Building Intelligent Self-healing apps using Machine Learning, Graph & PAL

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Matthew Mac Crory, SAP
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Session ID #83745

About the Speakers

Nancy Schultz

- Information Quality Leader, DowDupont
- 30 years of experience
  - Systems Development
  - Data Architecture
  - Data Migration (M&A)
  - Data Governance
  - Data Quality
- Fun Fact: I won't eat a sandwich if it's not cut on a diagonal

Vivek RR

- Technology Architect, SAP
- 12 years of SAP Experience focusing on native HANA Developments, XSA , SCP , S/4 Analytics & ABAP Programming.

Matthew Mac Crory

- Technical Quality Manager, SAP
- 2 years at SAP
- Drives necessary services out of SAP's proactive and reactive support portfolio and ensures delivery at the right point in time

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Key Outcomes/Objectives

1. Documenting User Needs using Human Centered Design Techniques

2. How to utilize HANA Advanced Analyst options available as a part of HANA 2.0 SPS4

3. Key features of SAP Leonardo foundation

4. Building hybrid applications on HANA (On – Premise) using Graph & cloud APIs.

Agenda

- Dow.Inc – Who we are?
- Digital Transformation – Why Automate?
- Exploring Options – Developing Proof of Concept
- Summarizing Results
- Identifying Technical Solutions (in detail)
- Assessing Pros & Cons of each Technical Solution
- Conclusion

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ABOUT DOW

Corporate Stats[1]

2018 Pro Forma Op. EBITDA of **$9.1B**

2018 Pro Forma Op. EBIT of **$6.2B**

2018 Pro Forma Net Sales of **$49.7B**

113 manufacturing sites in **31** countries

Serving customers in **~160** countries

OUR AMBITION
To become the most innovative, customer-centric, inclusive and sustainable materials company in the world

OUR GOAL
Profitable growth & best-in-class performance

OUR CORE VALUES
Integrity
Respect for people
Protecting our planet

NEW DOW IS A BETTER AND STRONGER COMPANY

- **Focused, streamlined and resilient portfolio**

- **Significant earnings growth drivers in place today**

- **Industry-leading low-cost, low-risk profile**

- **Disciplined returns-driven approach to capital allocation**

- **Favorable fundamentals in our core value chains**

New Dow is Uniquely Positioned to Maximize Shareholder Value

NEAR TERM PRIORITIES

PROFITABLE GROWTH

Capitalize on growth and value-add materials science opportunities

Enhance customer-centricity and speed of innovation through 'Digital Dow'

Complete USGC investments; advance next brownfield increments

DISCIPLINED CAPITAL ALLOCATION

Prioritize lower-risk, faster-payback projects, with capex ≤ D&A

Maintain and improve leadership positions in core markets

Higher ROIC, FCF & returns to shareholders

LOW-COST OPERATING MODEL

Achieve best-in-class cost structures

Deliver cost synergy run-rate by end of 1Q19 ($1.365B)

Reach next level of productivity through 'Digital Dow'

BEST OWNER MINDSET

Implement most value-creating strategies

Culture of benchmarking

Enhanced disclosure (capacities, market-based transfer pricing)

Digital Dow – Why Automate?

LOW-COST OPERATING MODEL

Achieve best-in-class cost structures

Deliver cost synergy run-rate by end of 1Q19 ($1.365B)

Reach next level of productivity through 'Digital Dow'

DIGITAL DOW

REQUIRES HIGH LEVELS OF DATA QUALITY

AUTOMATION INCREASES PRODUCTIVITY

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Defining the Problem

Identify the Opportunities	Document the Challenge	Outline the Benefits
Bring New and Improved Customer Experience Capabilities	Eliminate Potential for Customers to Experience Web Ordering Delays due to Master Data deficiencies	**Improved** Customer Experience and Product Delivery
Build Predictive Power Leveraging Our Data Assets	Use Historical data to Simplify Data Correction Process and Predict Missing Data	**Improved** accuracy of Master Data, **Reduced** Correction Cycle Time and **Improved** Employee Productivity
Expand Digital Co-innovation Globally	Define a reusable solution to embed ML/AI into Dow's Data Quality Processes	**Established** Platform to expand Machine Learning to multiple use cases

