INTEL COGNITIVE COMPUTING:
THE COGNITIVE REVOLUTION IS HAPPENING NOW

Intel’s Saffron is making business naturally smarter today.

The AI Summit – September 29, 2016
INTEL BUILDS THE HARDWARE INTELLIGENT SYSTEMS RUN ON
INTEL SUPPLIES THE DATA INTELLIGENT SYSTEMS NEED
INTEL BUILDS SOME OF THE BEST SOFTWARE AND SERVICES IN THE INDUSTRY
WE NEED MORE TOOLS.

WE NEED BETTER TOOLS.

(AND WE NEED THEM NOW.)
What is cognitive computing?

The ability to **reason, understand, remember, learn, and act**

with human-like intelligence

in collaboration with **humans and other systems**

using **structured and/or unstructured data**.
Saffron: Intel’s Cognitive Solution

Allows users to **make connections, recognize similarities, automatically classify, suggest recommendations, predict future actions** and more.

Built on the back of an **associative memory** principle that allows you to **use all of your data at query time** - giving you the **most accurate outcomes** possible.

**Instant, autonomous** and **continuous learning** enables users to evaluate and respond to additional information as it's encountered.
How Saffron works
*The 4 C’s of Cognitive Computing*

<table>
<thead>
<tr>
<th>Connections</th>
<th>Saffron unifies data sources, by <strong>connecting</strong> people, places, things, events at the entity level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Counts</td>
<td>Saffron also <strong>counts</strong> the frequency of the connections between entities in context of who, what, when, where, and why</td>
</tr>
<tr>
<td>Context</td>
<td>Saffron continuously learns the <strong>context</strong> in which three objects are connected as new data arrives</td>
</tr>
<tr>
<td>Closeness</td>
<td>Saffron measures the <strong>closeness</strong> of the similarity between objects based on the context of the question or problem</td>
</tr>
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</table>
Why Cognitive Computing?

- UNPRECEDENTED ACCURACY
- RAPIDLY DEPLOYABLE (SECURELY)
- OFTEN OFFERS RESULTS WHEN SUPERVISED LEARNING FALLS SHORT
- PROVIDES REAL ROI IN MULTIPLE VERTICALS

- High-tech Manufacturing
- Healthcare
- Financial Services
- Defense and more...
### (Some of) Saffron’s Customers

<table>
<thead>
<tr>
<th>Healthcare Personalization</th>
<th>Customer Personalization</th>
<th>Personalized Asset Maintenance</th>
<th>Software Testing &amp; Defect Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem</strong></td>
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</tr>
<tr>
<td>Accurately diagnose two heart conditions with highly similar signatures. Misdiagnosis may be fatal. <strong>54% Accuracy on avg</strong></td>
<td>Know Your Customer’s Needs: 5 Product Levels, 1,353 Products, 12M Members, <strong>20 – 35% Accuracy</strong></td>
<td>Aircraft Downtime Time and Money Lost: <strong>66% Accuracy, 16% False Alarms</strong></td>
<td>30,000 FTE’s Globally, 1,000+ Clients: <strong>Highly Competitive Innovation Demands</strong></td>
</tr>
<tr>
<td><strong>Results With Saffron</strong></td>
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</tr>
<tr>
<td>92% Accuracy in diagnosis</td>
<td>93% Accuracy</td>
<td>94% Accuracy, 1% False Alarms</td>
<td>10-15% Productivity Improvement</td>
</tr>
<tr>
<td>10,000 Attributes (v. 7) used</td>
<td>Relevant Individualized Product Recommendations</td>
<td>Faster aircraft turnaround</td>
<td>50% Test Script DeDup</td>
</tr>
</tbody>
</table>
Healthcare Personalization at Mount Sinai

**CHALLENGE:** Accurately identify between two similar presenting heart conditions: 
**restrictive cardiomyopathy** and **constrictive pericarditis**

- **7 Attributes Analyzed**
- **10,000 Attributes Analyzed**

**CARDIOLOGISTS**
- Traditional Statistics: 54% Accuracy
- Dr. Partho Sengupta: 76% Accuracy
- Artificial Intelligence: 92% Accuracy
Speckle-tracking Echocardiography (STE)
Initializing Saffron Memory Base (SMB)

<table>
<thead>
<tr>
<th>Patient</th>
<th>Class</th>
<th>A</th>
<th>B</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CP</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>CP</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>RCM</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>RCM</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

(A:1, B:2, C:3), (A:1, B:2), (A:1, C:3), (B:2, A:1), (B:2, B:2), (B:2, C:3), (C:3, A:1), (C:3, B:2), (C:3, C:3)

+ CP

+ RCM
Classifying New Patients

Patient | Class | A | B | C
-------|-------|---|---|---
      5 |    ?  | 1 | 2 | 2

Patient | Class | A | B | C
-------|-------|---|---|---
      6 |    ?  | 1 | 1 | 3

Classifying New Patients
Saffron remembers...

