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AAE Webinar: Actuaries and the emergence of data science

May 10th, 2023

Dr. Colm Fitzgerald FIA FSAI - Chair of AAE Data Science Syllabus Task Force

AAE Data Science Syllabus – Task Force

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AAE Data Science Syllabus – Overview

- Objectives
- Research undertaken
- Perceived challenges
- Syllabus
  - Principles of syllabus
  - Early draft of syllabus
    - Overview
    - High level structure
    - Some granular detail
- Next steps and discussion

Objectives of AAE Data Science Task Force

- To draft an AAE Data Science Syllabus as a support for member associations.
- To liaise with member associations, universities, and other educational bodies in the actuarial and data science field to get an understanding what programs already exist.
- To draft a structure on how a Data Science Syllabus could be presented to potential participants, especially as a CPD offering.

Implicit Objectives

- To create a syllabus that would be attractive to actuaries.
- And attractive to employers.
- That would enhance the reputation of actuaries.
- Ideally building on actuarial tradition.

Research (1)

- Reviewed the data science syllabuses created by other actuarial associations around the world, including in Europe.
- Reviewed new syllabuses and educational evolution in the data science area in the IFoA, France, Germany, Switzerland, Nordic associations, Spain, Ireland, the US (SoA & CAS), Australia and in Canada.
- Australian (pre-qualification) and Swiss (post-qualification) offerings were considered standouts, along with those from IFoA and the US.

Research (2)

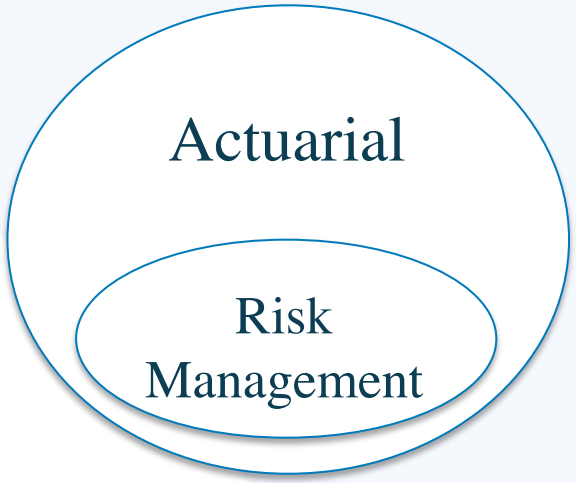
- Reviewed the work of the Alliance for Data Science Professionals in the UK.
- The IFoA are looking at joining this alliance that is aiming to create a professional data science designation.
- Other parties include RSS, BCS, IMA, ORS.
- The alliance website sets out standards that have been agreed for data scientists.

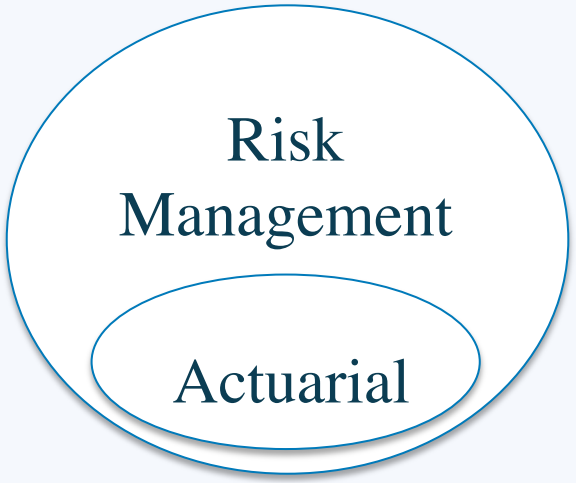
Research (3)

- Reaching out to high caliber actuaries and data scientists and other related professionals.
- Arnaud Deltour (Belgium), Pedro Écija Serrano (Dublin), Darrgh Pelly (Dublin), the Innovation Team in Irish Life Assurance (Dublin), Ceall O'Dunlaing (Dublin), Dr. Clifford Friend (UK), Dr. Paul King (UK), Prof. Brendan Murphy (Dublin), Prof. Claire Gormley (Dublin), Fergal McGuinness (Zurich), Laura Kennedy (Dublin), Dr. Greg Doyle (Ireland).
- Thanks to all the above for their help.

Perceived Challenges (1)

- Evolution of the profession over the last 30 years
  - Equitable Life failure in 2000
  - Solvency II, CERA/ERM (SP9) and CRO function
  - Data analytics / AI / ChatGPT – likely implications.
  - The issue of character and ethical credibility





  - Recent scares regarding actuarial employment.

Perceived Challenges (2)

- Syllabus must be attractive to actuaries
- It must have a competitive advantage
  - Must not be of a low or middle standard / without any edge
- Danger arising from being a conservative association
  - Shocks to a system generally only happen under conservative rule