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Our Process

1. Identify Customer Pain Points, Value and Desired Outcomes
2. Engage SAP Max Attention Innovation Channel to Explore Use Cases
3. Design Proof of Concept
4. Provide Data for Evaluation
5. Identify Solutions
6. Review Solutions and Explore Cost
7. Access Architecture Needs
8. Determine Next Steps
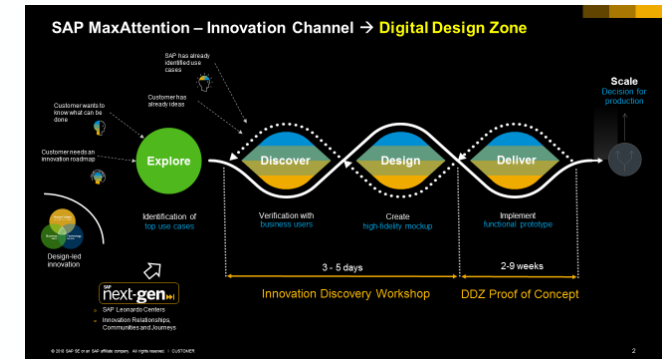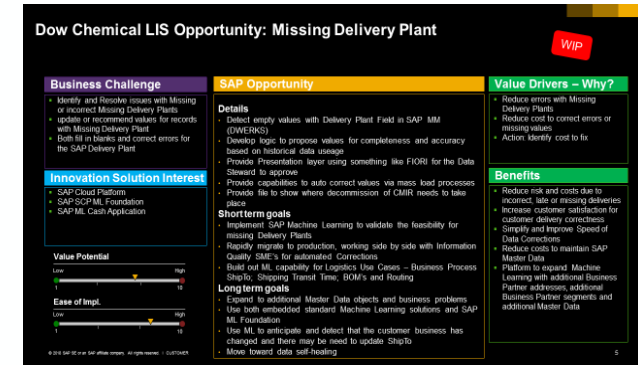
Business Challenge

Business Issue:

✓ Dow was experiencing cases of shipping or production delays due to some missing master data, specifically assignment of a material or related plant information.

✓ The key challenge is to build an effective solution to identify the missing plant or provide recommendation to business on possible plant suggestions .

Key Benefits

✓ Reduce risk and costs due to incorrect, late or missing deliveries

✓ Increase customer satisfaction for customer delivery plant correctness

✓ Simplify and Improve Speed of Data Corrections

✓ Reduce costs to maintain SAP Master Data

✓ Provide a repeatable process and technical platform for integrating ML/AI to support data "self-healing"

Use Case – Missing Delivery Plants

Functional Objective:

To resolve customer pain point of Late Delivery's due to Missing or Incorrect Delivery Plants.

Technical Objective: To predict the best delivery plant based on sales history.

Scope of Evaluation:

- Graph Engine/SQL
- Predictive Analytics Library in HANA(PAL)
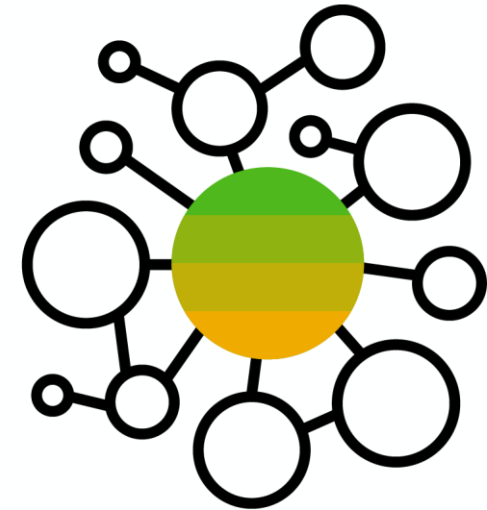- Machine Learning(ML)

First Phase Evaluation :

- Identify general pattern of possible plant suggestions based on Sales history transaction data.

Note: Dow Chemical supplied data extracts to evaluate a solution for Missing Delivery Plants

Technical Evaluation – Graph

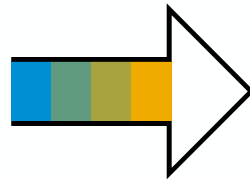# SAP HANA Graph – An Introduction

- **Networks**
  Social, company/organizations, utility grids, production
  and supply chains, citation networks, authorization and
  role concepts, knowledge graphs...