**Heat Map Showing Matrixes of Associations**

The green and red rectangular cells represent the presence of significant interactions seen with constrictive pericarditis (green) and restrictive cardiomyopathy (red). The 2 heat maps shown on the left are overlapped to form the third heat map on the right. The matrix of associations seen in constrictive pericarditis (green) and restrictive cardiomyopathy (red) are primarily non-overlapping with only minimal overlap (yellow).
...and outperforms other methods

Random Forests approach AUC, other methods fall short

- Saffron
- Random Forest
+ Support Vector Machines
× k Nearest Neighbor
◇ Deep Learning

Best classification performance (AUC)

Fast learning rate
Personalization at USAA

Increasing Accuracy of Anticipation & Personalization using Saffron’s cognitive platform

CHALLENGE: Improve anticipation of customer needs and recommend additional products for customers by using Saffron’s enhanced personalization.

Five levels of products taken into account:
1. Major Line of Business
2. Line of Business (e.g., Mutual Fund Series)
3. Product Offered (e.g., Aggressive Growth Fund)
4. Product Qualifier (e.g., Roth IRA)
5. Individual Product SKU (e.g., #153)

Current level of personalization powered by Saffron:
- Major Line of Business: 6 products available, 38.3% of customers selected
- Line of Business: 22 products available, 29.5% of customers selected
- Product Offered: 155 products available, 5.6% of customers selected
- Product Qualifier: 195 products available, 5.0% of customers selected
- Individual Product SKU: 482 products available, 2.1% of customers selected

Current level of personalization:
- 93% of customers selected products
- 91% of customers selected products
- 84% of customers selected products
- 79% of customers selected products
- 76% of customers selected products
Post-Silicon Verification at Intel

Global engineering giant Intel needed a way to quickly identify duplicate and similar sightings and close more unique sightings – hopefully resulting in less technical debt per stepping and increased cadence.

Saffron ingested data across numerous sources and locations, and ran real-time similarity analysis to determine likely duplicates. The information available during discovery also proved helpful in the root cause analysis of unique sightings.

Faster identification of duplicate and similar sightings projected a technical debt reduction at each stepping, a faster cadence, increased sighting closure and annual savings in the millions.

**Takeaways**

- By unifying global engineering departments and multiple data systems, **Saffron reduced the average debug time 35% within one month**
- By reducing duplicates and helping engineers determine root cause of sightings and issues, each stepping carried over less technical debt and increased the cadence of releases.

**Reduction of debug time with the first month**

**Millions projected saved annually**

**Increased release cadence**
## How we use Saffron at Intel

<table>
<thead>
<tr>
<th>Situations We Avoid</th>
<th>Saffron’s Sweet Spots</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No Pain:</strong> Companies with many data scientists already have highly-tuned, adequately working models</td>
<td><strong>Personalization:</strong> of each customer and product combination, which customer could not accomplish with logistic regression. Spam filtering, churn and other behaviors reacting to changing environment.</td>
</tr>
<tr>
<td><strong>Analyze Once:</strong> Human with machine efforts to understand and report post mortem historical patterns</td>
<td><strong>Defect Resolution:</strong> global development of complex products (hardware and software) unifying siloed ITS systems and multiple sets of structured and unstructured data</td>
</tr>
<tr>
<td><strong>Point Solution:</strong> Single apps/point solutions already exist with little margin to improve</td>
<td><strong>Predictive Maintenance:</strong> Recall from 66 to 100%. False alarms from 16 to 1%. LOTS of parts, 45+ data sources, structured &amp; free text</td>
</tr>
<tr>
<td><strong>Low Dimensionality:</strong> Few columns of structured data with vast rows for statistical power</td>
<td><strong>Sensor Diagnosis:</strong> Echocardiograph of 10K simultaneous sensor variables with only 15 exemplars of each class. Genomic microarrays as well</td>
</tr>
<tr>
<td><strong>Stationary Environment:</strong> Industries that are not dynamic. Batch train-deploy of static models suits them</td>
<td><strong>Fraud and AML:</strong> dynamic constantly changing threats and attacks changing vectors.</td>
</tr>
<tr>
<td><strong>Dynamic Enough:</strong> Parameter re-tuning on a weekly/monthly basis is good enough for business tempo</td>
<td><strong>Risk Intelligence:</strong> demands for instant knowledge update at the time of fraud adjudication. Needed for polymorphic attack detection</td>
</tr>
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CHOOSE YOUR TOOLS WISELY