Data Management and Visualization

INTRODUCTION TO THE COURSE

Daniele Apiletti

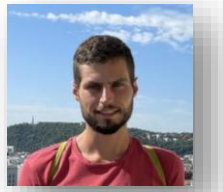
Teaching staff

Daniele Apiletti

- Data Warehousing
- OLAP, extended SQL
- NoSQL
- Lectures and… any other business

Diego Monti

- Data Visualization
- Lectures and practices



Simone Monaco

- practice of NoSQL (MongoDB)
- practice on Data Warehousing
- teaching assistance

You can **contact** us

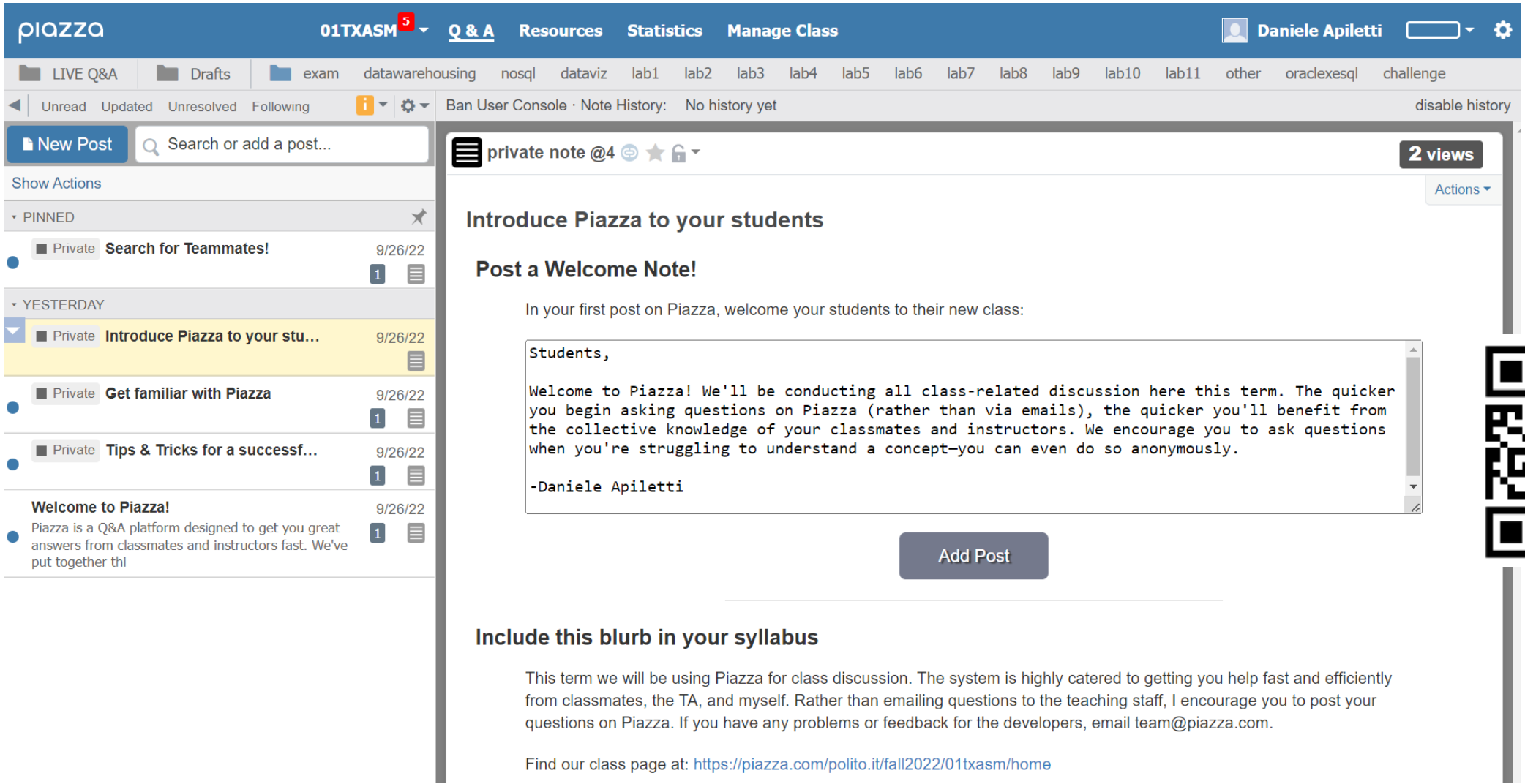
- during lectures and practices
- on **Piazza**

https://piazza.com/polito.it/fall2025/01txasm

Piazza Q&A

We are using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from both classmates and teachers. Rather than emailing questions to the teaching staff, please post your questions on Piazza, even **anonymously** or **privately**.

