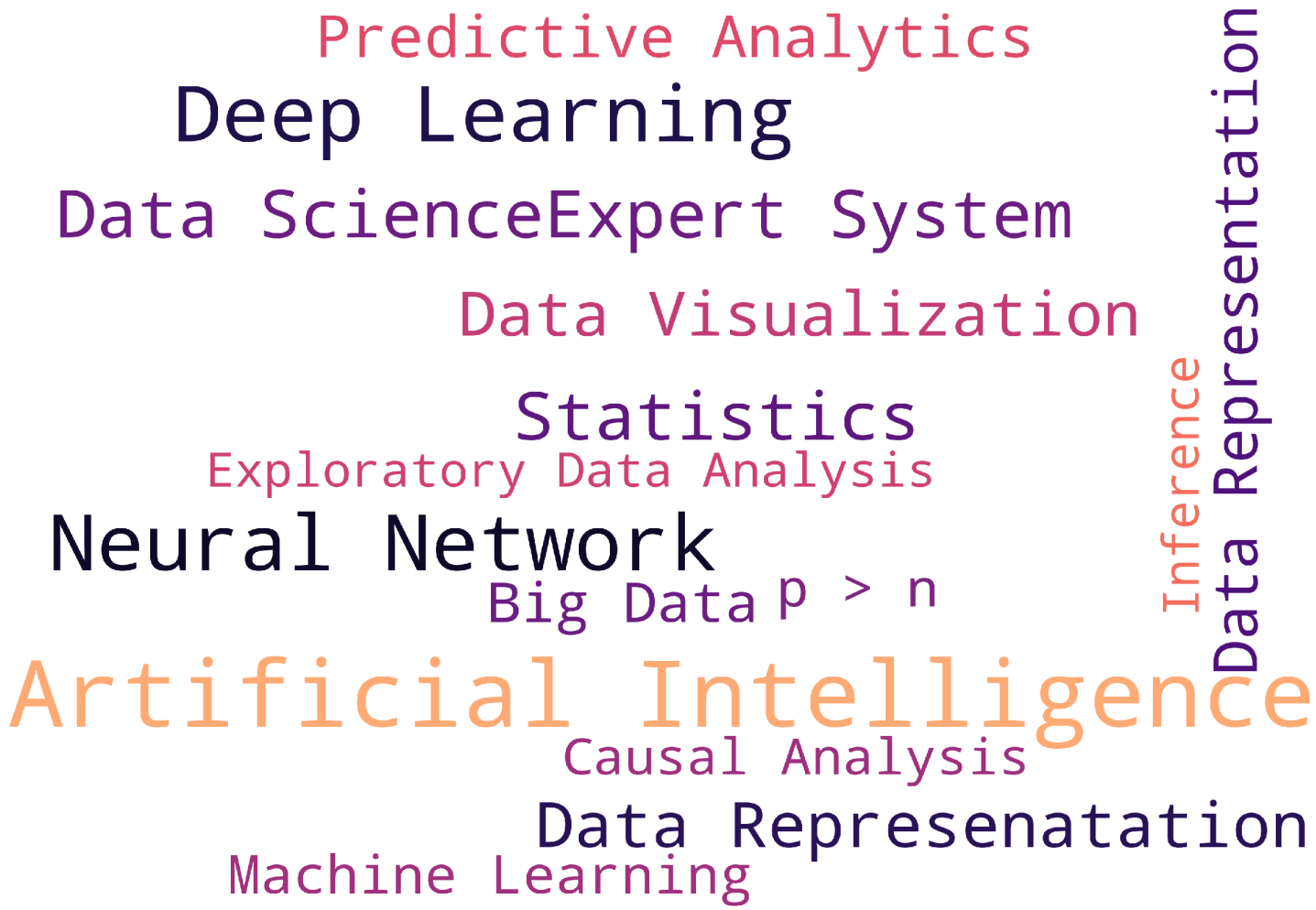
The Promise, Pitfalls and Process of AI

Stephen J. Mildenhall

May 20-21, 2019

ST. JOHN'S UNIVERSITY
Tobin College of Business
School of Risk Management


Predictive Analytics
Deep Learning
Data ScienceExpert System
Data Visualization
Statistics
Exploratory Data Analysis
Neural Network
Big Data
p > n
Artificial Intelligence
Causal Analysis
Data Represenatation
Machine Learning
Inference
Data Representation


1006 Woodbine Ave
Oak Park, Illinois
Google
Street View - Oct 2018
Lindberg Park
Google

Buying a House: How Much to Offer?

Facts and Features

Type
Single Family

Year Built
1928

Heating
Radiant

Cooling
Central

Parking
2 spaces

Lot
7,400 sqft

INTERIOR FEATURES

Bedrooms

Beds: 3

Bathrooms

Baths: 1 full, 1 half

Heating and Cooling

Heating: Radiant

Heating: Gas

Cooling: Central

Basement

Appliances

Appliances included:
Dishwasher, Dryer, Garbage disposal, Microwave, Range / Oven, Refrigerator, Trash compactor, Washer

Flooring

Floor size: 2,346 sqft

Flooring: Hardwood

Other Interior Features

Fireplace

See More Facts and Features

Home Value

Zestimate

$565,863

1010 Woodbine Ave, Oak Park,

Contact Agent

Or call 773-974-9996 for more info

Nearby Similar Sales

SOLD: $565,000
Sold on 05/23/18
3 bds, 2 ba, 1,932 sqft
846 Linden Ave, Oak Park, IL 60302

SOLD: $560,000
Sold on 05/29/18
3 bds, 2.5 ba, 2,660 sqft
830 Belleforte Ave, Oak Park, IL 60302

SOLD: $570,000
Sold on 04/26/19
4 bds, 2.5 ba, 2,332 sqft
913 Linden Ave, Oak Park, IL 60302

SOLD: $550,000
Sold on 11/13/18
3 bds, 2.5 ba, 1,696 sqft
1047 N Grove Ave, Oak Park, IL 60302

SOLD: $540,000
Sold on 11/30/18
4 bds, 2.5 ba, 2,204 sqft
1015 Woodbine Ave, Oak Park, IL 60302

See sales similar to 1010 Woodbine Ave

Comparables

- Statistics: learning from data
- **Descriptive** statistics: summarize with no interpretation
- **Exploratory** data analysis (EDA): claims about current sample

Generalizing Comparables

- Relevant comparables may not be available
- Extend limited data
- **Predictive** modeling: estimate value for an **out of sample** unit
- Buyer's perspective

Understanding Comparables

- Seller's perspective: does an investment to
  - remodel the kitchen or
  - paint or
  - landscape or
  - add a bathroom or
  - make life easier for my broker

  make sense?

