

# Application of Alternative Data in Credit Decisioning

April 2018

# Moody's Analytics Helps Capital Markets and Credit Risk Management Professionals Worldwide

## Outstanding Success

- » Part of 100-year-old organization
- » Continually awarded for credit expertise and risk and regulatory solutions
- » Recognized expertise across all main industry sectors

## Top Clients World-Wide

- » 247 of top 450 asset managers
- » 55 of top 100 largest corporations
- » 291 of top 500 commercial banks
- » 64 of top 100 insurance companies
- » Over 1,200 community banks

## Deep Expertise

- » Leading credit insight
- » World-class quantitative credit and portfolio analytics
- » Award-winning software and services to manage risk and performance

## Global Reach

- » 16 offices in 11 countries
- » 2,400 employees world-wide
- » Global partnerships
- » Clients represent 3,900 institutions worldwide operating in 120 countries



# Alternative Data in Credit Decisioning



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Director of Product  
Management

# Location and Behavior Analytics Create New Frontiers in Commercial Loan Credit Decisions

		Risk Dimensions	Solutions
		Underwriting CRE Loan	Location, location, location
Property-specific attributes	Lender due diligence and reporting data requirements		
Loan-specific characteristics	Moody's AnalyticsCMM and CRE Scorecard		

		Risk Dimensions	Solutions
		Underwriting C&I Loan	Borrowing entity business and operating financials
Location of the business, especially for SME companies	<b>Location Analytics</b>		
Behavior of the business / customers	<b>Behavior Analytics</b>		

# Where Do People Get Location Info Today?

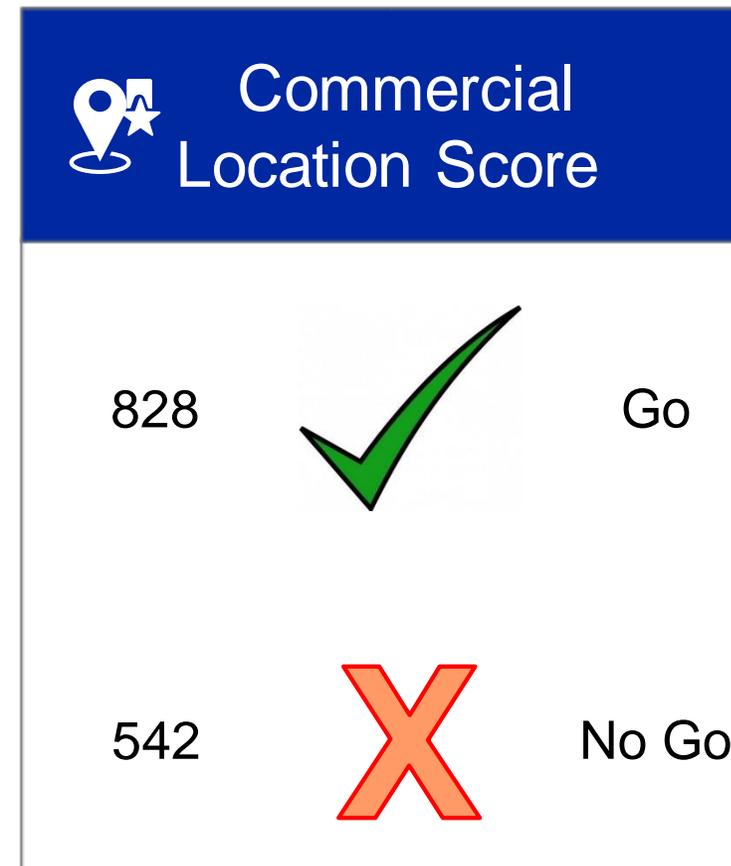
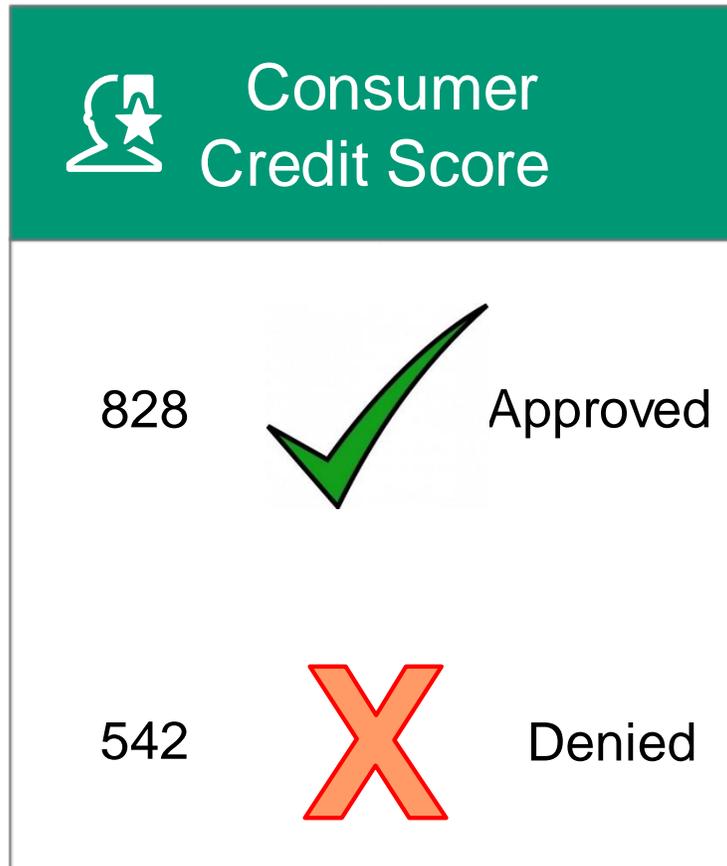
- » Real estate brokers
- » Sales/lease comps
- » Your trusted local business contacts
- » Google/Bing maps
- » Social media
- » Property intelligence platforms

All good ideas. But very fragmented, and sometimes very subjective.

A consistent, objective measure would be better!

