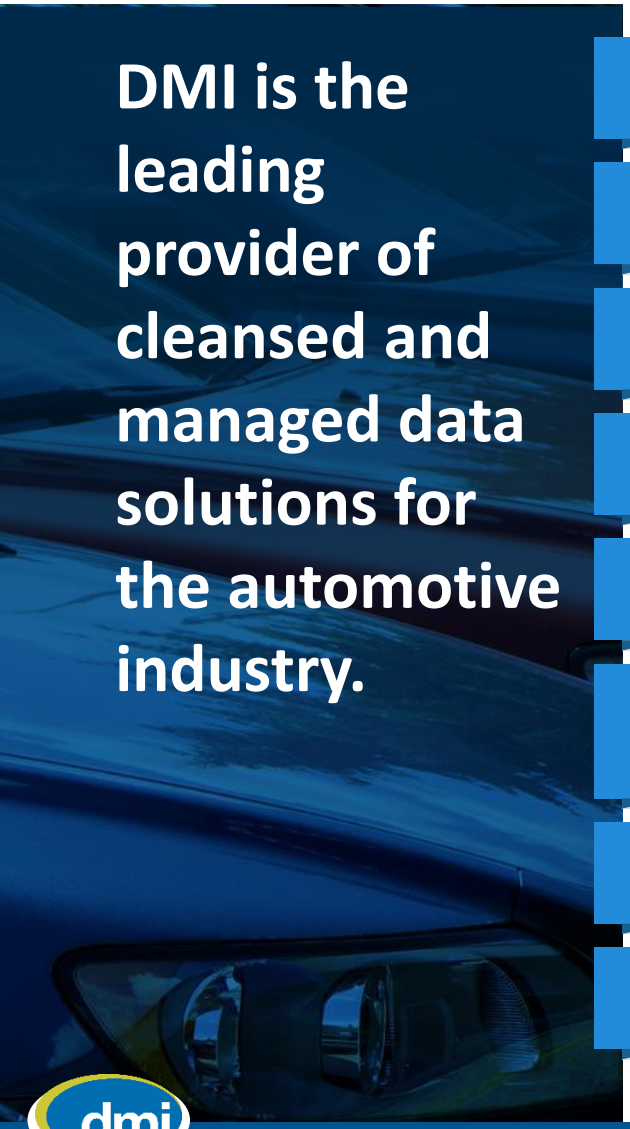
Vehicle Attributes and Ensembles

March 10, 2015

Verisk Analytics

SERVE | ADD VALUE | INNOVATE

DMI OVERVIEW



DMI is the leading provider of cleansed and managed data solutions for the automotive industry.

- **18+ years** of automotive data experience
- **Strategic division of** CDK Global formerly ADP Dealer Services
- Acquired **IntegraLink in 2010**
- Directly provide data services for **every OEM in North America**
- Leading aggregator of automotive data — **over 400 sources** (OEM, DMS, & Third-Party)
- Manage data collection from nearly all U.S. and Canadian Dealerships — **more than 23,000 dealerships with over 140,000 data connections**
- Significant investment in **people, processes, and infrastructure** to deliver enterprise class solutions
- Leading innovation with industry proven **Enterprise Data platform**

DMI SOLUTIONS OVERVIEW

InfoIQ® Data Solutions

SALES
- Vehicle Inventory
- Vehicle Sales
- Sales Lead Matching
- Auction Data

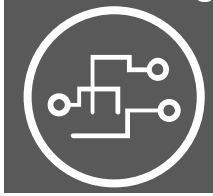
SERVICE
- Vehicle Repair Orders
- Operation Code Categorization
- Service Appointments
- Open Repair Orders

PARTS
- Parts Inventory
- Part Number Standardization
- Parts Invoice
- Parts Source Stocking

CRM
- Customer Data

ENTERPRISE DATA MANAGEMENT
- DDR
- DDX

CDK Third-Party Access Program



MANAGED BI-DIRECTIONAL INTEGRATION

InfoIQ® Vehicle Solutions

INVENTORY MANAGEMENT
- Vehicle Command
- Monroney Data
- Image Management
- Real-Time Inbound / Outbound

CERTFIED PRE-OWNED (CPO)
- OEM Program Management
- Reporting
- Sale Matching
- Video

VIDEO SOLUTION
- Dynamic Real-Time
- Motion

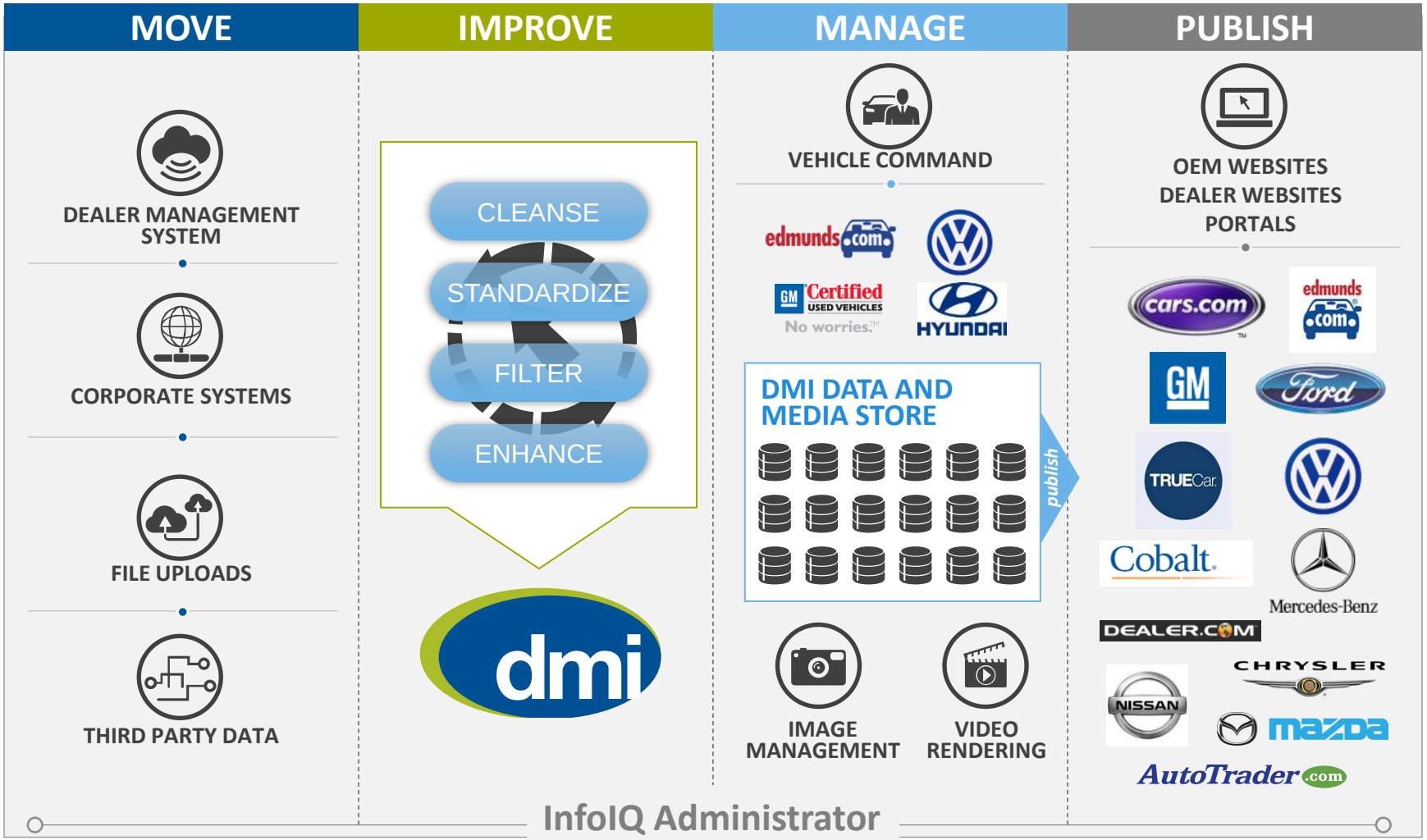
InfoIQ® Parts Solutions

PARTSVOICE PARTS LOCATOR
- Open Dealer Locator

eBay MADE EASY
- Automated Marketplace Listings

CASH DISCOVERY PROGRAM
- Idle Parts Stock Marketplace

INFOIQ® SOLUTION ARCHITECTURE



IMPROVE – VEHICLE DATA

Data Standardization

Dealer free text ('slop') is converted into a standard set of expected ('strict') values. For vehicle inventory records alone, DMI manages over 2 million slop-strict mappings to deliver normalized content our clients need to run their programs.

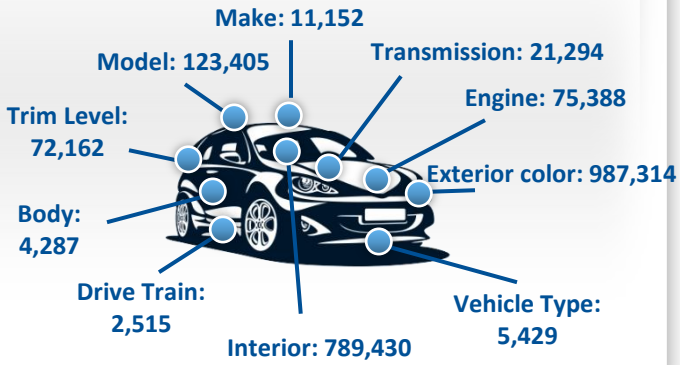
DMI manages over 2 million slop-strict mappings

Data Mappings

DMI maps Vehicle Attributes, Standard Features, and Options. There are over 123,000 mappings to describe the vehicle attribute "model" alone.

