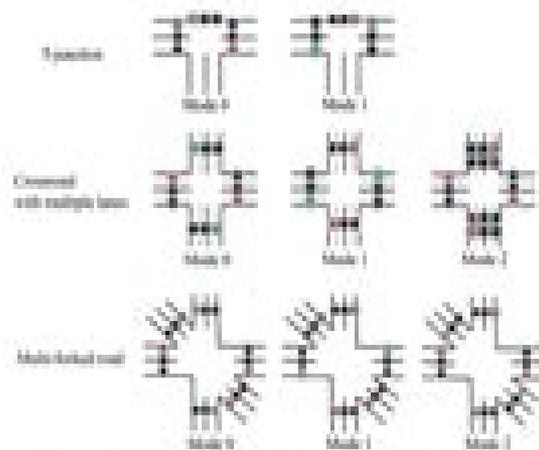


# Traffic Signal Optimization using Quantum Annealing

## Intersection State Definitions

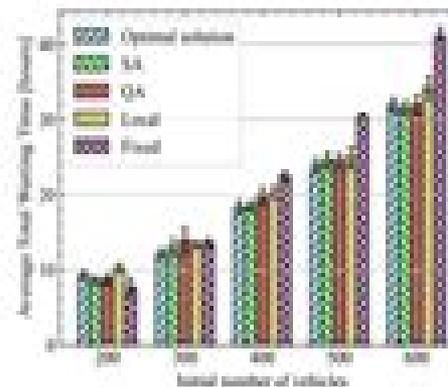


## QUBO Formulation

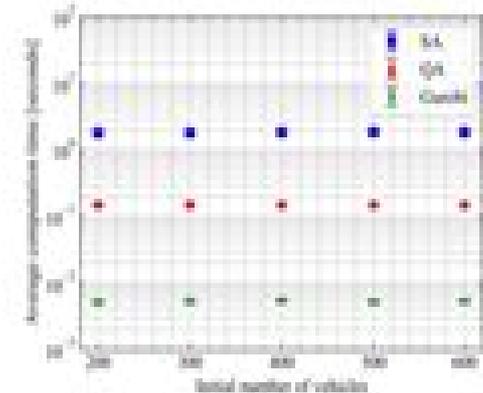
$$\min_{\vec{x}} H(\vec{x}) = - \sum_{lm} C_{lm} x_{lm} - \beta \sum_{(lm, jn)} B_{ij} R_{lm, jn} x_{lm} x_{jn} - \gamma \sum_l \left( \sum_m x_{lm} - 1 \right)^2$$

## Results

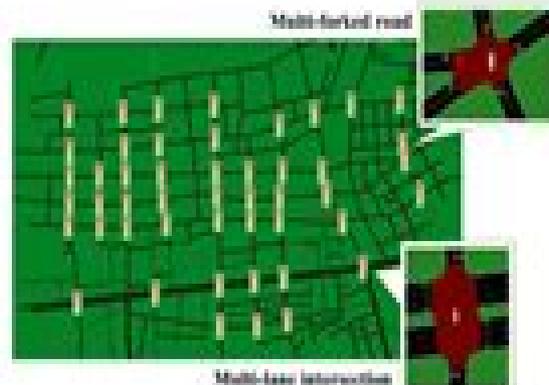
### Total Waiting Time



### Computation Time



## Real-World Map Used in Simulation



- **Efficient Traffic Signal Optimization:**

The QUBO model reduces vehicle waiting times at complex intersections, achieving a reduction of up to 28.9% in high-traffic scenarios.

- **Quantum vs. Classical Solver Performance:**

Owing to hardware limitations, D-Wave quantum annealer is currently less accurate and slower than classical solvers such as Gurobi.

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**Ulrike Henny-Krahmer**



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## **Table of Contents Topics In Optimization**

1. Understanding the eBook Topics In Optimization
  - The Rise of Digital Reading Topics In Optimization
  - Advantages of eBooks Over Traditional Books
2. Identifying Topics In Optimization
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Topics In Optimization
  - User-Friendly Interface
4. Exploring eBook Recommendations from Topics In Optimization
  - Personalized Recommendations
  - Topics In Optimization User Reviews and Ratings
  - Topics In Optimization and Bestseller Lists
5. Accessing Topics In Optimization Free and Paid eBooks
  - Topics In Optimization Public Domain eBooks
  - Topics In Optimization eBook Subscription Services
  - Topics In Optimization Budget-Friendly Options

6. Navigating Topics In Optimization eBook Formats
  - ePub, PDF, MOBI, and More
  - Topics In Optimization Compatibility with Devices
  - Topics In Optimization Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Topics In Optimization
  - Highlighting and Note-Taking Topics In Optimization
  - Interactive Elements Topics In Optimization
8. Staying Engaged with Topics In Optimization
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Topics In Optimization
9. Balancing eBooks and Physical Books Topics In Optimization
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Topics In Optimization
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Topics In Optimization
  - Setting Reading Goals Topics In Optimization
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Topics In Optimization
  - Fact-Checking eBook Content of Topics In Optimization
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

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