Interactions entre les évènements de la vie d’un client assuré

Interactions between the events in the life of an insured client

beneva

Beneva

75 ans d’histoire

- **Compagnie d’assurance**
- **Né du regroupement La Capitale et de SSQ Assurance**
- **Assurances auto, habitation, vie, entreprise et produits financiers**

75 years in the making

- **Insurance company**
- **We are La Capitale and SSQ Insurance coming together as one**
- **Auto, home, life, commercial Insurances and financial products**

$26,8 billion
in assets
en actif

3,5 million
clients and members
de membres et clients

5 000
employees
employés

Objective

- Develop a good knowledge of our customers
- Use survival models to be able to prioritize the processing of disability cases
- Improve the quality of our models by introducing competitive risks
- Take into account explainability when choosing the best model to our data.

Survival model

- Models time to event data;
- Estimates survival functions;

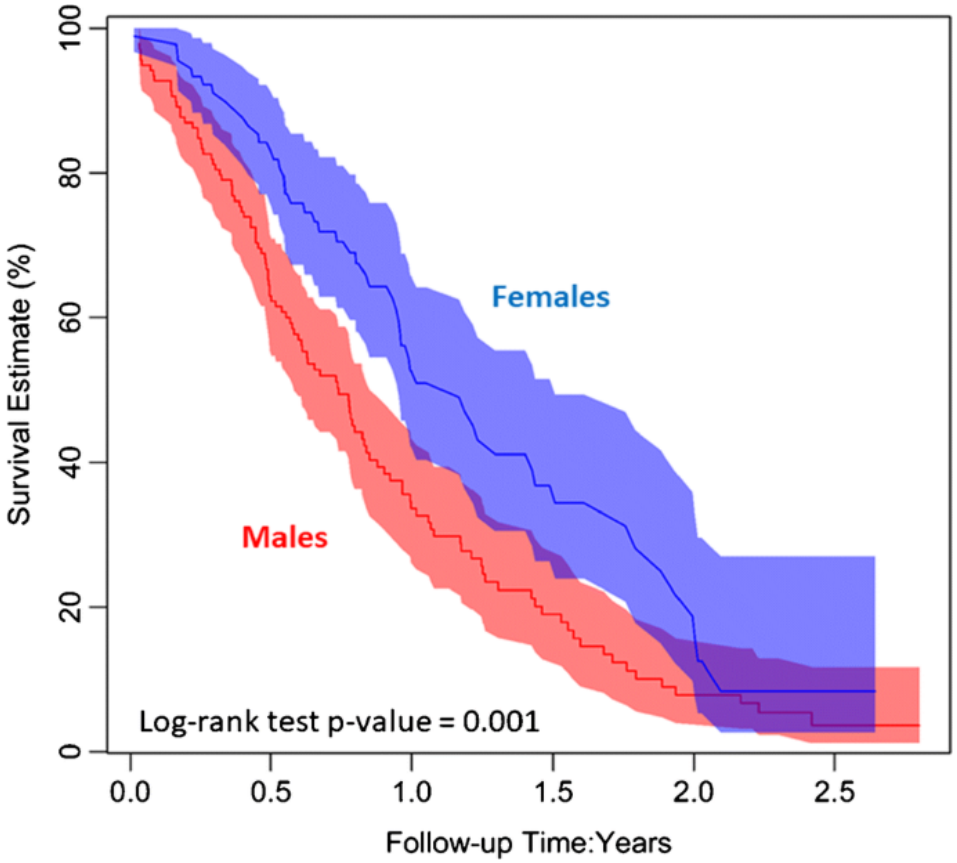
$$S(t) = \Pr(T > t), T \geq 0.$$

- Hazard function :

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t}$$

- Cumulative hazard function :

