arity

Advances in Personal Auto Ratemaking

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March 2019

Agenda

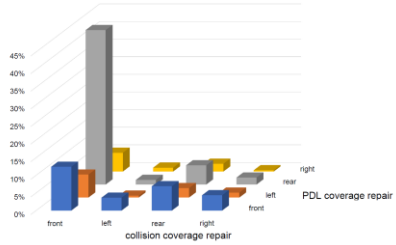
- Ratemaking (and related) news
- Telematics-based pricing
- Interaction between telematics and ADAS

Ratemaking (and related) News

Progress on Automatic Emergency Braking

Percent distribution of matched pairs of collision & PDL estimates by point of impact

1981-2017 models, 2016 calendar year



Source: IIHS HLDI

AEB Progress

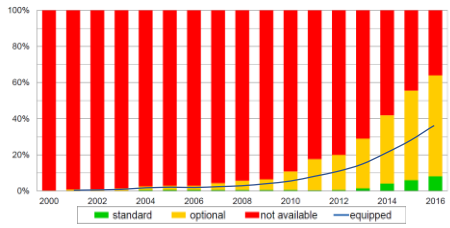
10 automakers equipped most of their 2018 vehicles with automatic emergency braking

IIHS News, March 13, 2019
https://www.iihs.org/iihs/news/desktopnews/10-automakers-equipped-most-of-their-2018-vehicles-with-automatic-emergency-braking

- >50% vehicles produced by 10 automakers from Sept. 2017 through Aug. 2018 were equipped with automatic emergency braking
- Was <33% for the previous year
- About a third of vehicles produced have other advanced capabilities like pedestrian detection
- Toyota equipped 2.2 million (90%) of its vehicles with AEB
- Nissan equipped 1.1 million (78%) of its vehicles with AEB
- Honda equipped almost 1 million (61%) of its vehicles with AEB
- Tesla equipped 100 percent of their vehicles with AEB
- Mercedes-Benz equipped over 92% of their vehicles with AEB
- Volvo also equipped over 92% of their vehicles with AEB
- 8 manufacturers equipped AEB in less than 25% of its production

New vehicle series with forward collision warning

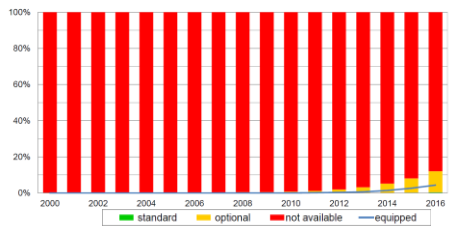
By model year



Source: IIHS HLDI

Registered vehicles with forward collision warning

By calendar year



Source: IIHS HLDI

Gender Rating

Gender rating

Commissioner issues regulations prohibiting gender discrimination in automobile insurance rates.
New rule prohibits gender rating; promotes fairness and social equity

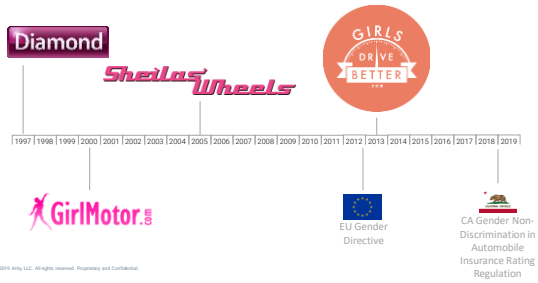
California Department of Insurance Press Release, 1/3/2019
http://www.insurance.ca.gov/0400-news/0100-press-releases/2019/release003-19.cfm

Gender can no longer be used to calculate auto insurance rates in California and other states
As rates go higher, insurers have other ways to calculate risk, including the monitoring of driving behavior.

Washington Post, By Fredrick Kunkle, February 11, 2019
https://www.washingtonpost.com/transportation/2019/02/11/gender-can-no-longer-be-used-calculate-auto-insurance-rates-california-other-states/

- The Gender Non-Discrimination in Automobile Insurance Rating Regulation became effective 1/1/2019.
- Commissioner Jones has previously taken steps to prohibit and prevent denial of coverage or claims for medical services based upon actual or perceived gender identity.
- Likely to result in lower premiums for young male drivers at the expense of young female drivers.
- Regulators are increasingly pressuring insurers to focus more on driving behaviors.

