

### THE AI-DRIVEN UNIVERSITY: DREAM OR HALLUCINATION? Amin Qazi, UC San Diego | Amass.co Session ID 84317

May 7 – 9, 2019



## **About the Speaker**

### Amin Qazi

- Enterprise Architect, UC San Diego
- Principal, Amass



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## **Key Outcomes/Objectives**

- 1. Understand AI, and data and data warehousing roles in supporting AI
- 2. Show how capturing events in near-real time can manage risk
- 3. Where to embed AI, including data streams



## Agenda

- What is a university?
- UC San Diego's data warehouse & Al strategies
- Use cases that inform thinking, design, and implementation



## **Summary**

- Al is:
  - important and challenging
  - changing how you collect, store, and use data
  - critical
- UC San Diego has taken an aggressive approach to change our thinking, and adopt new processes to prepare for this change
- Accomplishing the same is possible, but may be hindered by strategy, leadership, and resources





# Universities are complex, multi-faceted organizations businesses.

- Finance
- HR
- Education
- Research
- Hospitality
- Medical

- Athletics
- Facilities
- Retail
- Logistics
- Investments



# They are also mired in outdated ways of thinking.

- Finance
- HR
- Education
- Research
- Hospitality
- Medical

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- Investments



## Al drives benefits across the organization.

Organizations implementing AI report the following benefits:



Influencing Sales

3 in 4 increase sales of new products and services by more than 10%



Boosting Operations

78% increase operational efficiency by more than 10%



Engaging the Customer

75% enhance customer satisfaction by more than 10%



Generating Insights

79% generate new insights and better analysis



Source: Capgemini

## Al is already embraced by fast-growers\*.

Organizations' rating of the importance of AI today and in three years.



## **Can we get to the AI Promised Land?**



## **Can we get to the AI Promised Land?**

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## Spoiler

- Yes
- And no
- And maybe



## **Can we get to the AI Promised Land?**

## Spoiler

- Yes
- And no
- And maybe

### Out of scope

- Operations
- Talent management
- Regulations
- Ethics
- etc.



## What is AI?

**Artificial Intelligence** "the science of getting computers to act without being explicitly programmed" (Stanford University)

Machine Learning "ability to learn without being explicitly programmed" (Arthur Samuel)

Reinforcement Learning Supervised Learning

Predictive Learning



## What is AI?

### Reinforcement Learning



Control (no target variable)

### **Supervised Learning**



Classification (categorical target variable)

### **Predictive Learning**



Control (categorical target variable)

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### Where was AI in 2016?



would ever make, like adding milk chocolate to a clam linguine or mayonnaise to a Bloody Mary." UC San Diego

## Hoof-n-Honey Ale (by IBM Watson)

- 4 oz. India pale ale
- 1 oz. veal stock
- 2 slices peach
- 4 oz. Burgundy wine
- 1 egg white
- 1 tsp. sugar
- 1 piece grilled beef
- Honey
- Warm water

## Where is AI today?

### warehouses



aws

capacity planning

### visual assessment





Source: The Economist, April 13-19, 2019

## What is AI?



### Doing the same things, better

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### Leaner, faster operations

- Using automation to improve the efficiency of business-as-usual processes
- Reducing the cost of simple, routine processes, while maintaining or improving quality of experience

#### Tailored products and advice

- Personalizing
   interactions to more
   closely meet the unique
   needs of customers
- Providing convenient, high-quality service, while maintaining scalability

#### Ubiquitous presence

- Making products and services available to customers in their preferred format and channel
- Expanding the reach of institutions' channels and offerings geographically and across customer segments

#### Smarter decisionmaking

- Using advanced data science to optimize business outcomes (e.g., higher retention rates)
- Integrating large volumes of data to derive better insights across the university (e.g. better space management)

### Doing something radically different

### New value propositions

- Differentiating offerings through new operating models and ways of working
- Building brand new pedagogies, products, services and business models that use AI at the core

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Source: World Economic Forum

## Data are priceless.

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**Data collection is changing.** 

Not more of the same.

