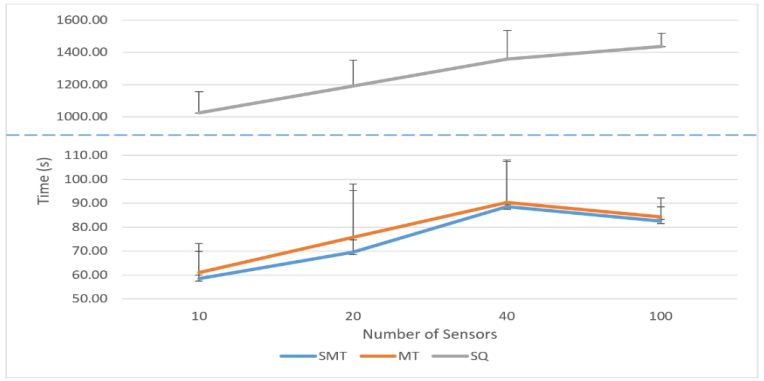
10 Robots



20 Robots

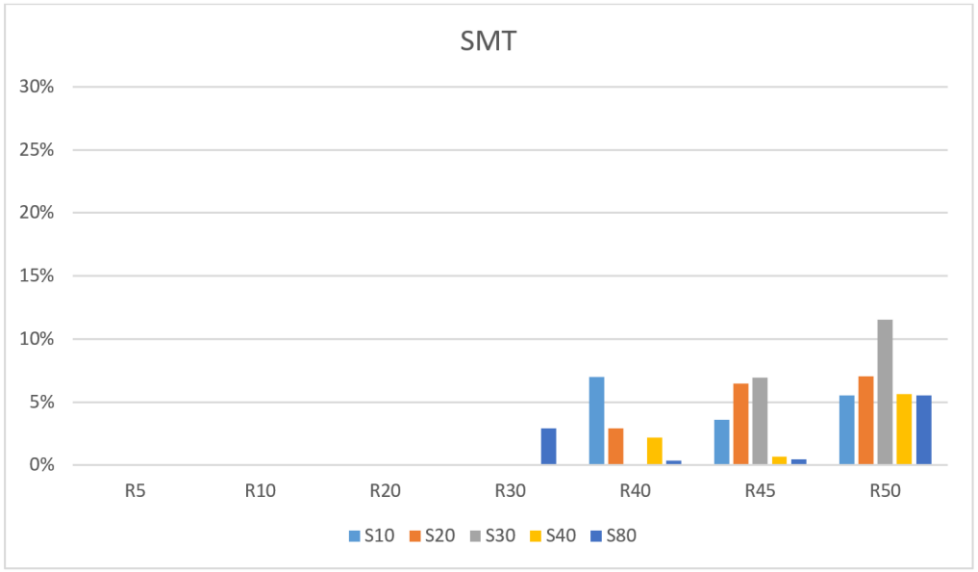


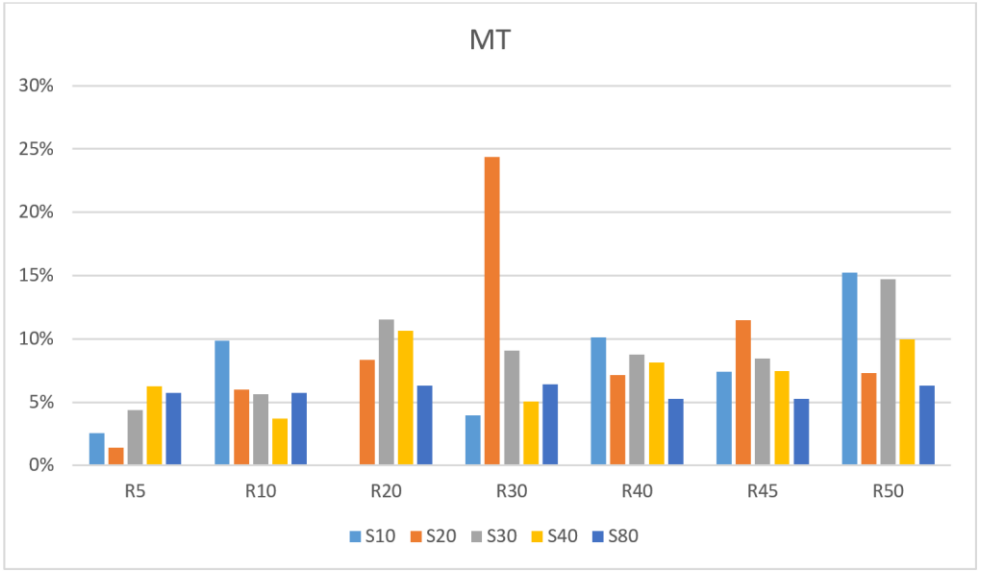