UK Motor Insurance Market



Pricing for Distracted Driving

Distracted Driving

Texting-While-Driving Bans and Motor Vehicle Crash–Related Emergency Department Visits in 16 US States: 2007–2014
New rule prohibits gender rating; promotes fairness and social equity

By Alva O. Ferdinand, Ammar Aftab, and Marvellous A. Akinlotan, 12/1/2019
https://ajph.aphapublications.org/doi/10.2105/AJPH.2019.304999

- Study finds that states with bans on texting while driving saw an average 4% reduction in emergency department visits after motor vehicle crashes
- States that implemented primary bans on all drivers saw an 8% reduction in crash-related injuries.
- Drivers of all ages saw reductions in the number of injuries following crashes.

Distracted Driving

Pricing Insurance to Reflect Distracted Driving Risk
Insurance companies are finally putting a price on the risk of distracted driving

Insurance Journal, by Kyle Stock, April 24, 2018
http://www.insurance.ca.gov/0400-news/0100-press-releases/2018/release002-18.cfm

5 Steps to Understand Distracted Driving

Insurance Thought Leadership, by Kyle Schmitt, October 18, 2018
http://insurancethoughtleadership.com/5-steps-to-understand-distracted-driving/

- The percentage of losses attributed to distraction over the last several years has tripled, costing the industry an estimated $9 billion annually.
- Teenagers tend to drive distracted the most
- Insurers are increasingly pricing for distracted driving
  - Traditional carriers are relying on MVR data to provide insights on mobile phone use while driving
  - Phone-based telematics is increasingly being used to identify this risk without reliance on police or MVR

Unsexy Actuaries Are 97.28892% Certain They Need Stronger Brand

Data Scientists

Unsexy Actuaries Are 97.28892% Certain They Need Stronger Brand

Bloomberg News. By Michael Sasso, November 30, 2018
https://www.bloomberg.com/news/articles/2018-11-30/unsexy-actuaries-are-97-28892-certain-they-need-stronger-brand

How do actuarial and data science skills converge at P&C (re)insurers?

PwC. March, 2018
https://www.pwc.com/us/en/insurance/publications/assets/pwc-pc-actuaries-data-scientists-role.pdf

- Data scientists are increasingly performing work that would have been performed by actuaries ten years ago

"If a data scientist can do 60% of what we do and do it cheaper, that's a threat to us. We have to add value over what we do."

- William Fornia, FSA, EA, MAAA, FCA

- With more sophisticated automated and data driven rating processes, and a rise in on-demand insurance products, data scientists will have an increased role in rate development by 2030.

Data Scientists

Actuaries Have Many Roles To Play in a Changing World

Actuarial Review. By Lucian McMahon, January 7, 2019
https://ar.casact.org/actuaries-have-many-roles-to-play-in-a-changing-world/

- Actuarial science is a profession. Data science is not.

"Data scientists can struggle to get the actual data science to work because they don't understand the business problem. Actuaries make strong data scientists because of that."

- Shane Barnes, FCAS, CSPA

"Stop seeing threats as threats … and start seeing threats as opportunities. Insurance is going to evolve to be more tech-savvy. Actuaries can be at the forefront of that."

- Anita Sathe, FCAS

Use of Social Media Data For Pricing

Pricing with Social Media

New York Insurers can Evaluate Your Social Media Use— If They Can Prove Why Its Needed

Wall Street Journal. By Leslie Scism, January 30, 2019
https://www.wsj.com/articles/new-york-insurers-can-evaluate-your-social-media-use-if-they-can-prove-why-its-needed-11548885602

- NY regulator to allow life insurers to use data from social media and other nontraditional sources when setting premium rates
- Insurers will have to prove the information doesn't unfairly discriminate against certain customers
- Life insurers will have to show that the algorithms and data are free of bias against racial minorities and other protected groups.
- Insurers can't just rely on an outside vendor's claim that its process is fair

Introduction to Telematics-based Pricing

What is telematics?