- **Inferential** statistics

Machine Learning (ML)

- **Machine learning**: an algorithm allowing computer to build and improve a model from more **data**

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- GLMs
- Logistic regression
- Decision trees
- Exam **MAS** material

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- **Not ML**: expert system, knowledge base

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ML Problems

- Classification
- Regression
- Transcription
- Machine translation
- Anomaly detection
- Synthesis
- Impute missing values
- De-noise
- Density estimation

Comparables. . .

Comparables. . .

- Encapsulate considerable domain expertise

...and are a powerful data representation

Three Houses in Same Town: Rank by Market Value

Three Houses in Same Town: Rank by Market Value

Three Houses in Same Town: Rank by Market Value

Three Houses in Same Town: Rank by Market Value

1) $A < B < C$
2) $B < A < C$
3) $B < C < A$
4) $C < B < A$
5) None of the above

FYI, values are $x : 3x : 9x$

Home Facts by Data Source ALL SOURCES COMBINED COUNTY RECORDS County website Beds: 6 – Baths: 7.5 4.5 Sqft: 12,000 7,914 Lot: 39,622 sq ft / 0.91 acres 39,621 sq ft / 0.91 acres Type: Single Family Single Family Year Built: 1929 1929 Last Sold: Aug 2011 for $2,100,000 – Parking: Attached Garage Garage - Attached Cooling: Central Central Heating: Gas – Fireplace: Yes Yes Days on Zillow: 47 – MLS #: 10322977 – Other facts Additional Features: Air Conditioning: Zoned, Space Pac, Appliances: All Stainless Steel Kitchen Appliances, 2nd Bedroom Level: 2nd Level, Built Before 1978 (Y/N): Yes, Electricity: Circuit Breakers, 400 Amp Service or Greater, Family Room Level: Not Applicable, Heat/Fuel: Hot Water/Steam, 2+ Sep Heating Systems, Zoned, Sewer: Sewer-Public, Listing Type: Exclusive Right To Sell, Master Bedroom Level: 2nd Level, Parking Type: Garage, Water: Lake Michigan, Kitchen Level: Main Level, Living Room Level: Main Level, Exposure: W (West), S (South), E (East), N (North), Sale Terms: Conventional, 3rd Bedroom Level: 2nd Level, Equipment: Sump Pump, Sprinkler-Lawn, Power Generator, Kitchen Type: Pantry-Closet, Eating Area-Table Space, Island, Basement Bathrooms (Y/N): Yes, Addtl Room 2 Level: 2nd Level, Bath Amenities: Double Sink, Steam Shower, Lot Description: Corner, Addtl Room 4 Level: Main Level, Addtl Room 1 Level: 3rd Level, Addtl Room 3 Level: 3rd Level, 4th Bedroom Level: 2nd Level, Addtl Room 3 Name: Office, Addtl Room 5 Level: 3rd Level, Addtl Room 1 Name: 5th Bdrm, Addtl Room 2 Name: 6th Bdrm, Frequency: Not Applicable, Attic: Full, Interior Stair, Finished, Addtl Room 6 Level: Basement, Addtl Room 7 Level: 2nd Level, Addtl Room 9 Level: Main Level, Addtl Room 8 Level: 2nd Level, Status: New, Addtl Room 4 Name: Library, Addtl Room 5 Name: Attic, Addtl Room 9 Name: Gallery, Square Feet Source: Estimated, Master Bedroom Bath (Y/N): Full, Age: 81-90 Years, Area Amenities: Street Lights, Street Paved, Sidewalks, Pool, Garage On-Site: Yes, Additional Rooms: Recreation Room, 5th Bedroom, Sitting Room, 6th Bedroom, Recent Rehab (Y/N): Yes, Additional Sales Information: List Agent Must Accompany, 2nd Floor Laundry, In-Law Arrangement, Heated Floors, Breezeway, Dog Run, Fireplace Location: Other, Is Parking Included in Price: Yes, Type of House 2: 2 Stories, Garage Ownership: Owned, Laundry Level: Not Applicable, Additional Rooms: Terrace, Attic, Office, Gallery, Library, Addtl Room 6 Name: Recreation Rm, Addtl Room 7 Name: Sitting, Addtl Room 10 Level: Main Level, Addtl Room 8 Name: Sitting, Addtl Room 10 Name: Terrace, Aprox. Total Finished Sq Ft: 0, Total Sq Ft: 0, Lot Dimensions: 215 X 184, Tax Year: 2017, Parcel Identification Number: 15013170210000 – Appliances Included: Dishwasher, Dryer, Garbage disposal, Microwave, Range / Oven, Refrigerator, Washer – County Name: Cook County Cook Covered Parking Spaces: 4 4 Exterior Material: Brick, Stone Stone Floor Covering: Carpet, Hardwood – Heating Type: Forced air – Laundry: In Unit – Parcel #: 1501317021 1501317021 Pets: Contact manager – Roof Type: Slate Slate Room Count: – 0 Room Types: Dining room – Stories: 0.0 2.0 Structure Type: Tudor Split level Unit Count: 0 0 Zillow Home ID: 123561615 –
From https://www.zillow.com/homes/for_sale/Oak-Park-IL-60302/123561615_zpid/84453_rid/globalrelevanceex_sort/41.897302,-87.808603,41.886408,-87.826799_rect/15_zm/?