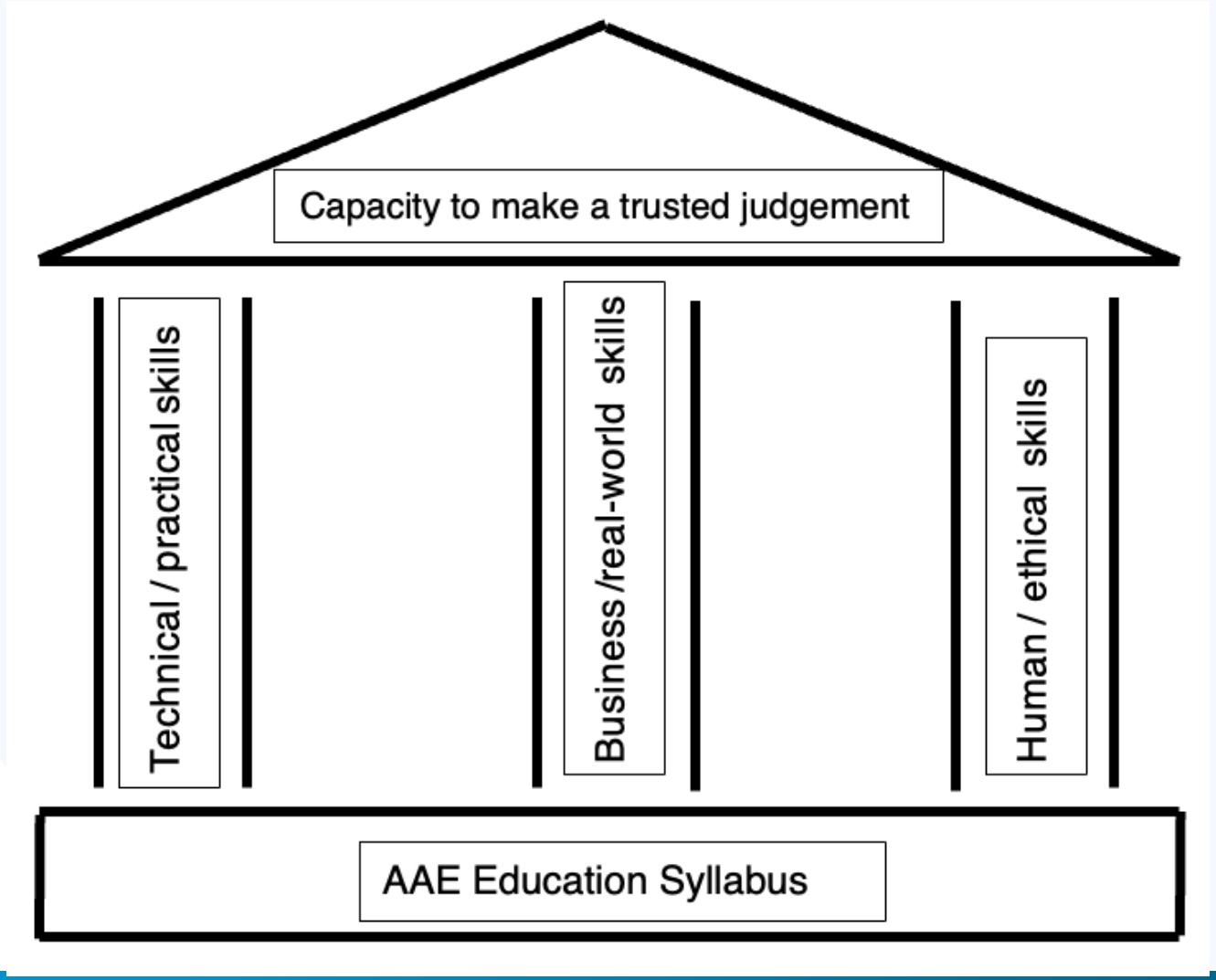
Perceived Challenges (3)

- Much of actuarial work in now tick-box work – ripe for disruptive competition – especially because historical barriers to entry to our profession have fallen (for example, the removal of commutation functions).
- The syllabus likely requires significant investment in new actuarial educational materials.

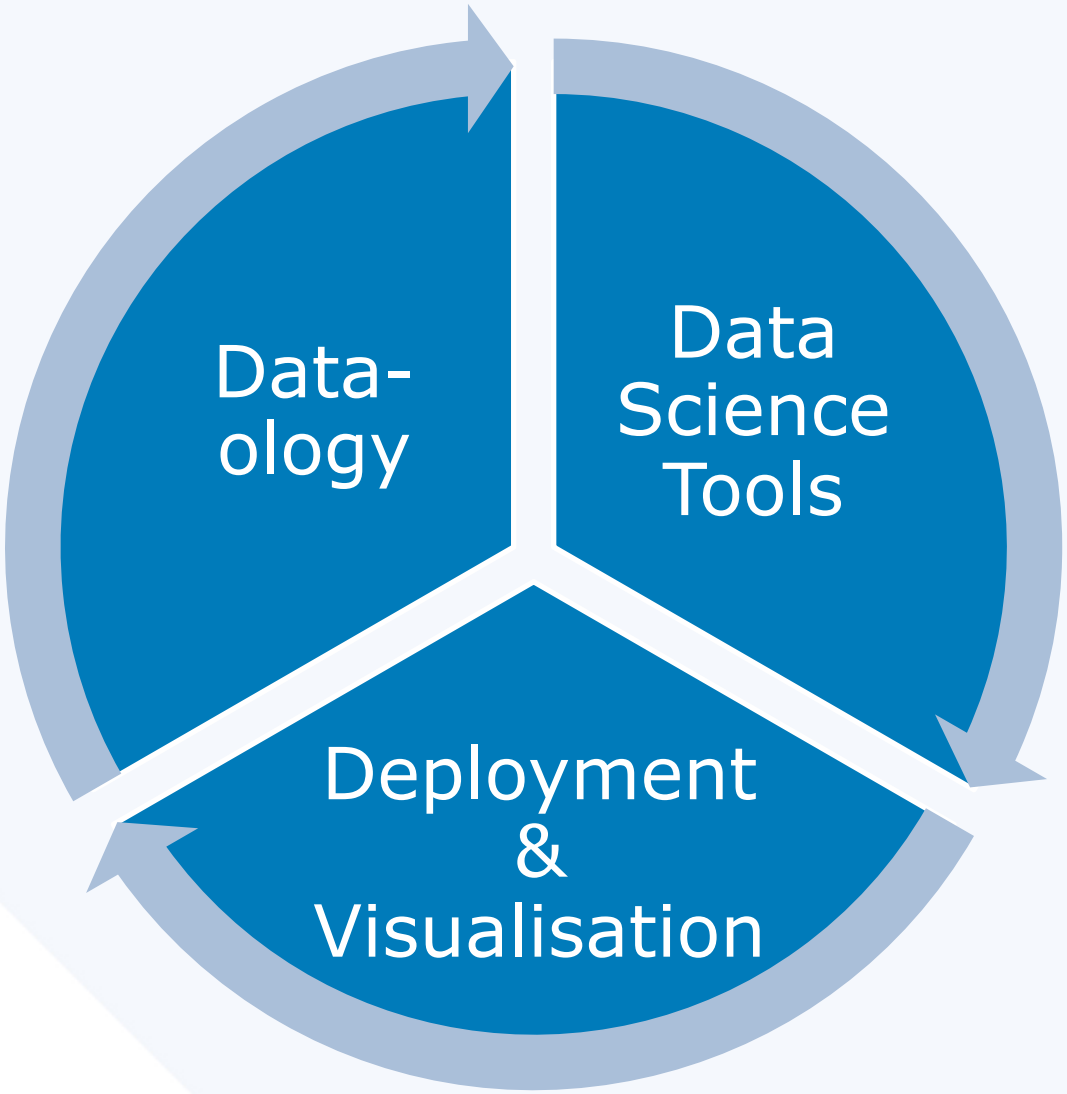
Principles for AAE Data Science Syllabus