## Different.







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## Technology affects the realm of possibilities.



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## Data are different.





## Data are different.

# Data management needs to be different.





# Data processing will be different.





# Again, not more of the same.





# New reference architecture for data to support Al.





## **Design Principles**

- 1. Everything is a verb
  - All data are loaded into a very long, very wide, insert-only activity table. Relevant changes/deletions are new rows. Idempotency
- Streaming is the new dominant way to move data in/out **2. Express maximum semantic complexity**All data (attributes, rows) are added ahead of actual use
- - No aggregates. All data is stored in and processed at its lowest level of granularity
- 3. Curated views
  - No dimensional modeling. No joins! Curated views present a long list of attributes for analysts to choose from
  - Curated views are designed for specific analysis needs (vignettes)
- 4. Speed and ease is of the essence
  - Sub-second analyst click response. Real-time data where needed

  - Curated views must make it very easy for analysts to manipulate
    Push logic (set and Boolean) to the back-end, free the front end for visualization
- 5. Redundancy and data explosion are good

  No need to conserve space. Curated views can be overlapping and duplicative
  A hierarchy of reusable SQL code results in an OO-like, highly reusable environment
- 6. Democratize it
  - Make it easier to understand, consume and use
  - Enable the community to share, encourage bottom-up data analysis and use



**Student analytics scope** 

- **1. Give analysts access to anonymized views**
- 2. Enable real-time, personalized mobile messaging, alerting, etc.
- 3. Allow for rich, comprehensive, large scale learning analytics



### **UC San Diego's next generation data warehouse uses**

Employee Acti	ivitv Hub	Proiect Activity Hub		Research Activity Hub								
	···· <b>/</b> ·····	Sources	Uses	Sources Uses								
Sources     Uses       PPS     Positions     Co       UCPath     Pay     Sources       Hire Online     Training     JD       JD Online     Performance       UC Learning     Engagement       Kuali Protocols		Jira IT project analysis Confluence Portfolio analysis SeviceNow Resource allocations		Interfolio Ro PPS Re Kuali Oi Tables	ole/affiliates sys search scholar acle Finance / F	tem appointment PM	Faculty a Sponsor Research Research	appointment a red project fin h compliance h portfolio an	and roles ancial ar analysis alysis	s nalysis		
Employee LMS				/ People / Organi	Identity zation	Facilities	Activity Hub		Financ	ial Act	ivity Hub	
Performance Management				Facili Common Hierar	ities Activities chies	<u>Sources</u> Tririga	<u>Uses</u> Classroom utilizatio	on ES	ources SR Finance	<u>Uses</u> Activity	v pattern analysis	
				Commo	n Tools	CAIVIS	Walk-time	E	SR Studget	Multi-fu	analysis und analysis	
Sources	dent Activit	y Hub		Tableau / Cognos SPSS / R			IDC Analysis Maintenance Planning			Budget forec	revenue modeling ing and asting	
SIS	Enrollment			Mobile Mo	essaging		Event					
LMS VAC	Demograph Majors/min	nics ors		Embedded Pla	atform Tools							
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DARS ProSam Slate Co-curricular	Learning ar Student eng Applicants/	egree halytics gagement Applications		Spatial Analys Text Mining R		Sources	<u>Uses</u>		ServiceNo Finance	w L B	SS Analysis ottleneck analysis	
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Activity hubs ingest data via a streaming message service. Curated views and activity tables should employ "duplicate safe" rendering methods, allowing for idempotent messages. This relaxes data consistency significantly, easing the integration complexity.

The streaming analytics connection point allows for directly connecting the streaming ingestion engine with a real-time streaming analytics machine learning platform to process inbound messages

Conforming software meets the streaming message-based ingestion method and submit directly to the activity hub message layer.

Non-conforming software needs a "wedge" integration point that helps calculate differences in snapshots to determine incremental adds, updates and deletes. The ODS and other tools for this wedge can exist in any platform(s), including HANA. The principle define choice is long-term cost and performance needs.

