Artificial Intelligence of Things

Determining the what and how-to for business outcomes
Agenda

AI / IoT Applications
How successful practitioners of AI/IoT are realizing benefits
9:00am – 9:30am

Key Ingredients
Analytics lifecycle, enterprise analytics, and operationalized AI
9:30am – 10:45am

Getting Started
Kickstarting AI/IoT initiatives at your organization
11:00am – 11:30am
Transforming a world of data into a world of intelligence
SAS in a glance

Customers in every industry worldwide count on SAS

Continuous revenue growth since 1976
Record revenue of $3.24 billion up 1.25 percent over 2016.

Revenue percentages by region
- Americas: 49.0%
- Asia Pacific: 36.5%
- Europe, Middle East and Africa: 14.5%

SAS’ Analytics: Innovation changes the world

Revenue Reinvested in R&D: 26%
Cloud Revenue Growth: 15%
Industry Average: 12.5%

58 Countries with SAS offices
83,000 Customer sites worldwide

Analysts rank SAS as a leader in:

Analytics
Machine Learning
Big Data
Data Science Platforms
Real-Time Marketing
Data Integration

Data Quality
Fraud Detection
Risk Management
Streaming Analytics
Retail Analytics

In 2017, analysts ranked SAS a leader or leader equivalent in more than 30 reports.
What is AI?

Practical Aspects of AI Possibilities
Artificial Intelligence (AI) is the science of training computers to perform tasks that typically require human intelligence to complete.
Evolution of Artificial Intelligence

1950s-1970s
Neural Networks

1980s-2010s
Machine Learning

Present Day
Deep Learning and Cognitive Systems

SAS
1976
What makes AI work?

Modern ML and DL Algorithms
• Flexible state-of-the-art performance
• Factorization Machines for sparse data
• Auto-tuning & automation

Scalable for Big Data
• Storage of large tables to fit in memory
• Linear scaling with dataset size
• Parallelizable using multi-threaded in-memory technology

Model Deployment & Production
• Support for real-time decisioning
• Language-agnostic APIs
<table>
<thead>
<tr>
<th>Core Capabilities</th>
<th>Machine Learning</th>
<th>Natural Language</th>
<th>Computer Vision</th>
<th>Forecasting and Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Visualization</td>
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<tr>
<td>Decision Support</td>
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AI/IoT Applications

How successful practitioners are realizing benefits
Performance Assessment

Extract real-time insights during games

Object Detection
Supply Chain Stability

Improve response to changes in the market

Natural Language Understanding
Manufacturing Optimization

Identify defects during production

Pattern Recognition
Improve Patient Care

Assemble end-to-end solution for image-based problems

Image Processing
Wildlife Conservation

Provide non-invasive monitoring of endangered species

Image Recognition
Energy Forecasting

Use short and long-term variability to improve accuracy

Deep Learning
Data Management
Visualization
Decision Support
Deployment
Key Ingredients

Analytics Lifecycle | Enterprise Analytics | Operationalized AI
How to Frame an Analytics Project

**Problem / Opportunity**
- Profitable Growth
- Data Security
- Innovation
- Customer Experience
- Productivity
- Attracting/Retaining Customers
- Impact of Fraud
- Reputation Management

**Business Value**
- Automation
- Collaboration
- Artificial Intelligence
- Prescriptive Modeling
- Analytics Culture
- Forecasting
- Text Analysis
- Machine Learning
- APIs
- Exploration
- Data Mining
- Visualization
- Self-Service
- Advanced Analytics
- Predictive Modeling
- Statistics
- Data Management

**Benefit / Outcome**
- Increased Shareholders’ Equity
- Risk Reduction
- Competitive Advantage
- Increased Loyalty
- Cost Reduction
- Market Share
- Risk Management
- Brand Equity

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How to Frame an Analytics Project

Analytics Lifecycle

**Data**
the foundation of everything we do

**Deployment**
where we get the value out of analytics

**Discovery**
the act of finding something we had not known before
SAS empowers you to integrate analytical results and insights back into your organization with speed and at scale, from the simple to the most complex operating environments.

Enrich your data with the widest set of analytical capabilities - from statistics to machine learning to cognitive, from SAS to open source languages for analytics - with end-to-end support for the entire analytics life cycle.

Unlike other data management vendors, SAS delivers cleansed, governed, real-time data from all your sources that enables your analytics across the organization.