- Aim to classically educate actuaries in data science up to the level where they can judge the merits or otherwise of professional data science work.
- They can subsequently choose to become an expert in a narrower element of data science.
- Example, becoming a conductor in music.

AAE Data Science Syllabus - Overview

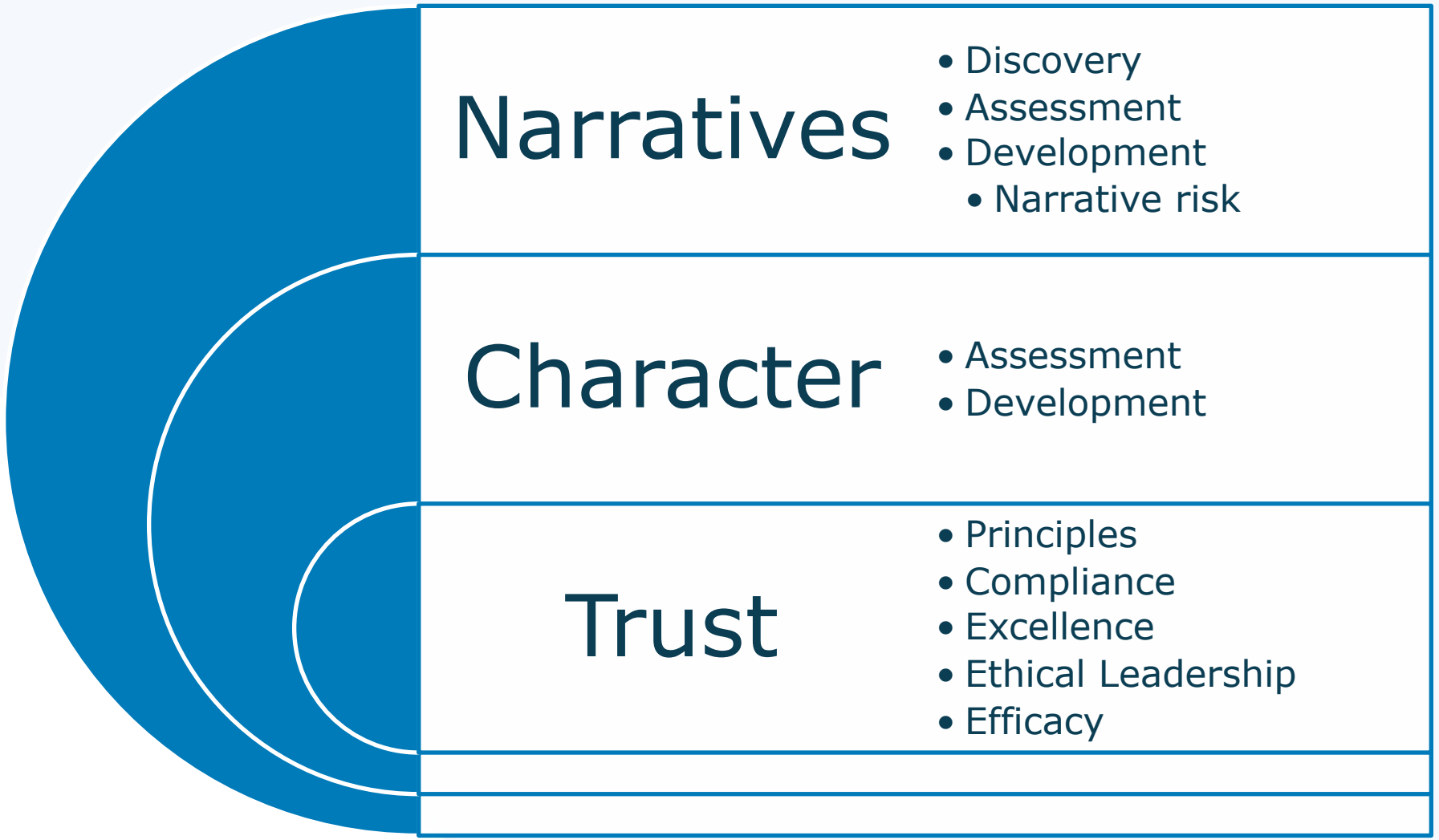


Technical & Practical Skills



Business & Professional Skills

Ethical & Human Skills



Syllabus – Granular Details

- The granular level of the data science syllabus is still work in progress.
  - Further iteration is required.
- Consultation amongst the actuarial profession along with wider consultation is the next step of that iteration.