- **Use cases**
  Customer intelligence and product recommendation
  Supply and production chain analysis
  Fraud detection, compliance and risk analysis
  Authorization control and security management

- **Challenges**
  Represent large amounts of highly connected data
  Capture new, complex relationships as they are established
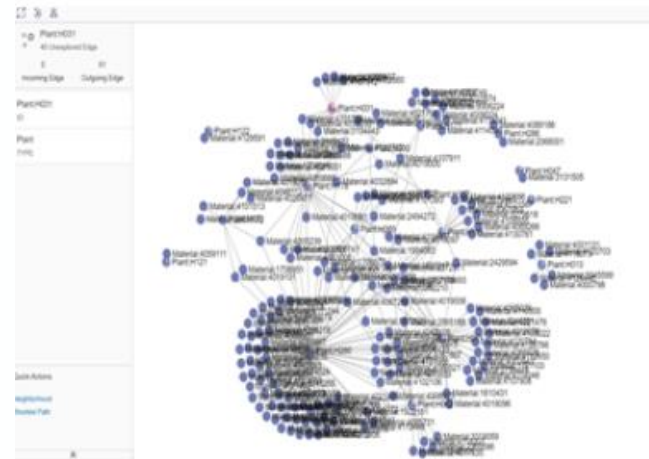 Extract meaningful insights from relationships for business
  processes

Graph Representation of Sales History Data

Sales history data

* Chart does not reflect Actual Dow Data

Graph workspace with combination of SalesOrg/ShiptoCustomer & Plant

Graph workspace with combination of SalesOrg/ShiptoCustomer, Plant & Material

Consumption of Graph Spaces

- Consumption of Graph Space in Calculation Views/UI5 apps

- Data Accuracy will be 99% as the graph nodes not trained rather built as nodes/vertices based on actual data

- HANA Scripts & modeling logic can be built on top of graph nodes for the conditions and exceptions

- Evaluation includes pattern identification of generic pattern (first phase)

Technical Evaluation – Predictive Analysis Library (PAL)

Example Cross Validation Results

Naïve Bayes Classifier & Back Propagation Model

- 12 out of 14 predicted correctly for both
- Approximately 95% accuracy with predictions

CREATEDON	MATERIAL	SALESORG	NAÏVE	BPNN	ACTUAL
1/2/2017	402	A7	H2	H2	H2
1/2/2017	208	A7	H0	H0	H0
1/2/2017	401	A7	H2	H2	H2
1/3/2017	409	A7	H2	H2	H2
1/3/2017	406	A7	H2	H2	H2
1/3/2017	406	A7	H2	H2	H2
1/2/2017	227	A7	H0	H0	H0
1/3/2017	409	A1	H1	H1	H1
1/2/2017	410	A7	H0	H0	H0
1/3/2017	403	A1	H0	H0	H0
1/3/2017	266	A1	H0	H0	H1
1/5/2017	407	A7	H0	H0	H2
1/4/2017	410	A7	H2	H2	H2
1/6/2017	402	A7	H2	H2	H2

