

Employing Deep Learning for Real-Time Sewage Level Prediction within Smart Cities

Jin Xing Philip James Stuart Barr School of Engineering Newcastle University

Newcastle upon Tyne as a Smart City





mewcast

COMMUNITY, NEWCASTLE, NEWS

Newcastle named as one of the top smart cities in the UK

Written by Valentino Komusar on 11th December 2017

More in Community:



calls for metro link to



Photo by Steve Drew/PA Archive/PA Images.

Newcastle is the second fastest growing region for digital and technology employme been ranked as one of the top smart cities in the UK.

Commissioned by Huawei UK and conducted by Navigant Consulting, the report is bas evaluations of 20 cities and their strategies, key projects and overall readiness in using



Washington 15th March 2019



Sunderland Restaurant Week returns for sixth time in March 2019

Urban Observatory



http://newcastle.urbanobservatory.ac.uk/



Traffic Observation





Air Quality Monitoring





Real-Time Sewage Level Gauge



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Real-Time Data Streaming



```
> sock = new WebSocket('wss://api.newcastle.urbanobservatory.ac.uk/stream');
  sock.addEventListener('message', (m) => console.log(JSON.parse(m.data).data));
<- undefined</p>
  $ {serverTime: 1539081500016}
  v {brokerage: {...}, entity: {...}, feed: {...}, timeseries: {...}} 1
    v brokerage:
      vbroker:
         id: "UTMC Open Car Park Feeds"
        ▶ meta: {}
        proto : Object
       id: "CP_GH_MILLRD"
      ▶ meta: {}
      ▶ __proto__: Object
    ventity:
      > meta: {name: "Mill Road", address: "Mill Road"}
       name: "Car park at Mill Road"
      proto : Object
    ▼ feed:
      > meta: {totalSpaces: 283}
       metric: "Occupied spaces"
      proto : Object
    ▼timeseries:
       unit: "Spaces"
      ▼value:
         data: 106
         time: "2018-10-09T10:43:00.000Z"
         timeAccuracy: 20.004
         type: "Integer"
       ▶ __proto__: Object
      proto : Object
    proto : Object
```

- Sampling Interval: 5min
- Format: JSON
- Size: ~5MB
- We need to extract sewage level data
- Periodic model training/retraining (24 hours)

Recurrent Neural Network



- Proposed for Natural Language Processing (Mikolov et al., 2010)
- Hidden "memory" (*h_i*) to capture previous information (Lecun et al., 2015)
- Very successful in Time Series Analysis (Graves, 2013)



Long-Short Term Memory (LSTM)



- Using a memory cell (C), an input gate (I), an output gate (O) and a forget gate (F).
- LSTM could handle exploding and vanishing gradient problems that can be encountered when training traditional RNN (Gers et al., 1999)



Experiment Implementation



- Four layers of LSTM (Xingjian et al., 2015)
- Training start from October 2018-January 2019
- Testing with real-time data collected in February and March 2019
- Tensorflow + Keras + Kafka + Apache Storm (Xing and Sieber, 2016)



The Initial Result





Integrating Traffic and Weather Data





Encoder + LSTM



- Convolutional Neural Network for High-Order Feature Extraction (Cui et al., 2016)
- Spatial Pyramid Pooling (+) (He et al., 2015)
- Reuse previous LSTM network



The Improvement





Conclusion



- Smart City = IoT + Deep Learning?
- Real-time and Burstiness
- It is still very hard to predict extreme situations
- Integrating various datasets may help, if we have a good understanding of them
- Hyper-Parameter Tuning with geospatial knowledge (Greff et al., 2017)
- More challenging when integrated with imagery data analysis (Zhu et al., 2017)

Conclusion



- Smart City = IoT + Deep Learning?
- Real-time and Burstiness
- It is still very hard t
- Integrating various good understanding
- Hyper-Parameter Tı (Greff et al., 2017)
- More challenging w analysis (Zhu et al., 2



Call for Papers: Urban Deep Learning



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Guest Editor

Dr. Jin Xing

School of Engineering, Newcastle University, Newcastle Upon Tyne, NE1 7RU, UK Website | E-Mail

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Dr. Wen Xiao

School of Engineering, Newcastle University, Newcastle Upon Tyne, NE1 7RU, UK Website | E-Mail

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State Key Lab. LIESMARS, Wuhan University, Wuhan 430072, China

Website | E-Mail

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Guest Editor

Prof. Liangpei Zhang State Key Lab. LIESMARS, Wuhan University, Wuhan 430072, China

Website | E-Mail

Interests: pattern analysis and machine learning; image processing engineering; application of remote sensing; computational Intelligence and its application in remote sensing image processing; application of remote sensing









Topics in Urban Deep Learning



- New deep neural network models for urban scene classification;
- 3D deep learning for urban scene understanding;
- New recurrent neural network algorithms for urban change detection;
- Advanced training and testing of deep learning methods;
- Real-time urban sensing data analytics using deep learning algorithms;
- Generative adversarial network for remote sensing data fusion;
- Innovative reinforcement learning algorithms for transportation management.

GISRUK 2019 @ Newcastle



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Thank you!



jin.xing@newcastle.ac.uk

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urban observatory







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