Smarter IBM i / AIX applications with Accelerated Machine Learning & H2O Driverless AI

PowerVUG Webinar – Oct 16th 2019
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Ludovic Enault
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Montpellier Client Center (France) - EMEA

Our Offerings
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Co-Creation Lab Workshops
Hands-On Technical Enablement
Demonstration/PoT
PoC/Benchmark

PowerAI Vision
IBM PowerAI
Spark
H2O.ai
IBM Watson
NVIDIA
redhat

Analytics, ML/DL
Modernization
Virtualization
Cloud / Hybrid Cloud
Performance Benchmarks
Agenda

→ Introduction : H2O Driverless AI + AIX / IBM i Bundle
→ H2O Driverless AI (DAI) : How it works? Customer case example
→ Demo – Driverless AI + IBM i/AIX – CRM & Customer Churn
→ Q & A
AIX/IBM i – H2O Driverless AI Solution

IBM Power Systems Enterprise Server

ETL customer Data via JDBC Connector

H2O Fast Start Bundle (AC922+H2O DAI)

Feature Engineering & AI Model Training

ML Inference Engine

AI Scoring

IBM DB2

ORACLE DATABASE

AIX

LINUX (inference engine)

AC922

Java MOJO can be deployed in IBM i, AIX and Linux LPAR
Why Inferencing on IBM i/AIX?

*Deployment happens where data is located.* Some data is intended to never leave the highly available and secured mission critical Power Systems. Client want to get started from where they are

**Security:** POWER RAS and Security provided by IBM POWER Systems

**Bring high SLA to AI**

*Low latency:* Able to process very high volume of data for AI inferencing with minimal network delays. Networks designed to support operations that require near real-time access to rapidly changing data.

**Workload increment:** Combine AI and application workload efficiency. Manage both AI inference, existing applications and DB workloads on one Power system.
H2O Driverless AI Complements IBM PowerAI Vision

IBM PowerAI Vision delivers Deep Learning for Images

H2O Driverless AI is Automatic Machine Learning

Facial Insights
Press "Take Photo" to select a photo

Time Series
Example: Flat File

Log

Sensors

NLP
H2O Driverless AI: How it Works

1. Drag and drop data
   Ingest data from cloud, big data and desktop systems
   - HDFS
   - SQL
   - Local
   - Amazon S3
   - Snowflake
   - Google BigQuery
   - Azure Blob Storage

2. Automatic Visualization
   Understand the data shape, outliers, missing values, etc.
   - Automatic Machine Learning

3. Automatic Machine Learning
   Use best practice model recipes and the power of high performance computing to iterate across thousands of possible models including advanced feature engineering and parameter tuning
   - Advanced Feature Engineering
   - Algorithm
   - Model Tuning
   - Survival of the Fittest
   - Powered by GPU Acceleration

4. Automatic Scoring Pipelines
   Deploy ultra-low latency Python or Java Automatic Scoring Pipelines that include feature transformations and models.
   - Machine Learning Interpretability
   - Model Documentation
   - Deploy Low-latency Scoring to Production

Model Recipes:
- i.i.d. data
- Time-series
- More on the way

Advanced Feature Engineering + Algorithm + Model Tuning
Use cases examples: AI in Financial Services

**Wholesale / Commercial Banking**
- Know Your Customers (KYC)
- Anti-Money Laundering (AML)

**Card / Payments Business**
- Transaction Frauds
- Collusion Fraud
- Real-Time Targeting
- Credit Risk Scoring
- In-Context Promotion

**IT Infrastructure**
- Security Cyberlake
- DoS Detection and Protection
- Master Data Management

**Retail Banking**
- Deposit Fraud
- Customer Churn Prediction
- Auto-Loan

Logos:
- CapitalOne
- PayPal
- Experian
- Equifax
- MarketAxess
- Wells Fargo
Example: Financial Fraud Detection

- Driverless AI matched 10 years of expert feature engineering
- Increased accuracy from 0.89 to 0.947 (6%) in detecting fraudulent activity
- 6X speed up when using H2O4GPU with Driverless AI