40 Robots



Average of 15 runs with random configuration for each setup

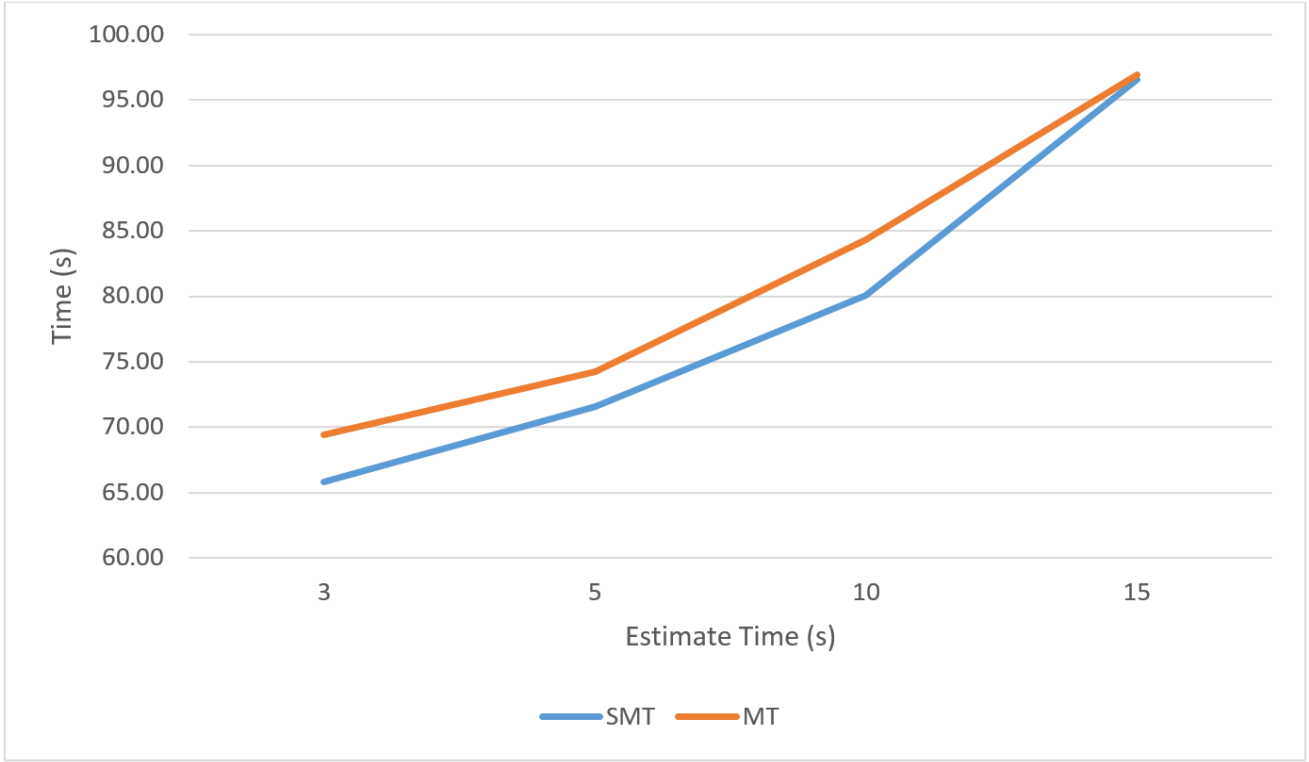