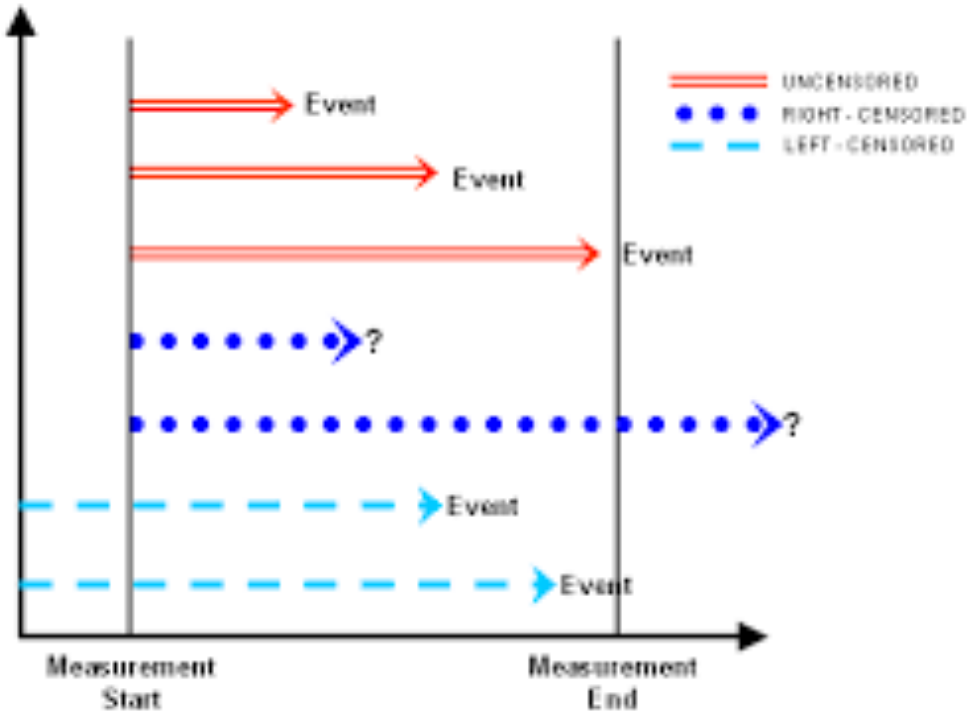
$$H(t) = \int_0^t h(u)du$$



$$\mathrm{CIF}(t) = 1 - S(t)$$

Censoring

- They do not experiment the outcome by the end of the study;
- They are lost to follow-up or withdrawn from the study before it ends.

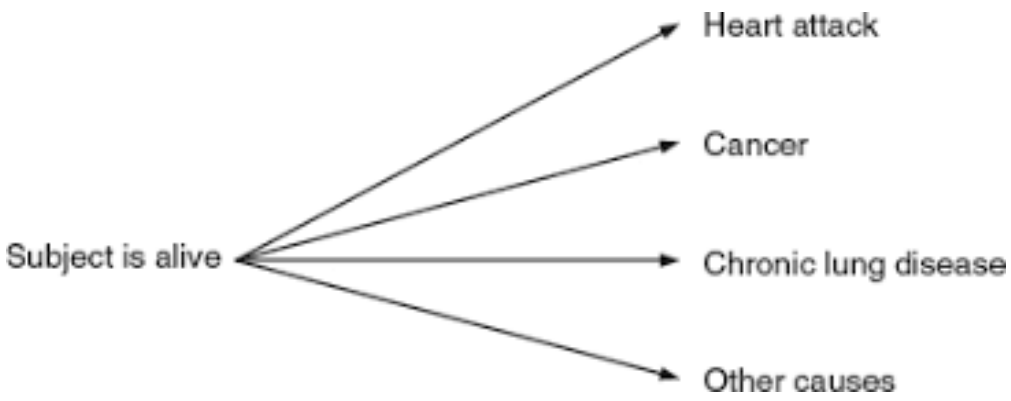


Noninformative censoring : occurrence or timing of censoring events is independent of the event of interest.

What are Competing Risks?