**Let's disrupt the entire business!**

# Location Score – A Parallel of Consumer Score



**Unique ID:** Social Security Number (SSN)

**Assessor's Parcel Number (APN)**

# Business Applications of Location Score

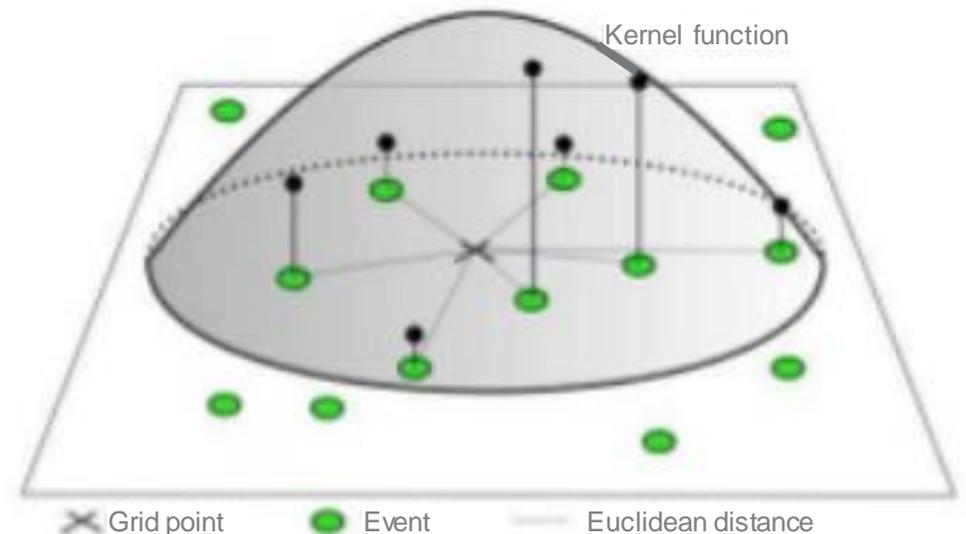
## C&I Location Scores

## CRE Location Scores



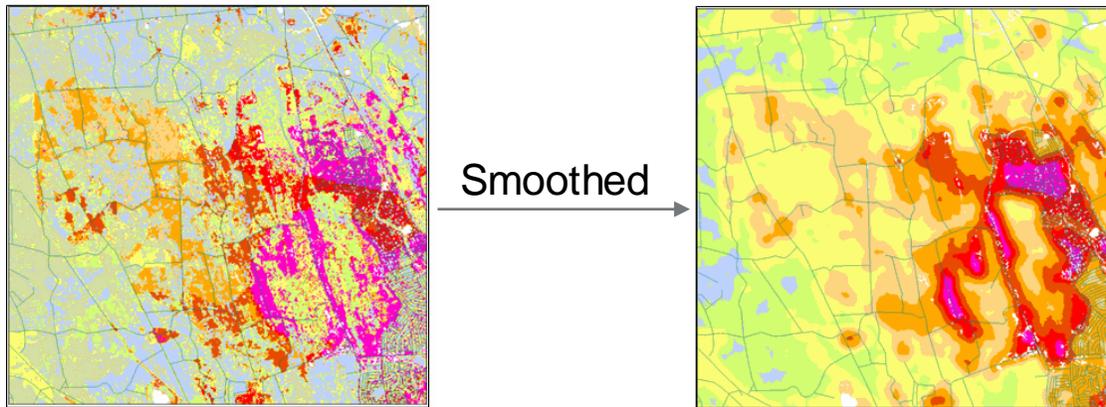
# Geospatial Methodology – Spatial Kernel Density

- » Based on discrete points of observation scattered across space, we want to develop a continuous density to cover the entire space
- » Using safety as an example
  - Crime incidents occurs at discontinuous locations
  - Our method helps evaluate the safety of every location in space based on nearby incidents



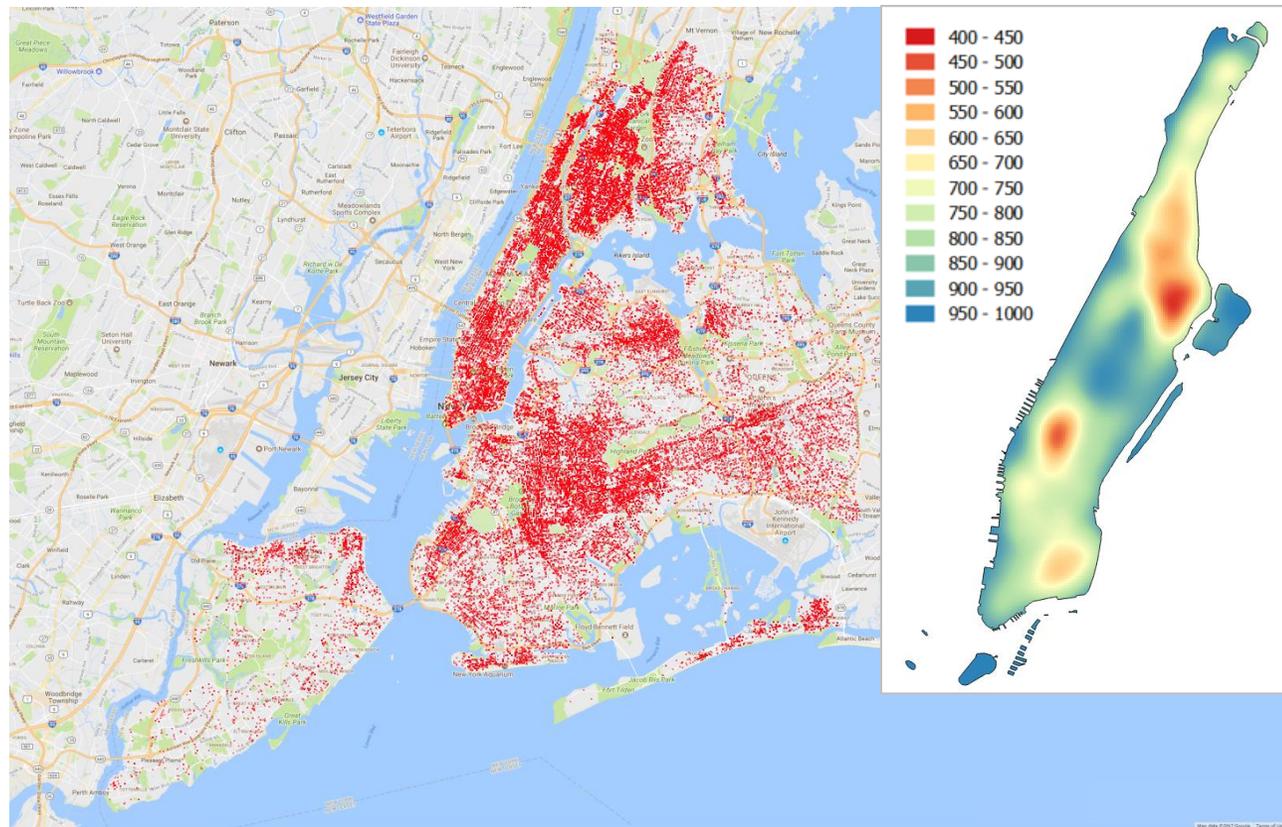
# Geospatial Methodology – Spatial Smoothing

- » The opening of a trendy restaurant benefits the residents who live on the block
- » Meanwhile, people who live within a few blocks of the restaurants also benefit albeit to a less degree
- » We apply a spatial smoother to “spread” the accessibility to urban amenities



# Safety Scores Based on Open Data

RPT_DT	OFNS_DESC	CRM_ATPT_CPTD_CD	LAW_CAT_CD	Latitude	Longitude
9/30/2017	MURDER & NON-NEGL. MANSLAUGHTER	COMPLETED	FELONY	40.80106379	-73.95048191
9/30/2017	ASSAULT 3 & RELATED OFFENSES	COMPLETED	MISDEMEANOR	40.6774067	-74.00639712
9/30/2017	INTOXICATED & IMPAIRED DRIVING	COMPLETED	MISDEMEANOR	40.62322682	-74.14922697
9/30/2017	HARRASSMENT 2	COMPLETED	VIOLATION	40.65469792	-73.9076236
9/30/2017	ROBBERY	COMPLETED	FELONY	40.74749494	-73.88532107