“Driverless AI is giving amazing results in terms of feature and model performance”

Venkatesh Ramanathan
Senior Data Scientist, PayPal

H2O Driverless AI and IBM POWER9 GPU Systems are bringing together the best of breed AI innovation. To handle the increasingly complex workloads of AI you need an integrated system of software and hardware:

- supports nearly 2.6x more RAIM POWER9 M, 9.5x more I/O bandwidth than comparable systems.
- Nearly 2X the data ingest speed and over 50% faster feature engineering.
- With GPU accelerated machine learning delivering nearly 30X speedup on model building.
- Support for up to 6 V100 GPUs on a single system.
Demonstration

*Accelerated Machine Learning with H2O.ai Driverless AI*

CRM Demo using Driverless AI on AC922 and H2O Inference Engine on IBM i or AIX Power Hardware

Data Procurement

Dataset Preparation

Feature Engineering

Model Training

Predictions, Deployment

Customer Data

Data Quality and Transformation

Feature Engineering

Model Building

Scoring Pipeline

Driverless AI

Features

Target

Deployment executable

H2O Inference engine deployed in Linux LPAR along side AIX or IBM i

From DB2 or Oracle on AIX or DB2 on IBM i via JDBC connector on H2O DAI
**Smarter IBM i apps made easy with Driverless AI**

**CRM & Customer Churn scenario**

Customer Relationship Management – IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

### Customers Dashboard

<table>
<thead>
<tr>
<th>CUSTOMERID</th>
<th>GENDER</th>
<th>STREAMING</th>
<th>CONTRACT</th>
<th>PAPERLESS</th>
<th>PAYMENT</th>
<th>MONTHLY</th>
<th>TOTAL</th>
<th>CHURN</th>
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<tbody>
<tr>
<td>7590-VHVEG</td>
<td>Female</td>
<td>No</td>
<td>Month-to-month</td>
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**Initial CRM**

No Customer Churn risk estimate per customer
Smarter IBM i apps made easy with Driverless AI

CRM & Customer Churn scenario

1. Extract CRM data (or JDBC)
2. Import & Visualize Data
3. Model Export
4. Augment IBM i Applications
5. Monitor Models & Iterate

Optimized for GPU-Accelerated Power9 Servers

Recommendation Engine
Scoring Pipeline

Customer Relationship Management - IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

Customer Dashboard

<table>
<thead>
<tr>
<th>Customer</th>
<th>Gender</th>
<th>Stream</th>
<th>Contract</th>
<th>Payment Type</th>
<th>Payment Amount</th>
<th>Month</th>
<th>TOTALCH</th>
<th>CHURN</th>
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<tbody>
<tr>
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<td>Female</td>
<td>Yes</td>
<td>One year</td>
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Business Database
Business Application
Demonstration

Accelerated Machine Learning with H2O.ai Driverless AI


Included: Video + Presentation
Extract data from Db2

- Customer Churn Demo
  - Customer segmentation: is this customer going to leave now? soon? or not?

- Dataset from Db2 CHURN.CHURNCUST2

- Use ACS for data transfers (CSV <-> Db2)

- Ipython, ML Libraries and/or Jupyter on IBM i for Data Preparation

- Driverless AI has many connectors to datasources.

  ➔ In this scenario: Data exported in CSV format.
Smarter IBM i apps made easy with Driverless AI

CRM & Customer Churn scenario

1. Summary with JDBC Connection
   - Optimized for GPU-Accelerated Power9 Servers

2. Import & Visualize Data
   - Create & Test Models
     - JDBC
     - Direct Db2 Connection

3. Model Export
   - Recommendation Engine
     - Scoring Pipeline
     - Augment IBM i Applications
     - Model Inference

4. Monitor Models & Iterate

Customer Relationship Management - IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

**Customer Dashboard**

<table>
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<td>Yes</td>
<td>Bank transfer</td>
<td>109.70</td>
<td>7904.25</td>
<td></td>
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</table>

Business Database

Business Application
### Data Connectors: JDBC Connection to DB2 for i

<table>
<thead>
<tr>
<th>Name</th>
<th>Path</th>
<th>Size</th>
<th>Rows</th>
<th>Columns</th>
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**Data Connectors - JDBC**
Dataset Import in Driverless AI

Drag and drop data – Churn.csv
Ingest data from Db2 for i
Data Visualization on Driverless AI

Automatic Visualization
Understand the data shape, outliers, missing values, etc.
Create new model

Automatic Machine Learning
Use best practice model recipes and the power of high performance computing to iterate across thousands of possible models including advanced feature engineering and parameter tuning.