Home Facts by Data Source ALL SOURCES COMBINED COUNTY RECORDS County website Beds: 5 4 Baths: 4.0 3.5 Sqft: 3,360 3,360 Lot: 13,560 sq ft / 0.31 acres 13,562 sq ft / 0.31 acres Type: Single Family Single Family Year Built: 1899 1898 Last Sold: – – Parking: Detached Garage Garage - Detached Cooling: Central – Heating: Gas – Fireplace: Yes Yes Days on Zillow: 117 – MLS #: 10344749 – Other facts Additional Features: Addtl Room 5 Level: Not Applicable, Appliances: Oven-Double, All Stainless Steel Kitchen Appliances, 2nd Bedroom Level: 2nd Level, Built Before 1978 (Y/N): Yes, Sewer: Sewer-Public, Listing Type: Exclusive Right To Sell, Master Bedroom Level: 2nd Level, Parking Type: Garage, Space/s, Tax Exemptions: Homeowner, Equipment: Ceiling Fan, CO Detectors, Water: Lake Michigan, Kitchen Type: Eating Area-Breakfast Bar, Eating Area-Table Space, Island, Kitchen Level: Main Level, Living Room Level: Main Level, 3rd Bedroom Level: 2nd Level, Other Information: School Bus Service, Commuter Train, Historical District, Exposure: E (East), Electricity: 200+ Amp Service, Exterior Building Type: Frame, Addtl Room 2 Level: Main Level, Addtl Room 2 Name: Foyer, Addtl Room 3 Level: 2nd Level, Addtl Room 1 Level: 3rd Level, Addtl Room 4 Level: 2nd Level, 4th Bedroom Level: 2nd Level, Driveway: Side Drive, Concrete, Addtl Room 4 Name: Balcony, Addtl Room 1 Name: 5th Bdrm, Family Room Level: 3rd Level, Age: 100+ Years, Addtl Room 10 Level: Not Applicable, Addtl Room 6 Level: Not Applicable, Addtl Room 7 Level: Not Applicable, Addtl Room 8 Level: Not Applicable, Addtl Room 9 Level: Not Applicable, Frequency: Not Applicable, Attic: Full, Interior Stair, Finished, Foundation: Stone, Status: New, Square Feet Source: Assessor, Master Bedroom Bath (Y/N): Full, Bath Amenities: Soaking Tub, Area Amenities: Curbs/Gutters, Street Lights, Street Paved, Sidewalks, Garage On-Site: Yes, Parking On-Site: Yes, Additional Rooms: Balcony, 5th Bedroom, Additional Sales Information: List Agent Must Accompany, Heated Floors, Balcony, Parking Ownership: Owned, Fireplace Location: Other, Is Parking Included in Price: Yes, Parking: Driveway, Type of House 2: 3 Stories, Lot Dimensions: 78X175, Additional Rooms: Foyer, Garage Ownership: Owned, Laundry Level: Not Applicable, Aprox. Total Finished Sq Ft: 0, Total Sq Ft: 0, Basement Sq Ft: 0, Tax Year: 2017, Parcel Identification Number: 16071030160000 – Appliances Included: Dishwasher, Dryer, Garbage disposal, Microwave, Range / Oven, Refrigerator, Trash compactor, Washer – Assisted Living Community: No – Attic: Yes – Barbecue Area: No – Basement Type: Partial – Basketball Court: No – Cable Ready: No – Ceiling Fan: Yes – Controlled Access: No – County Name: Cook County Cook Covered Parking Spaces: 7 2 Deck: No – Disability Access: No – Dock: No – Doorman: No – Double Pane/Storm Windows: No – Elementary School: Oliver W Holmes Elementary Schoo – Elevator: No – Exterior Material: Stone, Wood Wood Fenced Yard: Yes – Floor Covering: Hardwood, Slate – Garden: Yes – Gated Entry: No – Greenhouse: No – Fitness Center: No – Heating Type: Baseboard, Radiant – High School: Oak Park & River Forest High Sch – Hot Tub/Spa: No – Intercom: No – Jetted Tub: No – Laundry: In Unit – Lawn: No – Legal Description: – (WORWICKS) SUB OF LT1 EX N7FT & ALL OF LT2 IN BLK2 IN KETTLESTRINGS ADD TO HARLEM SUB OF PT OF NW SEC 07-39-13 Middle School: GWENDOLYN BROOKS MIDDLE SCHOOL – Mother-in-Law Apartment: No – Near Transportation: No – Over 55 Active Community: No – Parcel #: 1607103016 1607103016 Patio: Yes – Pets: Contact manager – Pond: No – Pool: Yes – Porch: Yes – Roof Type: Asphalt Shake/Shingle Room Count: 9 0 Room Types: Dining room, Family room, Laundry room, Master bath, Walk-in closet – RV Parking: No – Sauna: No – Security System: No – Skylight: Yes – Sports Court: No – Sprinkler System: No – Storage: No – Stories: 3.0 2.0 Structure Type: Victorian Other Tennis Court: No – Unit Count: 0 0 Vaulted Ceiling: No – Waterfront: No – Wet Bar: No – Wired: No – Zillow Home ID: 3803093 –
From https://www.zillow.com/homes/for_sale/Oak-Park-IL-60302/3803093_zpid/84453_rid/globalrelevanceex_sort/41.898596,-87.787757,41.887702,-87.805953_rect/15_zm/?

