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Company introduction and journey so far

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Traffic Prediction
Cloud-based GPU accelerated deep learning

Signal Optimization
City scale multi-agent reinforcement learning
Our Vision of Smarter Transport
Vivacity Introduction

DETECTION
Road users are Detected and Classified

SENSOR
Our Sensor captures video for local processing

TRACKING
Within the field of view of the camera, we can track road users to produce paths

ANONYMOUS DATA OUT
The system can produce classified counts, path analysis, speed profile assessment and road space heat maps

ANALYTICS
We use Machine Learning on the data feeds to predict future traffic volumes

INSIGHT
The data and analytics can be used to improve everything from transport planning to enabling a proactive approach to incident management

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Advanced GPU accelerated traffic sensors

- Nvidia Jetson powered sensors
- All video processed by Vivacity’s GPU accelerated video analysis software on device
- Real time data on the classification, location and path of all vehicles and objects on the road
- Anonymised data – GDPR compliant
- Multi-interface communications, supporting Ethernet, 3G/4G, WiFi, Bluetooth, V2X (802.11p)
Detection and Tracking

Vivacity’s on-device real-time, multi-class, multi-object tracking technology enables us to gather an extremely rich dataset.
Benchmarked at 93 - 97% accuracy compared to human counting

Dense Urban Environment
Light Glare
Turning movements at intersections
Highways – fast and slow moving
Works day and night

Works day and night
Data Output

- Classified Count
- Speed
- Path
- Queue Count
- Headway
- Journey Times

API

Cloud Data Access Portal

Enables integration with 3rd party data platforms
Deployments

Over 1000 units deployed in the UK with public and private sector clients, and a growing reach of international projects
City-scale Sensing Network
Milton Keynes UK
Over 2 billion data points to date
Value for Practitioners
Transport planning:
Better demand data

• Before: manual, or temporary ATC
• Demand varies significantly
• 10% chance of misrepresenting typical demand by ~30%
• Now: full picture of frequency curves and geographic distribution
Anomaly Detection

• Probability envelope
• 68%, 95%, 97.5%
• Alert if consistently outside
• In alert state, show propagation
- Drivers only switch when green route congested
- SatNav data is too slow
- Predict this event, raise alert
- Use VMS to redirect drivers much earlier

-> Reduce congestion on green road
Traffic Prediction
Prediction overview
Compared Model Types

- Deep neural networks: 4
- Ensemble decision trees: 4
- Other ML: 2
- Statistical approach: 1
- Linear models: 6
- Probabilistic models: 2
- Baseline models: 2
Draw Conclusions

- Best model accuracy on unseen data
- Comparison across metrics and horizons
- Sensitivity to hyperparameter tuning
  - Training and predicting speed
Accuracy Comparison

- Overview

![Accuracy Comparison Chart]

- Lasso
- GaussianProcess
- ElasticNet
- AdaBoost
- PassiveAggressive
- naiveStep
- Tree
- HistoricAverage
- VAR
- Linear
- Ridge
- BayesRidge
- KNN
- SVR
- RandomForest
- GradBoost
- GRU
- SimpleRNN
- LSTM
- SimpleDNN

Average MAE across all horizons

- Other ML
- Probabilistic
- Stats
- Deep learning
- Baseline
- Linear
Accuracy Comparison

- Across horizons
Model Tuning Comparison
- Accuracy variation (30 minutes ahead)
Model Tuning Comparison

- Deep learning can give the best accuracy
- But also some of the worst
- And it has the most parameters to tune
- Gradient boosting is much more stable
- Best choice depends on use case and constraints
Model Speed Comparison

CPU models

GPU models

training duration (min)
Model Speed Comparison

- Deep learning was fast (GPU)
- XGBoost or LGBM: probably comparable
- And more tuning -> more models -> longer training
Traffic Signals Optimization
Signal Optimisation: Current Tech

• Outdated algorithms assuming limited compute available
• Based on very simple data
• Doesn’t include pedestrians and cyclists well
• Manual calibration
• Inflexible optimisation priorities
Signal Optimisation: Vivacity

• GPU-accelerated signal control
• -> Enabling reinforcement learning
• Automated, ongoing calibration
• Flexible optimisation priorities
• -> Less delay, more balanced system
• Ready to interface with Connected and Autonomous Vehicles
Road Authority Simulation

Road Authority

More junctions

- Gather data
- Calibrate simulation
- Train ML control system
- Deploy
- Demonstrate & configure
- Connect to signals

GPU-OTU

GPU-OTU

Vivacity
Transport for Greater Manchester
Gap-based stage extension  Reinforcement learning
Comparison to Gap-Based Optimisation

- Average waiting time
- Average journey time
- Total lost time
Integrated urban mobility optimisation

Real-time data sharing with CAVs

GPU enabled AI traffic signal control

Analytics and Insights
Get in touch

Yang Lu: yang@vivacitylabs.com
Shaun Howell: shaun@vivacitylabs.com

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