Non-conforming software



### **Student Activity Hub (SAH) Platform Overview**



# There are very high potential and impact from algorithms; hardware and vision, less so.



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Source: HolonIQ Global Executive Panel, April 2019, n=377

### **SAP HANA**

### **Data Ingestion and Analytics modelling overview**



### **Platform predictive capabilities**

#### **Classification Analysis**

- CART
- C4.5 Decision Tree Analysis
- CHAID Decision Tree Analysis
- K Nearest Neighbour
- Logistic Regression Elastic Net
- Back-Propagation (Neural Network)
- Naïve Bayes
- Support Vector Machine
- Random Forests
- Gradient Boosting Decision Tree
- Linear Discriminant Analysis (LDA)
- Confusion Matrix
- Area Under Curve (AUC)
- Parameter Selection/Model Evaluation

#### Rearession

- Multiple Linear Regression Elastic Net
- Polynomial, Exponential, Bi-Variate Geometric, Bi-Variate Logarithmic Regression
- Generalized Linear Model
- Cox Proportional Hazards Model

#### **Cluster Analysis**

- ABC Classification
- DBSCAN
- K-Means/Accelerated K-Means
- K-Medoid Clustering
- K-Medians
- Kohonen Self-Organized Maps
- Agglomerate Hierarchical
- Affinity Propagation
- Latent Dirichlet Allocation (LDA)
- Gaussian Mixture Model (GMM)
- Cluster Assignment

#### Time Series Analysis

- Single/Double/Brown/Triple Exponential Smoothing
- Forecast Smoothing
- Auto ARIMA/ Seasonal ARIMA
- Croston Method
- Forecast Accuracy Measure
- Linear Regression with Damped Trend and Seasonal Adjustment
- Test for White Noise, Trend, Seasonality
- Fast Fourier Transform (FFT)
- Correlation Function

#### Association Analysis

- Apriori
- Apriori Lite
- FP-Growth
- KORD Top K Rule Discovery
- Sequential Pattern Mining

#### Probability Distribution

- Distribution Fit/Weibull analysis
- Cumulative Distribution Function
- Quantile Function
- Kaplan-Meier Survival Analysis

#### Outlier Detection

- Inter-Quartile Range Test (Tukev's)
- Variance Test
- Anomaly Detection
- Grubbs Outlier Test

#### Recommender

- Factorized Polynomial Regression Models

- Adamic/Adar
- Katzß

#### Statistical Functions

- Mean, Median, Variance, Standard Deviation, Kurtosis, Skewness
- Covariance Matrix
- Pearson Correlations Matrix
- Chi-squared Tests:
  - Test of Quality of Fit
- Test of Independence F-test (variance equal test)
- Data Summarv
- ANOVA
- One-sample Median Test
- T Test
- Wilcox Signed Rank Test

#### **Data Preparation**

- Sampling
- Binning
- Scaling
- Partitioning
- Principal Component Analysis (PCA)/ PCA Projection

#### Other

- Weighted Scores Table
- Substitute Missing Values



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- 90+ prepackaged machine learning/predictive algorithms ٠
  - Supports association, clustering, classification, regression, time series, ...
  - Supports different types of data structured, streaming and series data
  - Real-time scoring for several algorithms
  - Integrated with open source machine learning libraries TensorFlow and R

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- Link Prediction
  - Common Neighbors
  - Jaccard's Coefficient

# Managing multiple ML models in the next generation analytics

How can we use machine learning to improve administrative processes, student success, research outcomes?