Home Facts by Data Source ALL SOURCES COMBINED COUNTY RECORDS County website Beds: 3 3 Baths: 1.0 1.0 Sqft: 2,080 1,376 Lot: 4,159 sq ft / 0.10 acres 4,158 sq ft / 0.10 acres Type: Single Family Single Family Year Built: 1914 1913 Last Sold: – – Parking: Detached Garage Garage - Detached Cooling: Central Central Heating: Gas – Fireplace: – – Days on Zillow: 104 – MLS #: 10260750 – Other facts Additional Features: Addtl Room 4 Level: Not Applicable, Addtl Room 5 Level: Not Applicable, 4th Bedroom Level: Not Applicable, Built Before 1978 (Y/N): Yes, Sewer: Sewer-Public, Listing Type: Exclusive Right To Sell, Parking Type: Garage, Tax Exemptions: Homeowner, Senior, Senior Freeze, Addtl Room 1 Level: Main Level, 2nd Bedroom Level: Main Level, Water: Lake Michigan, Kitchen Level: Main Level, Living Room Level: Main Level, Master Bedroom Level: Main Level, Other Information: School Bus Service, Commuter Bus, Addtl Room 3 Level: Main Level, 3rd Bedroom Level: Main Level, Addtl Room 2 Name: Recreation Rm, Addtl Room 1 Name: Breakfast Rm, Family Room Level: Basement, Addtl Room 2 Level: Basement, Age: 100+ Years, Addtl Room 10 Level: Not Applicable, Addtl Room 6 Level: Not Applicable, Addtl Room 7 Level: Not Applicable, Addtl Room 8 Level: Not Applicable, Addtl Room 9 Level: Not Applicable, Frequency: Not Applicable, Status: New, Square Feet Source: Plans, Master Bedroom Window Treatments (Y/N): Curtains/Drapes, 3rd Bedroom Window Treatments (Y/N): Shades, Exterior Building Type: Aluminum Siding, Addtl Room 2 Window Treatments (Y/N): Blinds, Family Room Window Treatments (Y/N): Blinds, Area Amenities: Curbs/Gutters, Street Lights, Street Paved, Sidewalks, Park/Playground, Addtl Room 3 Window Treatments (Y/N): Curtains/Drapes, Garage On-Site: Yes, 1st Floor Bedroom, 1st Floor Full Bath, Additional Rooms: Recreation Room, Breakfast Room, Sun/Florida Room Heated, Is Parking Included in Price: Yes, Addtl Room 3 Name: Sun/Florida Room Heated, Type of House 2: 1 Story, Lot Dimensions: 125 X 33, Garage Ownership: Owned, Laundry Level: Not Applicable, Aprox. Total Finished Sq Ft: 2080, Main Sq Ft: 1376, Total Sq Ft: 1376, Tax Year: 2016, Parcel Identification Number: 16053110300000 – Appliances Included: Dishwasher, Dryer, Range / Oven, Refrigerator, Washer – County Name: Cook County Cook Covered Parking Spaces: 2 2 Elementary School: Whittier Elementary School – Exterior Material: Wood Wood Floor Covering: Carpet, Hardwood, Linoleum / Vinyl – Heating Type: Forced air – High School: Oak Park & River Forest High Sch – Laundry: In Unit – Legal Description: – (HOOKERS) SUB OF NE SW SEC 05-39-13 Middle School: GWENDOLYN BROOKS MIDDLE SCHOOL – Parcel #: 1605311030 1605311030 Pets: Contact manager – Roof Type: Tile Shake/Shingle Room Count: – 0 Room Types: Dining room – Stories: 0.0 1.0 Structure Type: Bungalow Bungalow Unit Count: 0 0 Zillow Home ID: 3799641 –
From https://www.zillow.com/homes/for_sale/Oak-Park-IL-60302/3799641_zpid/84453_rid/globalrelevanceex_sort/41.902253,-87.774485,41.89136,-87.792681_rect/15_zm/?

Humans excel at image recognition...

- Humans can process images very quickly
  - The three images contain several **megabytes** of data, $p \gg n$
- Computers can process structured text very quickly
  - The raw text contains a few **kilobytes** of information
- Which system would you rather try to program?

...and many other problems computers find hard

Artificial Intelligence (AI)

- **Artificial Intelligence**: solving problems people find easy but computers find hard
  - Image interpretation
  - Conversation
  - Reading emotions
  - Catching frisbees
- Skills shared with other animals having neuron-based brains
- AI is a **problem domain**

The Premise of AI...

Appears people have gotten a long way with a **single** trick

- Recent studies suggests the mammalian brain uses a **single algorithm** to solve most tasks
- Previously machine learning research fragmented: distinct approaches for natural language processing, vision, motion planning, speech recognition

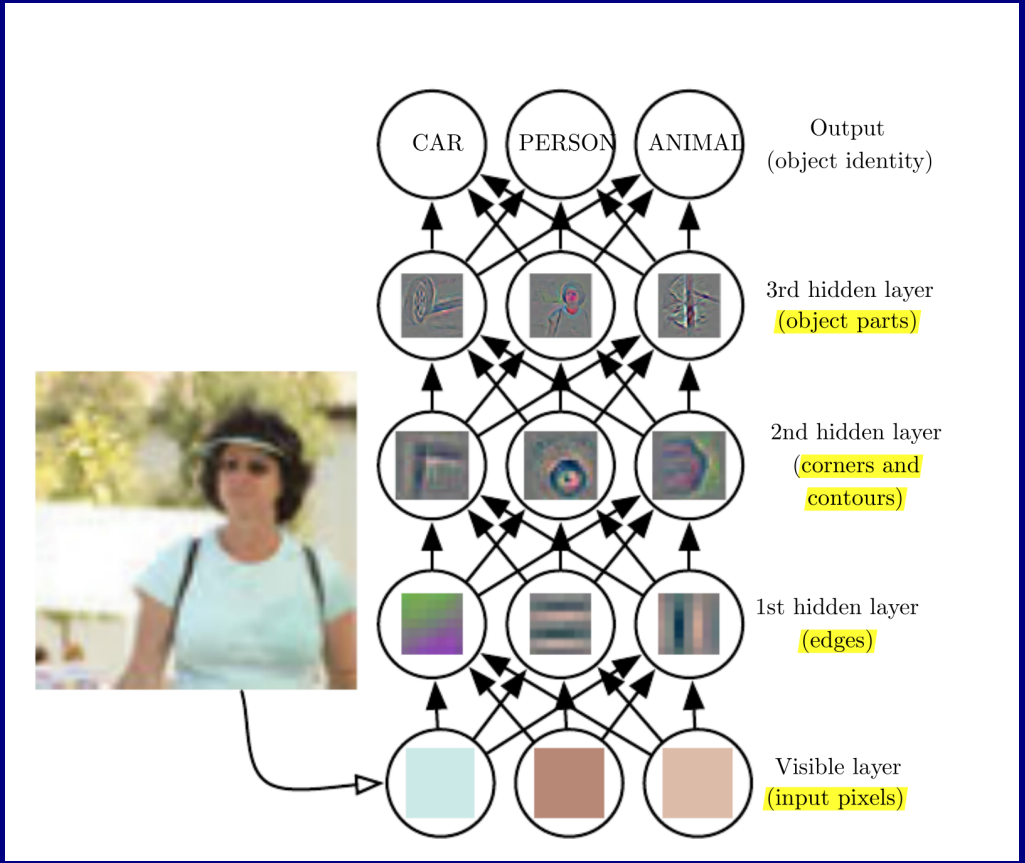
...today AI leverages a single general purpose algorithm inspired by, but not simulating, brain function to solve a wide range of problems

AI General Purpose Algorithm

- Learn **model** from experience
  - Use machine learning
  - *Show don't tell* background information
- Learn what is **important**
  - Data **representation** created simultaneously with model
- Understand the world as a **hierarchy of concepts**
  - Complicated concepts built out of simpler ones
- Hierarchy of concepts has many layers
  - **Deep** learning

AI General Purpose Algorithm...