In survival analyses, a competing risk (CR) is an event that :

- Prevents the event of interest to occur;
- Changes the risk of the event of interest



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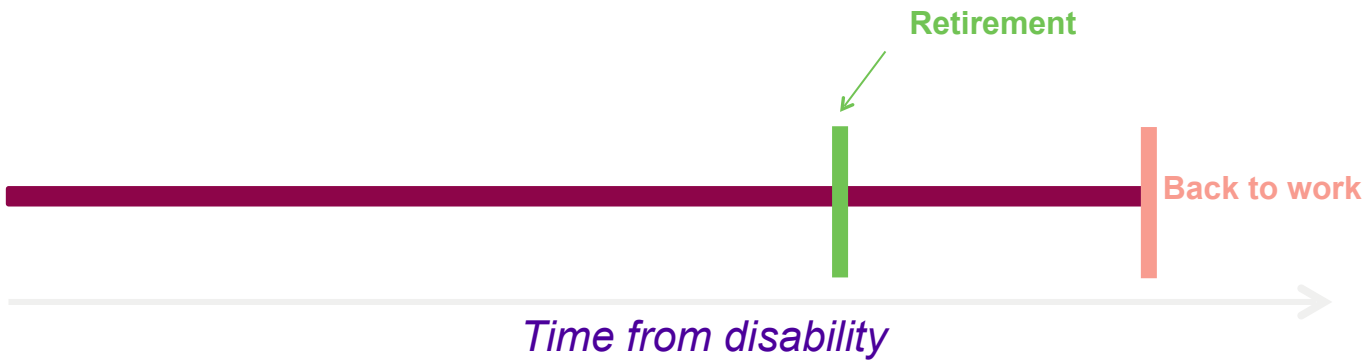

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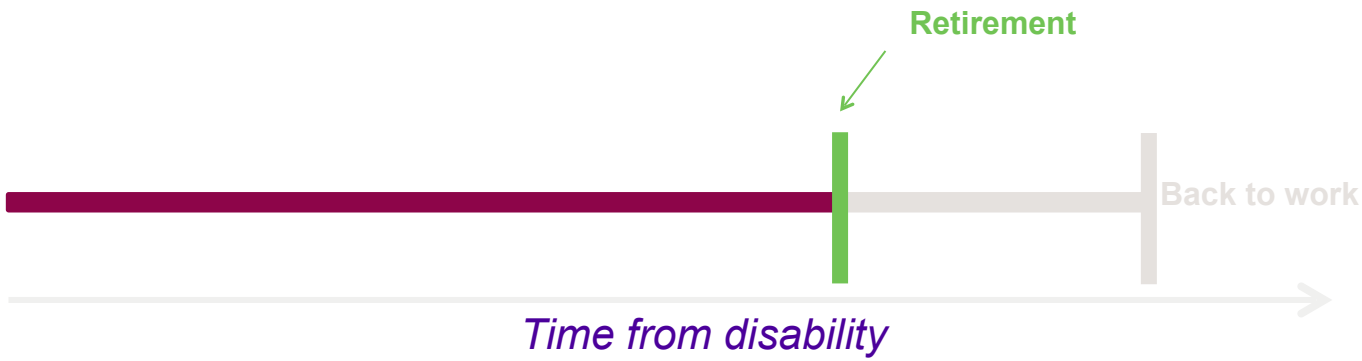

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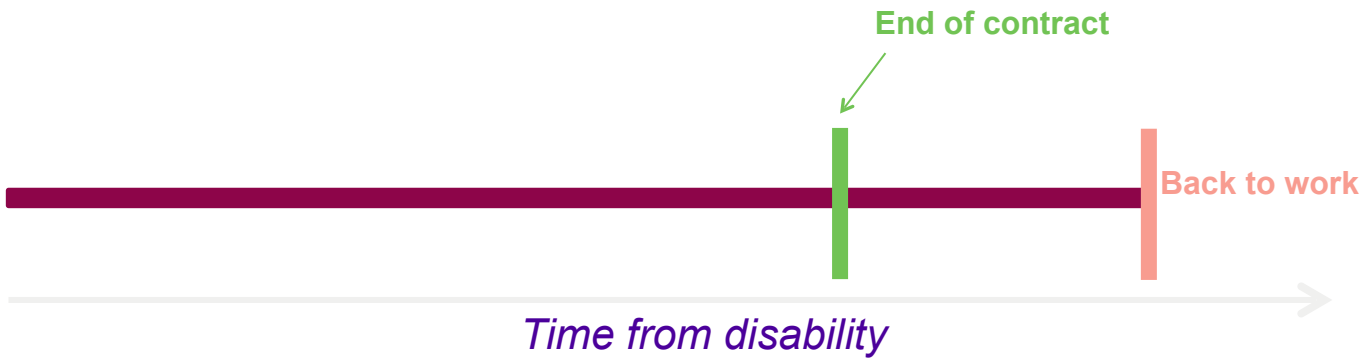