- The **science** of sending, receiving and storing **information via telecommunication** devices
- An **interdisciplinary** field that encompasses telecommunications, **vehicular technologies**, road transportation, road safety, and computer science
- The branch of **information technology** that deals with the long-distance **transmission** of computerized **information**

What does telematics mean to most insurance companies?

Enhanced pricing	Loss prevention	Claims enhancements	Ancillary services
Incorporate observed driving behavior directly in premium	Encourage or reward safe driving to reduce frequency and severity	Improved operations from FNOL through settlement including fraud detection	Vehicle recovery, roadside assistance, emergency call after collision, engagement

What does telematics mean to insureds?

Personalized pricing	Enhanced safety	Vehicle insights	Accident detection
Confidence and controllability in coverages and price	Identify safe and efficient routes	Insureds informed about their vehicle health	Receive immediate assistance at the time of incident

Ratemaking Process for Telematics-Based Pricing

Modeling Process

- Collect data
- Cleanse data
- Create features and dependent variable
- Build model
- Validate model
- Deploy model

Ratemaking Process

- Collect data
- Cleanse data
- Create features and dependent variable
- Build model
- Validate model
- Deploy model
  - Create filing
  - File
  - Use

Ratemaking Process for Telematics Pricing

- Generate data
- Collect data
- Cleanse data
- Create features and dependent variable
- Build model
- Validate model
- Deploy model
  - Create filing
  - File
  - Use

Generating and collecting telematics data

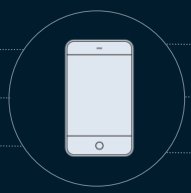
Generating rating data

1970s	Today
Self-reported to agent	Self-report to agent Self-report online Automated ordering of Insurance score, CLUE Report, Vehicle history Data generated from sensors

Generate telematics data: **Auto Insurance Version**

	OBD-II Device	Embedded systems	Smartphone
PROS:	Access to car's diagnostic and controller data, axis-aligned data	Most comprehensive source of vehicle systems and diagnostic information	Cost-effective, quantifies user behaviors, facilitates customer interaction, scalable, ubiquitous
CONS:	Expensive, no access to phone distractions or other user behaviors, some people require help installing	Reliance on OEMs, scalability relies on multiple partnerships, slow to proliferate	No direct access to car's data, limited battery charge,

Relevant smartphone sensors



- Gyroscope: orientation and angular velocity
- GPS: location and time
- Camera: observe road or driver
- Magnetometer: orientation relative to magnetic north
- Accelerometer: rate and change of velocity
- Bluetooth: connect to other devices

Embedded Telematics Systems

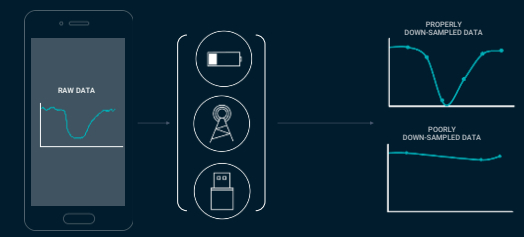
- Odometer
- Speedometer
- Brake pedal pressure
- Airbag control unit
- Steering angle
- Turn signal status
- Seat belt status
- "Check engine" light
- Cruise control status
- Trip fuel consumption

So, what data would you like to collect?

"I want all the data.
Give me all the data."

The granularity vs. scale trade-off

A central question of telematics data science



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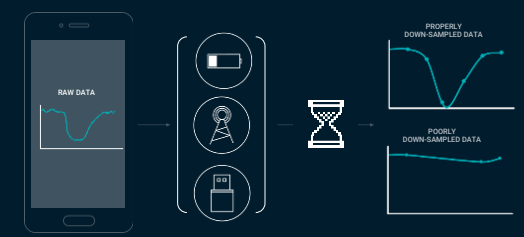
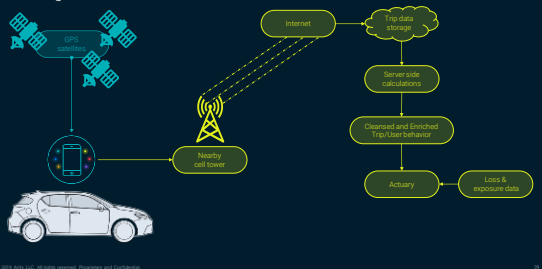


Collecting Telematics Data



What data to collect and send?