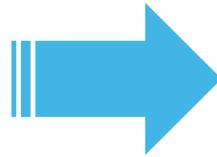
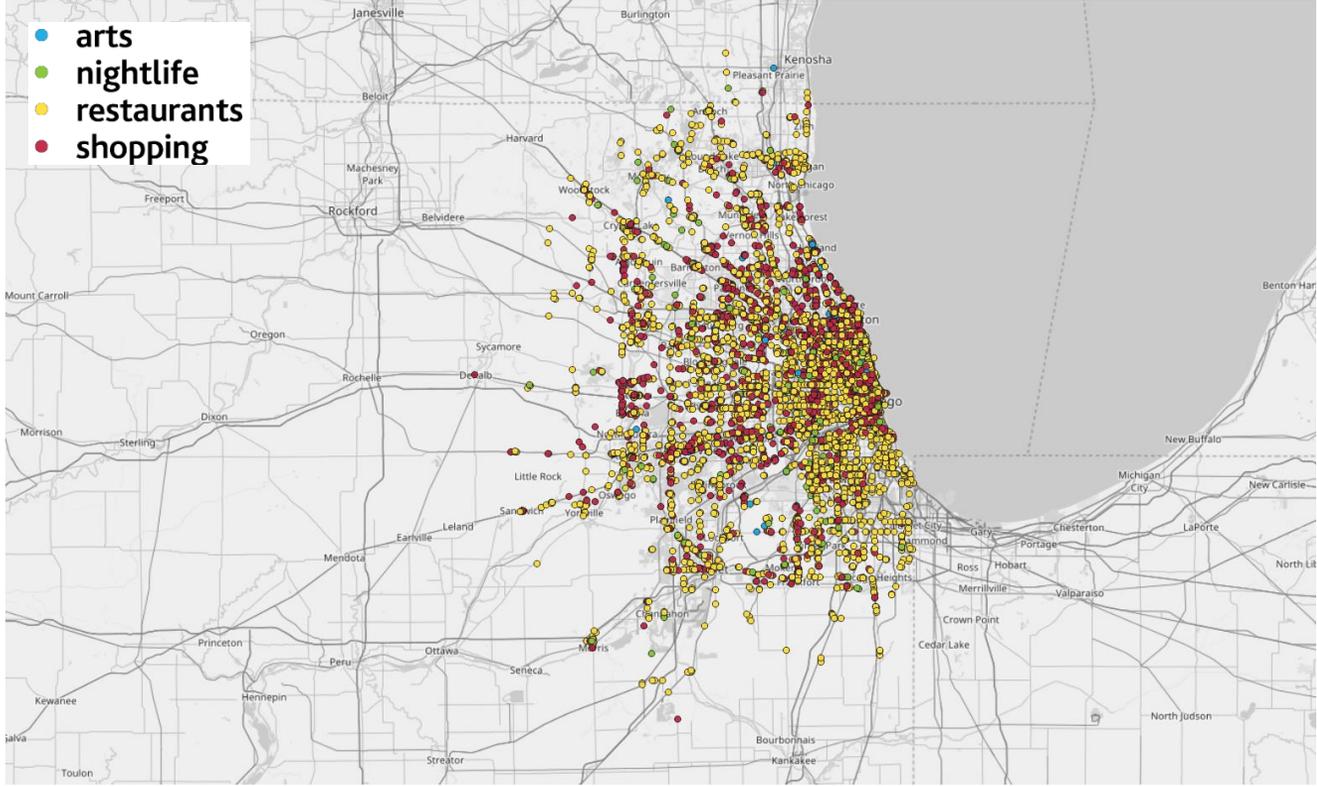
# Amenity Scores Based on Social Media Data