Predictive Analytics Library(PAL) Evaluations

Pros

- Native HANA algorithms available for training and prediction.
- Feed your data to PAL algorithms graphically and provide control parameters for the same.
- Depending on the complexity, you can include the plant determination logic in SQLscripts.
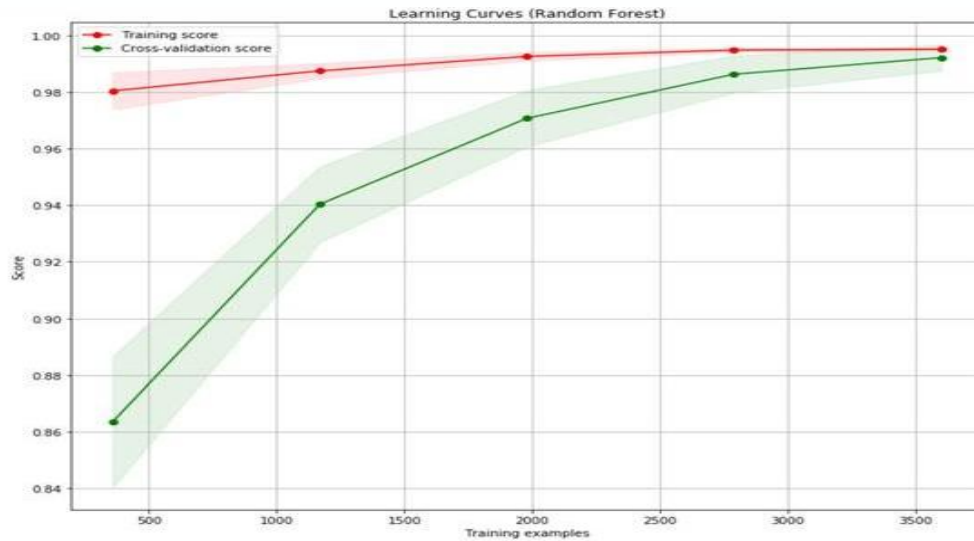
Cons

- Representative data set required for optimal training
- Multi level classifications not supported

Technical Evaluation – Machine Learning

Results of Dow specific custom Machine Learning model for single Plant under laboratory conditions

Learning Curves (Random Forest)
- Training score
- Cross-validation score

	Input				Output			
Sales Doc.	Created on	Material	Sales Org	PRD ShipTo Customer	Predicted Plant 1	Predicted Plant 1 Probability	Predicted Plant 2	Predicted Plant 2 Probability
766405	3/6/2017	1616	A740	2223	H1	0.00	H2	1.00
788206	10/11/2017	167	A740	2223	H1	0.00	H2	1.00
773471	5/16/2017	166	A740	2223	H1	0.01	H2	0.99
769818	4/7/2017	167	A740	2223	H1	0.02	H2	0.98
759905	1/2/2017	245	A723	2211	H1	0.03	H0	0.97
762092	1/23/2017	161	A713	8522	H0	0.03	H1	0.96
785574	9/14/2017	210	A713	1463	H0	0.06	H1	0.91
779706	7/17/2017	208	A713	1463	H0	0.03	H1	0.90
760409	1/9/2017	242	A723	2211	H1	0.08	H0	0.85
763296	2/3/2017	131	A713	1463	H0	0.09	H1	0.84
765294	2/23/2017	236	A723	2211	H0	0.05	H0	0.82
763495	2/7/2017	169	A723	2211	H0	0.11	H0	0.81
795245	12/13/2017	109	A713	1463	H1	0.21	H1	0.78
795083	12/12/2017	193	A713	1463	H1	0.21	H1	0.78
768883	3/29/2017	249	A723	2211	H1	0.13	H0	0.71
770268	4/12/2017	249	A723	2211	H1	0.13	H0	0.64

- Baseline accuracy: 86%
- Final accuracy: 99% on Cross Validation and test
- Need to evaluate on a larger dataset
- *Predictors: Ship to party, Created on and Sales Org*

- **Text highlighted in yellow** are the correct predictions
- *Training set:* 60% (800 records)
- *Test set:* 20% (200 records)