Turn the question around…

What features should be tested for inclusion in a model?

Creating telematics features

Popularity of telematics variables

Common
- Braking
- Time of day
- Speed
- Miles driven
- Accelerations

Less common
- Distracted driving
- Location
- Cornering/turns
- Trip duration
- Road type
- Trip count
- Weather

Not common
- Idle time
- Trip distance
- Fatigue
- Trip regularity
- Left vs. right turn

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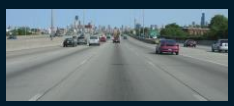
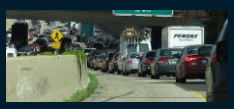
Time of Day example

Data to collect
- Date
- Time stamps
- Exposure - miles driven or hours driven?



Complication
- What happens when crossing time zone?
- Daylight saving time changes to standard time



 Top: Eastbound Kennedy Expressway at the Fullerton Av. By Anwiki at English Wikipedia. https://en.wikipedia.org/wiki/File:Eastbound_Kennedy_Expressway.jpg CC BY-SA 3.0. Bottom: Approaching Chicago, Illinois, Kennedy Expressway, I-90 and I-94 Eastbound. By Ken Lund from Reno, Nevada. https://commons.wikimedia.org/wiki/File:Approaching_Chicago,_Illinois,_Kennedy_Expressway,_I-90_and_I-94_Eastbound_(9187167503).jpg CC BY-SA 3.0

Braking example

Data to collect
- High frequency accelerometer or GPS data
- Speed

Complications
- Data must be high frequency to identify braking behavior
- If leveraging GPS, need to deal with gaps and bounces
- Need to avoid false positives like phone falling or tossing

Other data to collect

External data
- Accident incidences
- Roads types (highway/local, urban/rural, etc)
- Weather
- Traffic congestion

Internal data
- Loss, exposure, and other pricing information

Building a telematics model

What kind of model to build?

- Behavior-based insurance
- Distance-based insurance
- Mile-based insurance
- Mileage discount
- Pay-As-You-Drive
- Pay-As-You-Go
- Pay-How-You-Drive
- Pay per mile
- Try before you buy
- Usage-based insurance

