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AI education for actuaries: from machine learning to generative AI

13 June 2025 | 12.00 – 13.30 CEST



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Part II: Generative AI: challenges and opportunities in education



Questionnaire Gen AI in actuarial education

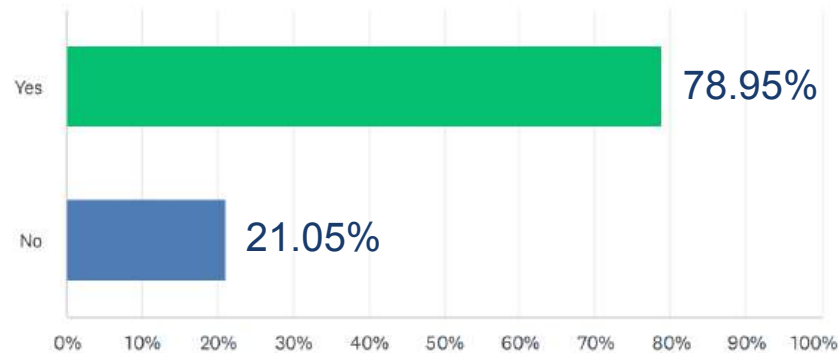
- Questionnaire sent to the FMAs of the AAE.
- Open between March 2025 and 30/05/2025.
- 1 answer (max) per association.
- 23 answers received.
- **Aim:** understand the impact on education of the availability of Gen AI tools.
- The questionnaire is essentially made of 3 types of questions:
 - introduction of specific policies regarding the use of Gen AI
 - perception of the (present and future) role of Gen AI in education
 - impact on the adaptation of the curriculum



Overview of the results

Did you observe a growing use of Generative AI tools used by your students/applicants ?

Answered: 19 Skipped: 4

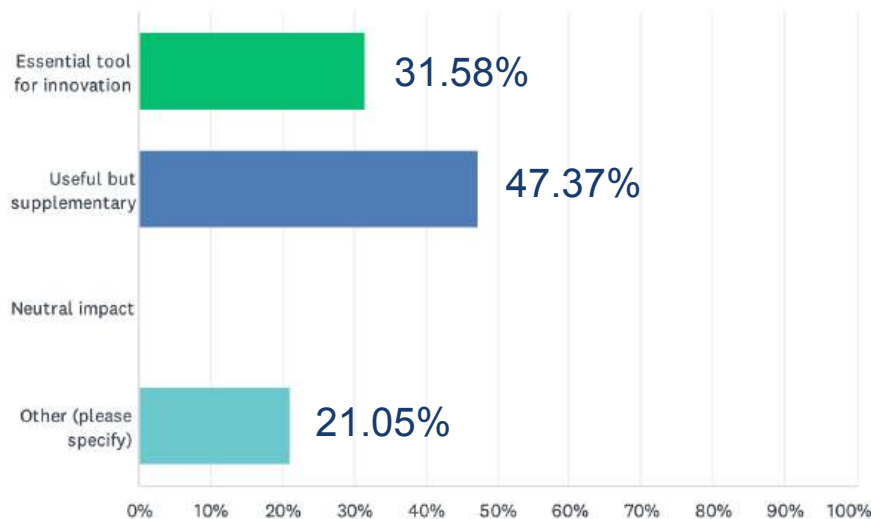




Overview of the results

How do you perceive the role of Generative AI in actuarial science over the next five years?