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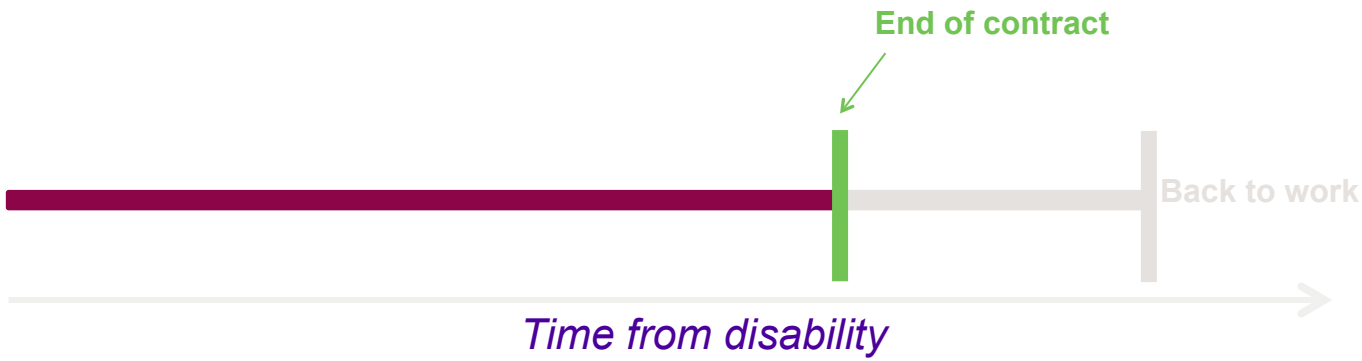

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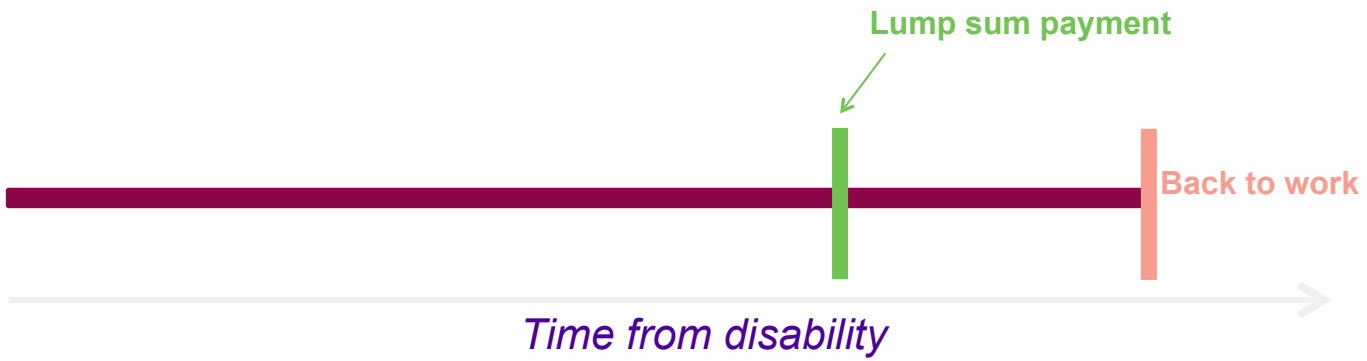