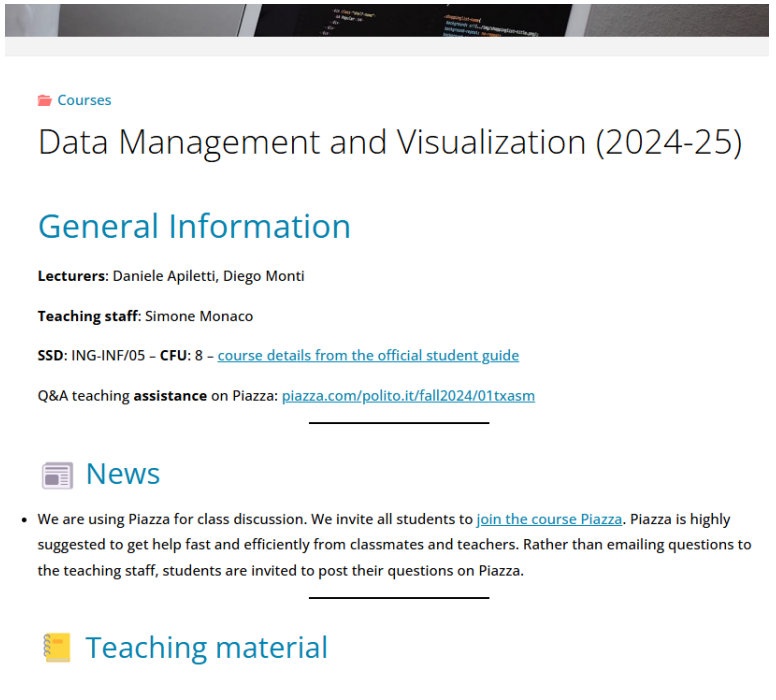
We might use Piazza for **announcements** in case of **failure** of either the Polito teaching portal or the Virtual Classroom services (or both).



Material

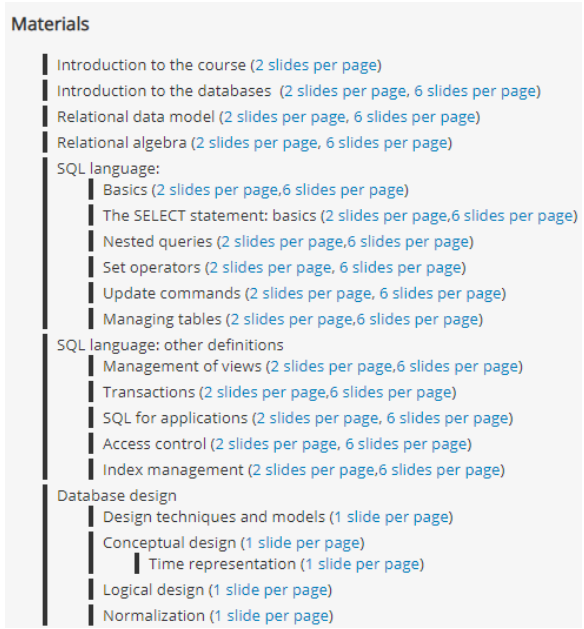
- Announcements on the official «teaching portal» private page https://didattica.polito.it/ or through institutional email

- Slides, texts of the practices, and all other materials are available on the **public page of the course** https://dbdmg.polito.it/