Answered: 19 Skipped: 4

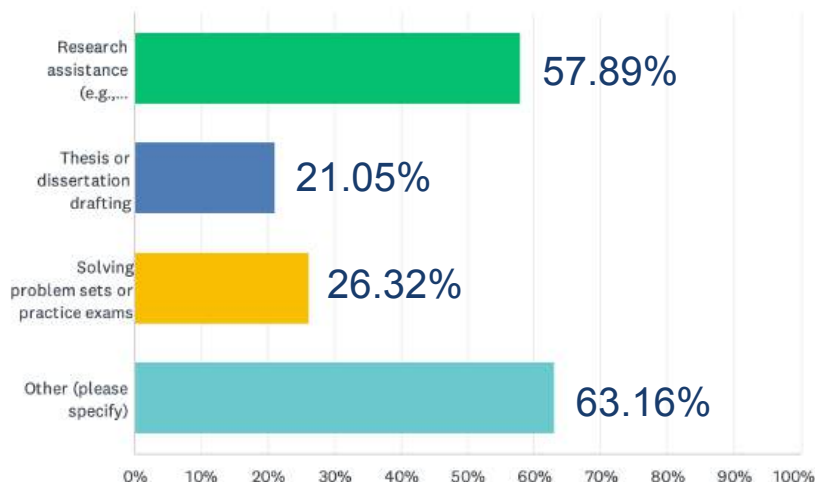


- « Other » : essentially two types of answers:
 - to stress the fact that all of actuarial activities will be transformed by Gen AI
 - to mention that widespread use will, at some point, be limited due to the possibility of errors.

Overview of the results

In what contexts are Generative AI tools explicitly allowed within your program or in universities? (Select all that apply)

Answered: 19 Skipped: 4

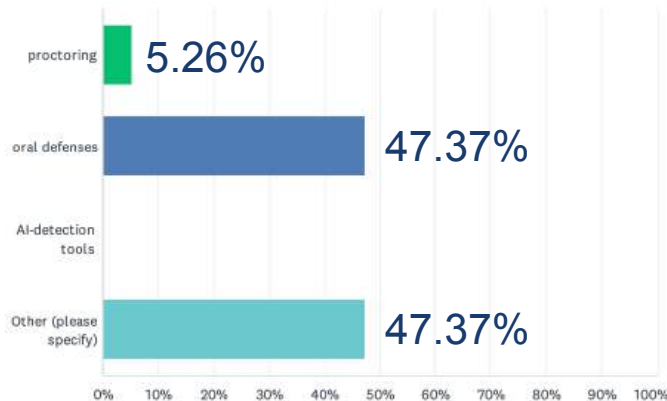


- On the other hand, 73.48% (over 19 answers) prohibit Gen AI in some specific context.
- The same proportion authorizes it (under restrictions) for writing thesis / dissertations.
- 63.16% prohibit its use during exams, if allowed this is always under some restrictions.

Ensuring academic integrity

How does your program or the universities ensure academic integrity in the era of Generative AI?

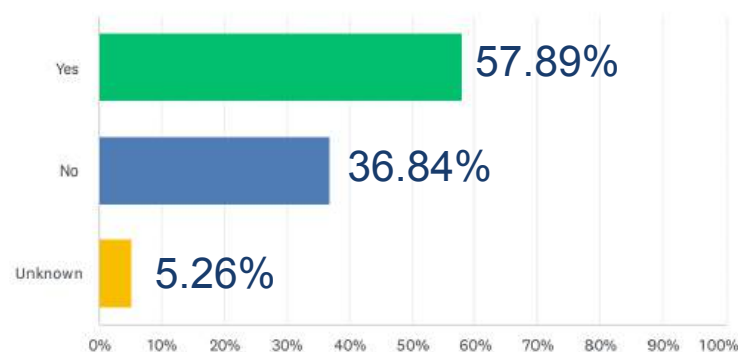
Answered: 19 Skipped: 4



- « Others » essentially means unknown or additional measures (like forbidding laptops and cell phones in exams)

Does your program / the universities incorporate training on ethical and effective use of Generative AI tools?

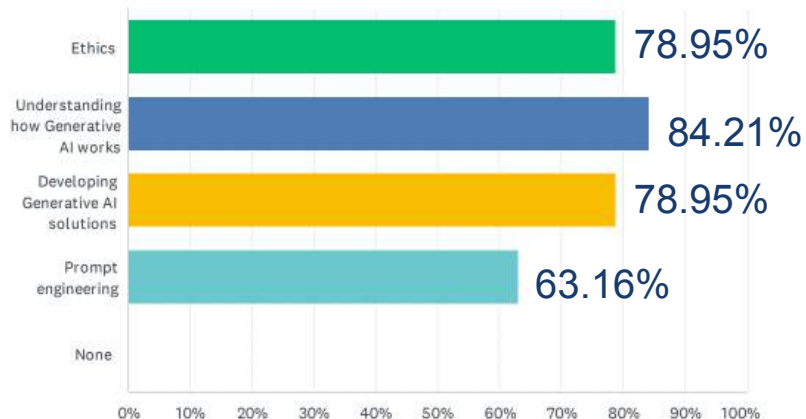
Answered: 19 Skipped: 4



Perspectives

What should be the aspects of Generative AI in which actuaries / future actuaries should be trained or sensitized?