Other attributes:

Mappings by vehicle attribute



IMPROVE – VEHICLE DATA

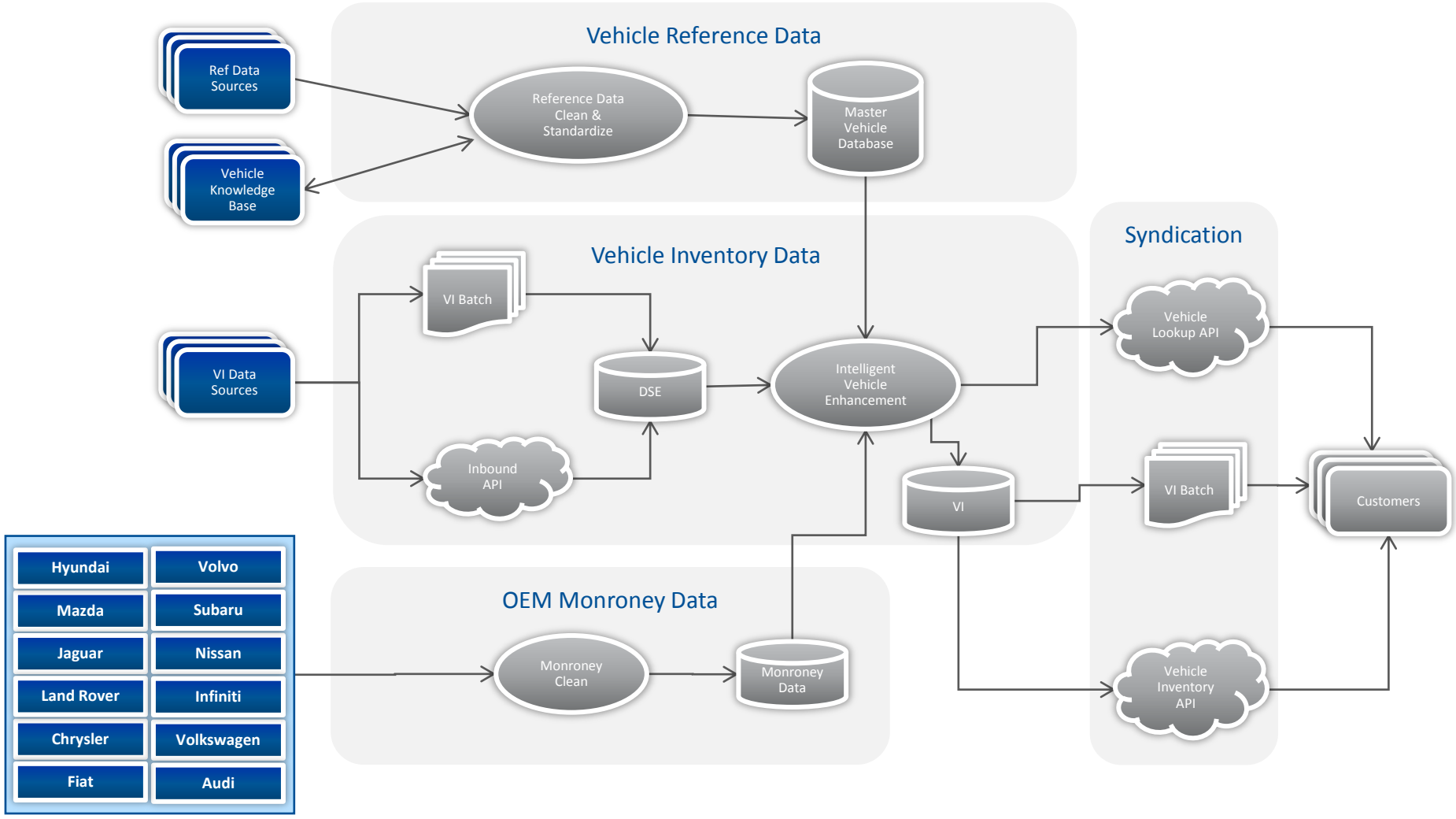
Raw DMS Data

```
CAR-INV : 5*20625A
STOCK-NO.  20625A
N/U  USED
ENTRY  11OCT14
DAYS  128
BALANCE  13,610.74
STICKER
ACV  12000.00
BASE-RET
COST-PACK
STATUS  S
SERIAL-NO.  JM1BL1UF6C1504779
MILES  34640
YR  12
MAKE  MAZD
MODEL  MAZDA3
TRIM-LEVEL  SPORT
MODEL-TYPE  C
BASE
BODY  SD
ENGINE  2.0 Liter MPI DOHC
TRANS
MILEAGE  34554
CERTIFIED
WHSL
CO  4
```

Cleaned Vehicle Data


```
- vehicle: {
    vin: "JM1BL1UF6C1504779",
    bodyDescription: "4 Door Sedan",
    bodyStyle: "Sedan",
    bodyDoorCount: 4,
    cityMPG: 25,
    classification: "Compact Car",
    driveTrainDescription: "Front-Wheel Drive",
    driveTrainType: "FWD",
    driveTrainWheelCount: 2,
    driveTrainFrontRear: "Front",
    engineDescription: "2.0L I4 16V MPFI DOHC",
    engineDisplacement: 2,
    engineDisplacementUnit: "L",
    engineBlockStyle: "I",
    engineCylinderCount: 4,
    engineValveCount: 16,
    engineFuelType: "G",
    engineFuelIntake: "MPFI",
    engineCamshaft: "DOHC",
    exteriorColorDescription: "Black Mica",
    exteriorBaseColor: "Black",
    exteriorColorCode: "16W",
    exteriorColorFinish: "Metallic",
  - features: [
      - {
            source: "OEM",
            description: " FRONT SEATBACK MAP POCKET"
        },
      - {
            source: "OEM",
            description: " FRONT & REAR STABILIZER BARS"
```

DMI VIN-Specific Vehicle Content Services



Recent vehicle headlines

- Recall after recall
- Hydrogenation
- VIN cloning
- Vehicle recognition app
- Smart-(fill in the blank)
- 3D printed cars

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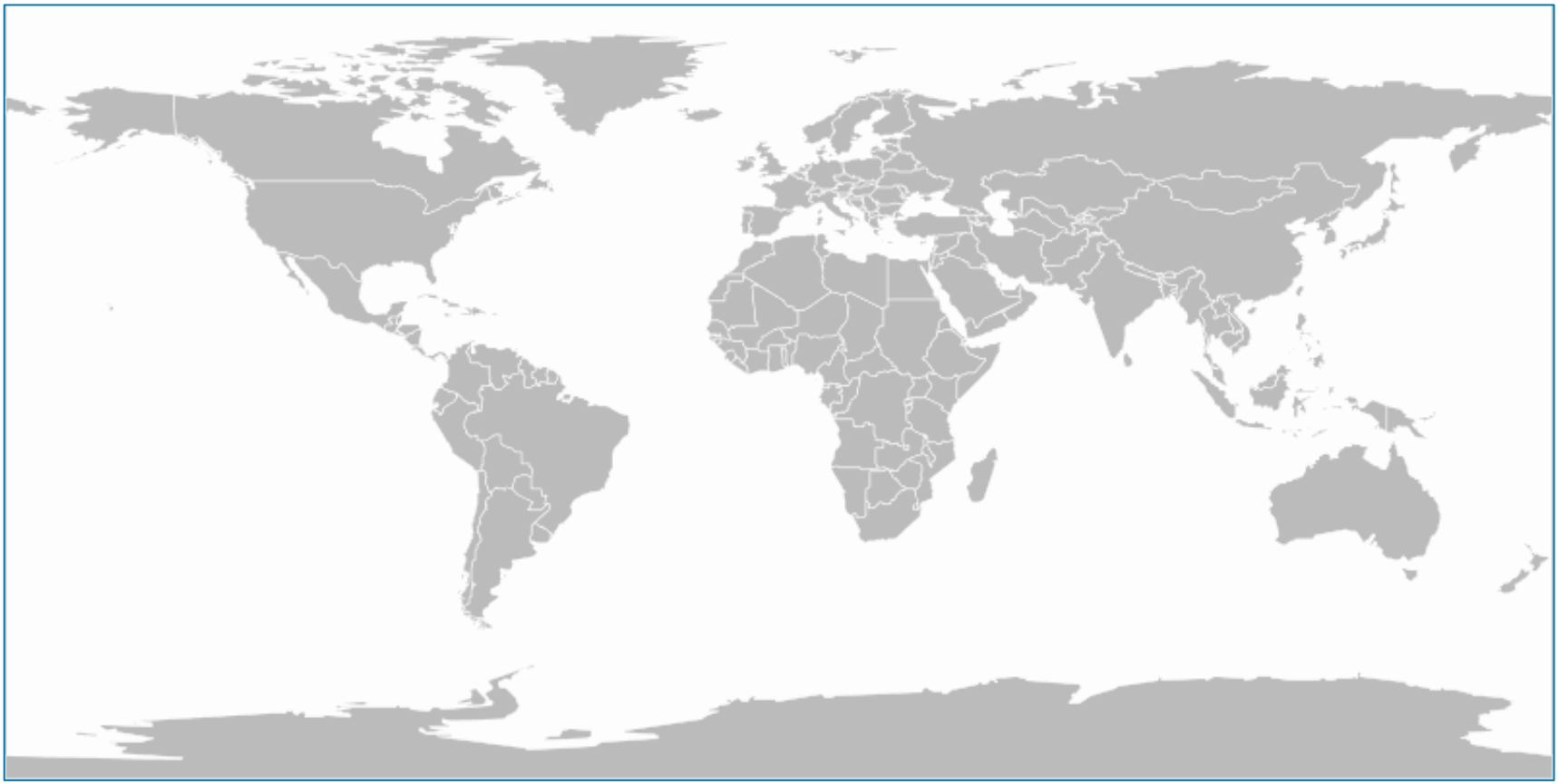
Airbag recall case study



