

# A Recommendation System For Insurance

Laurent Lesage, PhD Student

Foyer, Uni

28<sup>th</sup> April 2020

## 1 Recommendation system

- Context
- Architecture
- Results

## 2 Future work: Hawkes processes

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage
- Scope : car insurance product

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage
- Scope : car insurance product
- Specificity of insurance context:

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage
- Scope : car insurance product
- Specificity of insurance context:
  - ▶ **Data dimensions:** the number of covers is limited to a dozen of guarantees

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage
- Scope : car insurance product
- Specificity of insurance context:
  - ▶ **Data dimensions:** the number of covers is limited to a dozen of guarantees
  - ▶ **Trustworthiness:** insurance products are consumed differently from movies, books and other daily or weekly products

## Recommendation system: context

- Objective: optimize up-selling campaigns by automatically selecting the most likely customers to augment insurance coverage
- Scope : car insurance product
- Specificity of insurance context:
  - ▶ **Data dimensions:** the number of covers is limited to a dozen of guarantees
  - ▶ **Trustworthiness:** insurance products are consumed differently from movies, books and other daily or weekly products
  - ▶ **Constraints:** customers could have to respect some criterion (age, no-claims bonus level, vehicle characteristics, etc.)

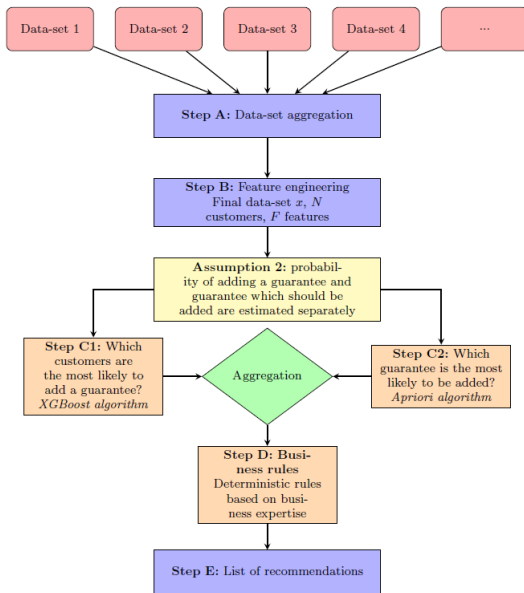


## 1 Recommendation system

- Context
- Architecture
- Results

## 2 Future work: Hawkes processes

# Recommendation system: architecture



## Focus on modelling: two independant models

- **Who is likely to add a cover?** XGBoost algorithm → supervised learning on customers who added a guarantee in the past. Estimates the probability for each customer to add a guarantee

## Focus on modelling: two independant models

- **Who is likely to add a cover?** XGBoost algorithm  $\rightarrow$  supervised learning on customers who added a guarantee in the past. Estimates the probability for each customer to add a guarantee
- **Which guarantee to suggest?** Apriori algorithm  $\rightarrow$  select the additional guarantee which is the best suited to the existing cover. For this purpose, we use the concept of an **association rule**:

$$R : R_1 = \{Guar.1, \dots, Guar.n\} \rightarrow R_2 = \{Guar.n + 1\},$$

and we choose, for a customer with a current cover  $\{Guar.1, \dots, Guar.3\}$  the rule with the highest confidence, that's to say the guarantee which is the most associated with the set of guarantees  $\{Guar.1, \dots, Guar.3\}$

## 1 Recommendation system

- Context
- Architecture
- Results

## 2 Future work: Hawkes processes

## Results on a pilot phase

Pilot phase: test of the recommendation system over a hundred customers.

**These customers were selected by their high probability to add a guarantee and among the portfolio of four collaborating agents.**

**Table:** Profile of customers selected for the pilot phase (VS average customer)

Characteristic	Delta (%)
Age	-2.2%
Living in Luxembourg City	+8.1%
Number of guarantees	-4.7%
Car insurance premium	+15.1%
Number of products	+27.4%
Number of vehicles	+10.1%
Age of vehicles	-6.4%
Price of vehicles	+33.5%
Scoring	+0.5 level
Number of amendments	11.1%

## Results on a pilot phase

Pilot phase: test of the recommendation system over a hundred customers. **These customers were selected by their high probability to add a guarantee and among the portfolio of four collaborating agents.**

Table: Pilot phase results

Conversion rate in literature	15%
Expected conversion rate (back-testing)	45%
<b>Observed conversion rate</b>	<b>38%</b>

## 1 Recommendation system

- Context
- Architecture
- Results

## 2 Future work: Hawkes processes



# Motivation

- Improve the accuracy of the recommendation system:

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change
    - ★ Move, new job, birth, etc.: new habits change how the customer drives and then what car or insurance he should get

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change
    - ★ Move, new job, birth, etc.: new habits change how the customer drives and then what car or insurance he should get
    - ★ Claims: the more the customer is likely to have an accident, the more he needs additional guarantees

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change
    - ★ Move, new job, birth, etc.: new habits change how the customer drives and then what car or insurance he should get
    - ★ Claims: the more the customer is likely to have an accident, the more he needs additional guarantees
- Innovative approach:

# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change
    - ★ Move, new job, birth, etc.: new habits change how the customer drives and then what car or insurance he should get
    - ★ Claims: the more the customer is likely to have an accident, the more he needs additional guarantees
- Innovative approach:
  - ▶ Classic models in insurance: customers' profiles only from an apriori vision