Answered: 19 Skipped: 4



- 15 associations (over 19 respondents) anticipate to change their policy regarding Generative AI in a near future.
- Anticipation of evolution of the regulation regarding Gen AI
- Ongoing discussions in the universities
- ...



Some conclusions on the questionnaire

- No « panic » regarding the impact of Gen AI in actuarial education...
- ... but still perceived by many as representing a « new deal ».
- Mix of positive and negative aspects, materialized by the fact that it is authorized in some situations, and not in others.
- Need for an « ethical » use.
- The question of dealing with errors (or « hallucinations ») is mentioned several times.



A conversation with Chat GPT

🔍 Pourquoi $-\log(E_i) > 0$ presque sûrement ?

Soit $E_i \sim \text{Exp}(1)$, donc une variable exponentielle de densité :

$$f_E(x) = e^{-x}, \quad x > 0$$

Alors :

- $E_i > 0$ presque sûrement
- $\log(E_i) < \infty$ mais peut être négatif (si $E_i < 1$)
- Donc $-\log(E_i) > 0$ toujours

Conclusion : $-\log(E_i) > 0$ pour tout $E_i > 0$, ce qui est toujours le cas avec une loi exponentielle.

- Translation:
 - $E_i > 0$ almost surely
 - $\log(E_i) < \infty$ but can be negative (if $E_i < 1$)
 - Therefore $-\log(E_i) > 0$ always.

✅ Revue du raisonnement

Soit $E_i \sim \text{Exp}(1)$, donc $E_i > 0$ toujours, avec une densité $f(x) = e^{-x}$ sur $(0, \infty)$.

- Quand $E_i < 1$, alors $\log(E_i) < 0 \Rightarrow -\log(E_i) > 0$
- Mais quand $E_i > 1$, on a $\log(E_i) > 0 \Rightarrow$ donc $-\log(E_i) < 0$

Tu as donc raison : la quantité $-\log(E_i)$ peut devenir **négative**, ce qui rend l'expression :

$$Z_i = \left(\frac{-\log(E_i)}{W} \right)^{1/\theta}$$

mal définie si on essaie de prendre une racine impaire ou paire d'un nombre négatif (pire encore si $1/\theta \notin \mathbb{N}$).

❌ Où est l'erreur d'origine ?

L'erreur vient du fait qu'on a voulu faire :

$$Z_i = \left(\frac{-\log E_i}{W} \right)^{1/\theta}$$

alors que le bon terme devait être :

$$Z_i = \left(\frac{\log(1/E_i)}{W} \right)^{1/\theta} \quad \text{ou plus proprement} \quad Z_i = \left(\frac{\log E_i^{-1}}{W} \right)^{1/\theta}$$

Et comme $E_i > 0$, $\log(1/E_i) = -\log(E_i)$, mais il faut s'assurer que ce qu'on prend à la puissance $1/\theta$ est positif, donc il faut explicitement prendre le module ou utiliser directement une autre variable positive.





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Part III: Learning how to develop Generative AI in actuarial applications

Use cases of Gen AI in actuarial sciences

- Three examples:
 - LLMs providing assistance to actuaries
 - synthetic datasets
 - scenario simulation
- LLMs: use of Gen AI as « ready-to-use » tools to help writing a report, to write code, to analyze a corpus of texts... (skill: **prompt engineering**)
- Synthetic datasets: attempt to use Gen AI to generate fake (but plausible) datasets of customers to share these datasets without confidentiality issues.
- Scenario simulation: **design** generative networks to simulate economic scenarios, natural disasters in the future...