- Hierarchy layers built using simple *neuron* nodes
- **Neural networks** build new covariates from non-linear **hinge** functions of existing covariates and the output of other layers
- Optimize overall fit with least squares



...algorithm inspired by our understanding of brain function

AI General Purpose Algorithm: A Naïve Description

- Neural networks and deep learning are fancy least squares
  - Solve using **gradient descent** = walking downhill
  - Stochastic gradient descent = probably walking downhill
- Approximate complex functions by **compositions of simple ones**
- Build and combine specialized problem solving nodes
  - recognize color...
  - recognize car vs truck vs bike vs motorcycle vs ...
  - can combine to recognize red car, blue truck, ...
- Pool, share and feedback information between nodes
- Nodes **simultaneously** learn **model** and data **representation**

AI Has a Long History...

Old Approach	New Approach
Knowledge base: hard-coded knowledge about world	**Machine Learning**: extract model from training data
Expert system: humans decide important features	**Representation Learning**: determine important factors of variation
Neural networks	**Deep learning** neural networks

...but hasn't always performed as expected

Why Is AI Working Now?

- Better algorithms
- More data
- Bigger models

‘Godfathers of AI’ honored with Turing Award, the Nobel Prize of computing

Yoshua Bengio, Geoffrey Hinton, and Yann LeCun laid the foundations for modern AI

By James Vincent | Mar 27, 2019, 6:02am EDT

SHARE

From left to right: Yann LeCun | Photo: Facebook; Geoffrey Hinton | Photo: Google; Yoshua Bengio | Photo: Botler AI

Why AI Is Working Now: **Better Algorithms**

Pre-2006 deep networks were believed to be very **difficult to train**

- Better algorithms devised by Hinton in 2006 allowed deeper models by making them faster to train
- Beginning of the deep learning era
- Tens of thousands of researchers working in AI/ML

A fast learning algorithm for deep belief nets

GE **Hinton**, S Osindero, YW Teh - Neural computation, **2006** - MIT Press

We show how to use "complementary priors" to eliminate the explaining-away effects that make inference difficult in densely connected belief nets that have many hidden layers. Using complementary priors, we derive a fast, greedy algorithm that can learn deep, directed …

☆ 99 Cited by 10337 Related articles All 61 versions

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☆ 99 Cited by 10337 Related articles All 61 versions

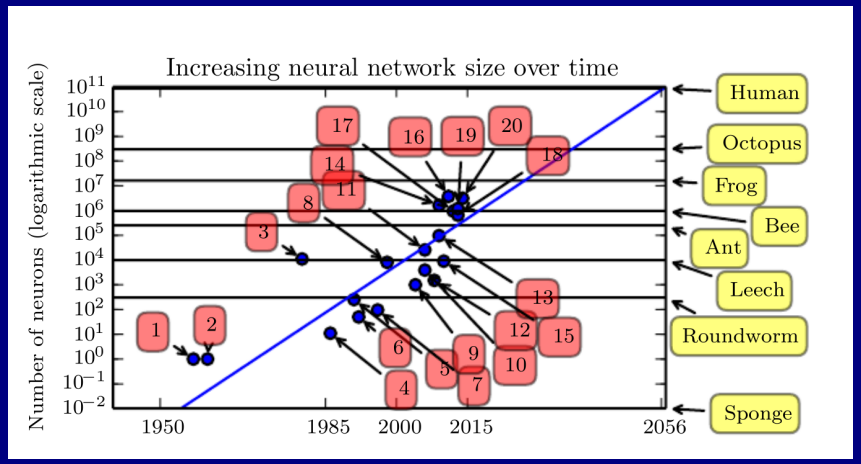
Premium calculation by transforming the layer premium density
S **Wang** - ASTIN Bulletin: The Journal of the IAA, 1996 - cambridge.org
This paper examines a class of premium functionals which are (i) comonotonic additive and (ii) stochastic dominance preservative. The representation for this class is a transformation of the decumulative distribution function. It has close connections with the recent developments …
★ 99 Cited by 706 Related articles All 8 versions

Why AI Is Working Now: **More Data**

- More data: IOT, Big Data, digitization of society
- **More data = less skill** required to train model
- Goodfellow data rules of thumb: a supervised deep learning algorithm will generally
  - achieve **acceptable** performance with around **5,000** labeled examples per category
  - will match or **exceed human** performance when trained with a dataset containing at least **10 million** labeled examples

Why AI Is Working Now: **Bigger Models**

- Bigger = **deeper** models
  - More computer power
  - Better algorithms
- Model size: **connections** and **number** of neurons or nodes
- Biological neurons not densely connected
  - Models within order of magnitude of mammal brains
- Number of neurons: current models are very small
  - Doubling every 2.4 years
  - **Match human brain by 2050**

