1. **Do you have definitions of DS and AI (or other concepts related to these) in your Member Association? If so, please define.**

Only three FMAs answered.

By **Data Science (DS)** we mean the science that deals with data in general. This includes the entire process of handling data, beginning with the collection and recording of data, the preparation and storage, the processing and evaluation up to data mining. When collecting and processing data, technical questions of data management are just as relevant as the principles of data protection regulations.

DS combines experience and skills in the programming of software tools, and knowledge of mathematics, statistics, and actuarial science to extract insights from data. This information can be translated by actuaries into tangible and measurable value, such as market intelligence, risk assessment and support for management and executive decisions

As defined in Wikipedia DS "employs techniques and theories drawn from [...] mathematics, statistics [...] and computer science"/information technology, including signal processing, and uses probability modelling, machine learning, statistical learning, computer programming, data technology, pattern recognition, prediction, uncertainty modelling and data warehousing.

The term **Artificial Intelligence (AI)** refers to the attempt to reproduce human-like decision-making structures by machine (usually using software). AI consists of high-tech systems and software that can function increasingly independently of humans and can execute tasks that would require intelligence when carried out by humans. In the insurance sector we can point out the use of algorithms and statistical, mathematical and actuarial models. With these issues, actuaries can perform specific tasks without the need for explicit instructions, since AI is based on patterns and inference. Furthermore, we also define in the following concepts that are closely related to AI.

Data Analytics is the extraction of (new) information from data under a specific question. This is often referred to as data mining. However, by data mining we mean the entire process as defined in the relevant data mining process models. **Data Mining** thus includes in particular the phases: Data acquisition, data preparation, modelling, data analytics, model validation, evaluation.

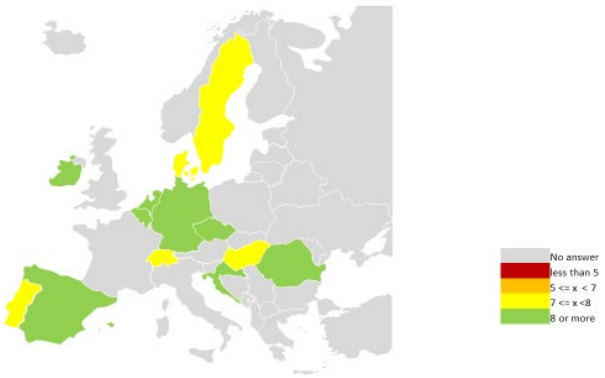
Since the specific questions we are confronted with are always of an actuarial nature or more generally concern the principle of insurance, we refer to them as **Actuarial Data Science (ADS)**. By ADS we understand the collection, recording, processing and evaluation of insurance-specific data under an actuarial question.

Machine Learning (ML) means the evaluation or analysis of the data (data analytics) and is usually carried out by machine learning methods. ML is in contrast to classical programming, where a (previously known and programmed) algorithm for data input is processed. With ML no algorithm is known in advance (and usually not afterwards). Based on a learning procedure, a model is trained instead using the input data. One also says that the model learns from the data. If the learning process is successful, the trained model can be applied to new data (**supervised learning**) or the model provides intrinsic patterns in the data and thus new information about the data (**unsupervised learning**).

The focus in **Statistical Learning (SL)** is on interpretation while the central task in monitored machine learning is prediction. Furthermore, the consideration of random errors and the quantification of uncertainty is a central instrument in SL procedures. Uncertainty in this context means both model non-uniformity and "simple" random fluctuations. A sharp delineation of areas is not possible because the transition between areas is almost fluid. Therefore, machine learning is often generally referred to as machine learning, even when statistical methods are used.

2. Consequences of DS/AI for the Actuarial profession

The question whether we think that the development of DS/AI might have consequences for the Actuarial Profession was answered unique. On a scale from 1 to 10, with 10 meaning fundamental consequences, nobody gave a rating below 5. The average rating was 8.25 and 25% of the respondents rated the consequences with the highest possible 10, which means the consequences are fundamental for the Actuarial Profession.