Target Column: Churn (YES/NO) for binary classification
Create new model

Automatic Machine Learning

- POWER9 supports nearly 2.6x more RAM, 9.5x more I/O bandwidth than comparable systems.
- Nearly 2X the data ingest speed and over 50% faster feature engineering.
- With GPU accelerated machine learning delivering nearly 30X speedup on model building.
- Support for up to 6 V100 GPUs on a single system

Experiment running – GPU Accelerated AutoML on POWER9
Export Scoring Pipeline

Automatic Scoring Pipelines
Export ultra-low latency Python or Java Automatic Scoring Pipelines that include feature transformations and models.

Here, the Java/Python Scoring Pipeline “scorer.zip” to be deployed on the inference system.

Scoring Pipeline export
Deploy Low-latency Scoring to Production on IBM i

- Invoke low latency scoring pipelines (real time, batch)
- Augment any IBM i apps (ILE, Java, Python,...) with Machine Learning models.

Model Inference with Live CRM data in Production (Db2)

Scoring Result
Customer classified in category Churn = NO, 0.81% Confidence
Java Mojo Scoring Pipeline on IBM i/AIX/Linux

Real time prediction on IBM i! (AIX/Linux) with the java MOJO Scoring Pipeline built by Driverless AI

Real time Customer Churn predictions on IBM i

```
OSG00 BENOIT 3 7 0010002BABV 0s
+ MOJO_FILE=mojo-pipeline.mojo
+ CSV_FILE=example.csv
+ LICENSE_FILE=
+ CMD_LINE='java -mx5g -Dai.h2o.mojos.runtime.license.file=cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo'
+ cat

MOJO file: mojo-pipeline.mojo
Input file: example.csv

Command line: java -Xmx5g -Dai.h2o.mojos.runtime.license.file=cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo pipeline.mojo example.csv
+ java -Xmx5g -Dai.h2o.mojos.runtime.license.file=cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo pipeline.mojo example.csv

Mojo load time: 2.291 sec
Churn, No.Churn, Yes
0.8248089878049829, 0.175192515119713
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Time per row: 4.100 msec (total time: 41.000 msec)
```
Manual Modeling vs. Driverless AI Accelerated Auto ML

- Customer Churn Dataset **WA_Fn-UseC_Telco-Customer-Churn.csv**
  
  Customer churn is when an existing customer, user, player, subscriber or any kind of return client stops doing business or ends the relationship with a company.

- Model Accuracy: 0.79 vs. **0.84**

- Time to market & effort: Days vs. Minutes with DAI AutoML w/ Feature Engineering, etc.
  
  What’s the business impact?

- It is just a quick comparison:
  
  Both modeling can be fine-tuned 😊

- Accelerated ML will be able to play with larger datasets

- Accelerated ML saves CPU cycles, saves time & effort, & licensing costs (IBM i offload)

- **Auto ML can create high quality models, that only experienced data scientists can build**
Demonstration

Accelerated Machine Learning with H2O.ai Driverless AI


Included: Video + Presentation
### Customer Relationship Management – IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

#### Customers Dashboard

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Initial CRM

No Customer Churn risk estimate per customer
### Smarter IBM i apps made easy with Driverless AI

**CRM & Customer Churn scenario**

#### Customer Relationship Management - IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

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<tr>
<th>CUSTOM...</th>
<th>GENDER</th>
<th>STREAMI...</th>
<th>CONTRACT</th>
<th>PAPERLE...</th>
<th>PAYMENT...</th>
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Real time Scoring
(Db2 CRM database)
### Smarter IBM i apps made easy with Driverless AI