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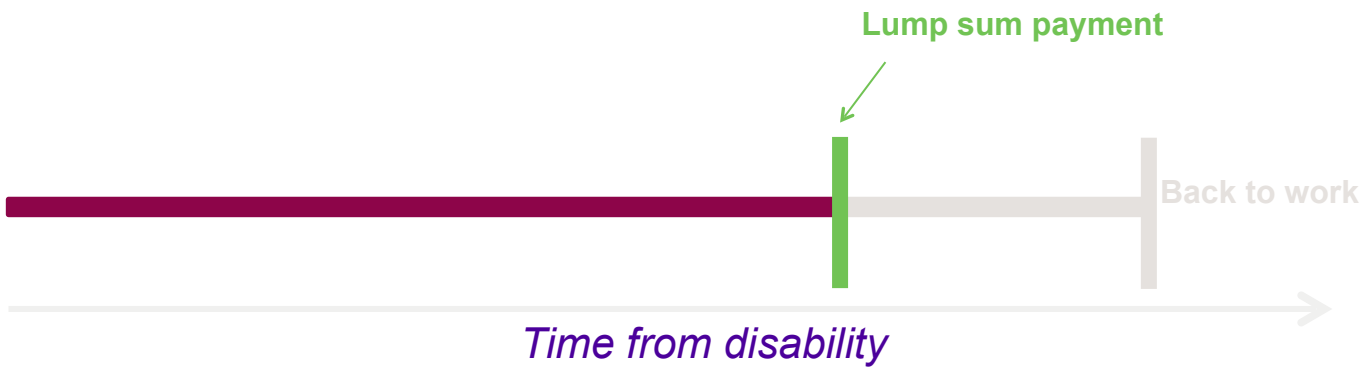