The result is a clear signal to deal with the topic and give it enough space for discussion. The comments on positive consequences can be divided into four groups:

- Attractivity for the profession: to attract new people to the profession
- Improvement of our existing service: get more and deeper insights, faster analysis of large amounts of data, become more efficient, Actuaries can focus on real added value services and gain higher precision
- New opportunities for Actuaries: expand the scope of work, making them more relevant outside financial services like medical, engineering, energy, environmental, etc., a chance to expand actuarial work within insurance companies to marketing, underwriting and claims management processes
- Strengthen the relevance of our profession

There are also negative consequences for the actuarial profession. The answers can be summarized into five arguments:

- Job destruction: less actuaries are needed than before. In the words ofDaniel Shreiber, CEO of Lemonade: “the next insurance leaders will use bots not brokers and AI not actuaries”
- Job downgrade: Actuaries are used as programmers and some typical actuarial skills become less relevant
- More education is needed (editor’s comment: is this a negative consequence?)
- Model risk of DS/AI is not well understood with black boxes, lack of deep understanding of insurance business, and the risk falls back on the actuary (editor’s comment: is this a negative consequence or rather an opportunity?)
- Role of the actuary and ethics, AI enables inequality and discrimination, decision taking by algorithms (editor’s comment: is this a negative consequence or rather an opportunity?)

3. Activities of Actuaries towards DS/AI

Actuaries will need increased education in the areas of

- Informatics:
    - Databases
    - Data Management
        - Data measurement and gathering (possibly need to connect to other industries).
        - Data quality (a view on cleaning and processing is needed).
        - Data visualization.
        - Pre-processing of data.
    - Programming skills (Python, R, C#, C++, …)
- Mathematics/Statistics: Machine Learning techniques, nonlinear regression, neural networks, clustering, …
    - Parameter selection (automated or actuarial expert judgement, mind discrimination, ethics).
- Business intelligence and strategy
    - Interpretation of model results.
    - Benchmarks
    - Key figures
- Communication skills

Actuaries need to implement new techniques in regular work

- Data preparation
- Pricing, product design, reserving, risk and capital management …
- reducing reporting deadlines, improving quality control, monitoring and optimizing balance sheets, and in their commercial applications

Actuaries need to observe trends and developments and follow regulatory implications. They need to develop of new risk assessment/risk mitigation tools and processes. And, finally, they need to define new roles for the profession according to Bühlmann: the Actuary of the 5th kind (Life, Non-life, ALM, Risk Management, Data Science) in, e.g. healthcare, retail, public sector, finance, real-time products, insurtechs, fintechs and risk prevention instead of risk compensation.

4. Expectations towards the AAE

While some MA's are skeptical as DS/AI is more seen as a global trend and thus more a matter of the IAA most of the MAs found several areas of possible actions for the AAE. They can be summarized like below.

- Training
    - online courses together with member associations, universities and Actuview
    - Offering a roadmap on courses including ratings and compulsory courses
    - Reduce training gap between traditional education and this new education
- Exchange
- Research
- Guidelines/Standards
    - Education
    - Ethics
    - Professionalism
- Inform
    - Highlight the critical items of interest brought by DS/AI techniques in actuarial duties.

    - Create awareness on the adequate governance that should be in place before using AI
    - Share best practices in applying DS/AI. For example, sharing some cases where a new technology was successfully applied/verified/monitored
    - Keep actuaries updated in terms of the DS/AI models
- Lobbying
    - European institutions
    - Employers
    - Strengthen the role of the actuarial function / appointed actuary
    - Defend the profession: Advocate with all stakeholders why actuaries are well placed/needed to handle data science topics
    - Lead the change
- Connect
    - Strengthen collaboration between member associations
    - coordinate joint efforts of the MAs to meet the challenges via CPD, common practicing, ethical and professionalism standards
    - Actuaries with non-actuarial experts from related professions
- Marketing

5. Other suggestions for the future work of AAE in this area

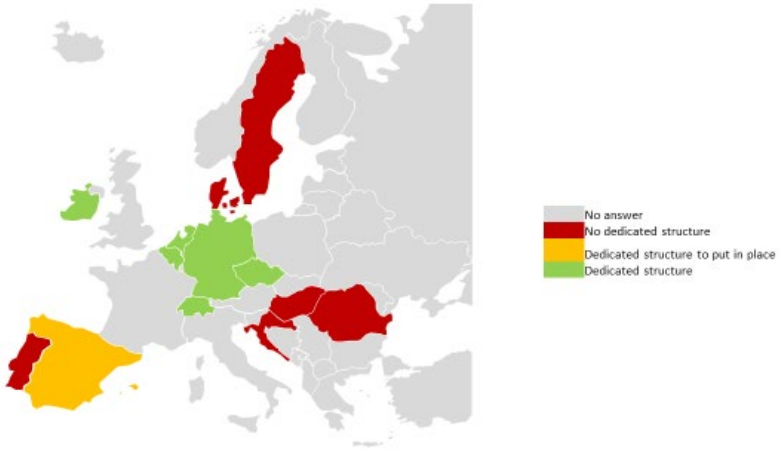
The survey gave some other interesting comments about ideas for future activities. They are very heterogenous, so listed in essence below:

- Expand and promote the definition/ role of the Actuary[1]
- Coordinate with other industries, not specifically limited to the financial services (e.g. interesting developments in predictive maintenance in heavy factories – which could be interesting for non-life/catastrophe risks). It would be advisable to work with external groups in which to combine different knowledge through collaborations with universities or with civil society organizations
- Organize an event where actuaries involved in DS&AI can meet and exchange (e.g. in the context of a broader congress).
- The AAE should mark the path for the actuary to go from a predictive model scheme to cognitive models
- Review the incidence of DS & AI in all its dimensions: Pricing, underwriting, reinsurance, management, etc.
- A topic to study will be the link between DS & AI and the technology called internet of things (IoT), since the technological developments that are taking place to connect all the systems and to create an interconnected environment will require the development of DS and AI models that allow the offer of insurance products adapted to every citizen.
- Do not lose sight of such relevant matters in the area of DS & AI such as equity, justice or privacy of data and calculations
- Have an extended vision of the ethic impact on Science which could change the Society and the insurance sector.

[1] Separate comment in this direction: In my experience, most insurance companies struggle to attract and retain data science talent as they cannot compete in CV prestige and financial remuneration with the technology companies. It is also less frustrating for data scientists to work at technology companies as they already have solutions for most of the day-to-day IT challenges of running a data science team and this plays a significant role in job satisfaction and retention. Insurance has a reputation for being boring and most of my data scientist contacts would rather work in the Pharmaceutical industry or digital marketing than go to a bank or an insurance company. Helping channel interested actuaries towards filling that specific niche could prove a relatively easy / quick win.

- On the qualification issue, if there is going to be one, it would make a lot of sense if it came from the AAE[2].
- None - as stated above, I am not convinced that it is for the AAE to run this agenda
- First, I do not understand what a "data strategy" should contain and why this is useful. A position paper is not really what should be done. The AAE should have a strategy and an execution plan how to deal with the current developments.
- Be open and inclusive, invite researchers and practitioners from other fields (including DS/AI) to share their ideas, without losing focus on pensions and insurance.
- To develop a discussion paper that FMAs can review and opine
- AAE should clearly define how an actuary should behave when addressing DS/AI topics.

6. Does a member Association have a dedicated structure



[2] More on this with a personal touch: I believe the US Society of Actuaries has one such qualification now (available to non-actuaries too) and the IFoA has debated for years the introduction of a data science specialist path in its syllabus. All actuaries will learn the basics and some may want to specialise (I suspect it is already in development). However, Brexit brings the issue of mutual recognition of qualifications across the EU so we need to take the potential usefulness of US or UK qualifications with a pinch of salt. Having a common data science qualification across the EU would be very practical and contribute towards best practice, high standards, etc. Presently, each national association is doing their best in this regard (the French have a qualification, the Spanish institute has been running good courses but without a formal qualification, I believe DAV might already have an insurance data science programme…) but skills and standards are bound to vary significantly. A separate point would be whether the market would value such qualification. My personal view is that a generic qualification would simply join the already crowded market of masters in data analytics, etc but that there could be interest for a more focused one such as 'insurance data science' or 'data science for financial services' that combined data science skills with knowledge on how those businesses operate, their environment, etc. The main challenge at the moment is finding individuals with expertise in data science coupled with business knowledge (essentially, the data science equivalent of an actuary) as otherwise the full potential of the professional is not fulfilled until that business knowledge is acquired. This has led to the rise of 'data translators' or 'data strategists' who are people who know enough of the business and data science to be either more effective at their job than a pure data scientist or to guide data science teams on how to best help the business. Given the proliferation of data science courses to meet past demand, the current and most immediate challenge is finding these 'data strategists'.