Experiment 2: Effect of Contention





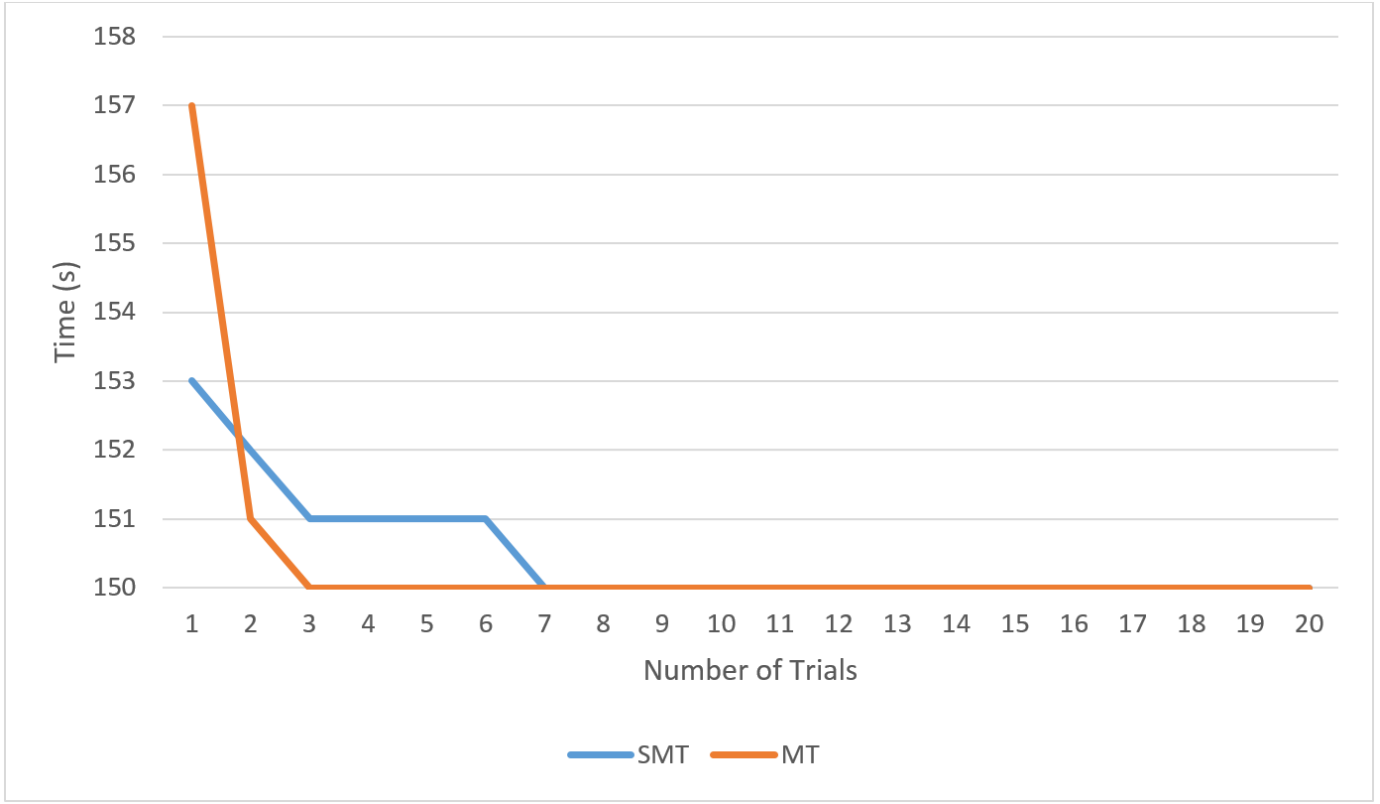
Standard Deviations of 20 runs with fixed configuration for each setup