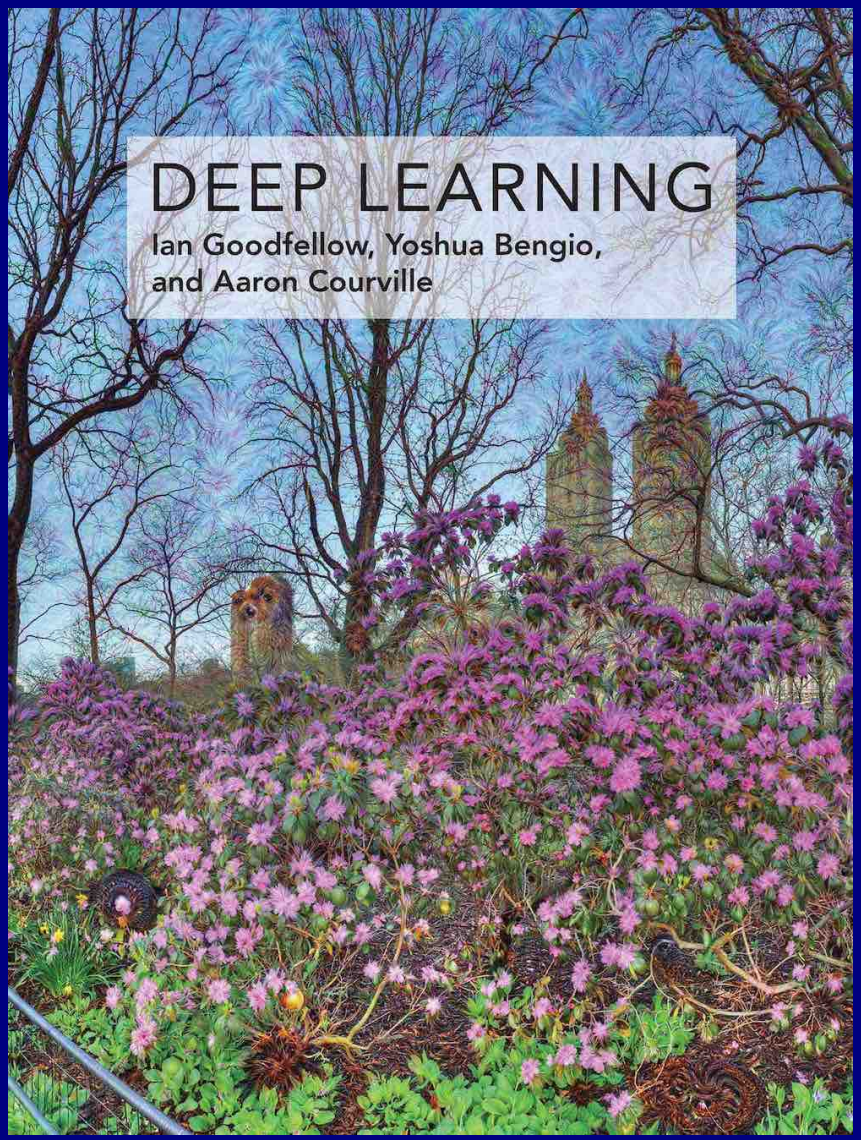


...can't expect much from a leech-brain sized network

Deep Learning Summary

Deep learning is an approach to AI. Specifically, it is a type of machine learning, a technique that allows computer systems to improve with experience and data.

- . . . machine learning is the **only viable approach** to building AI systems that can operate in complicated, real-world environments
- Deep learning. . . achieves great power and flexibility by learning to represent the world as a **nested hierarchy of concepts**



Central Park Dreamscape CGI

When Does AI Work Well?

Stunning results

- Static, rules based environment
- Clean, direct observations
- Essentially limitless data
- Definitive right answer

Examples

- Classification problems
- Image, speech recognition
- Pedestrian detection
- **Traffic sign classification**
- Simple dynamic control
- Reinforcement learning, robotics
- Synthetic data, alphaZero
- GANs

When Does AI Work Well?

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- GANs

Characteristics of insurance

- Behavioral feedbacks
- Dynamic: reacts as we learn
- Proxy data, not direct
- **Inherently small** classes
- Uncertain data: development
- Latent data

...AI works well on real world data

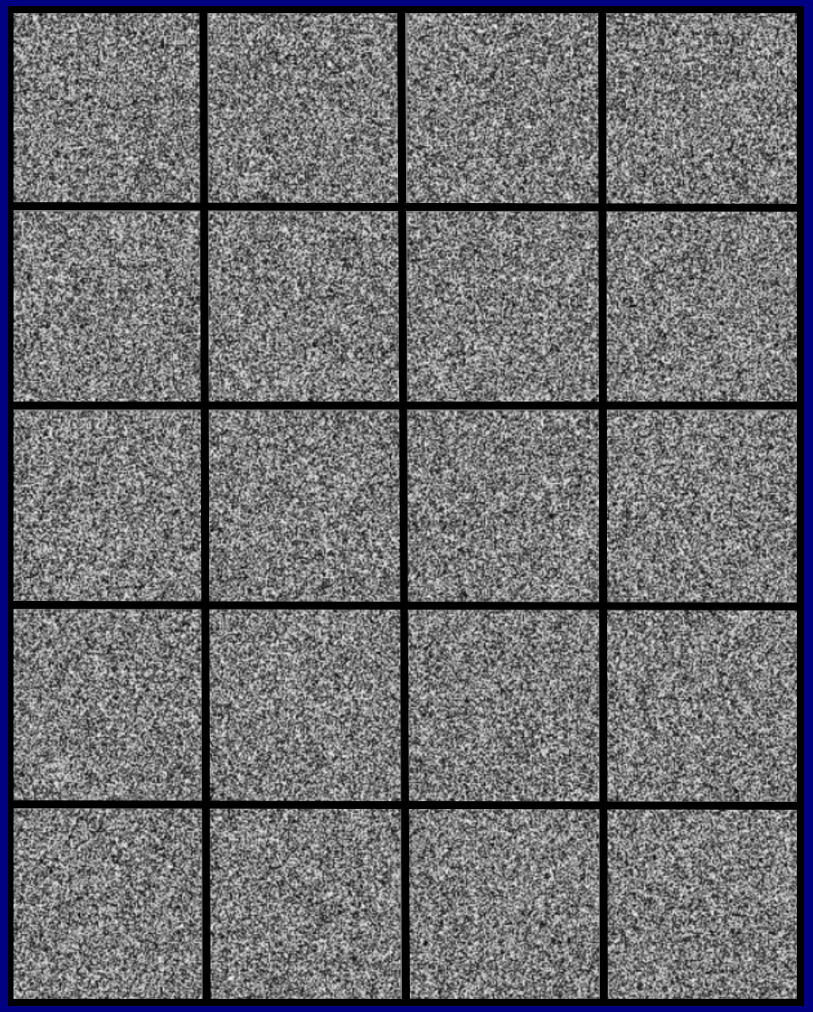
Real World Data

- **No Free Lunch** Theorem for ML
  Averaged over all possible data generating distributions, **every** *classification algorithm has the* **same error rate** *on new data*
- No machine learning algorithm is universally any better than any other
- The most sophisticated algorithm has the same average performance as predicting every point belongs to the same class
- ML ignores grim prognosis and finds rules that are probably correct most of the time

...regardless, AI works well on real data

AI Assumptions About *Real Data*

- Real data often appears very high dimensional ($p \gg n$) but really contains **hidden structure**
- Photographs do not look like random images
  - Continuous: image near a photograph recognizable
  - No jumps or cliffs
  - Not fractal-like



Real images occupy a **negligible proportion** of the total volume of image space

AI Assumptions About *Real Data*

Helpful **general purpose priors** or data rules of thumb

Representation learning: A review and new perspectives

Y Bengio, A Courville, P Vincent - IEEE transactions on pattern …, 2013 - ieeexplore.ieee.org

The success of machine learning algorithms generally depends on data representation, and we hypothesize that this is because different representations can entangle and hide more or less the different explanatory factors of variation behind the data. Although specific domain knowledge can be used to help design representations, learning with generic priors can also be used, and the quest for AI is motivating the design of more powerful representation-learning algorithms implementing such priors. This paper reviews recent work in the area of …

