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# Introduction to Machine Learning

James Ward Platform Evangelist

> jamesward.com @\_JamesWard

Machine Learning • Deep Learning • Predictive Analytics • NLP • Smart Data Discovery

#### Introducing Salesforce Einstein AI in the Salesforce Platform

#### World's smartest CRM

Empowering Sales, Service, Marketing & IT Everyone can build AI-powered apps fast

#### How Humans Learn





#### How Machines Learn



# What is Machine Learning?

Pattern Recognition via Zeros & Ones



# Machine Learning



# Machine Learning Spectrum

#### Use Cases

- Search Relevance
- Collaborative Filtering
- Decision Support
- Time Series Forecasting

#### Core Methods

- Compression
- Classification
- Regression
- Reinforcement

#### Frameworks

- Neural Networks
- Support Vector Machines

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- Decision Trees
- Bayesian Models
- K-Nearest Neighbor
- Logistic Regression



- Rate leads with how likely they are to close
- Categorize this text as offensive or not
- Recommend products based on what I've liked
- Detect anomalies in credit card purchase behavior



### **ML Core Methods**

- **Compression** Determine the pattern
- **Classification** Determine if "thing" is an x or y
- **Regression** Determine the correct output for an input
- **Reinforcement** Determine what action yields an award

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Collaborative Filtering





# Demo! https://dreamhouseapp.io/pio

### Pieces of the Puzzle

Prediction IO = Open Source Machine Learning Server

Heroku = Cloud platform to deliver, scale, and monitor apps built in any technology

Heroku Postgres = Relational database in the cloud, managed by Heroku

Heroku Connect = Data sync between Salesforce and Heroku Postgres

Apache Spark = Big Data Framework

Spark ML = Machine Learning libraries built on Apache Spark

Human Intelligence First

	User 1	User 2	User 3	User 4	User 5
Property 1	<b>~</b>	*	•	•	
Property 2	<b>~</b>	<b>~</b>	*	*	
Property 3	*	<b>~</b>	v	<b>v</b>	
Property 4	٠	*	<b>v</b>	<b>v</b>	
Property 5					<b>v</b>

#### Features

	4 Bedroom	Near Park	Good School	Views	New Build
Property 1		<b>v</b>	<b>v</b>		
Property 2	<b>v</b>			<b>v</b>	
Property 3			<b>v</b>		<b>v</b>
Property 4		<b>v</b>			
Property 5			<b>v</b>	<b>~</b>	

	4 Bedroom	Near Park	Good School	Views	New Build
User 1		<ul> <li>✓</li> </ul>		<b>v</b>	
User 2	<ul> <li></li> </ul>		$\checkmark$		
User 3		<ul> <li>✓</li> </ul>	<b>v</b>		
User 4		<ul> <li>✓</li> </ul>	<b>v</b>		
User 5			<b>v</b>	<b>v</b>	

**Deriving Features from Favorites** 

User 1	User 2	User 3	User 4	User 5			4 Bedroom	Near Park	Good School	Views	New Build			4 Bedroom	Near Park	Good School	Views	New Bui
v						Property 1		~	~				User 1		V		V	
v	V					Property 2	V			V		_	User 2	V		4		
	V	v	V			Property 3			V		V	—	User 3		V	4		
		v	V			Property 4		V					User 4		V	4		
				V		Property 5			V	~			User 5			4	V	
	User 1	User 1 User 2	User 1 User 2 User 3	User 1         User 2         User 3         User 4           ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓	User 1         User 2         User 3         User 4         User 5           ✓<	User 1         User 2         User 3         User 4         User 5           ✓         ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓         ✓           ✓         ✓         ✓         ✓         ✓	User 1         User 2         User 3         User 4         User 5	User 1     User 2     User 3     User 4     User 5     4 Bedroom       ·     ·     ·     ·     Property 1     ·       ·     ·     ·     ·     Property 2     ·       ·     ·     ·     ·     Property 3     ·       ·     ·     ·     ·     ·     Property 4       ·     ·     ·     ·     ·     Property 5	User 1     User 2     User 3     User 4     User 5       Image: Constraint of the state of the stat	User 1       User 2       User 3       User 4       User 5         ··       ··       ··       Property 1       ··       ··       ··         ··       ··       ··       ··       Property 2       ··       ··       ··         ··       ··       ··       ··       Property 2       ··       ··       ··         ··       ··       ··       ··       ··       ··       ··       ··         ··       ··       ··       ··       ··       ··       ··       ··       ··         ··       ··       ··       ··       ··       ··       ··       ··       ··       ··       ··         ··       ··       ··       ··       ··       ··       ··       ··       ··       ··       ··         ··       ·	User 1       User 2       User 3       User 4       User 5       4 Bedroom       Near Park       Good School       Views         · · · · · · · · · · · · · · · · · · ·	User 1     User 2     User 3     User 4     User 5       \$\scrip\$     \$\scrip\$	User 1       User 2       User 3       User 4       User 5         ··	User 1       User 2       User 3       User 4       User 5         ··	User 1       User 2       User 3       User 4       User 5       4 Bedroom       Near Park       Good School       Views       New Build       4 Bedroom       4 Bedroom         ·	User1       User2       User3       User4       User5         ····       ····       ····       ····       ····       ····       ·····       ·····       ·····       ·····       ······       ······       ·······       ····································	User1       User3       User4       User5       VerWard       See Park       Good School       Views       New Build       Image: Comparison of the comp	User1       User3       User4       User5       Image: Constraint of the constraint of th