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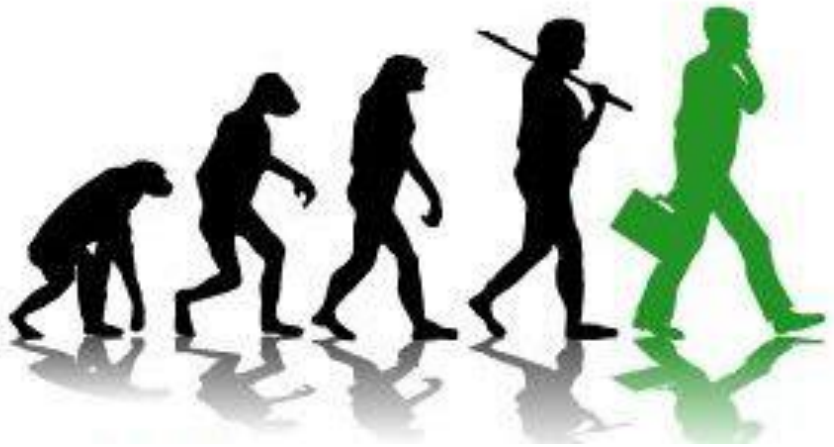
Evolution of vehicle ratemaking



Economics | Psychology | Experientialism | Physics | Engineering | History

What will be the next breakthrough?

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How to objectively identify a lemon

Economics	Psychology	Experientialism	Physics	Engineering	History
$18,500	Open-Air	Limon: 78% L/R	75” width	Safety Pick	Branded Title
“Age” 4	Performance	2 Drs: 83% L/R	3,800 lbs.	Stop-on-a-dime	98,000 miles

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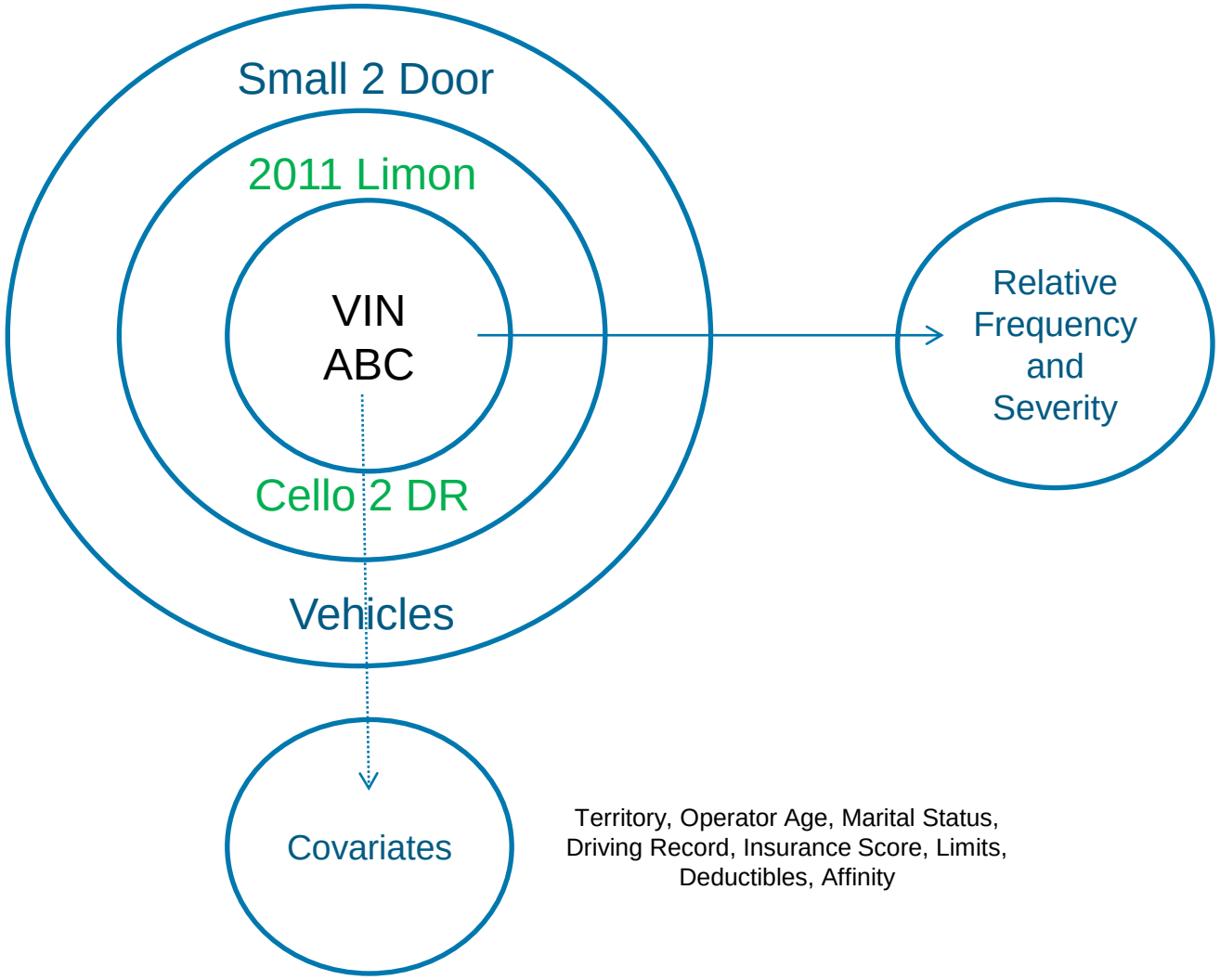
Symbol approaches -- experience



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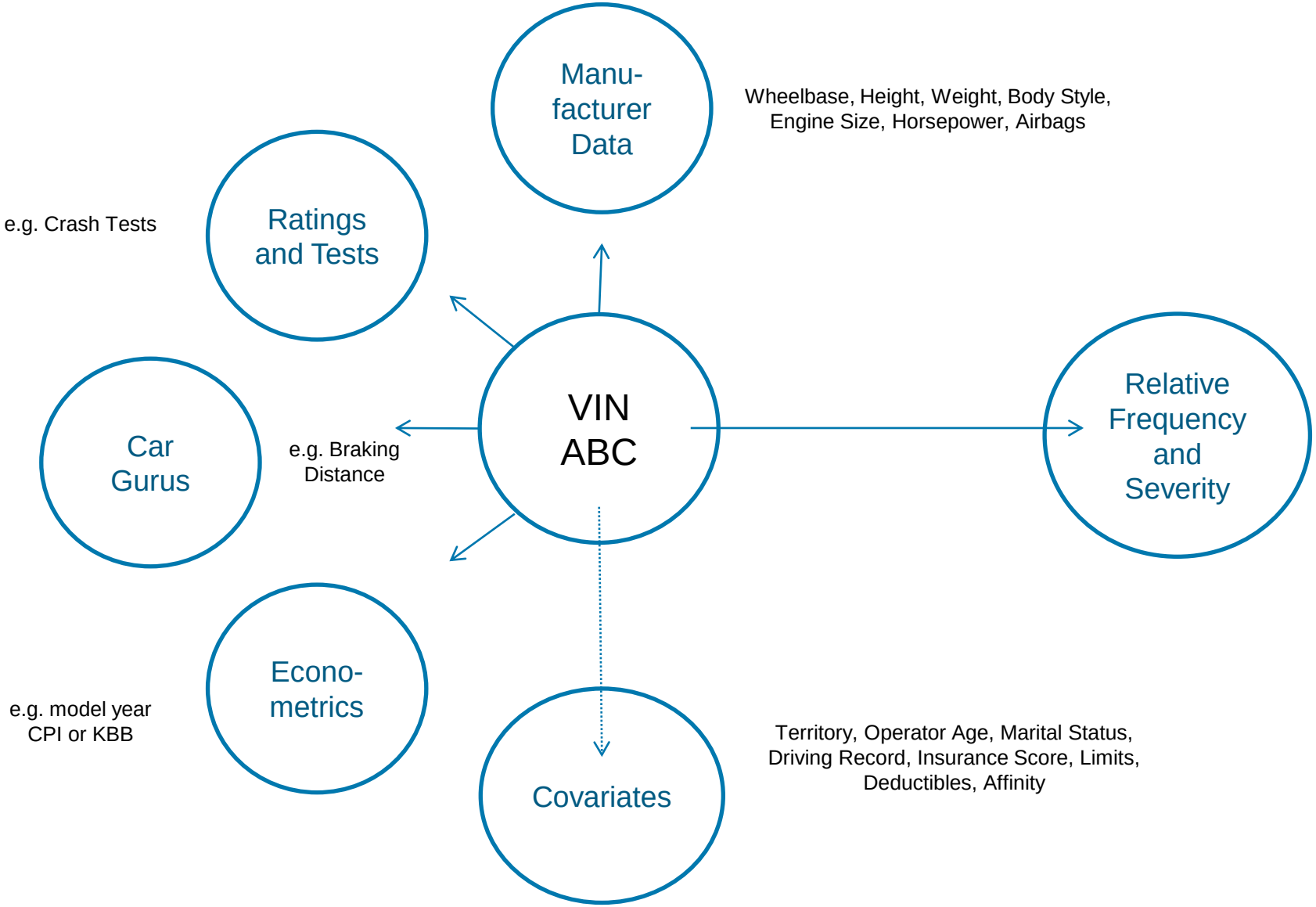
Symbol Approaches -- Attribute