Experiment 3: Effect of Estimate Time



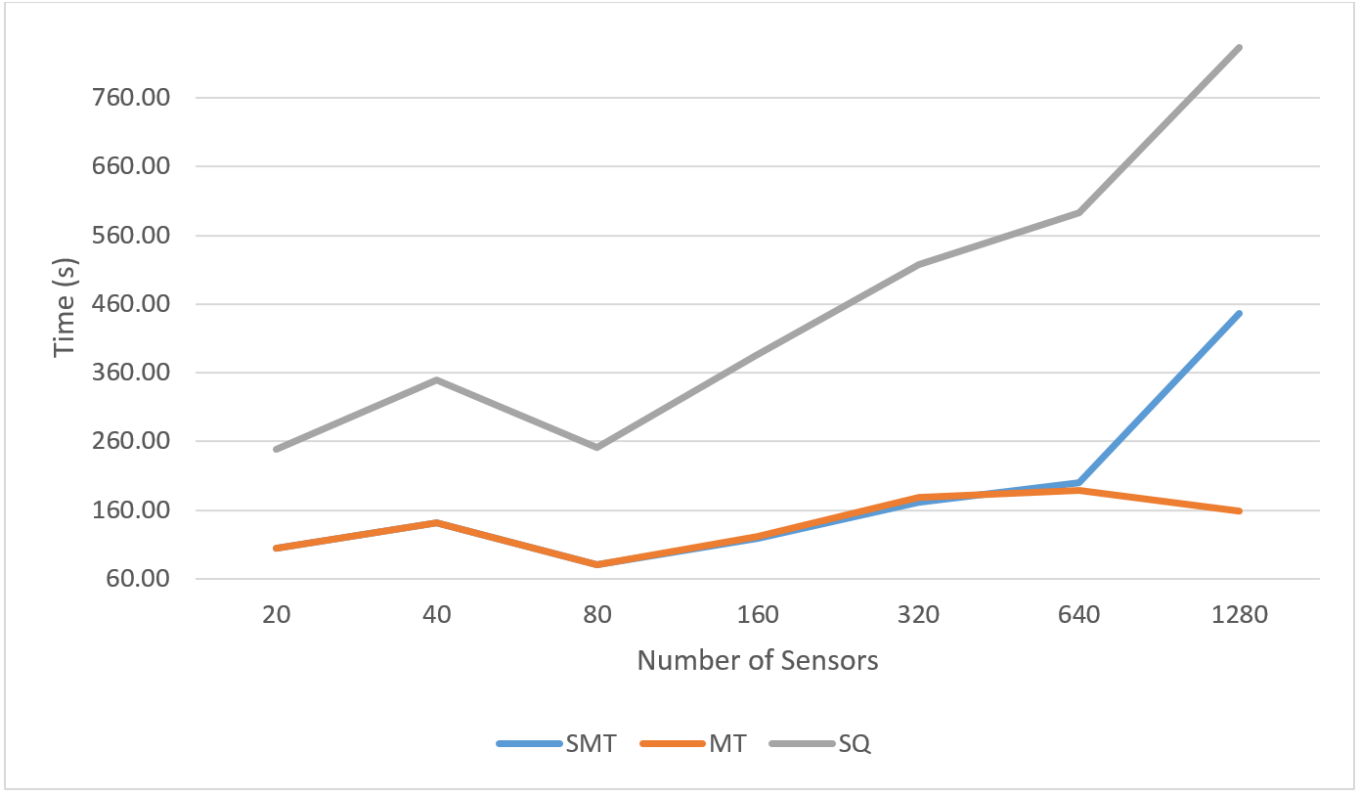
Average Response time of 20 runs with random configuration using 10 Robots and 100 Sensors