- Multiple models may be active per each business opportunity (e.g., student learning feedback, student success intervention, financial activity fraud detection)
- Multiple models will be developed and trained based on prior streams of data
- Multiple models will be deployed to actively interact with real-time streams of data, interacting with requesting systems and users, activating workflows
- Multiple models can be managed within a 'single pane of glass.' Operations can ensure reliability, detect anomalies, bring up and take down models
- Model measurement data feeds back into the next generation data warehouse to guide further model development
- Faculty experts can utilize this infrastructure to help provide needed expertise rather than use consultants
- The data within this environment can serve workbench for data science and research activities
- The next generation data warehouse (SAP HANA) has best-in-class de-identification capabilities transparent to the end-user, enabling safe use for researchers



## Managing multiple ML models in the next generation analytics

How can we use machine learning to improve administrative processes, student success, research outcomes?



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## What are our ingredients for technology?

- Data warehouse
- Data management
- Machine Learning
- Analysis
- Application / Interaction / Intervention



## Back to how ML/AI might apply at a university.

- Hospitality
- Medical
- Education
- Athletics
- Facilities
- Retail
- Logistics / Transportation
- Investments



# Without a clear goal, Al initiatives may be doomed from the start.

		Define Success Cr	d riteria
Finance		+	
HR		+	
Education		-	
Research		+	
Hospitality		-	
Medical		+	
Athletics		+	
Facilities		+	
Retail		+	
Logistics		+	
Investments		+	
	D		





# A common ontology greatly supports organization of data.

**K** 

	Defined Success Criteria	Common Ontology
Finance	+	+
HR	+	-
Education	-	-
Research	+	-
Hospitality	-	-
Medical	+	+
Athletics	+	-
Facilities	+	+
Retail	+	-
Logistics	+	+
Investments	+	+
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# In many areas, data are either not collected, or are scattered, de-centralized, and disorganized.

	Defined Success Criteria	Common Ontology	Structured Data
Finance	+	+	+
HR	+	-	+
Education	-	-	-
Research	+	-	-
Hospitality	-	-	-
Medical	+	+	-
Athletics	+	-	-
Facilities	+	+	+
Retail	+	-	+
Logistics	+	+	+
Investments	+	+	+
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# Many data are subjective, making machine learning more challenging.

	Defined Success Criteria	Common Ontology	Structured Data	Data Indep. of Human Variables
Finance	+	+	+	+
HR	+	-	+	-
Education	-	-	-	-
Research	+	-	-	+
Hospitality	-	-	-	-
Medical	+	+	-	-
Athletics	+	-	-	-
Facilities	+	+	+	+
Retail	+	-	+	+
Logistics	+	+	+	+
Investments	+	+	+	+
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# Much of a university's operations can benefit from the use of AI.

	Defined Success Criteria	Common Ontology	Structured Data	Data Indep. of Human Variables	Overall
Finance	+	+	+	+	+
HR	+	-	+	-	+
Education	-	-	-	-	-
Research	+	-	-	+	-
Hospitality	-	-	-	-	-
Medical	+	+	-	-	+
Athletics	+	-	-	-	-
Facilities	+	+	+	+	+
Retail	+	-	+	+	+
Logistics	+	+	+	+	+
Investments	+	+	+	+	+
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## There are still opportunities to extend the value of AI in many domains.



Source: HolonIQ Global Executive Panel, April 2019, n=334

# Much of a university's operations can benefit from the use of AI.

		Defined Success Criteria	Common Ontology	Structured Data	Data Indep. of Human Variables	Overall
ς	Finance	+	+	+	+	+
(	HR	+	-	+	-	+
	Education	-	-	-	-	-
	Research	+	-	-	-	-
	Hospitality	-	-	-	-	-
C	Medical	+	+	-	-	+
	Athletics	+	-	-	-	-
(	Facilities	+	+	+	+	+
(	Retail	+	-	+	+	+
5	Logistics	+	+	+	+	+
C	Investments	+	+	+	+	+
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### **UC San Diego's next generation data warehouse uses**