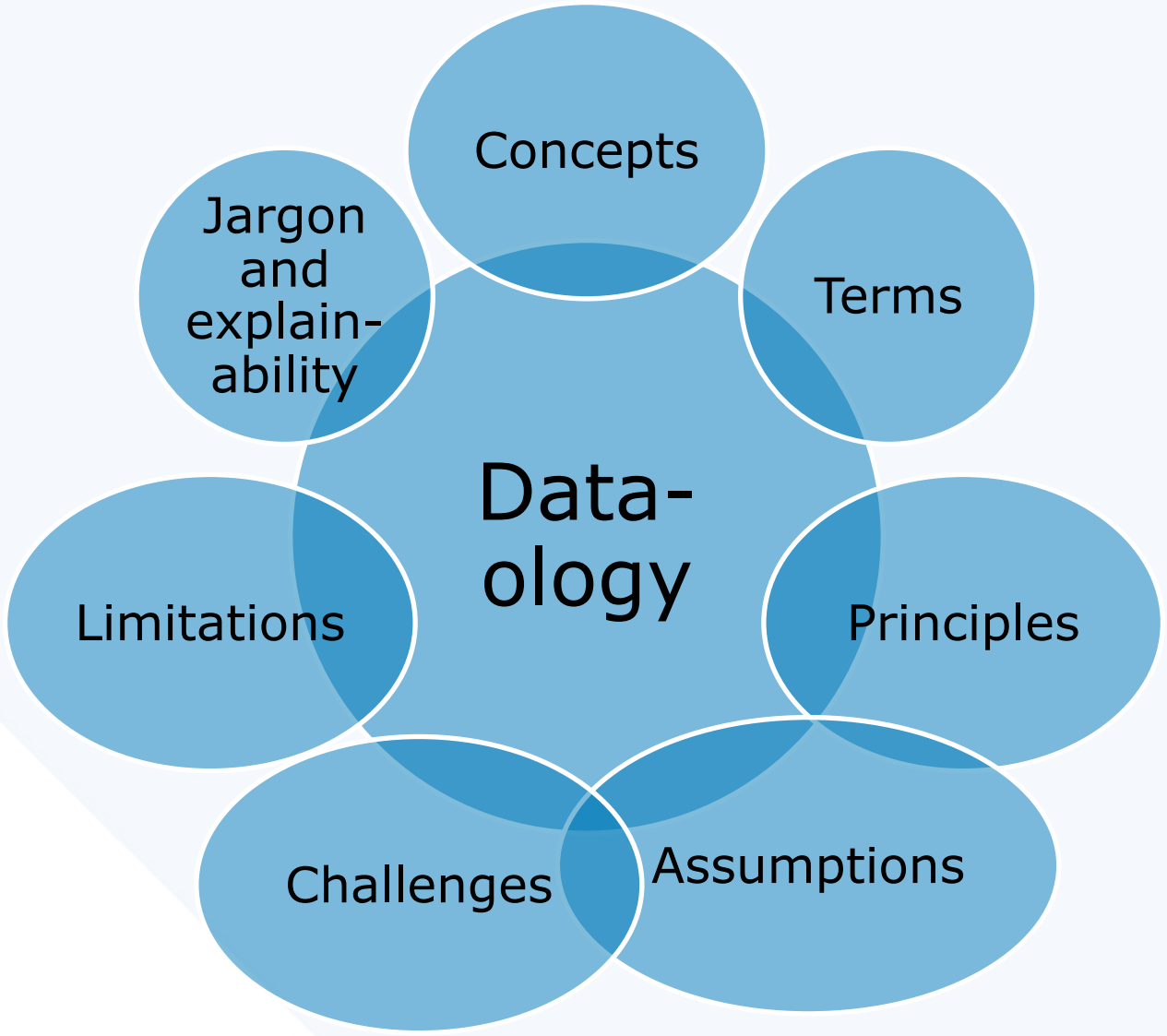
Technical & Practical Skills

- Overview
  - Data and Data Science methods and tools
    - Data-ology
    - Data science methods and tools
    - Deployment and visualization
- Aim
  - Show you can understand and do this with efficacy!
- Mathematical prerequisites.
  - Some actuaries may need to refresh their understanding of linear algebra (for examples, matrices, matrix multiplication, eigenvectors and eigenvalues), some basic calculus and some probability theory / econometrics.
- Grey area
  - Data and systems element of the AAE education syllabus.

Data Science - Basics

- Demonstrate an understanding of the following aspects of data science:
  - Concepts
  - Terms
  - Principles
  - Assumptions
  - Challenges
  - Limitations
  - Jargon and explain-ability