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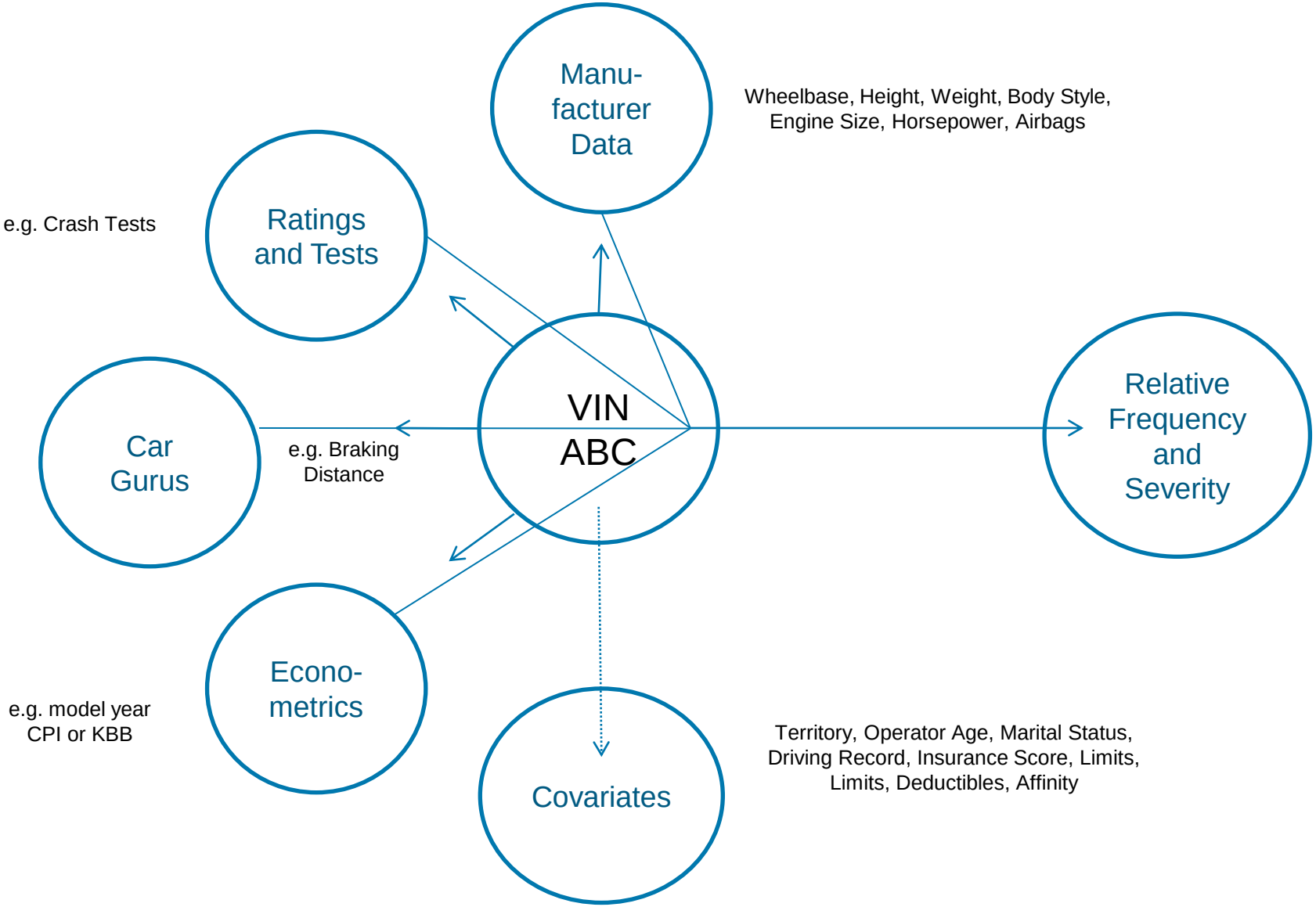
Symbol approaches -- attributes



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Fuzzy matching example

Sources:
Cars.com
Edmunds.com
Euroncap.org
Iihs.org/iihs/ratings
Iihs.org/iihs/topics/insurance-loss-information
Safercar.gov

Class	Make	Model
Small Family Car	Honda	Civic
Small Family Car	Honda	Civic Hybrid

Year	Make	Model	Style
2013	Honda	Civic	EX

Year	Make	Model	Configuration
2013	Honda	Civic Coupe	EX

Year	Make	Model
2013	Honda	Civic 2-door coupe

Year	Make	Model
2013	Honda	Civic 2DR FWD

Model Years	Size	Body	Vehicle
2011-2013	Small	Two-door Car	Honda Civic
2011-2013	Small	Two-door Car	Honda Civic Si

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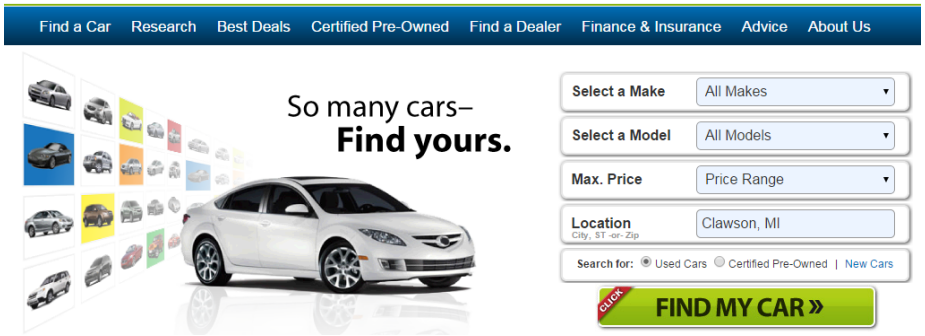
Vehicle Data in Vehicle Marketing



Pre-1958

- No options
- No data tracking
- Car buyers had no idea what was included in the cost of a vehicle

1958

- Automobile Information Disclosure Act
- Window Stickers track options and MSRP

Pre-1995

- Newsprint Marketing
- In store shopping
- Core attributes only - No Standard Features
- No Options

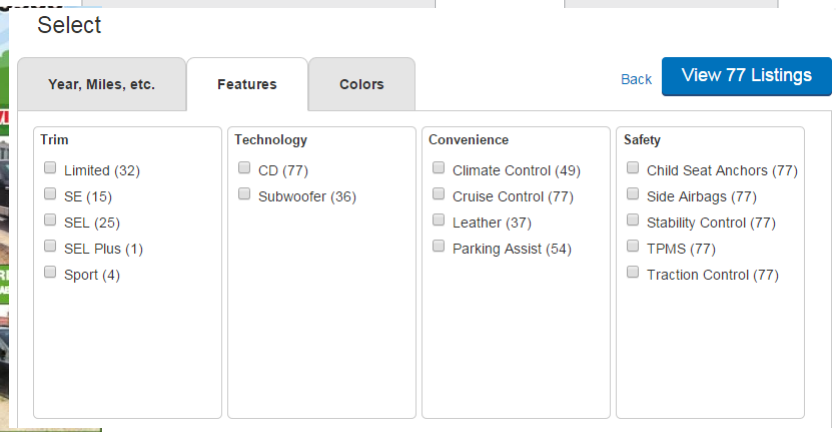
1995

- Digital Marketing – Online shopping
- Scramble to acquire dealer vehicle data
- Standard Decode Features

2010

- Vehicle Packages & Options
- OEM Build Data
- Long-tailed search

MR. STICKER Senator Mike Monroney in a 1963 ceremony with President John F. Kennedy



Insurance Vehicle Reference Data

- Determining Insurance Rates
  - To determine the vehicle risk factor, the impact of Specific Vehicle Attributes needs to be assessed by evaluating:
    - Accident Frequency
    - Damage/Repair Costs
    - Liability
    - Personal Injury
    - Safety Ratings
  - In order to do this, Standard VIN decoders are used to determine the attributes of every vehicle

Decoding a VIN

"Correct data is essential for Insurers to properly price insurance policies, and it is an ongoing problem that some data is particularly hard to verify." Bob U'Ren, VP Underwriting and Business Development Quality Planning Corp.