Understanding how it works

- Three persons who « do not exist », generated by GANs, from the website thispersondoesnotexist.com



- (Note some subtle dissymmetry issues)

Generative Adversarial Networks

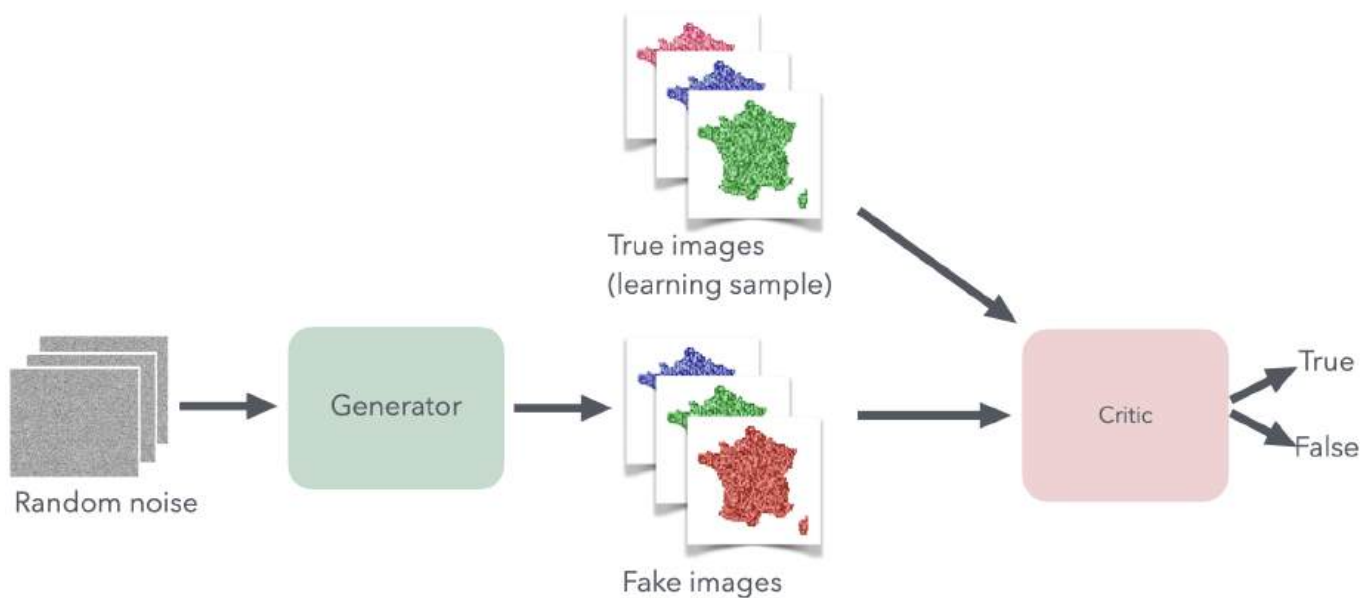


Figure 1 : Generative Adversarial Networks. The critic's objective is to detect fake images from real ones, while the Generator tries to « fool » the critic.

Diffusion models

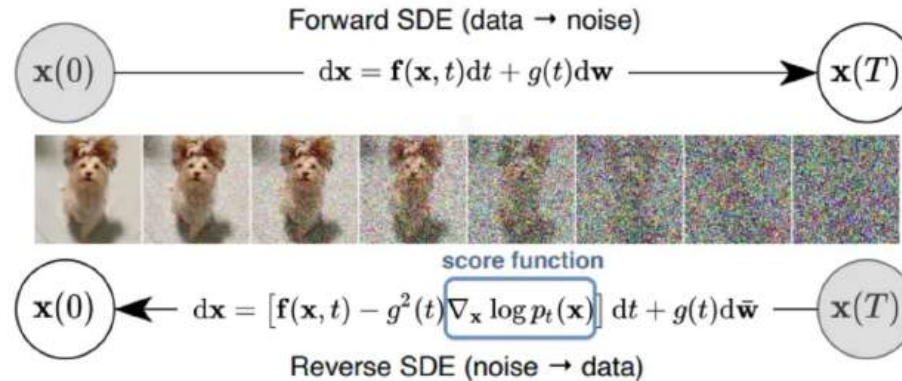


Illustration :

Song, Y., Sohl-Dickstein, J., Kingma, D. P., Kumar, A., Ermon, S., & Poole, B. (2020). **Score-based generative modeling through stochastic differential equations**. *arXiv preprint arXiv:2011.13456*.

- Add noise to an observation until you get something completely chaotic.
- Learn how to inverse the transformation.