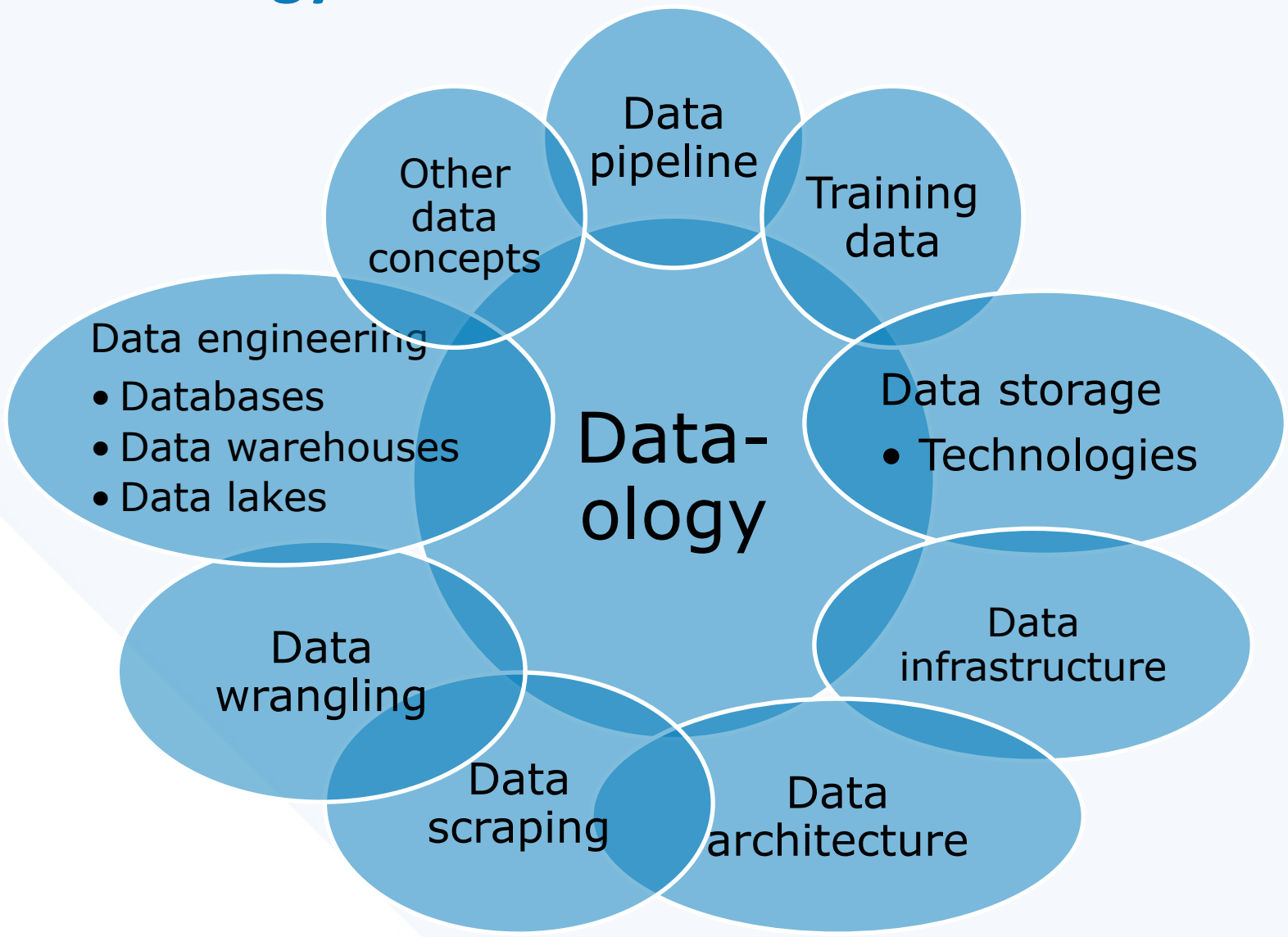
Data Science - Basics



Data-ology

- Demonstrate an understanding of modern data, including:
  - Data storage technologies
  - Training data
  - Data infrastructure
  - Data architecture
  - Data pipeline
  - Data scraping
  - Data wrangling
  - Data engineering
    - Databases, data warehouses, data lakes etc
  - Other data concepts

Data-ology


Data-ology
Data pipeline
Training data
Other data concepts
Data engineering
• Databases
• Data warehouses
• Data lakes
Data storage
• Technologies
Data infrastructure
Data architecture
Data scraping
Data wrangling

Data Science Methods and Tools

- Data Science Methods and Tools
  - Demonstrate technical proficiency in the use of modern data science methods and tools
- Overview / learning objectives
  - What methods and tools exist?
  - Where they might be used?
  - When might they be used?
  - How do you use them?
  - Why might you use them?

  - What are the emerging tools and techniques?
  - What perspectives might be taken?
    - For example, modelling versus strategy

Predictive Analytics / Machine Learning (1)

- Data Science Methods and Tools
  - Demonstrate technical proficiency in the use of Machine Learning / Predictive Analytics / Statistical Learning
- Machine learning (main topic)
  - Related topics, for example, data mining (discovery v prediction)
  - Potential benefits and limitations of machine learning
  - Concepts
    - Model training (estimation, assuming a target is defined)
    - Model validation (statistical testing, for example, goodness-of-fit)
    - Feature engineering and feature scaling
    - Regularization
    - Other

Predictive Analytics / Machine Learning (2)

- Approaches / ‘Types’
  - Unsupervised
  - Supervised (including semi-supervised)
  - Reinforcement / reinforced learning
  - Probabilistic / Bayesian approaches
  - Other types

Predictive Analytics / Machine Learning (3)

- Machine learning algorithms
  - There is a long and growing list of different types of algorithms used in machine learning.
  - Examples…
    - Neutral networks (different types basic, convolutional, recurrent, long short-term memory and deep learning)
    - Dimension reduction, including principal component analysis
    - Tree-based methods
    - Aspects of natural language processing
    - Decision trees
    - Generalised linear models
    - K-nearest neighbour

    Support vector machines
    Gradient boosted machines
    Random forests
    Support vector machines
    K-means clustering;

Predictive Analytics / Machine Learning (4)

- Examples… continued
  - Regression (linear and polynomial regression)
  - Clustering, including k-means
  - Generative Adversarial Networks (GAN)
  - Ensemble techniques
  - Further algorithms to be added…

  - Classification trees
  - Hierarchical clustering
  - Principal component analysis
  - GBM

- Interpretability.
- Advantages and disadvantages and likely usage (and ease of use) of different algorithms.
- Emerging algorithms

Software Skills

- Data Science Methods and Tools
  - Demonstrate technical proficiency in software skills and a wherewithal to make progressive and critical judgment regarding software for data science purposes.
  - Programming languages
    - R
    - Python
    - No code programming
  - Understanding necessary around code versioning (e.g. git and github), related software engineering concepts and code libraries.
  - Reliance on the opinions of others (e.g. R packages).