#### CRM & Customer Churn scenario

**Customer Relationship Management - IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline**

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**Enriched CRM Data With Churn Prediction**
Smarter IBM i apps made easy with Driverless AI

CRM & Customer Churn scenario

Fig. Node-RED Prototyping - CRM dashboard

Behind the scenes:
CRM application prototype integrated with a real time scoring Pipeline (Java MOJO)

Java MOJO Scoring Pipeline Invoked from the Node.js app
Get Started Today

Videos and Solution Brief
H2O Driverless AI Tutorials
Client Reference Case Study

Want to know more? Need support? Contact us:
- European Cognitive Systems CoC - IBM Montpellier  a2roy@fr.ibm.com  /  benoit.marolleau@fr.ibm.com
- IBM CSSC Workshop?  Ai Workshop at CSSC
- Worldwide Principal Offering Manager - Machine Learning / H2O Driverless AI:  luis.armenta@us.ibm.com

WML & Al Demos on the IBM WW Demo portal:  https://www.ibm.com/systems/clientcenterdemonstrations

Presentations, Demo Replays for the author:  https://ibm.biz/bma-wiki


H2O.ai Driverless AI (Trial 21 days):  https://www.h2o.ai/products/h2o-driverless-ai/
Demonstration

Accelerated Machine Learning with H2O.ai Driverless AI

Additional Content:

*Driverless AI Data Connectors & JDBC*
*(Data Procurement / Preparation phase)*

Smarter IBM i apps made easy with Driverless AI

CRM & Customer Churn scenario

1. Extract CRM data
2. Import & Visualize Data
3. Model Export
4. Augment IBM i Applications
5. Monitor Models & Iterate

Optimized for GPU-Accelerated Power9 Servers

Recommendation Engine
Scoring Pipeline

Summary with JDBC Connection

Customer Relationship Management - IBM i + Machine Learning Driverless AI MOJO Scoring Pipeline

Customer Dashboard

RESET

SCORING

CUSTOM... | GENDER | STREAM... | CONTRACT | PAPERLE... | PAYMENT... | MONTHL... | TOTALCH... | CHURN?
---+---+---+---+---+---+---+---+---
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0003-MKNFE | Male | No | Month-to-mon... | No | Mailed check | 59.90 | 542.40 | 0.26
0004-TLJLI | Male | No | Month-to-mon... | Yes | Electronic check | 73.90 | 280.85 | 0.37
0011-KKIFF | Male | Yes | Month-to-mon... | Yes | Electronic check | 98.00 | 1237.85 | 0.39
0013-EXCHZ | Female | Yes | Month-to-mon... | Yes | Mailed check | 83.90 | 267.40 | 0.44
0013-MK2HF | Female | Yes | Month-to-mon... | Yes | Credit card (au... | 69.40 | 571.45 | 0.27
0013-SM2OE | Female | Yes | Two year | Yes | Bank transfer (au... | 109.70 | 7904.25 | 0.23

Db2 for i

Business Database

Business Application

JDBC

Direct Db2 Connection
DAI Data Connectors: JDBC Connection to DB2 for i

How to configure a Db2 Data Connector:

1. Download a Db2 JDBC Driver first
   - Ex: Db2 for i type 4 jdbc driver jt400.jar : https://sourceforge.net/projects/jt400/
   - Db2 LUW : get the appropriate db2jcc4.jar

2. Get the original Driverless AI Config file aka /etc/dai/config.toml
   Many ways to do that, either from the image or a running container (docker cp etc.)
   - K8s example : kubectl cp -c dai-gpu-mop dai-demo-mop-6b75f6b5b9-kddd:/etc/dai

3. Edit this config.toml as shown below (refer to the Online doc for further information)

4. Inject config.toml, and the driver jar file(s) , to be mounted in your DAI POD/Docker container.
   - Inject it in your DAI image or better, use a K8s ConfigMap / persistent volume to persist it