Generic VIN Decoding only gets you so far

- The problem is that the vehicle information provided by these data sources typically only includes a VIN or the results of a standard VIN decode
- Standard VIN Decodes are based on the first 8 + 10th and 11th characters of the VIN
- VIN Decoders are only able to determine the "standard" attributes of a vehicle and, depending on the vehicle, are often ***NOT able to determine key attributes, such as engine, transmission or drivetrain***.
- ***VIN Decoders are unable to identify the Specific OEM installed options and packages***

VIN digits	1	2	3	4-8	9	10	11	12-17
	Country	Manufacturer	Type	Details	Check digit	Year	Assembly plant	Production number

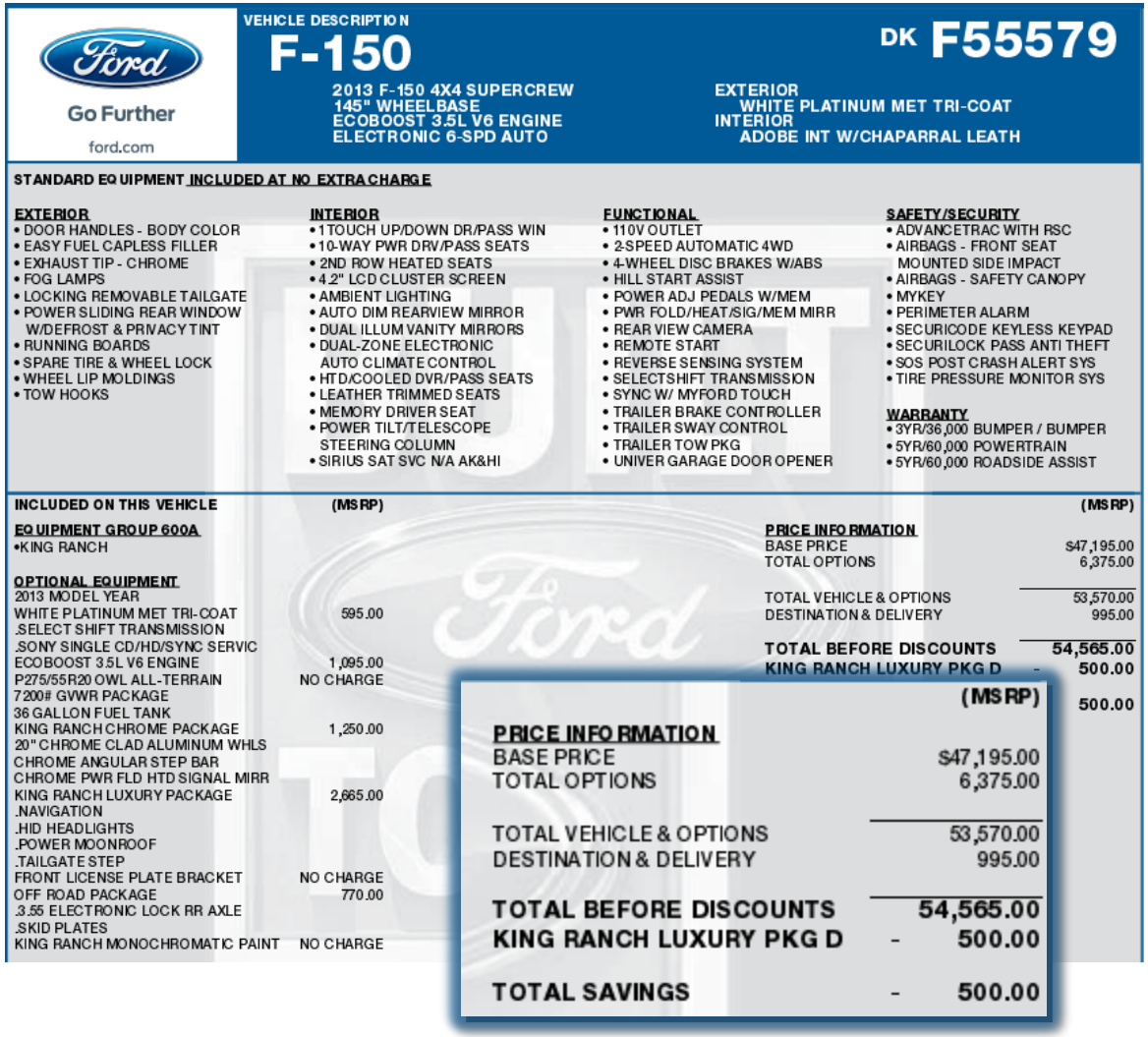
This is used, according to local regulations, to identify the vehicle type, and may include information on the automobile platform used, the model, and the body style. Each manufacturer has a unique system for using this field.

Decoding a VIN

Take this VIN for example: 1FTFW1ETXDKF55579

A standard decode reveals the following:

- Squish VIN = 1FTFW1ETDK
- Year, Make, Model = 2013 Ford F-150
- Unable to determine any of the following:
  - Trim – could be any of the following: XL, XLT, Limited, Lariat, FX4, King Ranch, Platinum
  - MSRP ranges from $37,130 to $53,300
  - Color: unknown
  - Options: unknown
- See Window Sticker example of this VIN, which includes $6,375 worth of options



Ford
Go Further
ford.com

VEHICLE DESCRIPTION
F-150
2013 F-150 4X4 SUPERCREW
145" WHEELBASE
ECOBOOST 3.5L V6 ENGINE
ELECTRONIC 6-SPD AUTO

DK F55579

EXTERIOR
WHITE PLATINUM MET TRI-COAT
INTERIOR
ADOBE INT W/CHAPARRAL LEATH

STANDARD EQUIPMENT INCLUDED AT NO EXTRA CHARGE

EXTERIOR
- DOOR HANDLES - BODY COLOR
- EASY FUEL CAPLESS FILLER
- EXHAUST TIP - CHROME
- FOG LAMPS
- LOCKING REMOVABLE TAILGATE
- POWER SLIDING REAR WINDOW W/DEFROST & PRIVACY TINT
- RUNNING BOARDS
- SPARE TIRE & WHEEL LOCK
- WHEEL LIP MOLDINGS
- TOW HOOKS

INTERIOR
- 1 TOUCH UP/DOWN DR/PASS WIN
- 10-WAY PWR DRV/PASS SEATS
- 2ND ROW HEATED SEATS
- 4.2" LCD CLUSTER SCREEN
- AMBIENT LIGHTING
- AUTO DIM REARVIEW MIRROR
- DUAL ILLUM VANITY MIRRORS
- DUAL-ZONE ELECTRONIC AUTO CLIMATE CONTROL
- HTD/COOLED DVR/PASS SEATS
- LEATHER TRIMMED SEATS
- MEMORY DRIVER SEAT
- POWER TILT/TELESCOPE STEERING COLUMN
- SIRIUS SAT SVC N/A AK&HI

FUNCTIONAL
- 110V OUTLET
- 2-SPEED AUTOMATIC 4WD
- 4-WHEEL DISC BRAKES W/ABS
- HILL START ASSIST
- POWER ADJ PEDALS W/MEM
- PWR FOLD/HEAT/SIG/MEM MIRR
- REAR VIEW CAMERA
- REMOTE START
- REVERSE SENSING SYSTEM
- SELECTSHIFT TRANSMISSION
- SYNC W/ MYFORD TOUCH
- TRAILER BRAKE CONTROLLER
- TRAILER SWAY CONTROL
- TRAILER TOW PKG
- UNIVER GARAGE DOOR OPENER

SAFETY/SECURITY
- ADVANCETRAC WITH RSC
- AIRBAGS - FRONT SEAT MOUNTED SIDE IMPACT
- AIRBAGS - SAFETY CANOPY
- MYKEY
- PERIMETER ALARM
- SECURICODE KEYLESS KEYPAD
- SECURILOCK PASS ANTI THEFT
- SOS POST CRASH ALERT SYS
- TIRE PRESSURE MONITOR SYS

WARRANTY
- 3YR/36,000 BUMPER / BUMPER
- 5YR/60,000 POWERTRAIN
- 5YR/60,000 ROADSIDE ASSIST

INCLUDED ON THIS VEHICLE	(MSRP)
EQUIPMENT GROUP 600A	
•KING RANCH	
OPTIONAL EQUIPMENT	
2013 MODEL YEAR	
WHITE PLATINUM MET TRI-COAT	595.00
.SELECT SHIFT TRANSMISSION	
.SONY SINGLE CD/HD/SYNC SERVIC	
ECOBOOST 3.5L V6 ENGINE	1,095.00
P275/55R20 OWL ALL-TERRAIN	NO CHARGE
7200# GVWR PACKAGE	
36 GALLON FUEL TANK	
KING RANCH CHROME PACKAGE	1,250.00
20" CHROME CLAD ALUMINUM WHLS	
CHROME ANGULAR STEP BAR	
CHROME PWR FLD HTD SIGNAL MIRR	
KING RANCH LUXURY PACKAGE	2,665.00
.NAVIGATION	
.HID HEADLIGHTS	
.POWER MOONROOF	
.TAILGATE STEP	
FRONT LICENSE PLATE BRACKET	NO CHARGE
OFF ROAD PACKAGE	770.00
.3.55 ELECTRONIC LOCK RR AXLE	
.SKID PLATES	
KING RANCH MONOCHROMATIC PAINT	NO CHARGE

PRICE INFORMATION	(MSRP)
BASE PRICE	$47,195.00
TOTAL OPTIONS	6,375.00
TOTAL VEHICLE & OPTIONS	53,570.00
DESTINATION & DELIVERY	995.00
TOTAL BEFORE DISCOUNTS	**54,565.00**
KING RANCH LUXURY PKG D	**- 500.00**
TOTAL SAVINGS	**- 500.00**

Decoding a VIN

With Non-Specific Information That Lacks Risk Relevant Data Like:

Specific Engine Size with Feature and Risk Differentiation Between a…

- ☑ 3.7 litres (225 Cu. In) *Slant-6* I6,
- ☑ 5.2 litres (318 Cu. In) *A* V8,
- ☑ 5.9 litres (361 Cu. In) *B* V8,
- ☑ 6.3 litres (383 Cu. In) *B* V8,
- ☑ 7.0 litres (426 Cu. In) *RB* V8,

Nor Did It Designate Any Other Options or Packages Differences That Effect Risk and Value!