 3,062

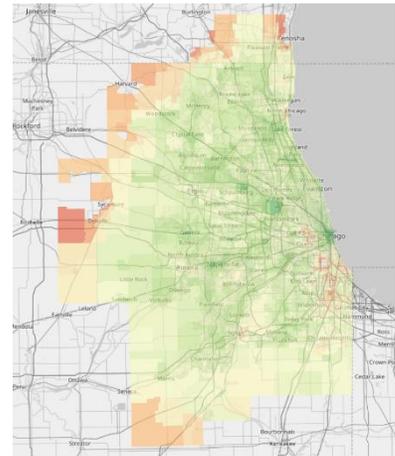
 5,766

 510

 126

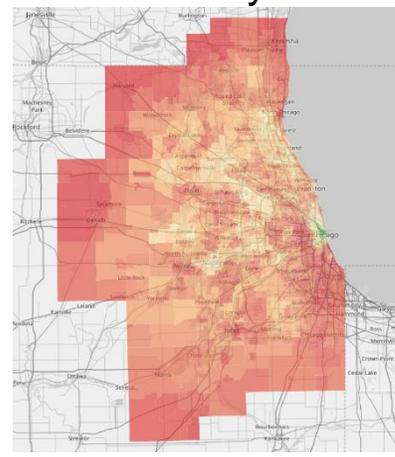


Volume



**Normalized Score**  
400 - 500  
500 - 600  
600 - 700  
700 - 800  
800 - 900  
900 - 1000

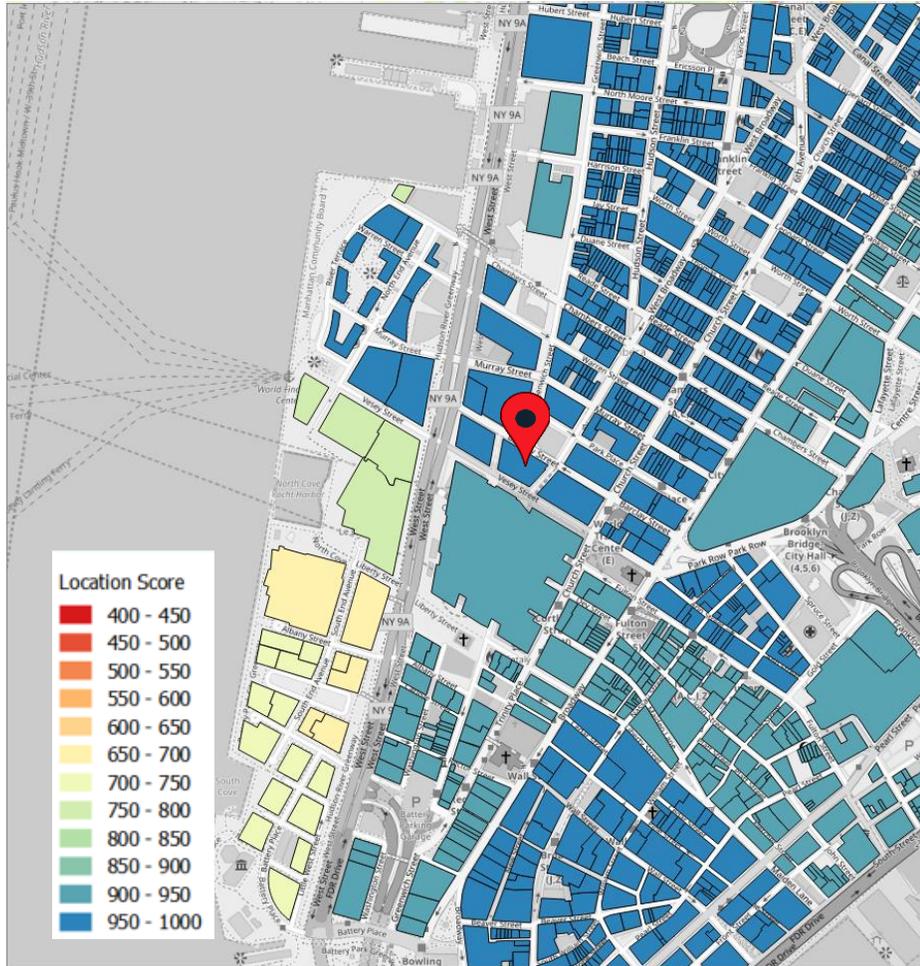
Variety



**Normalized Score**  
400 - 500  
500 - 600  
600 - 700  
700 - 800  
800 - 900  
900 - 1000

# Location Score Demo

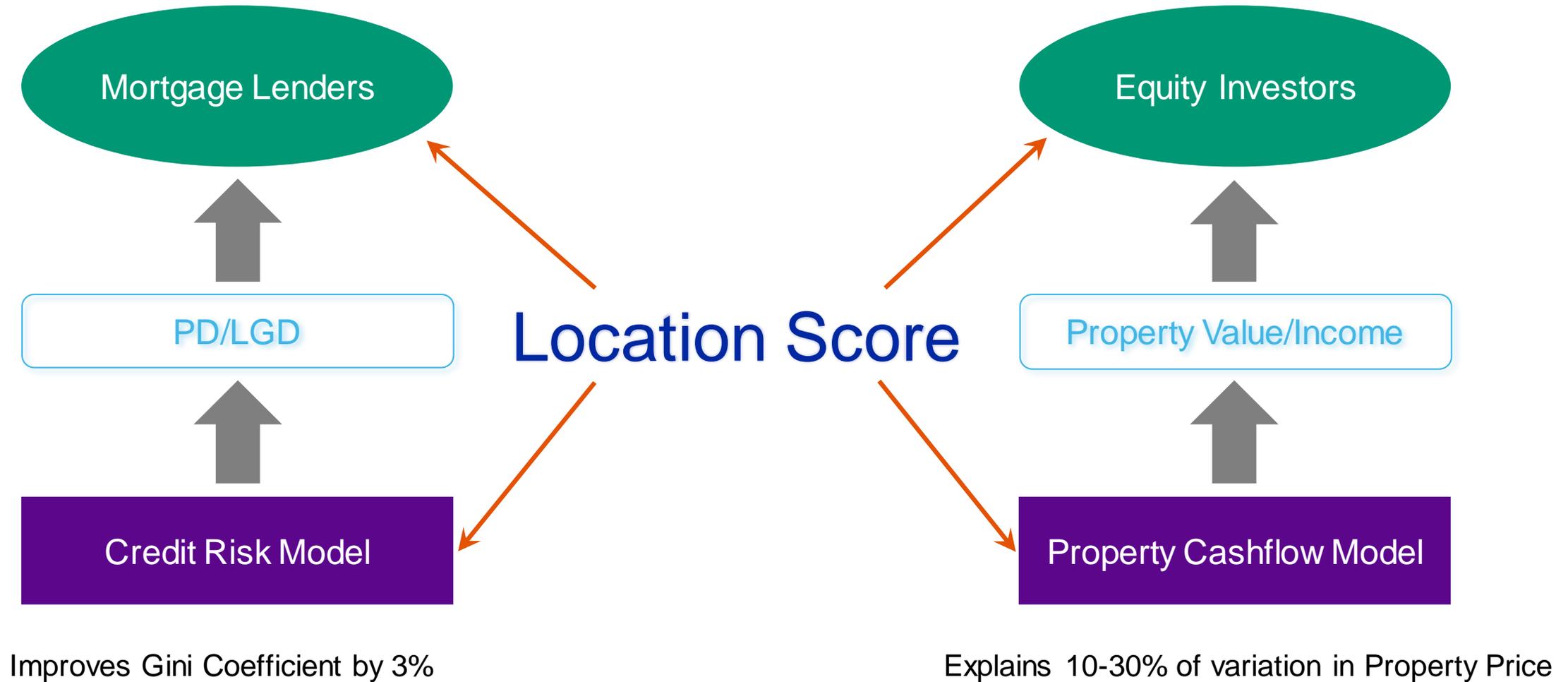
Address: 250 Greenwich St, New York, NY 10007



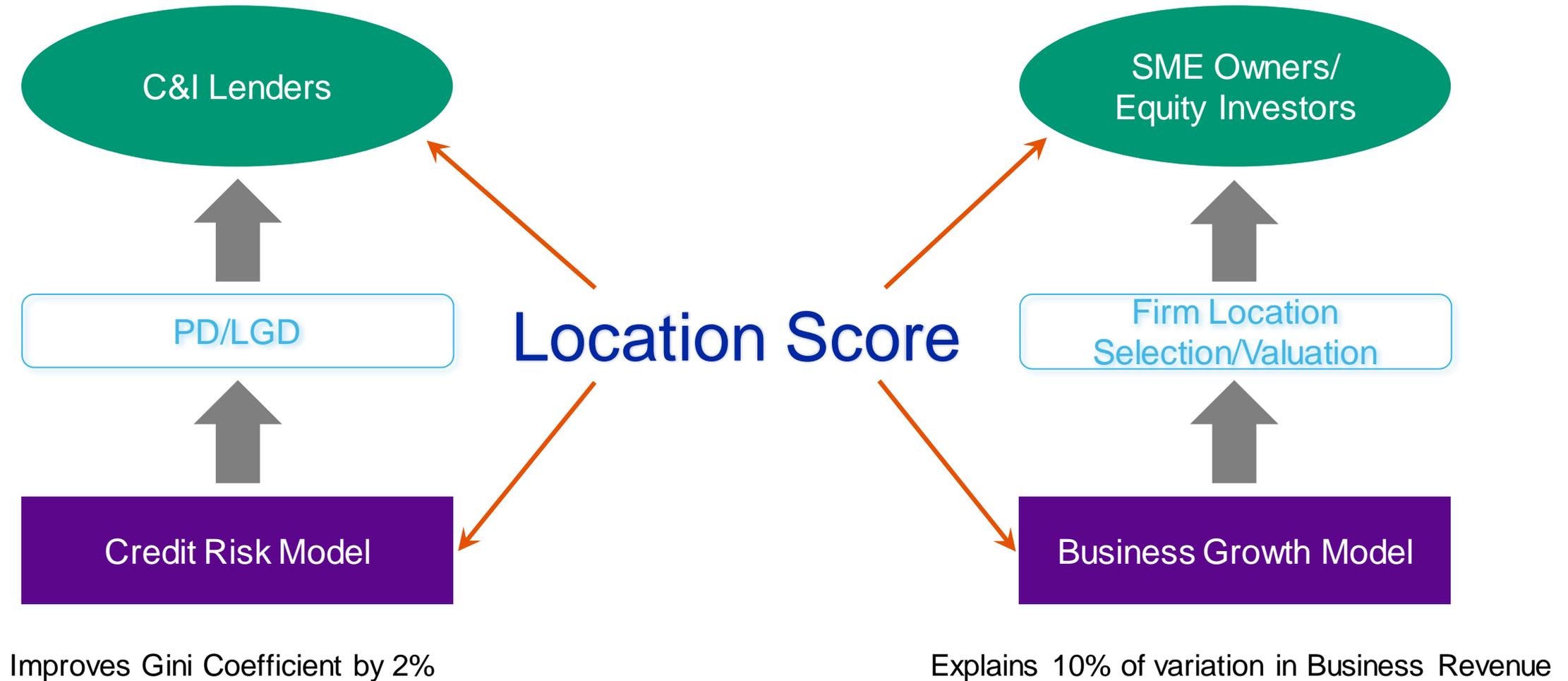
952

Per-capita Personal Income	\$71,599
Business Establishments	463
Average Payroll	\$6.8 bil
Distance to Subway	0.2 mi
Fair Market Rent	\$58 psf
Nearby Restaurants	14
Violent Crime Rate	1.75‰

# Using Location Score for CRE Assessment



# Using Location Score for C&I (SMEs) Assessment



# C&I Location Score: How is it Different from CRE and Why

Address: 250 Greenwich St, New York, NY 10007



		C&I	CRE
		845	952
Per-capita Personal Income	\$71,599	+	+
Business Establishments	463	-	+
Average Payroll	\$6.8 bil	+	+
Distance to Subway	0.2 mi	+	+
Fair Market Rent	\$58 psf	-	+
Nearby Restaurants	14	+	+
Violent Crime Rate	1.75‰	-	-

- C&I score weighs location factors differently

C&I	Competition
CRE	Higher Property Price

C&I	Higher Operation Cost
CRE	Higher Property Revenue

# C&I Location Score Works Better for Geo-Sensitive Industries and Smaller Firms

- Geo-sensitive sectors
  - Retail
  - Business Service
  - etc...