Employee Activity Hub Project Activity			ty Hub	v Hub R			Research Activity Hub				
Sources PPS UCPath Hire Online UC Learni Kuali Prot Employee CITI	e Activity Hub Uses Positions Pay Training Performance ng Engagement ocols LMS	Sources Uses Jira IT proj Confluence Portfo SeviceNow Resou	ty Hub ject analysis lio analysis rce allocations Commor People / Organi Facil	Sources Interfolio R PPS R Kuali O	ole/affiliates sys esearch scholar racle Finance / P Facilities	tem Fac appointment Spo PM Res Res	ess culty appointment a consored project fina search compliance search portfolio and Financi	and roles ancial analysis analysis alysis alysis			
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Redrock Student E Manage DARS ProSam Slate Co-curricu record Extension	Statistics p progressi ment Retention, time to d Learning al Student en ilar Applicants/ Test scores /MOOC Scholarship Non-matric	er term, on graduate rate, egree nalytics gagement Applications s os sulated progress/succe	Statistical & Machine Graphing A Spatial A Text M F	R Predictive Learning Algorithms Analysis fining	Advance Ad Sources BlackBaud Alumni iModules	ement & Alumni ctivity Hub <u>Uses</u> Constituent analys Financial analysis Campaign analysis	Workf Sources ServiceNo Finance Student Kuali Rese Kuali Builo Identity Sy	Flow Activity Hub Uses W LSS Analysis Bottleneck analysis Provisioning analysis Workflow analysis Vstem			

### **Streamlining student interactions with Al**.

University of Adelaide used Oracle Intelligent Bots to reduced call center wait times by 97% and resulted in 60% "Awesome" rating from students.

"The Al/natural language means the bot infers what a user means without having to hard-code every possible question. This vastly improves the bot's ability to provide a correct answer."





Source: Rubicon Red, 2018

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### **Matching student credentials** with job descriptions using AI.

Meijer Job Type: Min Educa

Compensi Job Locati Sign-on B

Expiration Skills Requ

Qualificatio

Greenlight (glcredentials.com) provides secure, simple, and instant sharing and validation of candidate records for academic admissions and transfers, internships, scholarships, and job applications.

They streamline manual processes using distributed ledger technology, or blockchain, allowing employers to digitally receive records that are secure and instantly tamper evident.





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## **Institutions struggle most with basics:** strategy, talent, and leadership.

	n = 103		<b>Ed lech</b> n = 140	
Lack of clear strategy for Al	50%		25%	
Lack of talent with appropriate skill sets for Al work	49%		39%	
Lack of leaders' ownership of and commitment to Al	39%		6%	
Lack of technological infrastructure to support Al	34%		21%	
Under-resourcing for AI	33%		34%	
Functional silos constrain end-to-end AI solutions	31%		13%	
Uncertain or low expectations for return on investment	30%		10%	
Lack of available (i.e., collected) data	20%		30%	
Personal judgement overrides Al-based decision making	19%		9%	
Limited usefulness of data	9%		4%	
Limited relevance of insights from AI	8%		8%	
Lack of changes to frontline processes after Al's adoption	6%		8%	
UC San Diego   AN IA	<b>55</b> .co	Source: HolonIQ	Global Executive Panel,	Ap

Lack

n = 91 35% 42% 12% 29% 26% 23% 20% 18% 7% 4% 3% 2%

**Services** 

K, Source: HolonIQ Global Executive Panel, April 2019, n=334

# The foundation for this transformation is exemplified in six key capabilities.





Source: Amass

**K** 

## But it's possible to start now.



## It's not about rich; it's about light.

- Users should be able to decide how they want to use data to meet their needs
- The technology should be easy to replace
- Your solution needs to be bespoke: balance re-inventing the wheel with following the herd





## **Summary**

- Al is:
  - important and challenging
  - changing how you collect, store, and use data
  - critical
- UC San Diego has taken an aggressive approach to change our thinking, and adopt new processes to prepare for this change
- Accomplishing the same is possible, but may be hindered by strategy, leadership, and resources





## **Thanks**





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# **Presentation Materials**

Access the slides from 2019 ASUG Annual Conference here: <u>http://info.asug.com/2019-ac-slides</u>







### For questions after this session, contact me at amin@amass.co or amqazi@ucsd.edu.





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