Modelling and Strategy

- Data Science Tools
  - Demonstrate technical proficiency in the use of modelling and strategy in data science.
- Modelling
  - Process modelling and model development and validation
- Strategy
  - Why are you doing this? (a potential competitive advantage for actuaries)
  - Necessary to:
    - Know limitations of any project
    - Know where you might need to hand over to an expert in one area
    - Know the context and the landscape and if it is uncharted territory
    - Know what the project will be used for and why
    - The narrative is key

Emerging methods and tools

- Data Science Tools
  - Demonstrate a wherewithal to keep up to date with emerging methods and tools in data science
  - Demonstrate a wherewithal to keep up to date with evolving methods, tools and other developments in data science.
- Emerging methods and tools
  - For example, natural language processing (for example, ChatGPT)
- Other areas
  - Recommender algorithms
  - Image analysis and object detection
  - Medical imaging and diagnostics
  - Hardware and the costs and economics arising
  - Fraud detection
  - Self-driving vehicles
  - Robotics and robo-advising

Technical & Practical Skills

- Deployment
  - Demonstrate a wherewithal to deploy the results of the application of data science methods and tools in a business environment
  - Demonstrate an understanding of data visualization techniques including emerging techniques.
- Actuarial applications
  - Regression for survival analysis in high dimension (penalized Cox model, Accelerated Failure Time models…)
  - Survival trees, survival random forests.
  - Neural networks for survival analysis
  - Other

Business & Professional Skills

Data Science - Business & Professional Skills

- Regulation
  - Demonstrate understanding of the regulatory and legal frameworks governing the application of data science.
  - Demonstrate understanding of the political and cultural environment and trends that influence the application of data science.
  - Demonstrate an understanding of the trends and reasons for the trends driving changes in data science regulation.
- Data science is increasingly regulated
  - For example, EU rules “AI for life” and “AI for good”.

Data Science - Business & Professional Skills

- Business context
  - Demonstrate the application of general actuarial business context awareness to commercial use of data science.
  - Demonstrate an understanding of the new and emerging roles in data science
- Actuaries typically require a general business environment understanding, including
  - Stakeholders
  - Other aspects of the business environment covered elsewhere in the AAE Education Syllabus
- Roles in Data Science
  - New and emerging roles
    - Data Wrangler, Data Ethicist & AI Ethicist and other specialist roles
    - Senior roles: Chief Data Officer, Chief Ethics Officer

Data Science - Business & Professional Skills

- Client Relationships
  - Demonstrate an understanding of the principles behind building and maintaining client relationships.
  - Demonstrate awareness of examples of successful and unsuccessful client engagements.
- Key element in the Alliance for Data Science Professionals Syllabus.
- The world largely works based on human relationships rather than being based mainly on numbers.

Data Science - Business & Professional Skills

- Communication and teamwork
  - Demonstrate a practical understanding of the communication skills required for successful business engagement in data science.
  - Demonstrate an understanding of the explain-ability challenges that arise in data science tools and methods, along with methods to overcome the challenges.
  - Demonstrate a practical capacity to work in a team, including an understanding of the challenges that occur and methods to overcome them.
- Communication skills with colleagues and with the general public are both imperative.

Data Science - Business & Professional Skills

- Innovation skills
  - Demonstrate the creative use of actuarial skills.
  - Demonstrate a capacity to take concepts from outside of the financial/insurance industry and use them in the financial/insurance industry and vice versa.
  - Demonstrate a capacity to evolve existing methods and tools in data science.

Data Science - Business & Professional Skills

- Project management
  - Demonstrate an understanding of the principles involved in project management in data science.