Favorites

#### Property Features

#### **User Features**

	User 1	User 2	User 3	User 4	User 5
Property 1	v				
Property 2	v	v			
Property 3		r	v	V	
Property 4			r	V	
Property 5					V

Favorites



#### **User Features**

	4 Bedroom	Near Park	Good School	Views	New Build
Property 1		~	4		
Property 2	~			~	
Property 3			~		~
Property 4		~			
Property 5			4	~	

#### **Property Features**



#### **Deriving Recommendations from Features**

	4 Bedroom	Near Park	Good School	Views	New Build		4 Bedroom	Near Park	Good School	Views	New Build			User 1	User 2	User 3	User 4	User 5
Property 1		4	V			User 1		<b>v</b>		~			Property 1	~	*			
Property 2	~			~		User 2	~		~				Property 2	4	~	*	*	
Property 3			~		~	User 3		~	~			—	Property 3		~	~	~	
Property 4		v				User 4		~	V				Property 4		*	v	V	
Property 5			v	~		User 5			V	~			Property 5					4

**Property Features** 

#### **User Features**

#### Recommendations

	User 1	User 2	User 3	User 4	User 5	
Property 1	V					1
Property 2	v	V				1
Property 3		V	V	v		1
Property 4			V	r		1
Property 5					V	1

	4 Bedroom	Near Park	Good School	Views	New Build	
Property 1		4	4			
Property 2	V			~		0
Property 3			4		4	X
Property 4		4				
Property 5			4	~		

Property Features

	4 Bedroom	Near Park	Good School	Views	New Build
User 1		~		~	
User 2	V		V		
User 3		~	~		
User 4		~	~		
User 5			~	V	

**User Features** 





# **Alternating Least Squares**

#### 1. Generate Random User Feature Data

	4 Bedroom	Near Park	Good School	Views	New Build	
User 1		~			~	
User 2			~		~	
User 3	V					
User 4		V		v		
User 5					~	

#### 2. Using Favorites, Compute Optimal Property Features



#### 4. Repeat

	4 Bedroom	Near Park	Good School	Views	New Build	
User 1			~			
User 2	V		~		~	
User 3	~					
User 4			~	4		
User 5		~			V	

#### 3. Using Property Features and Favorites, Compute Optimal User Features

	User 1	User 2	User 3	User 4	User 5			4 Bedroom	Near Park	Good School	Views	New Build
Property 1	v						Property 1		4			~
Property 2	V	V				$\mathbf{\nabla}$	Property 2	~			~	
Property 3		V	4	V		$\mathbf{h}$	Property 3					~
Property 4			4	~			Property 4		~			
Property 5					~		Property 5			~		

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The User Features & Property Features converge to a model that fits the training data

#### Latent Features

	Feature 1	Feature 2	Feature 3	Feature 4	Feature N
Property 1		<b>v</b>	<b>v</b>		
Property 2	<b>v</b>			~	
Property 3			<b>v</b>		<ul> <li>✓</li> </ul>
Property 4		$\checkmark$			
Property 5			<b>v</b>	<ul> <li>✓</li> </ul>	

	Feature 1	Feature 2	Feature 3	Feature 4	Feature N
User 1		<b>v</b>		<b>v</b>	
User 2	<b>~</b>		<b>v</b>		
User 3		<b>v</b>	<b>v</b>		
User 4		<b>v</b>	<b>v</b>		
User 5			<b>v</b>	<b>v</b>	

### **Dot Product**

#### Calculating Predictions

	Feature 1	Feature 2	Feature 3	Feature 4	Feature N
Property 1		<ul> <li>✓</li> </ul>	<ul> <li>✓</li> </ul>		
	Feature 1	Feature 2	Feature 3	Feature 4	Feature N
User 1		<b>v</b>		<b>v</b>	
	0 × 0	+ 1×1 -	+ 1×0	+ 0×1 ·	+ 0×0

# Recommendations

Matrix Factorization Model

	User 1	User 2	User 3	User 4	User 5
Property 1	9	7	5	5	0
Property 2	9	9	7	7	0
Property 3	7	9	9	9	0
Property 4	5	9	9	9	0
Property 5	0	0	0	0	9

#### Alternating Least Squares Spark ML Makes it Easy

val favorites: Seq[Favorite] = ...

val ratings = favorites.map(fav => Rating(fav.user, fav.prop, 1))

val (userFeatures, propertyFeatures) = ALS.train(ratings = ratings, rank = 5)

val predictions = userFeatures \* propertyFeatures

val predictionsForUser = predictions.filter(\_.userId == userId)

# CODE! https://github.com/jamesward/dreamhouse-sparkml

# Deployment

- Deploy it on Heroku
- Run on a Spark Cluster
- When to train?
- Where to put the model?

# PredictionIO

#### Open Source Machine Learning Server



- Template Gallery
- Event Server
- Model Persistence
- Engine Tuning & Versioning
- REST Endpoint for Predictions

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# Thank You