The Impact of Artificial Intelligence on Storage and IT

A SNIA EMEA Webcast
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SNIA-At-A-Glance

185 industry leading organizations

2,000 active contributing members

50,000 IT end users & storage pros worldwide
Agenda

- What is Intelligence, Artificial Intelligence and Machine Learning?
- The anatomy of an AI / Analytics Solution
- Building the AI Stack
What is intelligence?

- Intelligence is a person’s mental capability to perceive, reason, act, learn quickly, and solve problems (among other things)

- Pursuit to teach computers to develop similar mental capabilities

- KNOWLEDGE
- REASONING
- INTERACTING
- PROBLEM SOLVING
- LEARNING
- PERCEPTION

MANIPULATE, SENSE, AND MOVE OBJECTS
What is Artificial Intelligence?

Definition

The ability of computer systems to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages.

Example

- Turing Test: Inability to distinguish computer responses from human responses.
History of AI

- AI has been around for more than 50 years
- The term AI was introduced in 1956 by John McCarthy, an American computer scientist
- The growth and adoption of Machine Learning and Deep Learning have made AI real

Evolution of Artificial Intelligence
Many Approaches to Analytics & AI

No One size fits all…

**Supervised Learning**
- Regression
- Classification
- Clustering
- Decision Trees
- Data Generation

**Unsupervised Learning**
- Image Processing
- Speech Processing
- Natural Language Processing
- Recommender Systems
- Adversarial Networks

**Semi-Supervised Learning**

**Reinforcement Learning**

**Machine learning**

**Deep learning**

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Why is Everyone Talking about AI Now?

**Actionable data**

Enormous amount of data of all types
Critical for machines to learn

**Algorithms**

Availability of New Algorithms, Neural Network Research and Software

**Compute power**

GPU based computing with super compute power
Relatively low cost
From Descriptive to Prescriptive

Value & Benefits

- What happened (Descriptive)
- Why did it happen (Diagnostic)
- What is happening (Monitoring)
- What will happen (Predictive)
- What should be done (Prescriptive)

Competitive Advantage
DATA PIPELINE OPTIMIZATION

**Capture** Your Data At or Near the Source

**Filter** for Specific Event Information

Take any **immediate actions** necessary

**Aggregate** By Time Interval

**Join** with Other Data Sources

**Analyze** with AI/ML, and Analytics Tools
Unify End-to-End Data Pipeline for AI

**IoT**
Edge processing of data in motion
- Acquired
- Cached and stored locally
- Applied with rules and analytic models
- Queued, routed and orchestrated

**Fast data**
Core processing of data in motion
- Ingested
- Restructured, enriched
- Persisted for real-time usage and offline analytics
- Applied with rules and analytic models

**Big data**
Analysis of data at rest
- Hosted in data lakes
- Transformed and restructured
- Aggregated
- Structured by rules/models
- Prepared for DL

**AI**
Deep learning/machine learning
- Trains and builds analytic models
- Creates test models

Analytic models

Business systems

Primarily
Core Data Center

Primarily
Edge / Distributed
The Anatomy of AI Solutions

Training Model
The Anatomy of AI Solutions

- Business Systems
- Raw Archive Data
- Transform / Clean Data Processing
- Training Data
- Test Data
- Training Model

Primarily Core Data Center

Data Science Workbench / Tooling
The Anatomy of AI Solutions
The Anatomy of AI Solutions

Shared Central Data Lake
SDS or HCI
eye HDFS, CEPH, NFS, Object, etc.

Data Science Workbench / Tooling

Model Distribution
Model Packaging / Optimisation

Caching or Streaming layer SSD
eg. Cache, Redis, Kafka, NiFi etc.

Data Pipeline Config Management

PrimaryM Core Data Center

Trad New/NoSQL Biz Process

Traditional File Archive

Primarily

Local Data Lake
typically
Hyperconverged (HCI) or Converged

Caching or Streaming layer... SSD
eye Cache, Redis, Kafka, NiFi etc.

