Automated Machine Learning
For Autonomic Computing

ICAC 2012

Numenta
Subutai Ahmad
Autonomic Machine Learning

ICAC 2012

Numenta
Subutai Ahmad
Percentage of Machine Learning Papers in ICAC

- 2009: 15%
- 2010: 25%
- 2011: 35%
Numenta

Small company, located in Redwood City, CA

About 22 people
Numenta

Created in 2005

Jeff Hawkins, founder of Palm Computing and Handspring

Author of *On Intelligence*
Early Years

2005 – 2010

Focused on developing a new theory of machine intelligence and machine learning

Inspired by biology and specifically neuroscience
2012

Grok (BETA)
A product designed for automated streaming analytics

Data → Grok → Predictions

Dynamically Generated Models
Talk Outline

What are the challenges of traditional machine learning?
What are the properties of autonomic machine learning?
Numenta’s algorithm and Grok product architecture
The future – where should we go?
Machine Learning Challenges

Extremely manual
Support Vector Machines

or

Back propagation
Machine Learning Is Labor Intensive

Select the right algorithm

Experiment with parameters

Construct good input features

Robust testing and cross-validation
Application: Smart Meters
Application: Smart Meters
Machine Learning Challenges

Extremely manual  Automated
Machine Learning Challenges

Extremely manual → Automated

Static models
Application: Smart Meters
Application: Smart Meters
Machine Learning Challenges

- Extremely manual → Automated
- Static models → Continuous learning
Machine Learning Challenges

- Extremely manual → Automated
- Static models → Continuous learning
- Non-temporal
Application: Smart Meters
Application: Smart Meters
Machine Learning Challenges

- Extremely manual → Automated
- Static models → Continuous learning
- Non-temporal → Inherently temporal
Machine Learning Challenges

Extremely manual → Automated
Static models → Continuous learning
Non-temporal → Inherently temporal
Batch focused
Machine Learning Challenges

- Extremely manual → Automated
- Static models → Continuous learning
- Non-temporal → Inherently temporal
- Batch focused → Streaming architecture
Properties Of Autonomic Machine Learning

Automated

Continuous learning

Inherently temporal

Streaming architecture
Talk Outline

What are the challenges of traditional machine learning?

What are the properties of autonomic machine learning?

Numenta’s algorithm and Grok product architecture

The future – where should we go?
Grok

A prediction engine for automated streaming analytics
Grok Architecture

A cloud-based architecture running on Amazon AWS

- **WebApp** – Quickstart, Developer Dashboard
- **API Layer** – REST + Java, Python, JS
- **Grok Engine** – Modified Hadoop (streaming)
  - Models
  - Optimization
  - Stream processing

- **Compute Nodes**
- **Rabbit MQ**
- **Hbase**
- **User Metadata**
- **Models**

Customer App

Data

Predictions
How does this structure learn?

Cortical Learning Algorithm
The Cortical Learning Algorithm

1. Learns to encode common static patterns

2. Learns the common sequences of those patterns

3. Makes predictions about future patterns

4. Continuously creates, strengthens and weakens cell connections
Static pattern (time = 1)
Static pattern (time = 2)
Cells form connections to previously active cells.

Predicts its own future activity.
Multiple predictions can occur simultaneously.
High order sequences are enabled with multiple cells per column.
Typical Implementation Size

Columns 2000
Cells per column 30
Segments per cell 128
Connections per segment 40

Storage capacity for patterns and sequences is huge
Automated Streaming Architecture

Grok automatically estimates model parameters. Users stream data and it starts making predictions within minutes.
Grok Learning Demo
Application: Smart Meters
Typical Energy Profile
Grok Model Predictions
Long Range Temporal Predictions

At midnight, Grok makes predictions for next 24 hours.
Sequence Memory

Energy Usage - Actual vs Predicted

- Actual
- Predicted

Date: 13-May to 22-May
Smart Meter: Results

Model creation time about 60 minutes

Overall prediction accuracy within 2.5% to 5% of actuals

Grok able to make hourly, daily, weekly, and monthly predictions
Managing Server Capacity

Grok used to predict server demand

Used to provision instances ahead of time

Results show approximately 15% reduction in AWS cost

Incoming server demand, Actual vs. Predicted
Predictive Maintenance

Grok used to detect anomalies in gear bearing temperature

Can detect anomalies based on temporal characteristics

Can be used to proactively optimize maintenance schedules

Gear bearing temperature & Grok Anomaly Score
Numerous Applications For Grok & Autonomous Machine Learning

- Energy prediction
- Auto provisioning
- Preventive Maintenance
- Ad network optimization
- Credit card fraud detection
- Power management
- Server monitoring
- Malware detection
- Inventory management
Properties Of Autonomic Machine Learning

Automated

Continuous learning

Inherently temporal

Streaming architecture
What’s Next?

Autonomic Machine Learning is inevitable

Machine Learning as a field needs to expand its focus beyond just algorithms, and also address system level issues

Are there lessons from Autonomic Computing that should be applied to machine learning?

Hope: Autonomic Computing community is able to act as a catalyst, working with the Machine Learning community

Oh, and contact me if Grok sounds interesting for your application!
Thank you

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