Typical Dongle-based Pay-How-You-Drive Programs

Telematics Data

Premium

Insurance Coverage

$ → $ → $ → $

Term 1 | Term 2 | Term 3 | Term 4

Sometimes a telematics participation discount is applied at sign up

Some Mobile-based Pay-How-You-Drive Programs

Telematics Data

Premium

Insurance Coverage

$ → $ → $ → $

Term 1 | Term 2 | Term 3 | Term 4

Sometimes a telematics participation discount is applied at sign up

Some other Mobile-based Pay-How-You-Drive Programs

Telematics Data

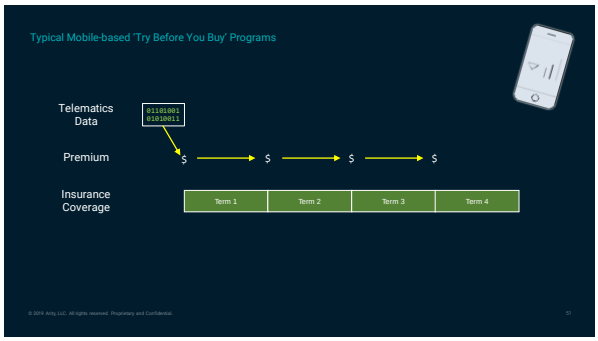
Premium

Insurance Coverage

$ → $ → $ → $

Term 1 | Term 2 | Term 3 | Term 4

Sometimes a telematics participation discount is applied at sign up


Typical Mobile-based 'Try Before You Buy' Programs
Telematics Data
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Premium
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Insurance Coverage
Term 1
Term 2
Term 3
Term 4
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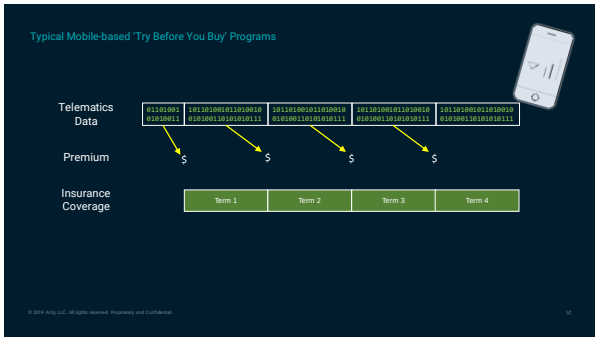
Typical Mobile-based 'Try Before You Buy' Programs
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Premium
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Insurance Coverage
Term 1
Term 2
Term 3
Term 4
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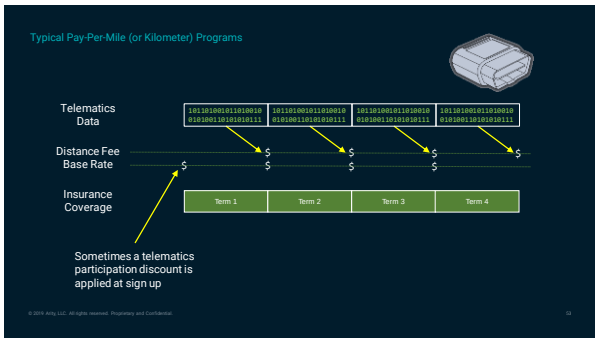
Typical Pay-Per-Mile (or Kilometer) Programs
Telematics Data
Distance Fee Base Rate
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Insurance Coverage
Term 1
Term 2
Term 3
Term 4
Sometimes a telematics participation discount is applied at sign up
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Some theories on why driving scores may significantly change

- Inexperienced drivers gaining experience
- Change in job
  - New commute route
  - New commute times
- Relocation
- Change in lifestyle
  - New baby
  - New significant other
  - New hobby
- Change in Car
- Drivers added to policy
- Drivers removed from policy
- Road construction
- Neurodegenerative and other diseases

Building a Telematics Model

Implementing telematics on top of existing rate plan

R

```
cpglm(pure_prem ~ telem_var1 + telem_var2 + telem_var3,
      link   = "log",
      weights= car_years,
      offset = log_trad_lc )
```

SAS

```
proc genmod;
model pure_prem = telem_var1 telem_var2 telem_var3  /
       dist=Tweedie
       link=log
       offset=log_trad_lc;
   weight car_years;
   run;
```

Spark MLlib

```
glm = GeneralizedLinearRegression(
    family='tweedie',linkPower=0, variancePower='varpwr'
    featuresCol='feature_trad_vars',
    labelCol='pure_prem',
    weightCol='car_years',
    offsetCol='log_trad_lc',
    fitIntercept=True).fit(train_df)
```

Interaction between Telematics and Advanced driver-assistance systems

Telematic Reaction to Automatic Emergency Braking

Did the driver or car hit the brakes?

- Mobile telematics cannot determine.
- OBD2 devices may be able to determine.

Does it matter who hit the brakes?

- The combined performance (vehicle and operator) determines the occurrence.
- AEB (forward or rear) should significantly lower costs.

Telematic Reaction to Automatic Emergency Braking

Should rates be raised or lowered for braking?

- Defective hardware or software is the manufacturer's liability
- Negligent driver's premiums should be increased
- Safe driving includes keeping a proper distance from objects in front of your vehicle.
- Failing to leave a proper distance from objects in front of your vehicle should result in higher premiums

Closing remarks

What we've learned

- Automakers continue to make vehicles smarter and safer.
- Some regulators are increasingly pressuring insurers to focus more on driving behaviors.
- Insurers are increasingly pricing for distracted driving.
- Use of gender in auto pricing is banned in 7 states and the EU.
- Telematics-based pricing provides a means to incorporate actual driving behavior into a rate plan.

Thank you.

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