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Machine Learning Evaluation

Pros

- Predicted probabilities for the predicted plants
- Cloud based solution.
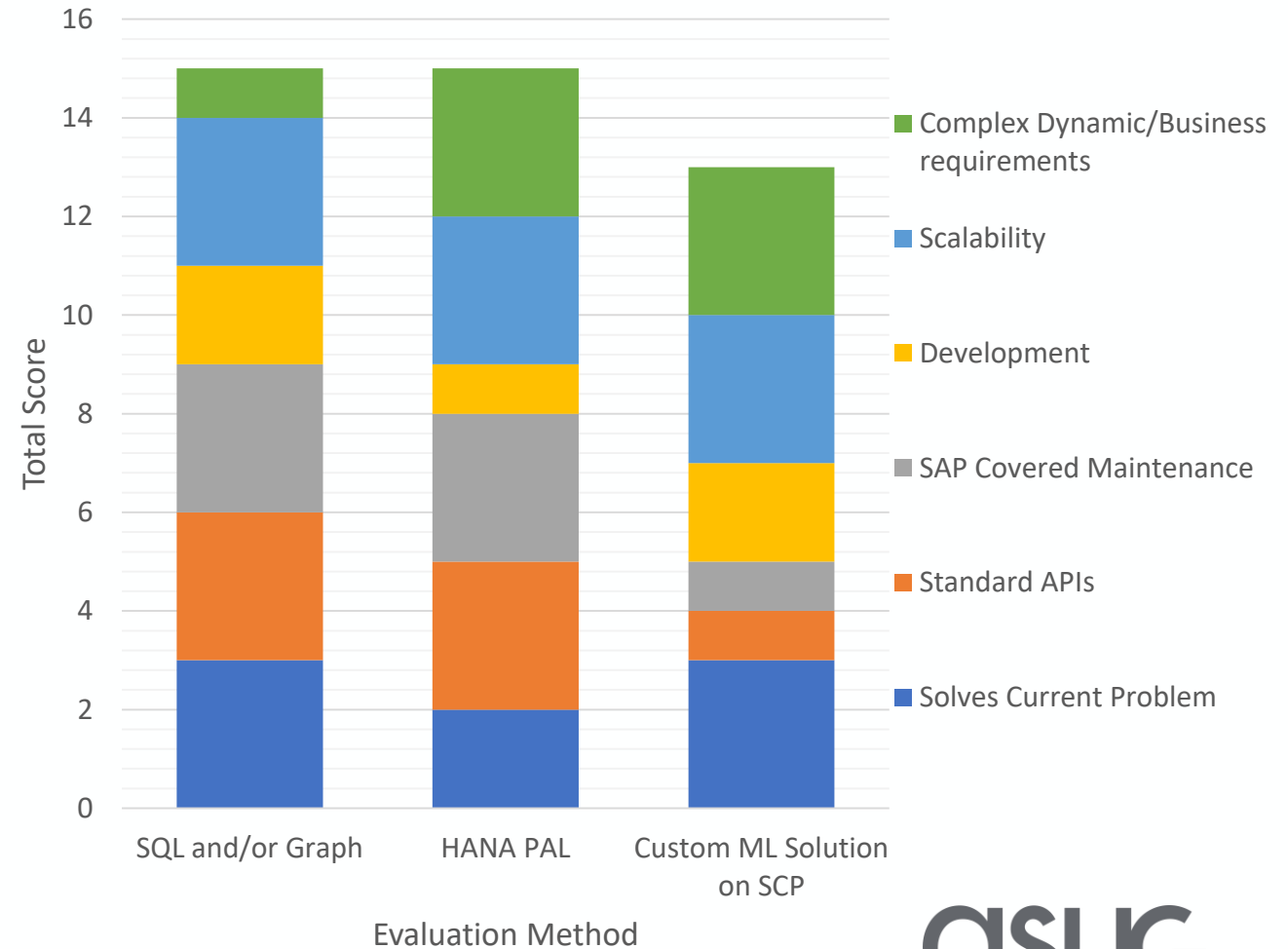- Automatic retraining
- Data scientist friendly

Cons

- Needs SAP cloud platform(SCP)
- Requires additional support

Technical Evaluation – Findings

Missing Delivery Plant Use Case Findings

Criteria	Solution 1: SQL and/or Graph	Solution 2: HANA PAL	Solution 3: Custom ML Solution on SCP
Solves Current Problem	3	2	3
Standard APIs	3	3	1
Platform	(On Premise, On Premise, Cloud)	(On Premise, On Premise, Cloud)	(On Premise, On Premise, Cloud)
SAP Covered Maintenance	3	3	1
Development	2	1	2
Scalability	3	3	3
Complex Dynamic/business requirements	1	3	3
Total	15	15	13

*Legend: 1 - Fair , 2 – Good, 3 – Very Good

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Future Engagement

- ✓ Dow to evaluate the technology options for the production type development model
- ✓ SAP Max Attention to be involved for additional use case discussions for front end / deployment platform
- ✓ Additional use cases might require hybrid technology deployments(HANA XSA/Machine Learning) depending on complexities of the use case.

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Presentation Materials

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http://info.asug.com/2019-ac-slides

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Q&A

For questions after this session, contact us at
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