Experiment 4: Effect of Learning



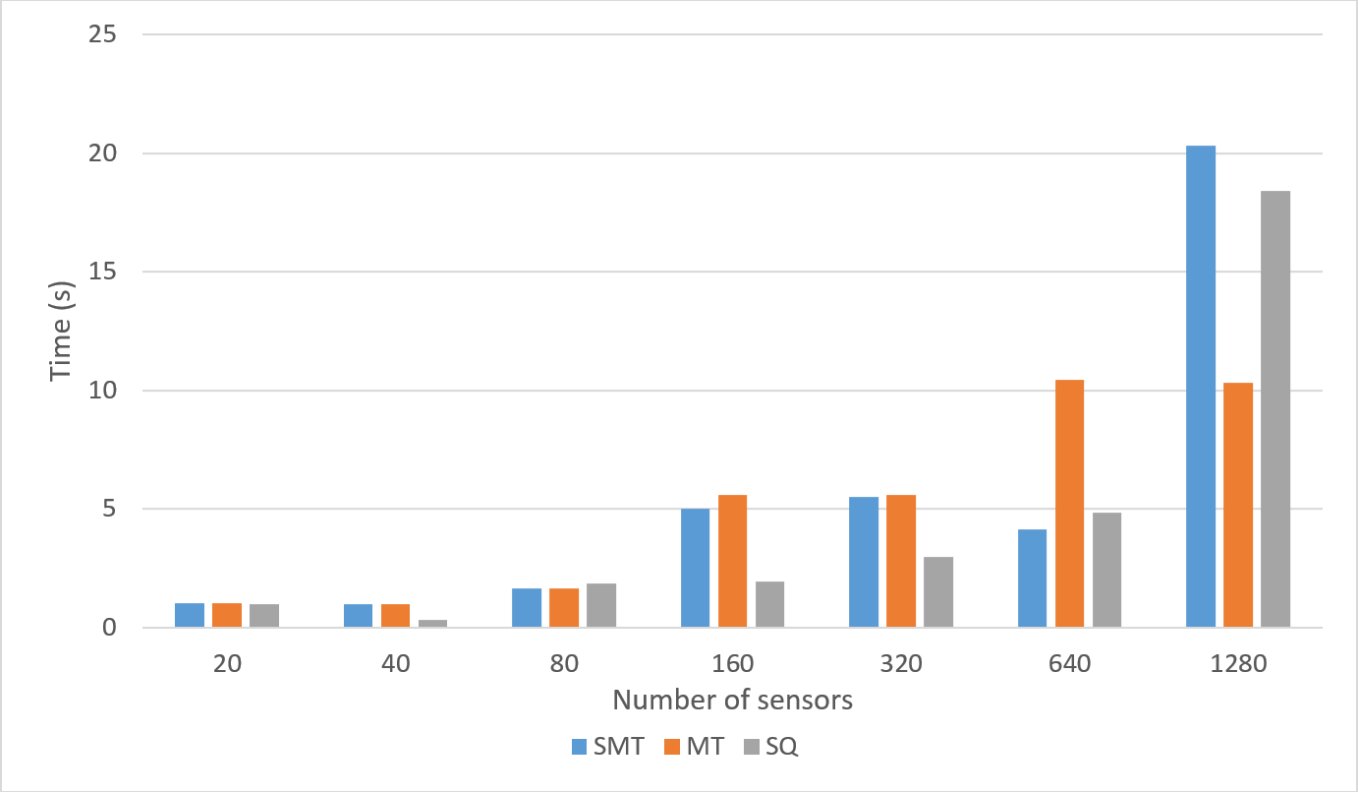
Average response time using Robots: [10,20,30,40] and Sensors: [10,50, 100,400]

Experiment 5: Effect of Network Size



Average response time of runs with random configurations using 4 Robots

Experiment 5: Effect of Network Size



Standard deviation of runs with random configurations using 4 Robots

Conclusion and Future Work

- Over 3000 experiments conducted
- SQ has the worst performance
- MT has the best learning rate
- In small networks SMT performs the best
- Test the effects of all parameters
- Examine different concurrent structures, such as data type

Environment and system configuration

- **Environment size:**
  - 1000 x 1000 pixels on MTL
  - 5000 x 5000 pixels on IPX
- **Sensor comm. Range:** 150 pixels
- **Max Speed:** 60 pixels/s
- **Learning Coefficient:** 0.7
- **Delta distance:** 10 pixels
- Experiments 1-3 ran on MTL
- Experiments 4-5 ran on IPX