- ✓ Location score improves default prediction
- ✓ Location score predicts firm revenue

Sales < \$2 Mil

- Gini coefficient ↑ 2%
- Explain 10% variation in firm revenue

Sales > \$2 Mil

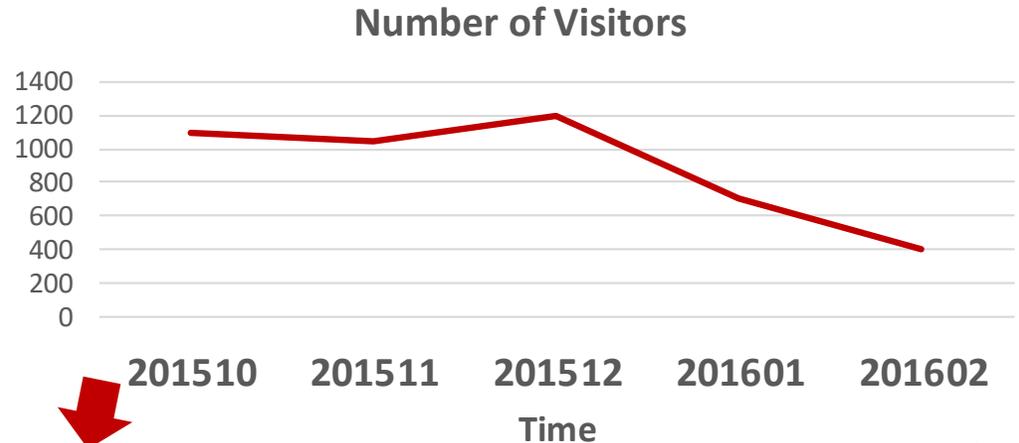
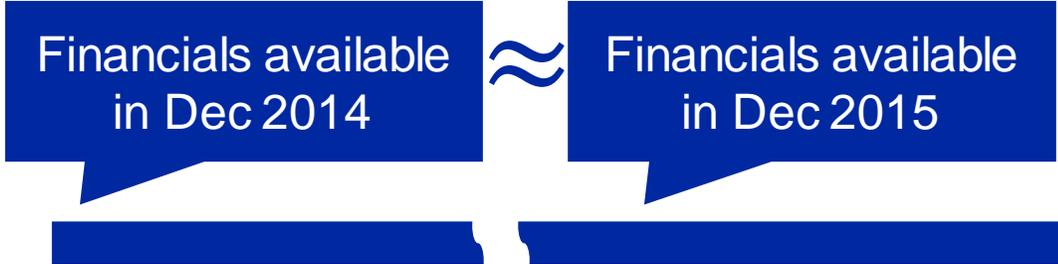
Muted effect

- Geo-insensitive sectors
  - Constructions
  - Transportation
  - etc...



The role of location score less obvious

# Behavior Analytics Further Enhance C&I Credit Scores



The main chef asked for a sharp increase in the salary. The owner had to let go the main chef in Jan 2016

Date	Rating
2016-1-21	2
2016-1-19	1
2015-12-5	4
2015-11-1	5

Defaulted in Apr 2016



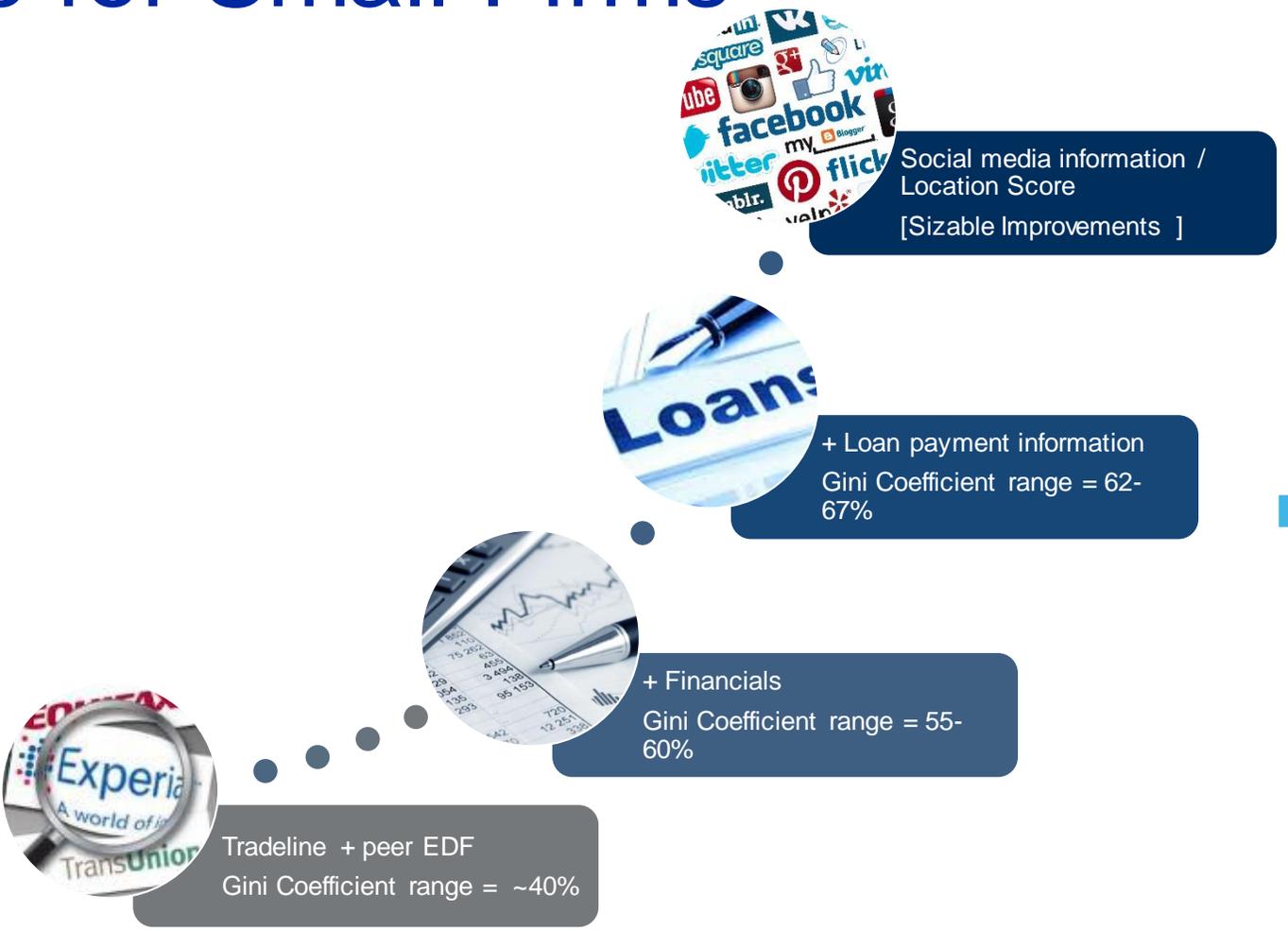
# Combining Various Information Sources to Better Measure C&I Credit Risk

