

AI- and IoT-driven Home Insurance

Xavier Maréchal

ABOUT ME



Xavier
Maréchal

Reacfin

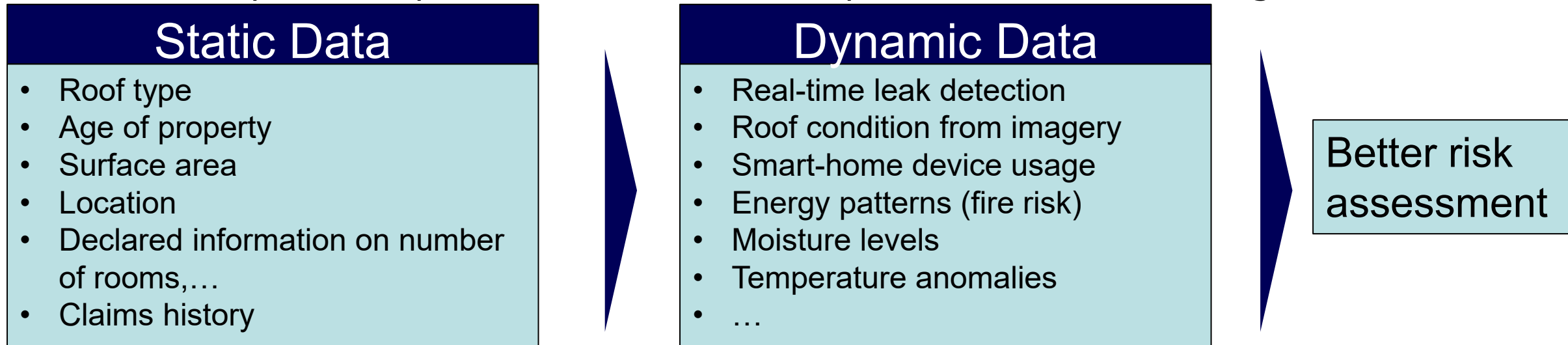
- **CEO** and one of the founders of **Reacfin**, a spin-off of the UCLouvain (Belgium) active for 22 years in actuarial science, quantitative finance and data science.
- Engineer (Applied Mathematics), **Actuary** and Master in Management Science.
- Board member of the **Institute of Actuaries in Belgium** and Chairman of the International Committee
- Working for 22 years as a consultant mainly in **non-life and health insurance** (pricing, reserving, DFA models) with a specific interest in data science for a few years.
- Regularly gives **training** on these topics for Reacfin's clients or for (actuarial) associations across Europe (and even further 😊).

Actuaries need richer, more granular data....

- For decades, actuaries and insurers have sought **richer data to sharpen their risk models** for pricing (and reserving).
Yet the information available at underwriting remained mostly static and incomplete.
- **New external data providers gradually filled part of the gap**, bringing car or property data, satellite imagery, climate models, and behavioural insights that strengthened insurance analytics.
- **Then IoT changed the game.**
Telematics in motor insurance became the first large-scale example of potential ***continuous risk assessment*** — turning real-time behaviour into pricing, prevention, and customer engagement.

...but home underwriting is still mainly based on few risk factors

- Home insurance is a **mature product** with limited differentiation, high stability and intense competition.
- AI combined with IoT represent the first real opportunity in years to **rethink prevention, pricing and claims management in home insurance** allowing a shift from pure compensation to continuous protection and risk mitigation.



➔ Home insurance is built on static snapshots — AI & IoT could turn it into a continuous data flow

1. AI-based Risk Scoring using satellite & aerial imagery

- Use cases and applications
 - Collection of **additional features** on roofing conditions, vegetation encroachment, solar panels, building materials,...
 - Geospatial hazard mapping (**Geo-coding**): wildfire zones, flood exposure, heat zones, drought-related subsidence.
- The **automated property characteristics extraction** reduces reliance on self-reported information.
- What's in it for **actuaries**?
 - Satellite imagery gives actuaries features they never had before
 - Helps improving prior estimates of claims frequency/severity.
 - Improved risk classification leads to strengthen portfolio quality