Streaming Data Sources

Trad New/NoSQL Biz Process

PrimaryM Edge / Distributed

Caching or Clean
Data Processing

Data Transport
Building the AI Stack

**Compute Hardware**

- **CPUs**
  - Traditional source of raw compute
  - Used for both training & inference
  - Hybrids with other technologies

- **GPUs**
  - High speed floating point hardware
  - De facto for AI training

- **ASICs & TPUs**
  - Application Specific Integrated Circuit
  - Reduced precision FP (for training) or integer (for inference) operations

- **FPGAs**
  - Field Programmable Gated Arrays
  - Effective for inference
  - Reprogrammable
Software Frameworks

**Frontend**
- Abstracts the mathematical and algorithm implementation details of Neural Networks
- Provides a high level building blocks API to define neural network models over multiple backends
- A high level language library

**Backend**
- Hides hardware-specific programming APIs from user
- Optimizes and parallelizes the training and inference process to work efficiently on the hardware
- Makes it easier to preprocess and prepare data for training
- Supports multi-GPU, multi-node execution
AI Stack

Modern Compute

GPUs, TPUs, FPGAs
- Optimized hardware to provide tremendous speed-up for training, sometimes inference
- More easily available on cloud for rent
AI Stack

Software

Modern Compute

TensorFlow, PyTorch, Caffe2, MxNet, CNTK, Keras, Gluon

- Library that implements algorithms, provides execution engine and programming APIs
- Used to train and build sophisticated models, and to do predictions based on the trained model for new data
Hardware accelerated platforms, supporting common software frameworks, to run the training and/or inference of deep neural networks

- Typically optimized for a preferred software framework
- Can be hosted on-premises or cloud
- Also offered as fully-managed service (PaaS) by cloud vendors like Amazon SageMaker, Google Cloud ML, Azure ML
AI Stack

API-based service

Platform

Software

Modern Compute

Amazon Rekognition, Lex & Polly; Google Cloud API; Microsoft Cognitive Services;

- Allows query based service access to generalizable state of art AI models for common tasks
  - Ex: send an image and get object tags as result, send mp3 and get converted text as result and so on
- No dataset, no training of model required by user
- Per-call cost model
- Integrated with cloud storage and/or bundled into end-to-end solutions and AI consultancy offerings like IBM Services Watson AI, ML & Cognitive consulting, Amazon's ML Solutions Lab, Google's Advanced Solutions Lab
Dataset Transform – ImageNet Example

- Raw data vs TFRecords
- Raw data is converted into packed binary format for training called TFRecord (One time step)
  - 1.2 M image files are converted into 1024 TFRecords with each TFRecord 100s of MB in size
TensorFlow Data Pipeline

1. **IO**: Read data from persistent storage

2. **Prepare**: Use CPU cores to parse and preprocess data
   - Preprocessing includes Shuffling, data transformations, batching etc.

3. **Train**: Load the transformed data onto the accelerator devices (GPUs, TPUs) and execute the DL model
Compute Pipelining

- Without pipelining

- With Pipelining (using prefetch API)

Image source: https://www.tensorflow.org/guide/
Parallelize IO and Prepare Phase

- **Parallelize IO**

  - **Sequential I/O**
  - **Parallel I/O**

- **Parallelize prepare**

  - **Sequential Map**
  - **Parallel Map**

Image source: https://www.tensorflow.org/guide/
Research Directions in AI

**Academic:**
- Using DL to replace heuristics-based decision within systems software, or even data structures
- Systems and platforms for DL
- Practical engineering optimizations to improve DL process/lifecycle/performance
- Workload and benchmarking
- Other areas like security, privacy, power etc.

**Industry:**
- Google Brain: hardware, AutoML
- FAIR: vision, video, AR
- Apple: speech & vision on-device
New Use Cases & Workloads Are Changing “Storage”

Workloads
- Legacy Operational apps
- Media & Entertainment
- Image Processing
- Analytics & Log Processing
- Container based apps

Capabilities
- Global Namespace
- Multi-temperature store
- Extreme Scale & Reliability
- Guaranteed Performance
- Agile Platform for heterogeneous data types
- Integrated Analytics

Delivered in a cloud-scale architecture with commodity economics across public and private clouds.
Summary

- AI is more than just training models!
- Data is no longer single purpose, but purpose+
- We need to simplify and unify data treatment
- Move to Shared Data Storage Architecture
- Unify Data Life Cycle
- Unify End-to-End Data Pipeline
- Pipelines are the new SAN
Additional Resources

- Presentation: Customer Support through Natural Language Processing and Machine Learning
  https://youtu.be/u1iRvWzMioM

- Presentation: Introducing the AI/ML and Genomics Workloads from the SPEC Storage Subcommittee
  https://youtu.be/47pmqFXYi-4

- White Paper: Is Your Storage Ready for AI?

- Article: Want optimized AI? Rethink your storage infrastructure and data pipeline
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