						
Data Type	Financial	Loan Payment Behavior	Trade Payment Behavior	Business Characteristics	Social Media	Location
Examples	Income statement, Balance sheet, General ledger	Current and historical loan payment status, credit lines utilization ...	Accounts payable status, trade lines utilization ...	Ownership structure, global cash flow, age of the firm ...	customer reviews/ratings, foot traffic, web traffic ...	crime rate, economic condition, neighborhood amenity, park ...
Possible Sources	Business, BVD, tax returns	Lending institutions, business	Credit Bureaus, Business	Business, Moody's Analytics CRD, BVD	Social media companies	Open data sources, Census, vendors
Level of Standardization	High	Medium	Medium	Medium	Low	Low
Frequency	Low	Medium	Medium	Medium	High	High

# An Example: A Suite of Models that Combine Business, Financial, Trade Behavior, and/or Loan Behavior Inputs Into Credit Scores

Firm A	Firm B	Firm C
<p><b>Trade Line payment:</b>                      Debt payment status – <b>Current</b> →                      Total balance owed – <b>\$25,000</b>                      Highest balance in last 12m – <b>\$45,000</b>                      Presence of tax liens and Civil judgments – <b>Yes</b></p> <p><b>Peer Financial Ratio Score – 1%</b></p> <p><b>69</b>    1.85%    Ba3.edf  <small>1-YEAR</small></p>	<p><b>Trade Line payment:</b>                      ... →</p> <p><b>Financial Ratios</b>                      Return on Assets – <b>15%</b> →                      Debt coverage – <b>10x</b> →                      Sales growth – <b>20%</b></p> <p><b>72</b>    1.22%    Ba2.edf  <small>1-YEAR</small></p>	<p><b>Trade Line payment:</b>                      ...</p> <p><b>Financial Ratios</b>                      ....</p> <p><b>Loan payment:</b>                      Loan payment status – <b>Past due 0-30 days</b>                      Utilization – <b>80%</b>                      Late payment in last 1 year – <b>Yes</b></p> <p><b>65</b>    3.25%    B1.edf  <small>1-YEAR</small></p>

# Alternative Data Improve Default Prediction, More So for Small Firms



Popularity measures (count of reviews or foot traffic) help predict loan defaults and store closures

Firm Size Bucket (Net Sales)	Increase in Gini Coefficient
< \$5Mil	12%
\$5Mil – 20Mil	8%
> \$20Mil	~0%

# Utilize Suitable Analytical Models

Generalized Additive Model	Alternative Approaches (e.g. Boosting)
With functional form, assumptions such as variable correlation matter.	No functional form, more data mining
Guided by economic theory and business intuition.	Results may not be intuitive, more of a “black box”
Does not work as well on complex relationships.	Fit complex, non-linear relationships better, easier to account for interaction across variables.
Spend more time on variable selection use fewer variables in the final model.	Spend less time on variable selection, use more variables.
Good performance	Performance can exceed GAM

# Motivation for looking into social media

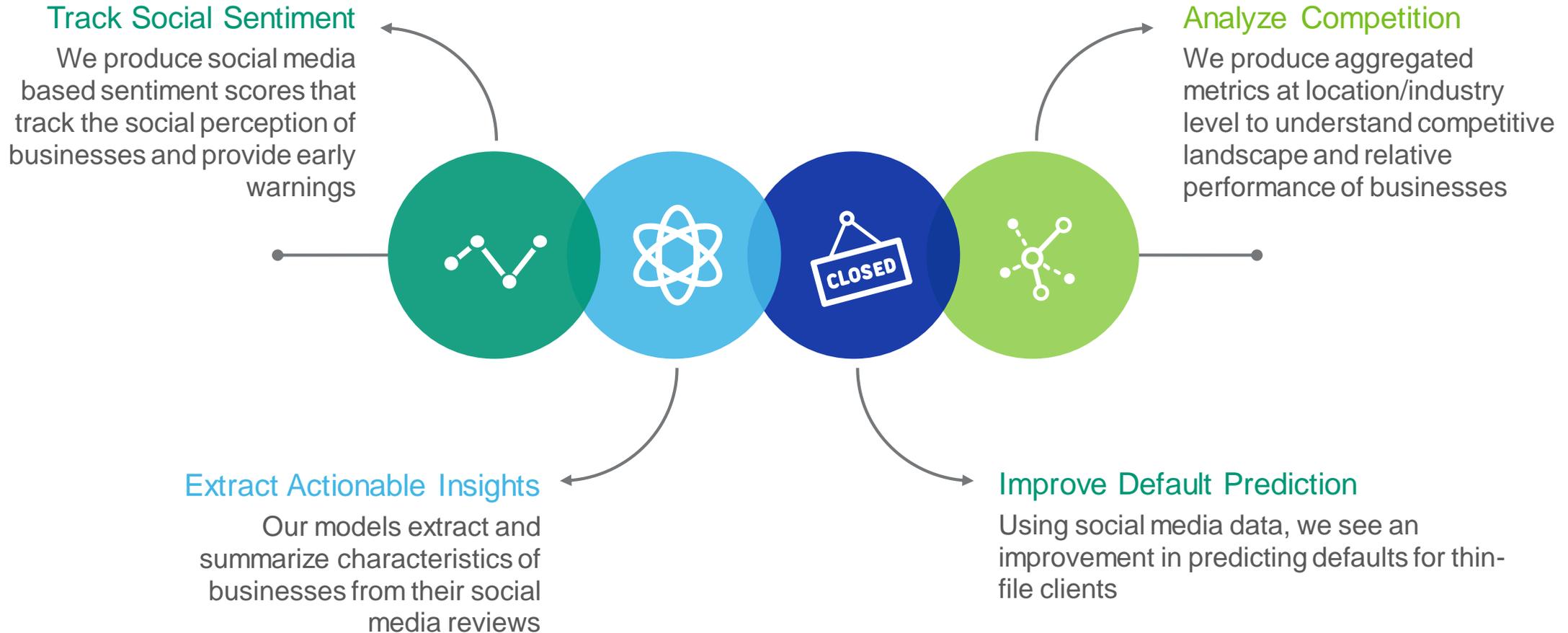
The screenshot shows the TripAdvisor page for Town Hall restaurant. At the top, there are navigation tabs for San Francisco, Hotels, Vacation Rentals, Flights, Restaurants, and Things to do. The restaurant's name, "Town Hall", is prominently displayed, along with its address: 342 Howard St, San Francisco, CA 94105-2262. A "Reserve with OpenTable" button is visible, showing a reservation for 2 guests on 2/25/2018 at 8:00 PM. Below this, there is an "Overview" section with a 4.0 star rating based on 296 reviews. A bar chart shows the distribution of reviews: Excellent (33%), Very good (44%), Average (16%), Poor (3%), and Terrible (2%). A map of the Financial District area is also shown.

The screenshot displays a hotel booking page for The Westin St. Francis San Francisco on Union Square. The page includes a "Reserve" button at the top left and a "We Price Match" badge. A search form is present with fields for "Destination/Property Name" (San Francisco), "Check-in Date" (Wednesday, March 7, 2018), "Check-out Date" (Thursday, March 8, 2018), "1-night stay", "2 adults", "No children", and "1 room". A "Search" button is at the bottom of the form. To the right, there is a "Room Info & Price" section, a "Facilities" tab, and a "Guest Reviews (3,063)" section. A "Very Good 8.3" rating is shown with 3,063 reviews. A photo of a hotel room is visible, and a "Reserve" button is next to it.