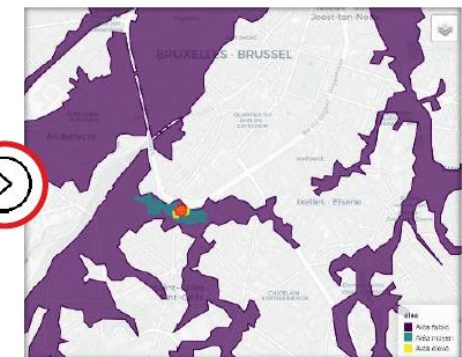
Geocoding



Maps



Spatial join



2. AI-powered portfolio and product analytics

- What's in it for actuaries?
 - Identify **hidden claim drivers** and non-linear risk patterns with ML models
 - E.g. home renovation history predicting claim severity
 - E.g. Identify clusters with unexpected loss ratios (profitability analysis)
 - **Detect emerging risks** in near real time and **simulate portfolio behaviour**
 - E.g. Ageing domestic infrastructure causing clusters of electrical damages
 - E.g. How the portfolio reacts to climate evolution (e.g., worsening hailstorms, increased drought risk, flash floods,...), including the impact of risk-mitigation programs
 - **Support preventive and parametric product innovation**
 - Parametric home protections (triggered by weather thresholds)
 - Prevention-first policies linked to sensor activation
 - Dynamic deductibles depending on behaviour or maintenance history
 - On-demand coverage for specific home assets

1. Water leak detection sensors

- **Water damage** is the #1 cause of non-natural home claims in many European markets.
- IoT leak detectors reduce frequency dramatically (sometimes 30–60%).
- Integration with **shut-off valves** → prevention instead of claims payments
- Examples
 - **Aviva's LeakBot** water-leak prevention (in partnership with HomeServe)
 - LeakBot clips onto the domestic water pipe, detects leaks and alerts the customer via app
 - HomeServe's network can then intervene quickly
 - Several major European carriers (**AXA, Zurich**,...) already tie pricing or conditions to the installation of **certified leak detection systems** for some of their products and/or in some countries



2. Other IoT devices supporting prevention

- **Fire and smoke prevention**

- Smart smoke and heat detectors linked directly to emergency services.
- IoT sensors identify early signs of fire through abnormal temperature, humidity, or voltage patterns.
- AI models flag irregular energy consumption that may indicate electrical faults or overheating appliances.
- Real-time alerts enable faster intervention and reduce severity.

- **Security & theft prevention**

- Smart doorbells, motion-activated cameras, and window/door sensors deter break-ins.
- Integration with home automation (lights, alarms) increases deterrence.
- Usage data (e.g., arm/disarm patterns, device activation) can support behaviour-based discounts.
- Video evidence accelerates claims validation and reduces disputes.

- **Additional sensors:** humidity, moisture, CO, temperature, electrical load monitoring,...

3. Smart home ecosystem integration

- Insurers increasingly partner with **smart-home device manufacturers** to offer connected home insurance products.
 - These partnerships open the door to new service models, including “**insurance-as-a-feature**” embedded directly into home automation platforms.
 - Coverage adapts to **real-time IoT signals** (risk conditions, usage, maintenance behaviour).
 - IoT data enables **prevention scoring** based on sensor usage, maintenance behaviour, and customer compliance with prevention recommendations.
- This ecosystem approach supports a shift from pure compensation to continuous protection and early intervention.
- Examples
 - **Aviva** acquired a majority stake in **Neos**, a smart home insurer combining cameras and sensors (leak, smoke, intrusion) with home insurance in one integrated package.
 - **AXA** has developed connected home insurance offerings, building a smart home hub and partnering with multiple IoT manufacturers to prevent burglary, fire, and water damage.

1. Pricing & risk models (1/2)

- IoT enables actuaries to blend traditional variables with **dynamic, behaviour-based signals**
- **Traditional (static):**
 - Location, dwelling characteristics
 - Construction type, roof material, property age,...
- **Dynamic (IoT/AI-based):**
 - Roof degradation score (from imagery)
 - Vegetation proximity / wildfire exposure
 - Leak detector activation rate
 - Sensor usage compliance (heating, smoke detector, security system)
- **Actuarial value**
 - Improved data quality
 - Reduced uncertainty in frequency
 - More accurate rating factors for better discrimination between “good risks” and “bad risks”
- **Parallel with motor telematics:**
 - Actuaries must design models that integrate **behavioural signals** with traditional risk variables.