Estimation of a distribution

- Mathematically speaking, the learning sample is made of observations $(X_i)_{1 \leq i \leq n}$ from an unknown probability distribution \mathbb{P}^* .
- The Generative network can be understood as a « black-box » used to approximate \mathbb{P}^* by some distribution \mathbb{P}_G .
- Compared to approximating the distribution by a standard parametric model (for example GLM), the network offers more flexibility, allowing to obtain more complex shapes of the distribution.
- In addition to $(X_i)_{1 \leq i \leq n}$, one may also have elements of context associated to each observation (covariates), which leads to a conditional version of the previous approaches.

Difficulties in deploying Gen AI in actuarial science

- Insurance mostly deals with **rare events**.
- This implies that the learning sample will be of small size, compared to the ones used to generate images (typically hundreds of thousands / millions of images).
- Additionally, the Generative Network essentially reproduced what they saw in the past (not completely true).
- If you want to project climate scenarios for 2050 for example, you need to find a way to include additional information on the trends.
- **Environmental cost of Gen AI.**
- In any case, the challenge is to **help the network learning faster**.



Specific case of extreme value analysis

- This idea of designing networks that learn faster has been used recently for extreme value analysis.
- For example, in natural catastrophes, Pareto tailed distribution are used, meaning that if X is the loss, $\mathbb{P}(X \geq t) = \frac{l(t)}{t^{1/\gamma}}$ with $\gamma > 0$ and $l(t)$ slow varying (meaning: almost constant for large t).
- Multivariate extremes: more complex representations (for example relying on extreme value copulas).
- In each case, you have approximation results for the tail.

Adapting the structure of the network to theoretical properties

- See for example: Allouche, M., Girard, S., & Gobet, E. (2022). EV-GAN: Simulation of extreme events with ReLU neural networks. *Journal of Machine Learning Research*, 23(150), 1-39.
- Lhaut, S., Rootzén, H., & Segers, J. (2025). Wasserstein-Aitchison GAN for angular measures of multivariate extremes. *arXiv preprint arXiv:2504.21438*.
- In Lhaut et al. (2025), illustration on financial data.

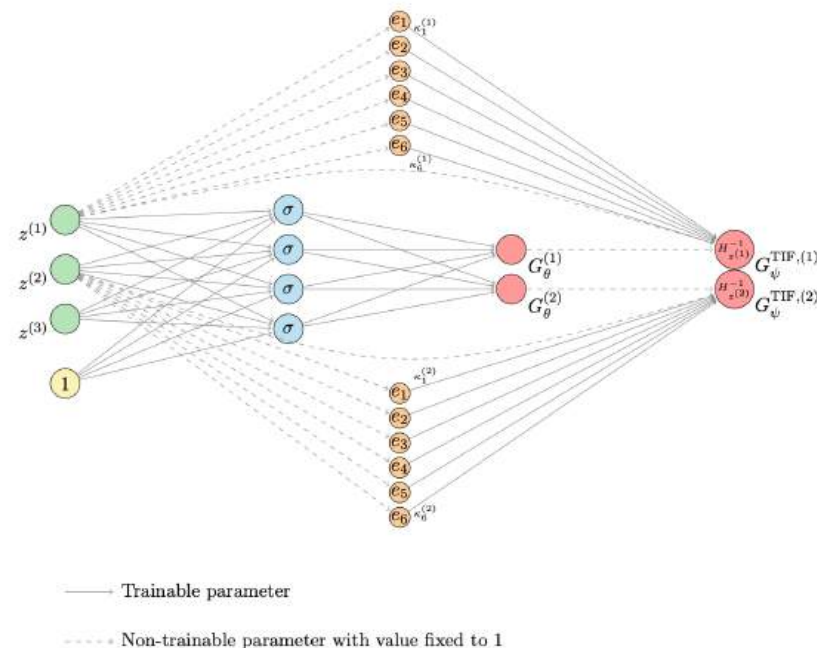


Figure 2: Generator of the EV-GAN with one hidden layer, $d' = 3$ and $d = 2$.

General conclusion

- Gen AI is not only a tool to provide « virtual assistant ».
- Education:
 - need to adapt to the fact that Gen AI is a new source to gather information
 - promote / define an ethical use
- Training of actuaries:
 - data science is now part of the tools actuaries should be able to understand / use
 - *Personal point of view*: actuaries should not stay as users of AI, but should also learn, at some extent, to develop Generative AI tools.



Thank your for your attention!

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