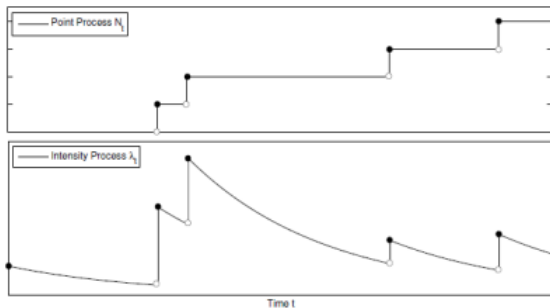


# Motivation

- Improve the accuracy of the recommendation system:
  - ▶ **Before:** recommendation built on past observations of customers
  - ▶ **After:** recommendation built on past observations of customers and on life events predictions
    - ★ Vehicle change: 70% of guarantees adds are from a vehicle change
    - ★ Move, new job, birth, etc.: new habits change how the customer drives and then what car or insurance he should get
    - ★ Claims: the more the customer is likely to have an accident, the more he needs additional guarantees
- Innovative approach:
  - ▶ Classic models in insurance: customers' profiles only from an apriori vision
  - ▶ Hawkes processes: many recent research papers, a few applied to insurance

# Hawkes Process: introduction

Hawkes Process is a category of point process. Idea of Hawkes Process: occurrence of an event increases the likelihood that this event happens again in the near future



Burglaries: when happening, criminals figure out that this specific area is vulnerable and then are more likely to commit crimes there

## Definition

**(Hawkes process)** Let's consider  $\lambda > 0$  (*background intensity*) and  $\mu : (0, +\infty) \rightarrow [0, +\infty)$  (*excitation function*). We denote  $\{t_1, \dots, t_n\}$  the sequence of past occurrences until time  $t$ . A point process is a Hawkes process if its conditional intensity function is of the form

$$\begin{aligned}\lambda^*(t) &= \lambda + \int_0^t \mu(t-u) dN(u) \\ &= \lambda + \sum_{k=1}^n \mu(t-t_k)\end{aligned}\tag{1}$$

Homogeneous Poisson process:  $\lambda^*(t) = \lambda$

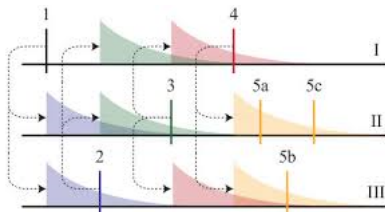
Non-homogeneous Poisson process:  $\lambda^*(t) = \lambda(t)$

## Example

$$\lambda^*(t) = \lambda + \sum_{k=1}^n \alpha \exp(-\beta(t-t_k))\tag{2}$$

# Multivariate Hawkes Process: example

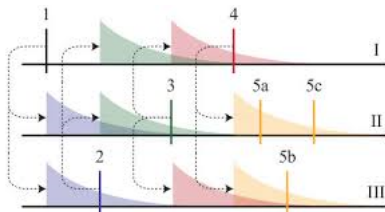
I: move, II: new job, III: new vehicle



- 1: Bob moves from Luxembourg to a French apartment → maybe a new job in France and a new car for different rides

# Multivariate Hawkes Process: example

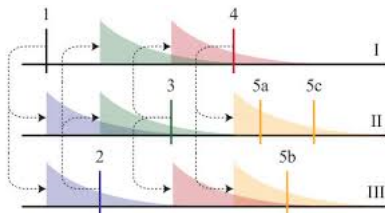
I: move, II: new job, III: new vehicle



- 1: Bob moves from Luxembourg to a French apartment → maybe a new job in France and a new car for different rides
- 2: Bob buys an estate car → maybe a birth incoming, which could imply a new move for a house or a new job (to earn more or work less)

# Multivariate Hawkes Process: example

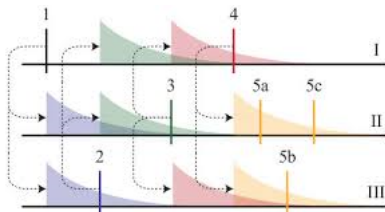
I: move, II: new job, III: new vehicle



- 1: Bob moves from Luxembourg to a French apartment → maybe a new job in France and a new car for different rides
- 2: Bob buys an estate car → maybe a birth incoming, which could imply a new move for a house or a new job (to earn more or work less)
- 3: Bob obtains a better paid job → the house becomes more affordable, and Bob could buy a better car

# Multivariate Hawkes Process: example

I: move, II: new job, III: new vehicle



- 1: Bob moves from Luxembourg to a French apartment → maybe a new job in France and a new car for different rides
- 2: Bob buys an estate car → maybe a birth incoming, which could imply a new move for a house or a new job (to earn more or work less)
- 3: Bob obtains a better paid job → the house becomes more affordable, and Bob could buy a better car
- 4: Bob buys a house in Belgium → maybe he is looking for a job in Belgium and maybe he could change his vehicle again

# Thank you for your attention!

Feel free to contact me for any question/remark:

- [laurent.lesage@foyer.lu](mailto:laurent.lesage@foyer.lu)
- [laurent.lesage@uni.lu](mailto:laurent.lesage@uni.lu)