5. Restart your DAI container to refresh the config.

/etc/dai/config.toml

```toml
# jdbc: JDBC Connector, remember to configure JDBC below. (jdbc_app_configs)
enabled_file_systems = "upload, file, hdfs, s3, jdbc"

jdbc_app_configs = '{"db2fori": {"url": "jdbc:as400://<IBMi-IP>;", "jarpath": "/etc/dai/jt400.jar", "classpath": "com.ibm.as400.access.AS400JDBCDriver"}}'

# Note: here, the jtopen driver jtopen.jar is mounted in the DAI Container, in /etc/dai
```
### DAI Data Connectors: JDBC Connection to DB2 for i

#### Data Connectors - JDBC

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</tr>
</thead>
<tbody>
<tr>
<td>TEST</td>
<td>..90/TEST.1568642468.7804182.bin</td>
<td>963KB</td>
<td>7K</td>
<td>21</td>
</tr>
<tr>
<td>Churn.csv</td>
<td>..urn.csv.1565400172.8270016.bin</td>
<td>1MB</td>
<td>7K</td>
<td>21</td>
</tr>
<tr>
<td>UCI_Credit_Card.csv</td>
<td>..ord.csv.1562228258.5946171.bin</td>
<td>4MB</td>
<td>30K</td>
<td>25</td>
</tr>
<tr>
<td>GoSales_Tx_NoIveBayes.csv</td>
<td>..ays.csv.1558533238.553315.bin</td>
<td>3MB</td>
<td>60K</td>
<td>5</td>
</tr>
<tr>
<td>WA_Fn-UseC.-Telco-Customer-Churn.csv</td>
<td>..urn.csv.1558036429.8231265.bin</td>
<td>1MB</td>
<td>7K</td>
<td>21</td>
</tr>
</tbody>
</table>
Configure your Data source:
Db2 Connection & Query with credentials to your Db2 database.
DAI Data Connectors: JDBC Connection to DB2 for i

Explore your dataset populated with fresh data from your Db2 for i database.
DAI Data Connectors: JDBC Connection to DB2 for i

Explore your dataset populated with fresh data from your Db2 for i database.
Demonstration
Accelerated Machine Learning with H2O.ai Driverless AI

Additional Content:
Java Mojo Scoring Pipeline on IBM i/AIX/Linux
(Model Inference, Deployment / Production phase)

Java Mojo Scoring Pipeline on IBM i/AIX/Linux

Build and Export the MOJO Scoring Pipeline
Java Mojo Scoring Pipeline on IBM i/AIX/Linux

Download the generated Scoring Pipeline

Customer Churn scoring pipeline
Java Mojo Scoring Pipeline on IBM i/AIX/Linux

Unzip the Scorer.zip file on the inference System.

Change the JVM version from 32 to 64 bit if necessary (necessary if max heap size >= 2.8GB).

Heap size needed depends on the model size. Default 5GB

Documentation: Typically, a good estimation for the amount of required memory is 12 times the size of the pipeline.mojo file.
Java Mojo Scoring Pipeline on IBM i/AIX/Linux

Real time prediction on IBM i !! (AIX/Linux) with the java MOJO Scoring Pipeline built by Driverless AI

```java
OS: BENOIT 3.7 001000205V OS
+ MOJO_FILE=mojo.pipeline
+ CSV_FILE=example.csv
+ LICENSE_FILE=
+ CMD_LINE='java -mx5g -Dai.h2o.mojos.runtime.license.file= -cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo'
+ cat

Running MOJO2 example

MOJO file : mojo.pipeline
Input file : example.csv

Command line : java -mx5g -Dai.h2o.mojos.runtime.license.file= -cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo pipeline.mojo example.csv
+ java -mx5g -Dai.h2o.mojos.runtime.license.file= -cp mojo2-runtime-2.1.4-all.jar ai.h2o.mojos.ExecuteMojo pipeline.mojo example.csv

Mojo load time: 2.291 sec
Churn.No,Churn.Yes
0.8248827688589287,0.1751972511619713
0.8103899585885214,0.1896184416147867
0.9204178228797432,0.07958217710256577
0.691176518485067,0.30882448951483296
0.83621997128458,0.1071802587954202
0.933176189255816,0.86662838947441843
0.8994874848032489,0.10512545696978114
0.7456717077228758,0.256328229227712417
0.6289845875872289,0.37101542341777984
0.3062417427592868,0.6973582572487192
Time per row: 4.100 msec (total time: 41.000 msec)
```