VIN Decodes Can't and Won't Give You The Granularity and Specifics Needed for Proper Rating and Risk Determination,

Comparison: DMI vs Standard Decode

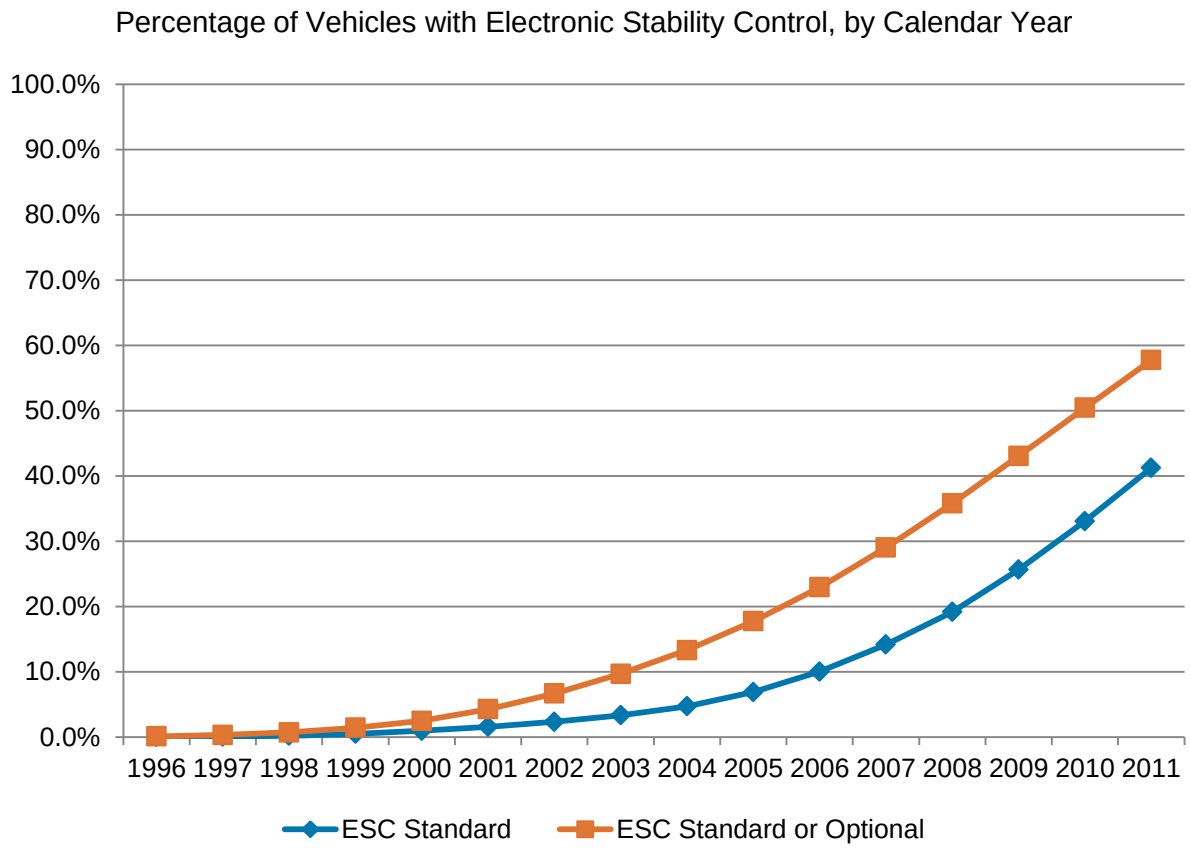
	DMI Decode			Standard Decode
VIN	5NPEC4AB3DH579773			5NPEC4AB3DH579773
MODEL_YEAR	2013			2013
MAKE	Hyundai			Hyundai
MODEL	Sonata			Sonata
TRIM_LEVEL	Limited 2.0T			
MODEL_CODE	27452F45			
EXT_COLOR_DESCRIPTION	Harbor Gray Metallic			
EXT_COLOR_BASE_COLOR	Gray			
DRIVE_TRAIN_DESCRIPTION	Front-Wheel Drive			
TRANSMISSION_DESCRIPTION	6-Speed Automatic			Automatic
BODY_DESCRIPTION	4 Door Sedan			4 Door Sedan
ENGINE_DESCRIPTION	2.0L I4 16V GDI DOHC Turbo			4 Cyl
ENGINE_CYLINDER_CNT	4			4
ENGINE_FUEL_TYPE	Gasoline			Gasoline
PAYLOAD_CAPACITY	22/34			22/34
SEATING_CAPACITY	5			5
WHEEL_BASE	110.00			
BODY_DOOR_CNT	4			4
INTERIOR_COLOR	Gray			
STOCK_NUM	64374			
INVENTORY_DATE	02/28/2014			
TYPE	Used			
INVOICE_PRICE	22374.00			
LIST_PRICE	$24,995.00			
Options	Code	MSRP	Description	Not available
	CF	100	Carpeted Floor Mats	
	CM	95	Cargo Mat	
	RS	250	Rear Spoiler	

Feature Normalization

- Prioritizes and Categorize Features
- Standardizes Features across Manufacturers and Sources
- Enables Feature Analytics
- De-Dupes Features across Sources
- Identifies Specific Feature Characteristics such as:
  - Pre-Collision vs Post Collision
  - Active vs Passive Safety Systems
  - Warning vs Mitigation Safety Systems
  - Audible, Visual or Haptic Feedback

Make	Stability-Control System Name
Acura	Vehicle Stability Assist (VSA)
Audi	Electronic Stability Program (ESP)
BMW	Dynamic Stability Control (DSC)
Buick	StabiliTrak
Cadillac	StabiliTrak
Chevrolet	Active Handling (cars); StabiliTrak (SUVs)
Chrysler	Electronic Stability Program (ESP)
Dodge	Electronic Stability Program (ESP)
Ford	AdvanceTrac
GMC	StabiliTrak
Honda	Vehicle Stability Assist (VSA)
Hyundai	Electronic Stability Program (ESP)
Infiniti	Vehicle Dynamic Control (VDC)
Jaguar	Dynamic Stability Control (DSC)

Example: optional to mandatory



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Comparing approaches

	Experience	Attribute
Speed	Trailing indicators	Leading indicators
Granularity	Reliant on MSRP w/in series	Trim level predictions
Objectivity	Intangibles and evolution	Defined set of attributes
Maintenance	Annual review	Resolution and remodeling
Accuracy	High at series level but limited within series	Limited for variations beyond modeled set of attributes

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Example: vestigial organs

2014 Honda CR-V EX

Feature	LX	EX
Price New	$24,195	$28,495
Body Style	SUV	SUV
Engine Size	2.4 L	2.4 L
Wheelbase	65.1”	65.1”
Weight	3,426 lbs.	3,545 lbs
Seats	Cloth	Leather
Coll. Sym – EXP		28% higher
Coll. Sym – ATTR		3% lower

Advantage: Attributes

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Example: unseen evolution

What's missing from this picture?

Feature	Mazda CX-9 Grand Touring	Volvo XC60 3.2
Price New	$36,625	$36,850
Body Style	SUV	SUV
Engine Size	3.7 L	3.2 L
Wheelbase	113.2"	109.2"
Height	68.0"	67.4"
Drive Wheels	AWD	AWD
Coll. Sym – EXP	Advantage: Experience	22% lower
Coll. Sym – ATTR		same