1. Pricing & risk models (2/2)

- **Example:** frequency model IoT data for home insurance
 - **Response:** annual claim count (Poisson or Negative Binomial distribution).
 - **Traditional features:** postcode risk index, dwelling type, construction, roof age, sum insured, composition of the house,...
 - **Additional IoT features** (after binning or transformation)
 - Leak sensor installed (0/1)
 - Compliance index (0–100 entered as spline): weighted score of recommended actions followed
 - Days offline last 90 days
 - Average number of alerts per month,...
 - **Models:**
 - GLM, GAM, GLMM (for multi-level or longitudinal effects), multi-state, ML (e.g. pre-modelling)
 - Potential separation between selection (propensity model) and behaviour (conditional on propensity)
 - **Example of results:**
 - IoT features improve Gini by +X points and reduce prediction error;
 - High-compliance policyholders show y% lower expected frequency.

2. Monitoring the impact of prevention

- Actuaries can **quantify the value** created by IoT-based prevention programs:
 - Prevented claims:** # avoided water, fire, or burglary losses
 - Reduced severity:** faster response = smaller losses?
 - Behavioural changes:** higher compliance reduces expected loss ratio
 - ROI of device subsidies:** Do subsidized sensors pay off? At what adoption level?
 - Segment-level impact models:** identify which customer groups benefit most
- Example of metrics**
 - Avg. water-damage cost reduction per detected leak
 - Severity drop when shut-off valves intervene early
 - Correlation between alarm usage and burglary claims
- This creates a **continuous actuarial feedback loop** that improves pricing, reserving and product design.

ROI Calculator



3. Claims automation and fraud detection

• Automation through AI

- Computer vision models evaluate damage from **photos, videos**, and **drone** imagery (roof damage, fire patterns, storm impact).
- NLP/LLM models **classify claims** and route them automatically.
- **Automated coverage-checking** and document extraction accelerate FNOL → settlement.

• Fraud detection

- Geospatial checks **validate consistency** with weather events.
- Metadata from photos/videos (including drone data) helps **detect altered claims**.
- IoT logs act as “**digital accident reports**”.

• Actuarial benefits

- **More consistent and predictable reserving** thanks to early and standardised severity estimates.
- **Shorter feedback loops** between claims and pricing=faster experience adjustments.
- Reduced leakage and fraud lead to **improved loss ratios**.

Ethical, regulatory & data governance challenges

- **Data governance**

- Balancing **data collection** with the value of continuous monitoring.
- Ensuring responsible retention, processing, and sharing of sensor data.
- Clear separation needed between **underwriting data** vs. **prevention-only data**.

- **Customer acceptance & fairness**

- **Privacy expectations** vary across countries and generations.
- **Transparency** on what is being monitored and why is essential.
- Risk of **algorithmic bias** (e.g., image-based roof scoring, neighbourhood inference).

- **Regulatory focus areas**

- **Explainability** of AI-driven decisions
- Records of training data and model evolution
- **Ability to justify** pricing factors from IoT data

- **Actuaries' role**

- Build **fairness checks** and **bias controls** into pricing and underwriting models.
- **Document** assumptions, data pipelines, and model governance.
- Ensure **clarity and transparency** toward regulators and customers.

How AI & IoT redefine the role of actuaries

- **From risk evaluators to risk influencers**
 - Actuaries no longer only price risk; they help design **prevention strategies** using sensor data.
 - They quantify avoided losses and shape incentives.
- **From model builders to guardians of trust & transparency**
 - Actuaries ensure **fairness, explainability, and governance** of AI-driven underwriting models.
 - They **bridge the gap** between advanced analytics and regulatory expectations.
- **From product designers to ecosystem architects**
 - Actuaries **define products** that combine insurance, sensors, emergency services, and digital apps.
 - They **evaluate partnerships** (device manufacturers, repair networks, smart-home platforms).

➔ **Overall shift:** the insurer of the future evolves from **reactive payer of claims** to **proactive risk partner**.

➔ Actuaries are uniquely positioned to **design, quantify, and steer** this transformation.

Thank you!

Please rate the conference via the survey-link you will receive per email.

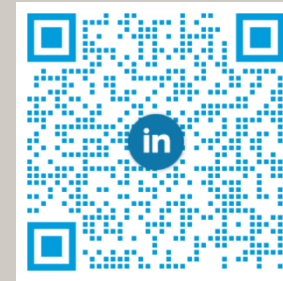
Visit our website



www.actuarial-academy.com

for more events.

Follow us on LinkedIn



www.linkedin.com/company/642904

for updates & actuarial fun.