Real time Customer Churn predictions on IBM i
ML Technologies & IBM i & AIX
Use integrated frameworks, languages on AIX & IBM i

Data & Scientific Packages Available

- Numpy, Pandas: Data Processing
- Scipy, Scikit-Learn
- IPython: interactive Python
- NLTK: Natural Language Processing
- Matplotlib, Jupyter: Data Visualization
- R Language (Interpreter, Runtime)

More to come? 😊

➡️ Useful in all phases of a ML project on AIX/IBM i
➡️ Especially for Data Preparation
➡️ GPU Acceleration often needed
Data Science tools & technologies

Kaggle 2017 Data Science Tools Survey

- **Python** 76.3%
- **R** 59.2%
- **SQL** 53.6%
- **Jupyter notebooks** 40.3%
- **TensorFlow** 28.4%
- **Amazon Web services** 23.5%
- **Unix shell / awk** 23.3%
- **Tableau** 20.4%
- **C/ C++** 19.2%
- **NoSQL** 19.2%
- **MATLAB/ Octave** 18.4%
- **Java** 18.3%
- **Hadoop/ Hive/Pig** 17.3%
- **Spark / MLlib** 17.1%
- **Microsoft Excel Data Mining** 13.7%

Get started with Data Science on Power (AIX/IBM i) using Open Source Technologies
H2O Driverless AI Complements IBM PowerAI Vision

IBM Power AI delivers Deep Learning for Images

H2O Driverless AI is an Automatic Machine Learning

Transaction Data: Store Level

Transaction ID | Date | Time | MM/DD/YY | Order number
--- | --- | --- | --- | ---
123456 | 10/01/2018 | 10:00 AM | 10/01/2018 | 1001
678901 | 10/02/2018 | 11:00 AM | 10/02/2018 | 1002
234567 | 10/03/2018 | 12:00 PM | 10/03/2018 | 1003
789012 | 10/04/2018 | 01:00 PM | 10/04/2018 | 1004
345678 | 10/05/2018 | 02:00 PM | 10/05/2018 | 1005
890123 | 10/06/2018 | 03:00 PM | 10/06/2018 | 1006
456789 | 10/07/2018 | 04:00 PM | 10/07/2018 | 1007
901234 | 10/08/2018 | 05:00 PM | 10/08/2018 | 1008
567890 | 10/09/2018 | 06:00 PM | 10/09/2018 | 1009
012345 | 10/10/2018 | 07:00 PM | 10/10/2018 | 1010

Example: Flat File

Sensors

Log
IBM POWER SYSTEMS

AC922

An Acceleration Superhighway
Unleash state of the art IO and accelerated computing potential in the post “CPU-only” era

Designed for the AI Era
Architected for the modern analytics and AI workloads that fuel insights

Delivering Enterprise-Class AI
Flatten the time to AI value curve by accelerating the journey to build, train, and infer deep neural networks
Seamless CPU and Accelerator Interaction

coherent memory sharing
enhanced virtual address translation

POWER9

Broader Application of Heterogeneous Compute
designed for efficient programming models
accelerate complex AI & analytic apps

"vanilla"

Other

PCIe Gen3

PCle Gen4

POWER8 with NVLink 1.0

POWER9 with 25G Link + NVLink 2.0

2x

5x

7-10x

Broader Application of Heterogeneous Compute
designed for efficient programming models
accelerate complex AI & analytic apps

"vanilla"

Other

PCIe Gen3

PCle Gen4

POWER8 with NVLink 1.0

POWER9 with 25G Link + NVLink 2.0

2x

5x

7-10x

Seamless CPU and Accelerator Interaction

coherent memory sharing
enhanced virtual address translation

POWER9