The screenshot shows a Yelp page for Town Hall restaurant. The page features a red header with the Yelp logo and navigation options like "Restaurants", "Nightlife", and "Home Services". The restaurant's name, "Town Hall", is displayed with a "Claimed" status and 1,857 reviews. The price range is listed as "\$\$\$ - American (New), Wine Bars, Desserts". A map shows the location at 342 Howard St, San Francisco, CA 94105. Below the map, there are several review highlights with photos of food. For example, one review says: "We finished with the Donuts & Coffee desert and the Butterscotch and Chocolate Pot De Creme - which was out of this world." in 65 reviews. Another review mentions: "Some of the more noteworthy dishes are the tuna tartare, pimento cheese, fried chicken, and of course the prosciutto." in 178 reviews. A "Write a Review" button is visible, along with options to "Add Photo", "Share", and "Bookmark".

- » Review, social media, and booking sites show useful information about a company from a perspective of a user.
- » From a lender's perspective who wants to learn/monitor public perception about a business, social media presentation is not concise/directly helpful.
- » Lenders would have to read the reviews and get a general sense of business's operations.

# Use cases

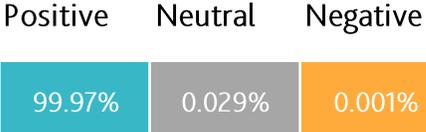


# Track Social Sentiment

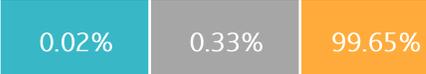
To create sentiment scores for social media reviews

We use deep recurrent neural networks to produce *positive*, *negative*, *neutral* class probabilities for each review.

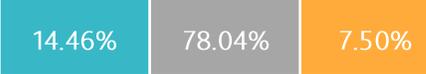
*“excellent hotel . room and location are amazing. staff is exceptionally helpful.”*



*“nothing was taken care of by the management and the 100 % money back guarantee is FALSE marketing . Beware”*

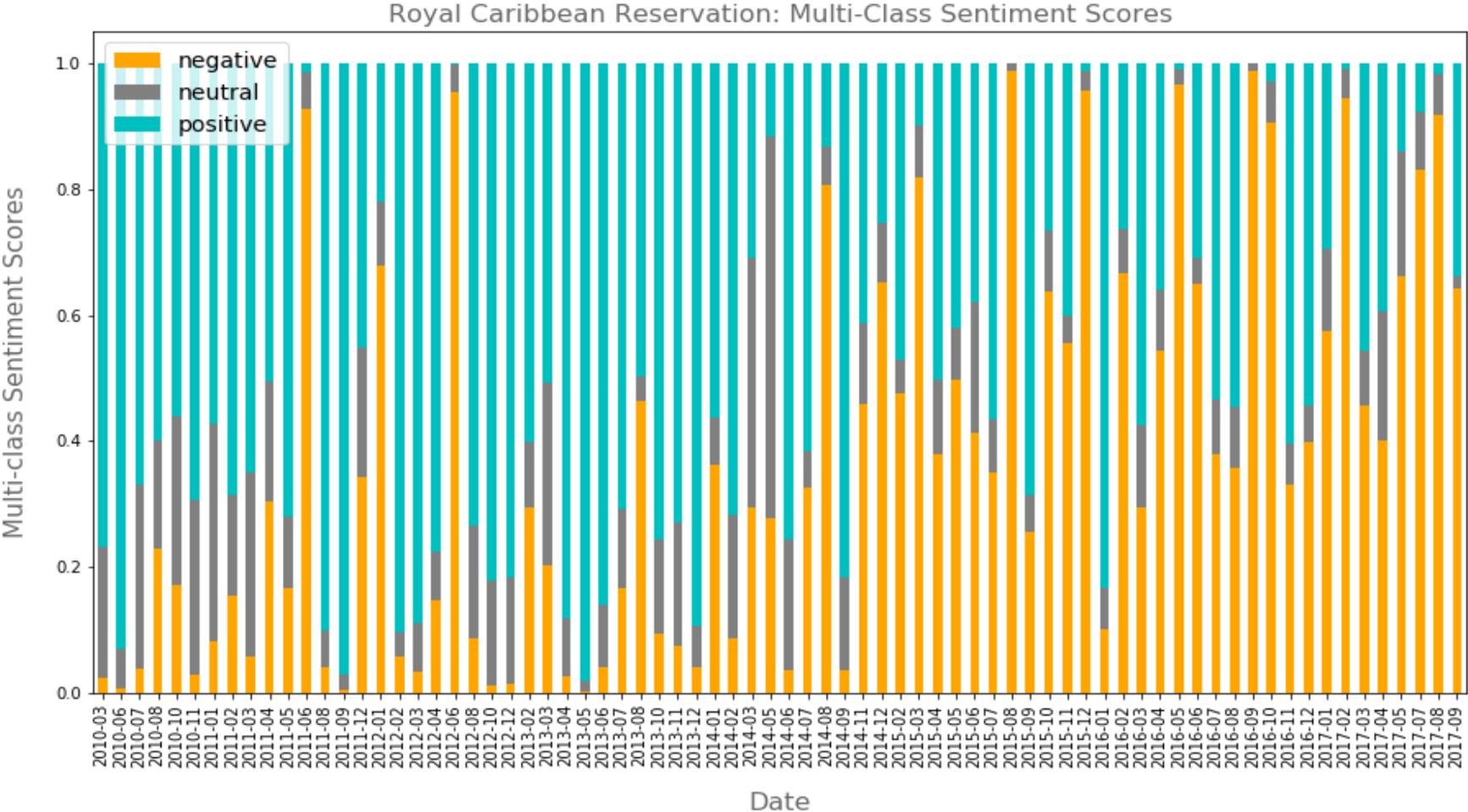


*“had the sausage combo plate . food was alright. sausages & potatoes were somewhat good.”*



# Track Social Sentiment

Royal Caribbean: increase in negative sentiment since mid-2014



# Extract Actionable Insights

## Royal Caribbean Reservation

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### Top Positive Reviews

---

great customer services , with professionals and amazing people , more than 62 nation ship and work together .

best trip of my life !!!! went on the 3 day majesty of the sea cruise from feb 13th-16th and it was the most magical experience ever ! best service . most awesome people . royal caribbean is the pinnacle of cruising . will most def be back . thanks for some amazing memories ! -

---

### Top Negative Review

---

this company is run by arrogant liars. they left my family stranded 6000 miles from home when their travel office failed to make our flight reservations. they emailed us confirmation of our tickets but no tickets had been purchased. after paying an additional \$ 10,000 at the airport in europe in order to get home, the president office at royal caribbean refused to refund what we had paid them for the tickets they never bought. they are crooks.

# Extract Actionable Insights

We summarize hundreds of reviews into few actionable insights

## Top Positive Insights

my ultimate favorite

amazing ships and destinations

the most magical experience ever

the best vacations

the food was amazing

## Top Negative Insights

racial profiling

a putrid smell

the incompetence and rudeness of the customer service reps

complete waste of time and money

I simply had food poisoning from their dirty kitchen

# Extract Actionable Insights

## Early warnings on operational risks

- » We can extract topics/themes that are relevant from a large corpus of reviews.
- » We can customize our algorithms to look for specific business relevant keywords of importance.