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AI Assumptions About *Real Data*

Assumption	Concerns
Smoothness	Weather, butterfly effect; singularities
Multiple explanatory factors	Sudden change in relationship
Common material drivers	or sentiment
Shared factors across tasks	Phase change or market crash
Hierarchical organization of factors	
Simple **linear** factor dependencies	Log-linear: earthquakes
Manifolds: real data is low d	
Natural clustering	
Sparsity, 80/20 explanatory rule	
Temporal and spatial **coherence**	
Causal factors	State dependent causality

AI Applications: Everything

AI Applications: Well... Almost Everything

Insurance-Related AI Applications

Good fit, already live

- Marketing
- Customer service
- Underwriting homogeneous classes = predictive modeling
- Claims processing
- Fraud detection
- Health care

Potential good fit

- Claims reserving
- Loss reserving, see Brian...
- Data quality
- Anomaly detection
- Data completion
- Underwriting **accounts** = detecting risk-aware management
- Risk management in high frequency lines

More Challenging for AI

Data rules fail

- Discontinuities
- State change
- Sentiment change
- Singularities: tornados, black holes
- Fractal data
- Butterfly effect
- Weather models
- Cat models
- Identify next mass tort

More Challenging for AI

Data rules fail

- Discontinuities
- State change
- Sentiment change
- Singularities: tornados, black holes
- Fractal data
- Butterfly effect
- Weather models
- Cat models
- Identify next mass tort

The Limits of Predictability

- Observations = **Trials** × **Probability**
- For Observations $\geq 5000\ldots$
  $\ldots$ need Trials $\geq 5000/\text{Probability}$
- For $p = 0.001$ need Trials ≥ 5 **million**
- For $p = 10^{-6}$ need Trials ≥ 5 **billion**

- For $p \approx 0.01$ see plenty of examples on r/CatastrophicFailure, r/IdiotsInCars, r/nononono, r/OSHA, r/Roadcam

AI Compared to Catastrophe and Weather Models

- Given Observations = Trials × Probability. . . is enough data **practically possible**?

- Weather and catastrophe models are physics-based models
- Physical models better than a learned phenomenological models
- Re-learning physics inefficient
- AI can work effectively in **conjunction** with physics-based models

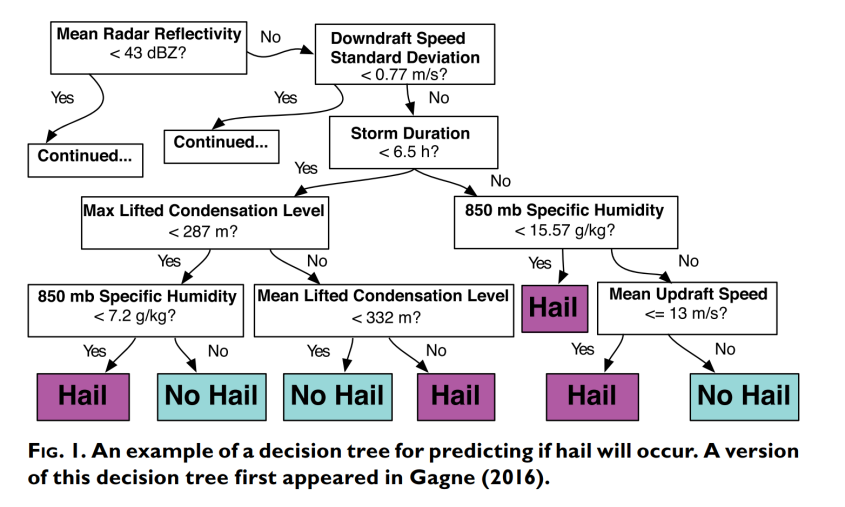


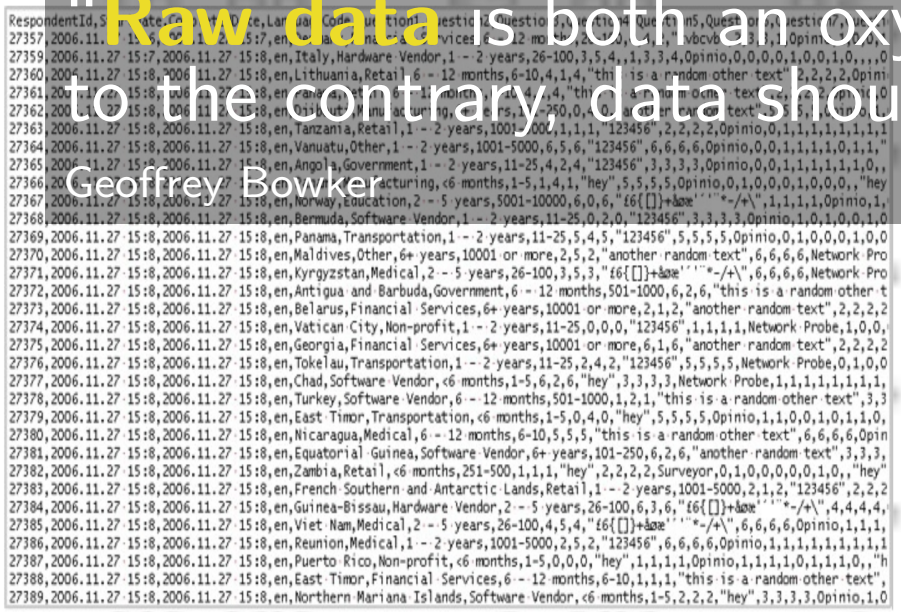
Fig. 1. An example of a decision tree for predicting if hail will occur. A version of this decision tree first appeared in Gagne (2016).