Enable with DATA

Enrich through DISCOVERY

Empower with DEPLOYMENT

Problem / Opportunity

Analytics Life Cycle

Benefit / Outcome

SAS DIFFERENTIATION

Profitable Growth
Data Security
Innovation
Customer Experience
Productivity
Attracting/Retaining Customers
Impact of Fraud
Reputation Management

Increased Shareholders' Equity
Risk Reduction
Competitive Advantage
Agile Strategy
Cost Reduction
Market Share
Risk Management
Brand Equity

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53% of data and analytics decision-makers say it takes too long to prepare data for analytics.¹

Unlike other data management vendors, SAS delivers cleansed, governed, real-time data from all your sources that enables your analytics across the organization.

Enrich your data with the widest set of analytical capabilities - from statistics to machine learning to cognitive, from SAS to open source languages for analytics - with end-to-end support for the entire analytics life cycle.

71% of enterprises don’t think their firms are effective at connecting analytics results to business outcomes.²

SAS empowers you to integrate analytical results and insights back into your organization with speed and at scale, from the simple to the most complex operating environments.

¹ Forrester: 2016 Insights Platforms Accelerate Digital Transformation
² Forrester, Forrester’s 2016 Predictions: Turn Data Into Insight And Action
THE SAS DIFFERENCE

WE ACCELERATE DATA ANALYSIS

SAS helps prep data specifically for analytics, and uses analytics to detect patterns and rules, to profile the data, to discover missing values.

Enrich through DISCOVERY

Machine Learning
Cognitive
Integration with Open Source
Visualization
Approachable Analytics

AND MAXIMIZE THE VALUE OF YOUR ANALYTICS.

SAS has automated the deployment, and can create real-time feedback loops for continuous optimization.

Empower with DEPLOYMENT

Reports
Models
Decisions at Scale
Automation
In-Memory
In-Database
In-Stream

Enable with DATA

Unstructured
Operational
Web
IoT
Hadoop

Benefit / Outcome

Increased Shareholders' Equity
Risk Reduction
Competitive Advantage
Agile Strategy
Cost Reduction
Market Share
Risk Management
Brand Equity

Problem / Opportunity

Profitable Growth
Data Security
Innovation
Customer Experience
Productivity
Attracting/Retaining Customers
Impact of Fraud
Reputation Management

Analytics Life Cycle

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With SAS you can:

- Democratize data across your organization
- Get data prepared quicker
- Ensure higher accuracy
- Accelerate time-to-insight

With SAS you can:

- Integrate all your analytics into your operations more quickly
- Create unmatched transparency
- Create powerful feedback loops.

Enable with DATA

Unstructured
Operational
Web
IoT
Hadoop

Enrich through DISCOVERY

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THE SAS DIFFERENCE

STRATEGIC

Enable with DATA

Enrich through DISCOVERY

Empower with DEPLOYMENT

Problem / Opportunity

Analytics Life Cycle

Benefit / Outcome

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THE SAS DIFFERENCE

STRATEGIC
Streaming Analytics
Edge | Speed | Analytics
Analytics Lifecycle

Traditional Analytics Lifecycle

Access - Store - Analyze
Analytics Lifecycle
Stream – Understand – Act

Data
- ETL
- Data Storage
  - Enrich
  - Store
  - Deploy
  - Model Dev / Execute / Monitor
    - \[ F(x) = \frac{\beta}{\left(\frac{N_{30}}{x}\right)^a + 1} \]
  - Deploy
  - Alerts - Reports - Decisioning

Streaming Data
- Streaming Model Execution
  - Enrich
  - Store
  - Deploy
Why “Edge” Analytics?

Benefits of Edge Analytics in IoT:

- **Latency** - in data transfer reduces “time-to-sight” which slows “time-to-action” for responses
- **Bandwidth** - Using limited bandwidth then prevents other critical uses
- **Cost** - Sending data incurs IT costs, processing data at the edge reduces costs
By 2019, about 40% of IoT-data will be stored, processed, analyzed, and acted upon close to, or at the edge of the network.

IDC 2016 IoT Futurescape
Event Streams are **high throughput, low latency** data flows

SAS Event Stream Processing provides:

- **Millions of events per second** throughput
- **Millisecond-microsecond** response latency
- On standard **commodity hardware**

**Throughput** - how many events per second can be ingested

**Latency** - the time it takes for an event to be processed through the defined workflow
High-End Streaming Analytics @ Edge
Multi-Phase, In-Stream Analytics

Live, in-motion event analysis

**In-Stream Analytics**
Deploy models trained on historical data at rest

**Text Analytics**
Extract entities, tokenize text, classify and identify sentiment

**Model Supervision**
Control runtime model deployment

**Machine Learning**
In-stream model training and scoring

**In-Stream Geofencing**
Real time location analytics

**In-Stream Time Patterns**
Time series detection and analysis

**Event Processing**
Compute, aggregate, filter, correlate events

**Data Quality**
Business rules data quality and policy definitions

**Open Source Integration**
Deploy Python and C models
SAS® Event Stream Processing
Advanced Streaming Analytics

In-Stream Analytic Model Deployment
SAS® DS2, Python, C
SAS® ASTORE Scoring support
SAS® Model Manager Integration