### Royal Caribbean Reservation

*I've taken several (5) Royal Caribbean Cruises. Each one worse than the next and I'm done.*

*The Europe cruise --- the sewage backed up, the sink filled the cabin, and I could not use the shower. Complaining to the front desk they told me they would have the Captain throw me off the ship! (Since it was a family outing 20+ people i decided not to pursue) (They did fix it by the second day)*  
*Caribbean Cruise -- No problems, except 90% of the food was terrible. Can you say deep fried? The best food was the lunch buffet as long you a made a hamburger.*

### Operational Risks

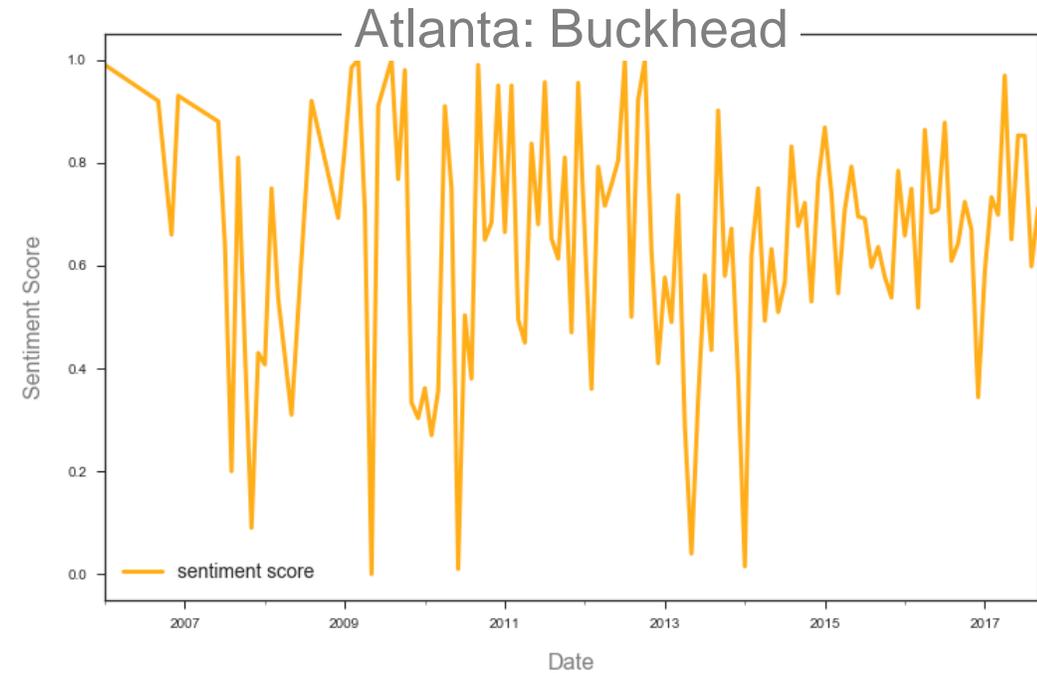
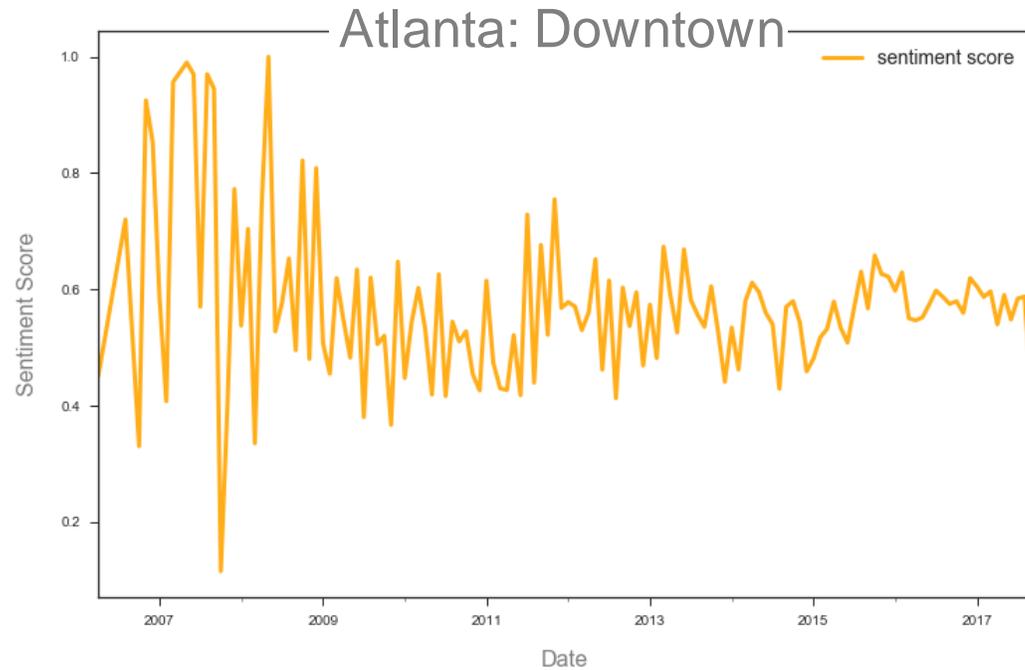
Sewage problems

Poor dining choices

Poor customer service

# Analyze Competition

## Comparing locations



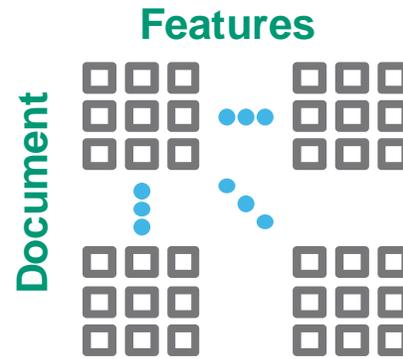
" Good service and very reasonable prices. Wine was amazing (because we brought our own). **I hope this restaurant can make it as it's a terrible location that has seen numerous other restaurants fail.** I believe their food and prices should create a good following."

# Improve Default Prediction

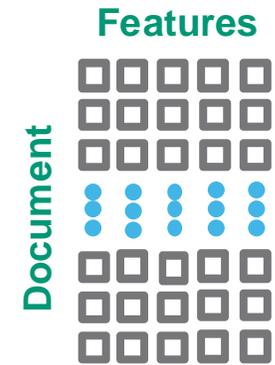
We extract credit relevant themes



Extract Terms



Create Document Term Matrix



Reduce Dimensionality

# Improve Default Prediction

We use Latent Semantic Analysis to extract text features

- » In addition to Sentiment Scores, we used Latent Semantic Analysis (LSA) on the review text and extracted theme based features.
- » Theme based features and review based Sentiment Scores improved accuracy by 3% in predicting defaults.

# Conclusion

Today, you've heard insights on our alternative data research in the credit process.



Drive innovation further with us!

Complete the post conference survey to engage with us on these solutions.

# Thank You!

» **Listen & Share:** You will receive a link to the recording of this session by email.

» **Join Us:**

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May 16<sup>th</sup> in New York

Small Business Lending – Client Advisory Roundtable  
June 12<sup>th</sup> & 13<sup>th</sup> in New York

Moody's Analytics Commercial & Ag Lending Conference (CALC)  
September 24<sup>th</sup> – 26<sup>th</sup> in Omaha, Nebraska

Moody's Analytics Summit  
October 22<sup>nd</sup> – 24<sup>th</sup> in Phoenix, Arizona

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