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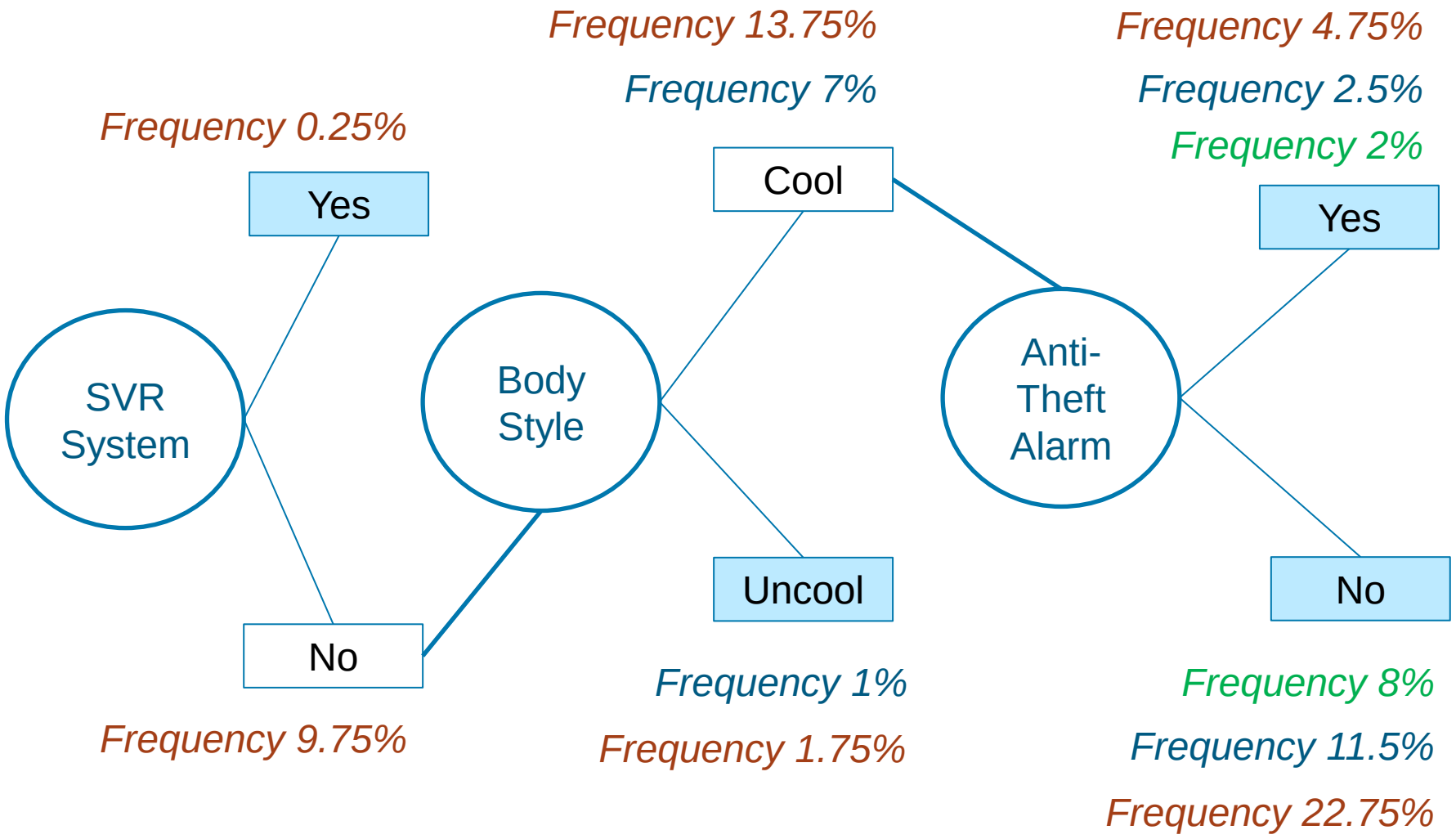
Potential decision tree – theft claims



NOTE: These results are hypothetical. Please do not reproduce.

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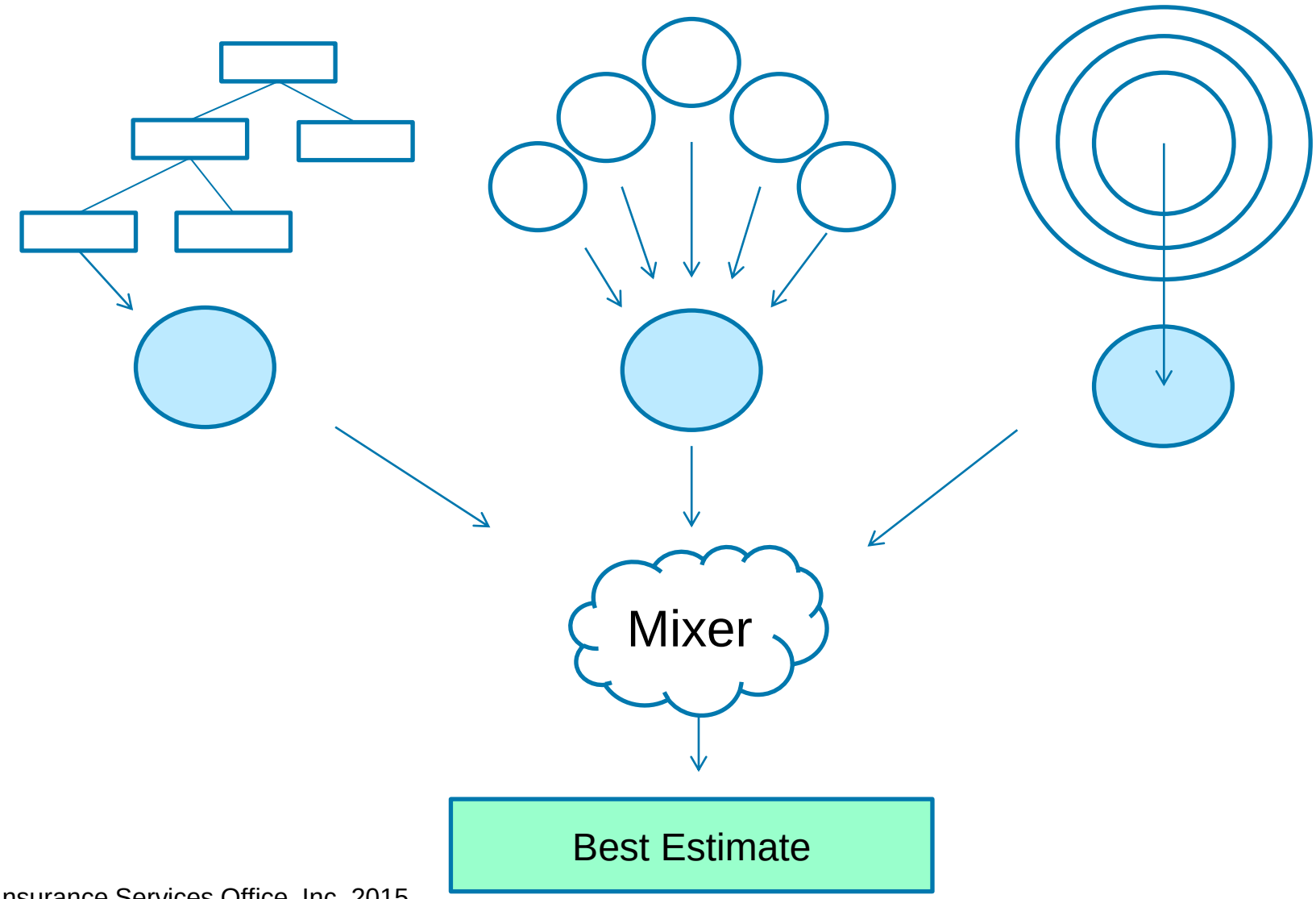
Best of all worlds



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Sample ensemble methods for vehicles

- Boosting
- Bagging
- Stacking

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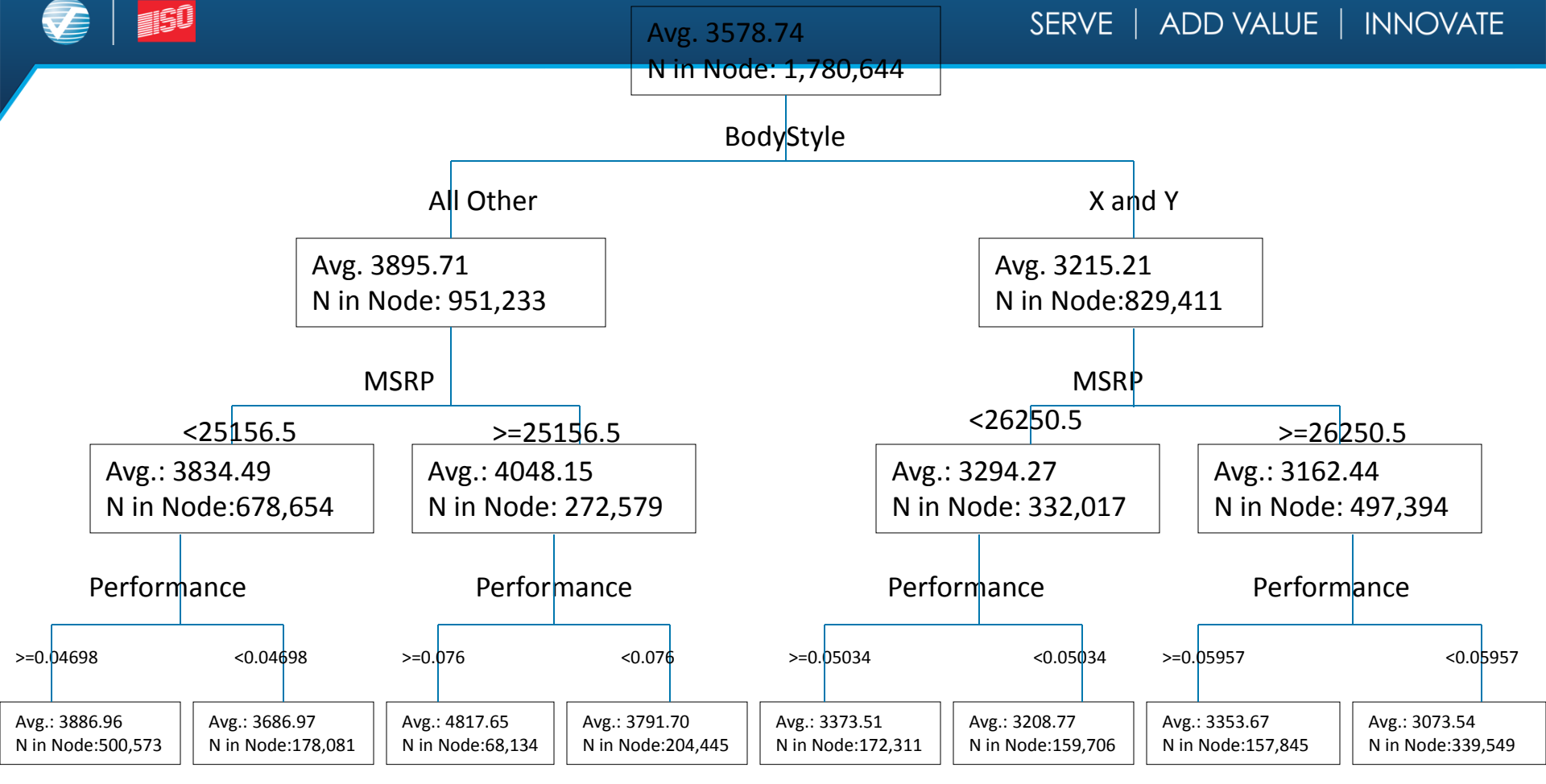