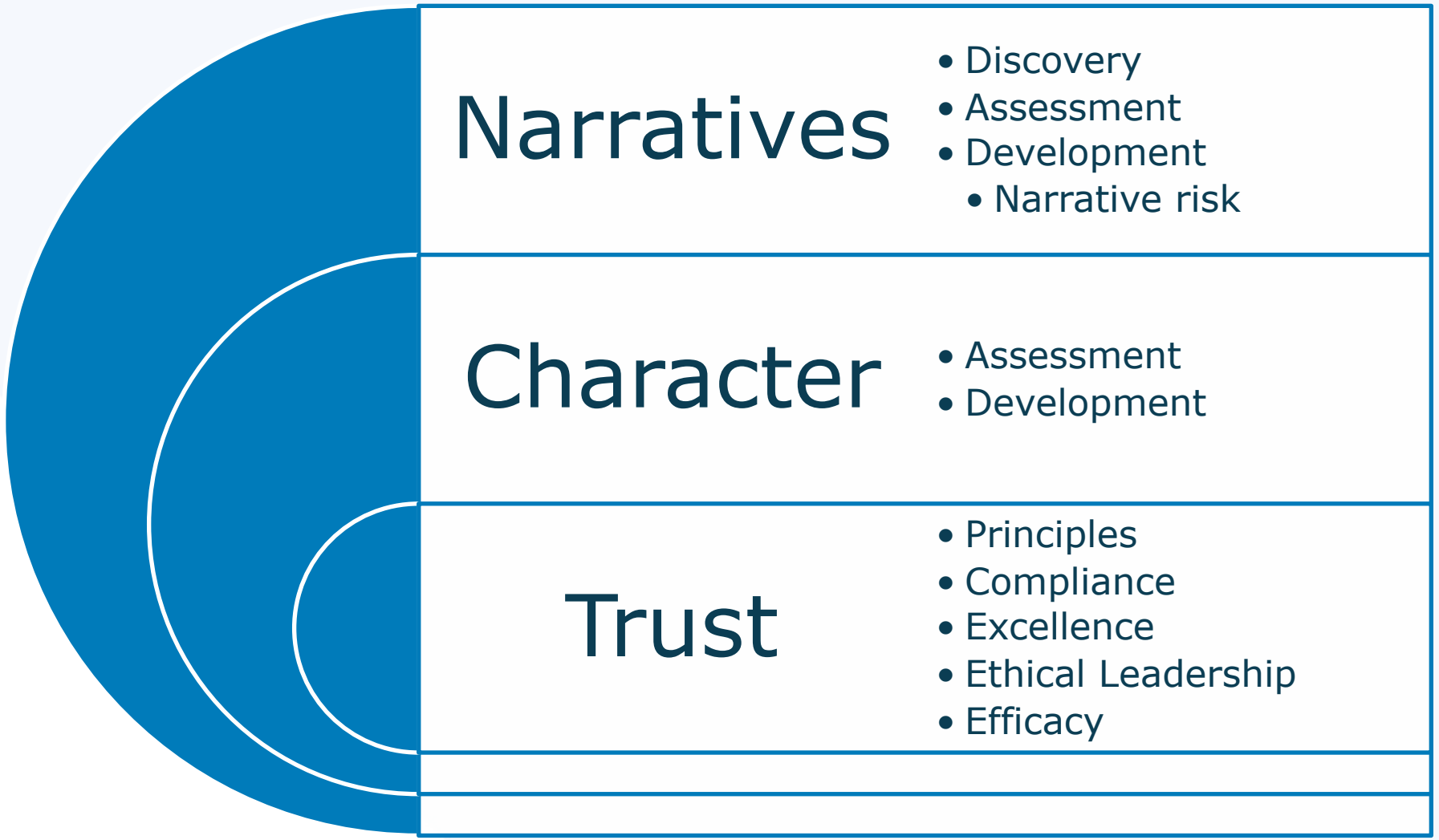
Data Science - Business & Professional Skills

- Business leadership / C-suite skills
  - Demonstrate an understanding of the skills required for senior positions of responsibility in data science in business environments, for example: chief data officer and chief ethics officer.

Data Science - Business & Professional Skills

- Application to actuarial problems
  - Demonstrate a capacity to apply modern data science methods and tools to actuarial problems.
  - Examples:
    - Regression for survival analysis in high dimension (penalized Cox model, Accelerated Failure Time models…)
    - Survival trees, survival random forests.
    - Neural networks for survival analysis
    - Other

Ethical & Human Skills

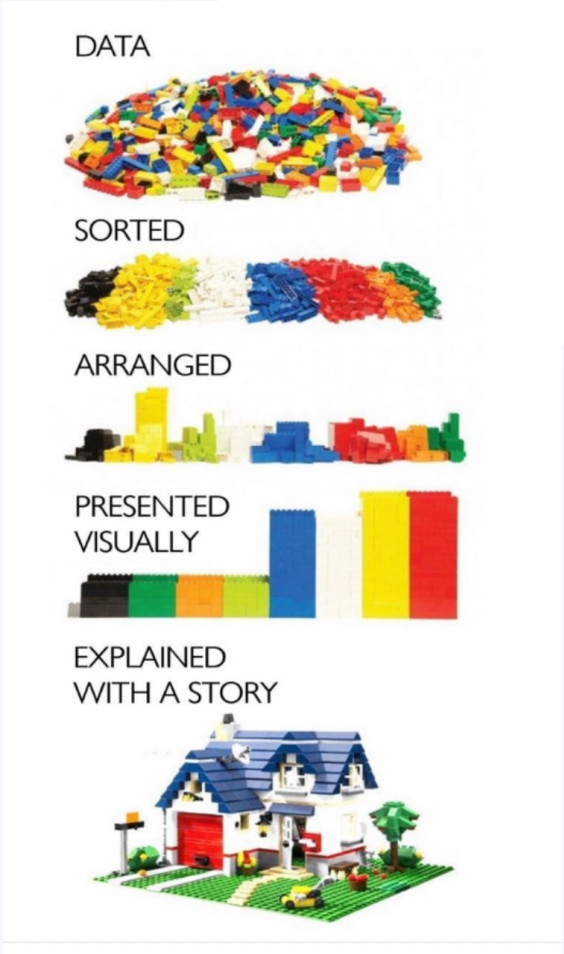


Ethical & Human Skills

- Overview
- Stand-alone skills
  - Considerable cross-over with previous elements of the syllabus when used in practice
- Traditional skills of actuaries, but like with communication skills, they were traditionally taught “on the job”, but given the size of the profession, this method can be problematic.