Streaming Algorithms & Machine Learning
Streaming Summary - Univariate Statistics
Streaming Pearson’s Correlation
Streaming Segmented Correlation
Weibull Distribution Fitting
Short Time Fourier Transform
Streaming Text Tokenization
Streaming Text Vectorization
Moving Relative Range
Streaming K-Means
Streaming DBSCAN
Random Forest*
Gradient Boosting Tree *
Factorization Machine*
Support Vector Data Description*
Deep Neural Network*
Convolutional Neural Network*
Bayesian Network*
Recurrent Neural Network
Support Vector Machines*
Streaming Support Vector Machines
Streaming Linear Regression
Streaming Logistic Regression
Streaming Fit Statistics
Streaming Receiver Operating Characteristic (ROC)
Streaming Histogram
Image Processing (Crop, rotate, resize, flip)
Robust Principle Components Analysis*

*Out-of-Stream Training & In-Stream Scoring
Reference Architecture for IoT using SAS®
Making analytics actionable for IoT

- Sensors
- IoT Gateways
  - with SAS ESP Edge
  - MQTT

Network Infrastructure

- Event Stream Manager
  - ESP Model updates
  - ESP Version updates

On-Premise or Off-Premise Data Center or Cloud

- SAS ESP Server
  - SAS Viya™
  - Hadoop

- Develop
  - Deploy
  - Enrich

EDGE

Data Center

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SAS® Event Stream Processing
Ecosystem Integration - 300+ Endpoints

**SYSTEMS & APPLICATIONS**
- Tervela
- Solace Systems®
- Teradata
- Greenplum Database
- Cisco
- Intel
- PI System
- OSIsoft
- boardreader™
- WebSphere MQ
- TIBCO RendezVous
- BACnet International
- Oracle
- GE Digital
- Axeda
- Twitter
- Gnip
- Axeda
- RSLogix 5000
- GE APM
- EJ-AR
- GE PAC

**OPEN SOURCE**
- RabbitMQ
- Apache Camel
- Hadoop
- Protobuf
- Kafka
- MapR
- NiFi
- Python
- Apache Cloud Foundry
- BOSH
- Chef
- Cassandra
- YARN
- Opentext

**STANDARDS**
- FILE/_SOCKET
- XML / JSON
- ODBC
- JMS
- MQTT
- OPC-UA
- HTTP RESTFUL
- WEB SERVICES
- WEBSOCKETS
- SMTP
- NETWORK SNIFFERS
- DB LOG SNIFFERS
- SYSLOG
- UVC

**PUBLISH & SUBSCRIBE API**
- CONNECT TO ANY SYSTEM WITH JAVA, C++, PYTHON
- FULLY DOCUMENTED AND EASY TO USE

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Getting Started

Kickstarting AI/IoT initiatives at your organization
Considerations

Summary

<table>
<thead>
<tr>
<th>DATA</th>
<th>DISCOVERY</th>
<th>DEPLOYMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access</td>
<td>Explore</td>
<td>Govern</td>
</tr>
<tr>
<td>Cleanse</td>
<td>Analyze</td>
<td>Embed</td>
</tr>
<tr>
<td>Prepare</td>
<td>Model</td>
<td>Monitor</td>
</tr>
</tbody>
</table>

AUTOMATE & ORCHESTRATE

Time to Value  
Performance  
Personnel  
Oversight

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SAS is working with customers today to make AI an Opportunity

**SciSports**

“Our ambition is to bring real-time data analytics to billions of soccer fans all over the world. By partnering with SAS, we can make that happen.”

Giels Brouwer  
Founder and CEO  
SciSports

**American Honda Motor Co.**

“Now, with SAS, it takes less than a minute to identify a suspicious claim. And in that time, they are finding a noncompliant claim 76 percent of the time.”

Kendrick Kau  
Assistant Manager  
Advanced Analytics group, Honda
Let us help you get started with AI

“Lack of available skills remains the greatest challenge for CIOs in terms of AI deployment”

Laurence Goasduff, Gartner, Dec, 2017

- PhD-level experts across multiple AI technologies
- Conduct assessments to accelerate your AI innovation opportunities
- Access to SAS and Open tools to best fit your unique environment
- Focused exclusively on your implementations with direct access to SAS R&D
The AI Journey

1. Data
2. People
3. Process
4. Technology

Innovation
Objective
Ethics
Culture

Purpose
Strategy
Leadership
Ownership

Criteria

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Thank you!
Let us know what you think