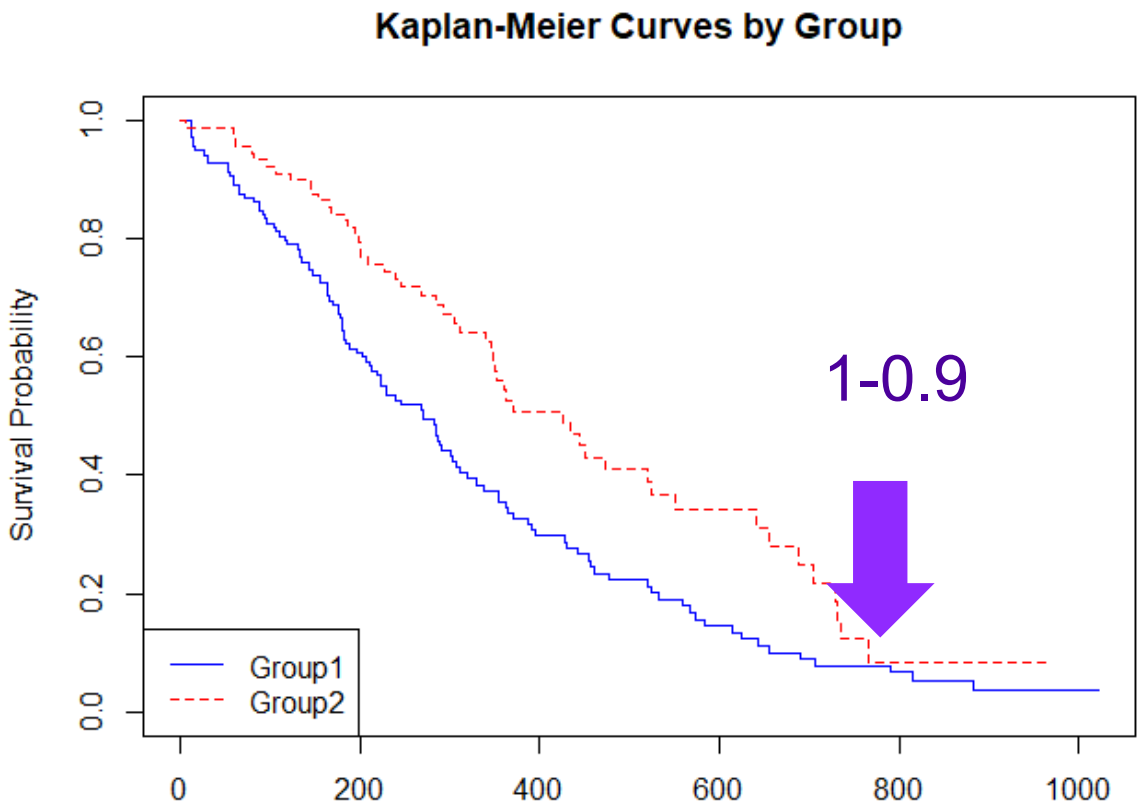
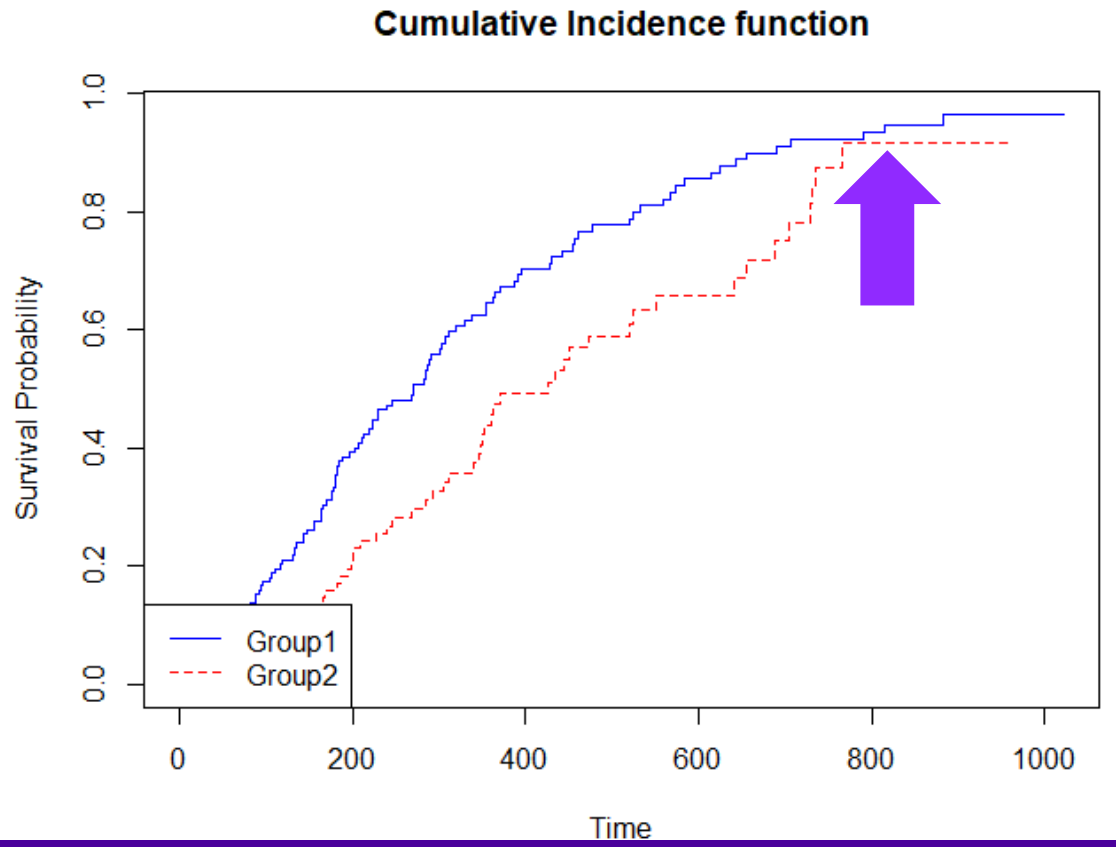