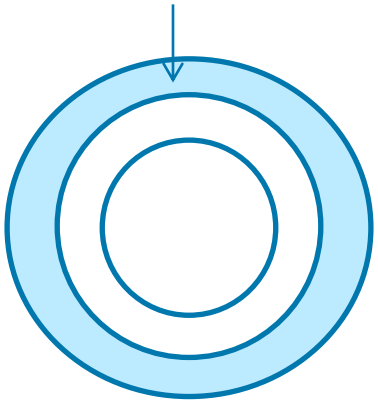

~6% reduction in mean absolute error compared to existing complement

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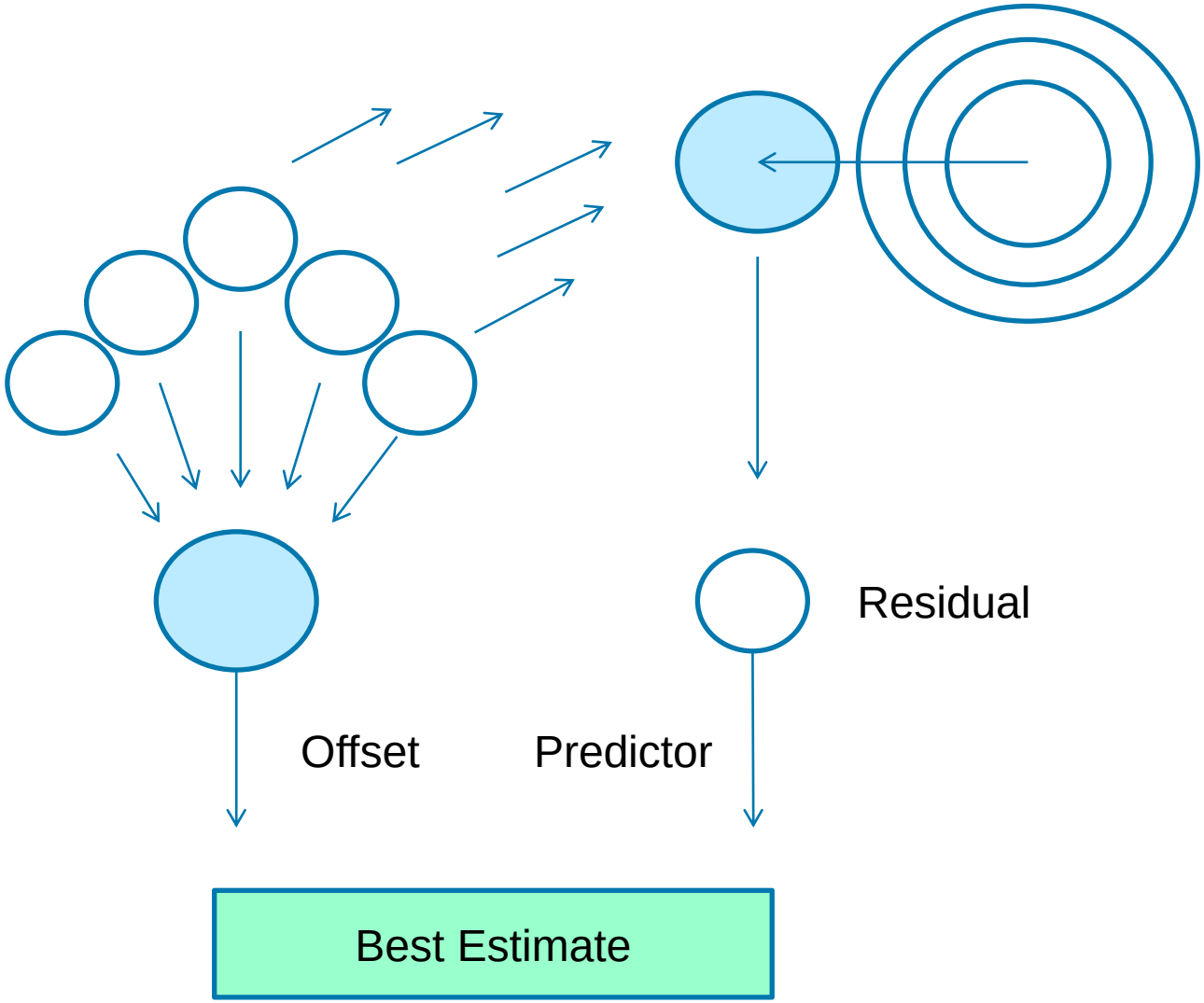
Simple ensemble approach



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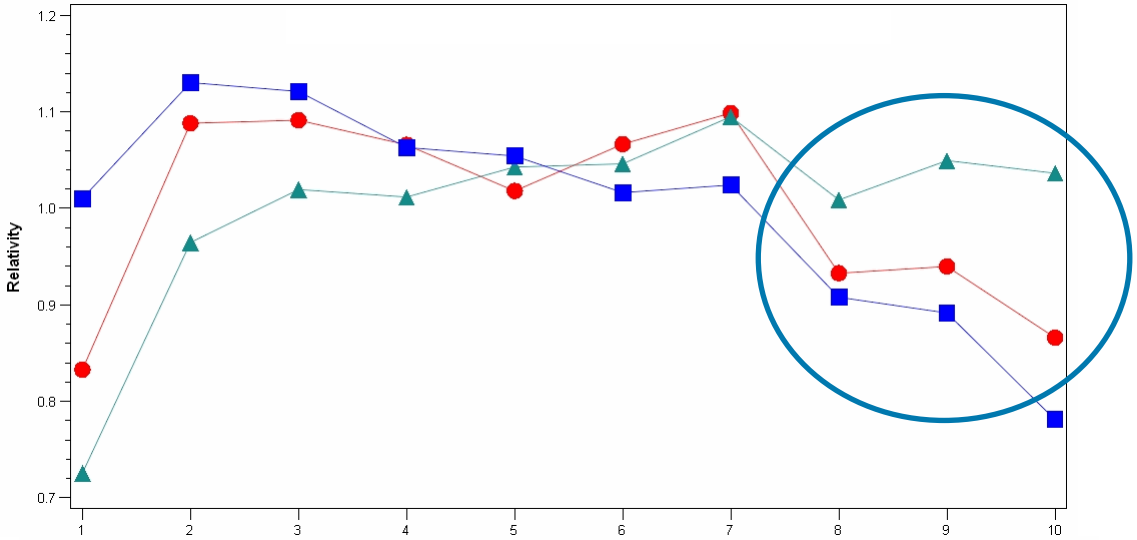
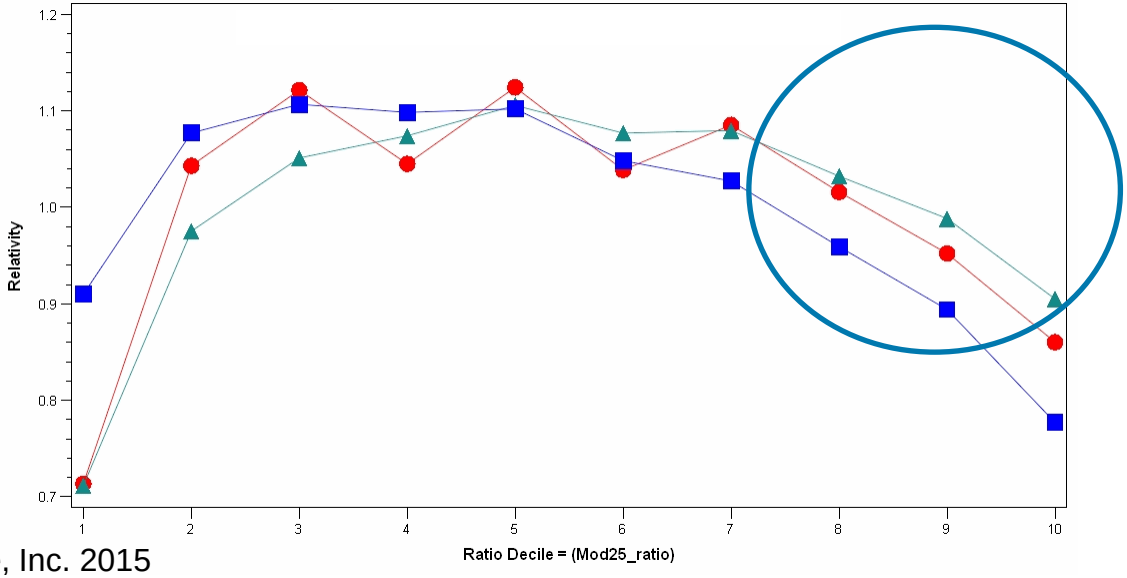
Double lift charts – no-fault

Attributes
vs.
Experience
vs.
Actual



Ensemble
vs.
Experience
vs.
Actual



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Recap

- Non-traditional data sources significantly enhance models
- Symbol approaches must evolve to handle more dimensions of vehicle risk
- VIN decodes may not provide a complete picture
- Combining multiple modeling approaches can produce more accurate estimates

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Questions?

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