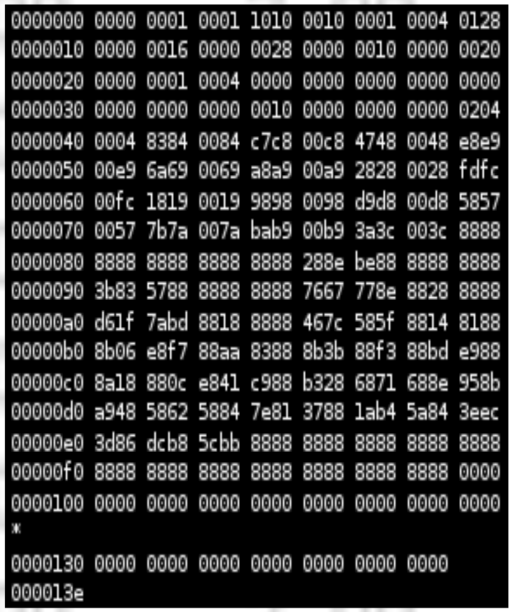
y

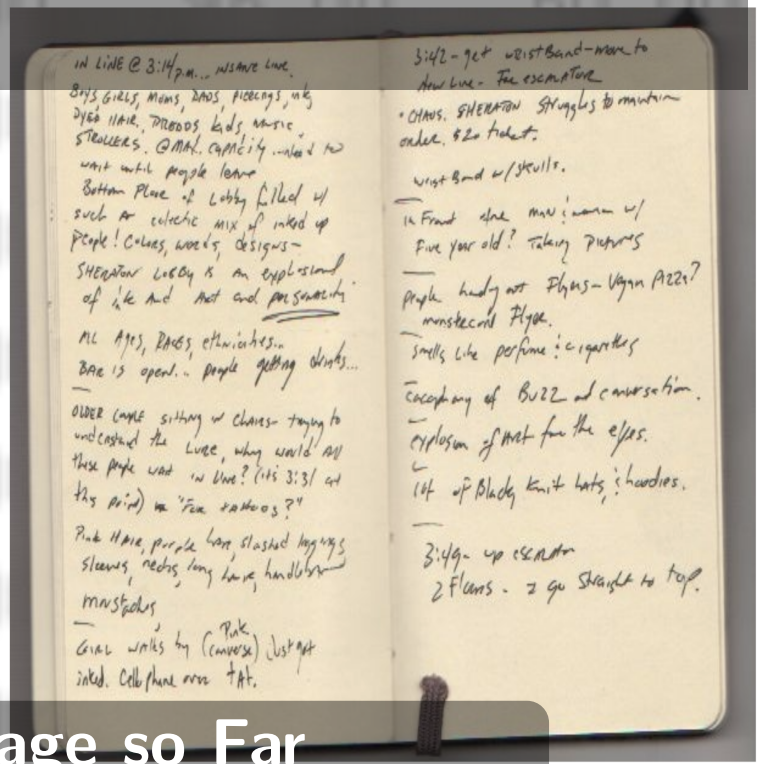
...AI already being applied to forecast high impact weather events

“**Raw data** is both an oxymoron and a bad idea; to the contrary, data should be cooked with care.”

Geoffrey Bowker







Message so Far

- Show don’t tell
- Input training data
- Derive data **representation**
- Derive **model** relationships

AI Bias and Sources of Modeling Failure

- Computers do not see images with semantic understanding
- Computers see things the eye cannot detect: lighting, type of camera
- Computers don't filter irrelevant information
- Basic statistics emphasizes training data must be a **random cross section** of population
  - Extend to include new characteristic picked up by ML
- Skills for AI modeling era
  - Enhanced methodological rigor **managing training data**
  - Technical tools to analyze and diagnose the **behavior** of the model
  - Training, education and caution in the **deployment** of ML in products

AI Bias and Sources of Modeling Failure

- How do the models fail?
  - Technical problem inherent in algorithm
  - Bad implementation
  - Institutional failure by large bureaucracy

- Understanding decisions in big organization very complex
  - Like evaluating ML models people are black boxes too

...AI is just a machine—think washing machine
not HAL9000—powerful but limited

Benedict Evans

Cheat Sheet

Term	Definition
Statistics	Learning from Data
Descriptive Statistics	Facts, no interpretation
EDA	Current sample only, not generalization
Predictive modeling	Estimate value for a new unit, (MAS I and II)
Inferential statistics	Understand importance of explanatory data over population
Knowledge base	Human curated explanation of complex real-world system
Expert System	Rules based explanation of complex real-world system
Artificial Intelligence	Problem domain; solving problems people find easy but computers find hard
Machine Learning	Algorithm allowing computer to build and improve a model from data
Neural network	Multi-layered, inter-connected hinge function regression model, loosely modeled on brain function
Deep learning	Approach to AI; type of ML; learn complicated concepts by building out of many simpler ones
Representation Learning	Use ML to process figure data representation

Practical

- OS: any OS will do, I'm using Ubuntu
- Cloud
  - AWS
  - Azure
- Frontend
  - R/Keras
  - Python
  - Others
- Backend
  - Tensorflow
  - Theano
  - CNTK

Hardware

"What happened is that the gaming market subsidized supercomputing for the next generation of artificial intelligence applications."
JJ Allaire and François Chollet

An Example

Example Summary

> *"[I]t's a simple mechanism that, once scaled, ends up looking like magic."*
> *JJ Allaire and François Chollet*

- Setting up an AI workstation may be easier than you think!
- For a very simple set of predictors, AI offers compelling performance results. Imagine what can be done with more granular data and more thought.
- The actuary tunes the construction of the model by establishing the predictor space, number of layers, hidden layers, &c.
- The box is very black. More work to be done here.
- Performance metrics and comparisons to traditional models can support our understanding of what we're doing.

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```
## May 2019 for CAS talk AI buzzword bingo image
from imageio import imread
import matplotlib.pyplot as plt
from wordcloud import WordCloud
import numpy as np

args = {'width':3600, 'height':2400, 'max_words': 200,
        'max_font_size':240, 'relative_scaling' : 0.4,
        'background_color' : 'white', 'prefer_horizontal':0.75}

words =['Artificial Intelligence', 'Big Data',
 'Causal Analysis', 'Data Represenatation', 'Data Visualization',
 'Deep Learning', 'Data Representation', 'Data Science'
 'Expert System', 'Exploratory Data Analysis', 'Inference',
 'Machine Learning', 'Neural Network', 'Predictive Analytics',
 'p > n', 'Statistics']
```

```
word_freqs = { w: (0.4 + 0.6 * np.random.rand()) for w in words}
word_freqs['Artificial Intelligence'] = 2.5
word_freqs['Deep Learning'] = 1.5
word_freqs['Neural Network'] = 1.5

wordcloud = WordCloud(colormap=plt.cm.magma, **args)

for i in range(30):
        wordcloud.generate_from_frequencies(word_freqs)
        plt.figure(figsize=(11,8.5))
        plt.imshow(wordcloud)
        plt.axis("off")
        plt.savefig(f'word_cloud_{i}.png', dpi=300)
        plt.show()
```