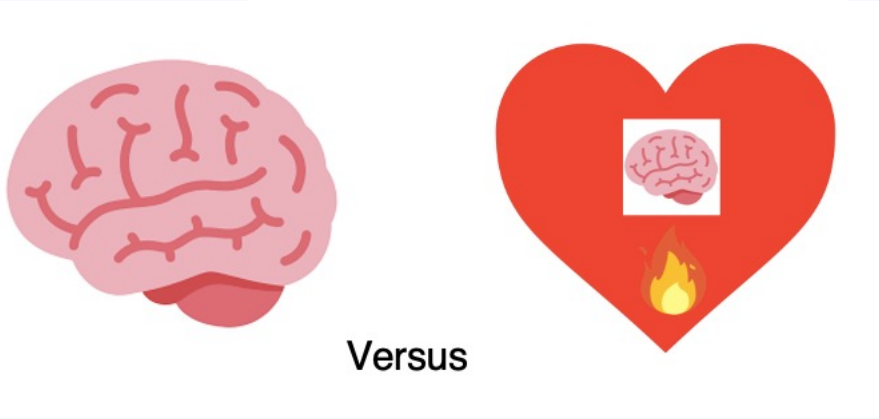
Narratives - turning data into a story

- Narratives
  - Demonstrate a wherewithal to make progressive judgment on ethical narratives related to data science.
- Turning data into a human narrative
  - Narrative discovery / assessment / development
  - Also know as “storytelling”
- Narratives dominate and limit analyses
  - Need to be able to engage at the narrative level to act in the public interest.
- Classical narratives (things as they are) versus romantic narratives (as someone might want things to be).



Character - understanding the people involved

- Human side to data science
  - Demonstrate a wherewithal to make progressive judgment on human matters related to data science.
- Character:
  - Assessing, managing and developing the people involved in the narrative
    - Character assessment
    - Character development
  - Assessing data science from a human perspective.

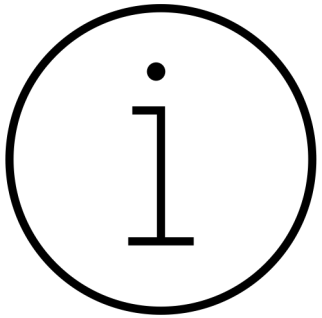


Who can you trust?

- Trust
  - Demonstrate a wherewithal to assess and to achieve trustworthiness
- Who, what and by how much can be trusted?
  - Assessing trustworthiness
  - Achieving trustworthiness
- Trust and professionalism
- Key element in achieving efficacy
  - Key element in the Alliance for Data Science Professionals Syllabus.

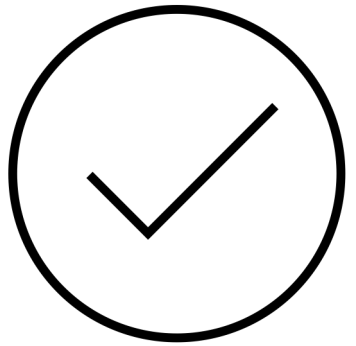
Ethical principles

- Demonstrating an understanding of the following ethical principles and constructs.
  - Tradition v Progress
  - Progress
    - Principles of progress
    - Progressive and regressive constraints on progress
      - Cultural
      - Behavioral
  - Prudence
  - Responsibility (individual & social)
- Demonstrate a wherewithal to make judgments based on these ethical principles and constructs.



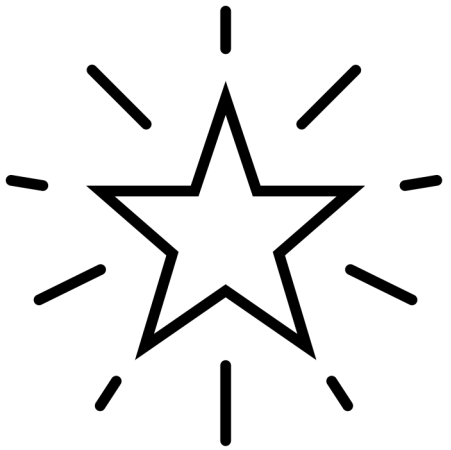
Compliance

- Compliance
  - Demonstrate a wherewithal to make progressive judgments regarding adhering to and respecting current cultural traditions and regulations in data science.
- Imperative of understanding existing norms and achieving compliance with professional standards.
  - Examples for data ethics
    - Discrimination / fairness
    - Bias, gender or ethnic
    - Privacy



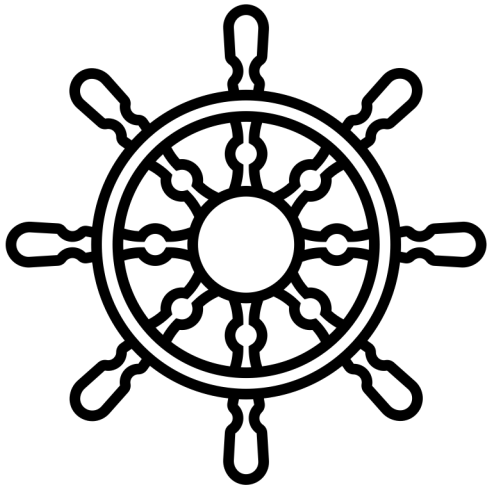
Excellence

- Excellence
  - Demonstrate a wherewithal to transgress norms to create more progressive norms within the application of data science



Ethical leadership

- Ethical leadership
  - Demonstrate a wherewithal to transgress norms to create new, more progressive and socially responsible norms in the application of data science



Next steps and discussion

- Consult with stakeholders
- Evolve syllabus in response
- Fund and create educational material to enable actuaries to adhere to the syllabus – ideally at the European level for economies of scale and in the interests of the smaller associations
- Assessment issues
- Potentially creating a new actuarial designation, a ‘currency’ that actuaries can use based on meeting the syllabus objectives.

Assessment

- New style of assessment likely required
  - Modelling Practice (CP2) in IFoA
    - Simulating a real-life day in work
    - Applying wherewithal to unseen problem
    - Required to model data, produce results and communicate to colleagues and client
  - Assessment with open-book and internet access.
  - Individual and team assessments
  - Project assessment to examine harder to assess elements
    - Notoriously difficult to soundly grade

Thank you

- Thank you for your attention.
- Questions, comments and feedback are very welcome?
- Email: colm.fitzgerald@ucd.ie / info@classicactuarialeducation.com

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