Problems with censoring Competing Events

- Censored in an informative way.
- Estimating outcome of interest in unrealistic setting.

Cumulative Incidence function





- **No competing risks** : cumulative Incidence function estimated as 1- Kaplan-Meier estimate of the survival function

- **Aalen-Johansen method** : Individuals who experience competing events are no longer to be at risk of developing the event of interest.

Model1- Cox

$$h(t, X) = h_0(t) \cdot exp(\beta X)$$

Standard case

Hazard function :

$$h(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T \leq t + \Delta t | T \geq t)}{\Delta t}$$

Cumulative Hazard function

$$H(t) = \int_0^t h(u)du$$

$$S(t) = \exp(-H(t))$$

$$CIF(t) = 1 - S(t)$$

Competing Events

Case Specific Hazard function

$$h_k^{cs}(t|X) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T < t + \Delta t, D = k | T \geq t, X)}{\Delta t}$$

Cumulative CSH function

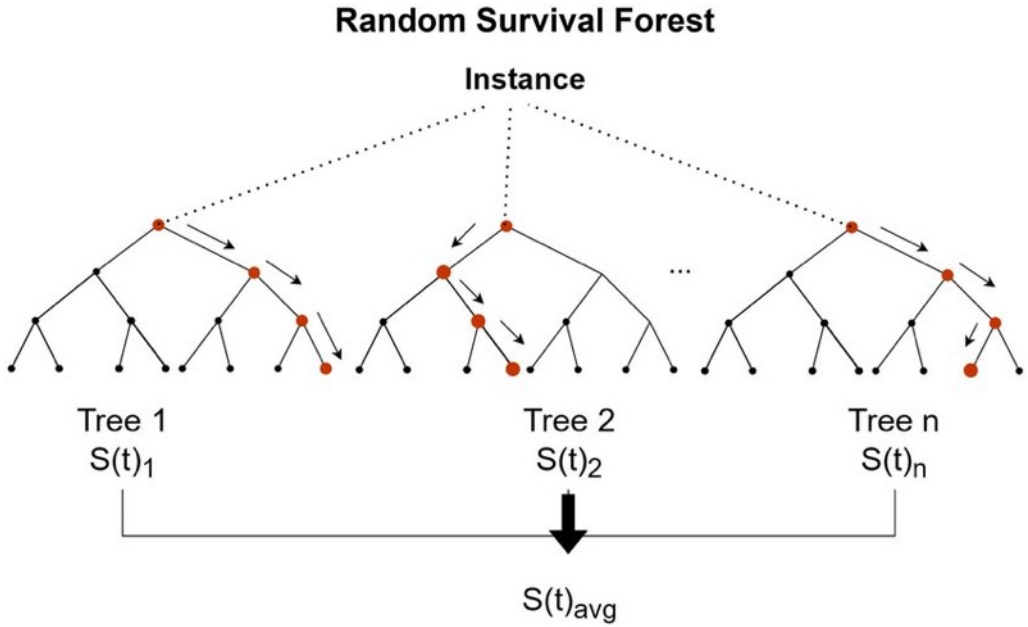
$$H_k(t) = \int_0^t h_k(s)ds$$

$$S(t) = \exp\left(-\sum_{k=1}^{K} H_k(t)\right)$$

$$CIF_k(t) = \int_0^t h_k(s)S(s)ds$$

Model 2- Random Survival Forest

- Extends random forests to censored data.
- Ensemble of survival trees
- Randomness comes from each tree being trained on a different bootstrap data sample.
- Optimal split is found at each node using a random subset of covariates.



Quelques éléments

Cox proportional hazards

- Widely used and provide interpretable results by estimating hazard ratios.
- Suitable when the proportional hazards assumption.
- Need interpretable results.

Random forest models

- Flexible, can capture complex relationships, and are robust against overfitting.
- Suitable when assumptions of proportional hazards may not hold or when interpretability is less important compared to prediction accuracy.

The choice between the two methods depends on the specific requirements of the analysis and the nature of the dataset.

Questionnement / Questioning

What would be the best way to exploit the information in a survival model in order to be able to prioritize the processing of disability cases.

- Which class of method is more suitable for our Use case (Cox vs Survival Forest);

Données / Data

To test the proposed solutions :

Will provide the team with anonymized data set similar to the real data set.

ID	Survival in days	Status	VAR01	VAR02	VAR03	…
1	115	1	0	2298	51	
2	552	2	0	0	52	
3	1102	0	3148	0	85	
4	1941	0	0	2240	84	
5	273	2	3199	0	46	
6	20	1	0	2099	75	

Merci / Thanks

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Questions?