Pre-requisites: **relational model** + SQL

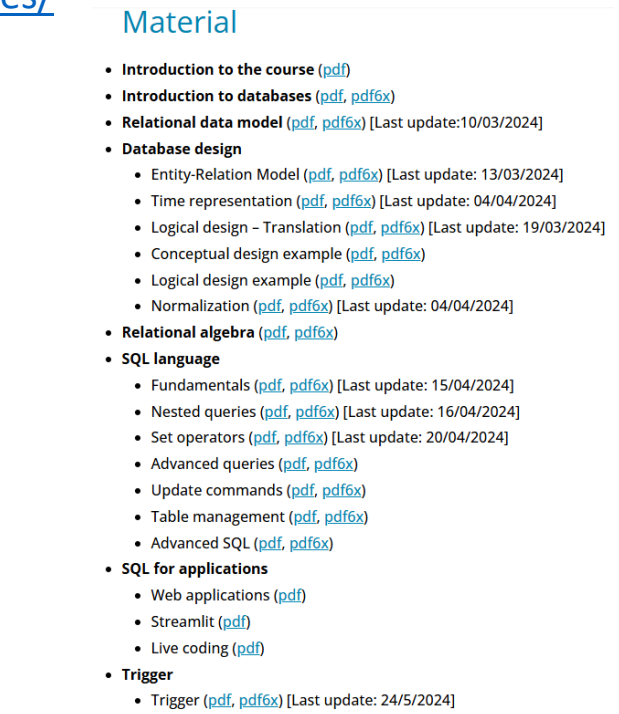
- «Introduction to databases» **videolectures** on the **portal** https://didattica.polito.it/



Materials

- Introduction to the course (2 slides per page)
- Introduction to the databases (2 slides per page, 6 slides per page)
- Relational data model (2 slides per page, 6 slides per page)
- Relational algebra (2 slides per page, 6 slides per page)
- SQL language:
  - Basics (2 slides per page,6 slides per page)
  - The SELECT statement: basics (2 slides per page,6 slides per page)
  - Nested queries (2 slides per page,6 slides per page)
  - Set operators (2 slides per page, 6 slides per page)
  - Update commands (2 slides per page, 6 slides per page)
  - Managing tables (2 slides per page,6 slides per page)
- SQL language: other definitions
  - Management of views (2 slides per page,6 slides per page)
  - Transactions (2 slides per page,6 slides per page)
  - SQL for applications (2 slides per page, 6 slides per page)
  - Access control (2 slides per page, 6 slides per page)
  - Index management (2 slides per page,6 slides per page)
- Database design
  - Design techniques and models (1 slide per page)
  - Conceptual design (1 slide per page)
    - Time representation (1 slide per page)
  - Logical design (1 slide per page)
  - Normalization (1 slide per page)

- «Introduction to databases» **slides** on the public web **page** https://dbdmg.polito.it/wordpress/teaching/databases/ https://dbdmg.polito.it/dbdmg_web/2022/introduction-data-bases/



Material

- **Introduction to the course** (pdf)
- **Introduction to databases** (pdf, pdf6x)
- **Relational data model** (pdf, pdf6x) [Last update:10/03/2024]
- **Database design**
  - Entity-Relation Model (pdf, pdf6x) [Last update: 13/03/2024]
  - Time representation (pdf, pdf6x) [Last update: 04/04/2024]
  - Logical design – Translation (pdf, pdf6x) [Last update: 19/03/2024]
  - Conceptual design example (pdf, pdf6x)
  - Logical design example (pdf, pdf6x)
  - Normalization (pdf, pdf6x) [Last update: 04/04/2024]
- **Relational algebra** (pdf, pdf6x)
- **SQL language**
  - Fundamentals (pdf, pdf6x) [Last update: 15/04/2024]
  - Nested queries (pdf, pdf6x) [Last update: 16/04/2024]
  - Set operators (pdf, pdf6x) [Last update: 20/04/2024]
  - Advanced queries (pdf, pdf6x)
  - Update commands (pdf, pdf6x)
  - Table management (pdf, pdf6x)
  - Advanced SQL (pdf, pdf6x)
- **SQL for applications**
  - Web applications (pdf)
  - Streamlit (pdf)
  - Live coding (pdf)
- **Trigger**
  - Trigger (pdf, pdf6x) [Last update: 24/5/2024]

Pre-requisites: **relational model** + **SQL**

Please join the poll at

https://www.menti.com/al3fu6qams14

Enter code **4904 4920**

What is data management? (1)

Data management is

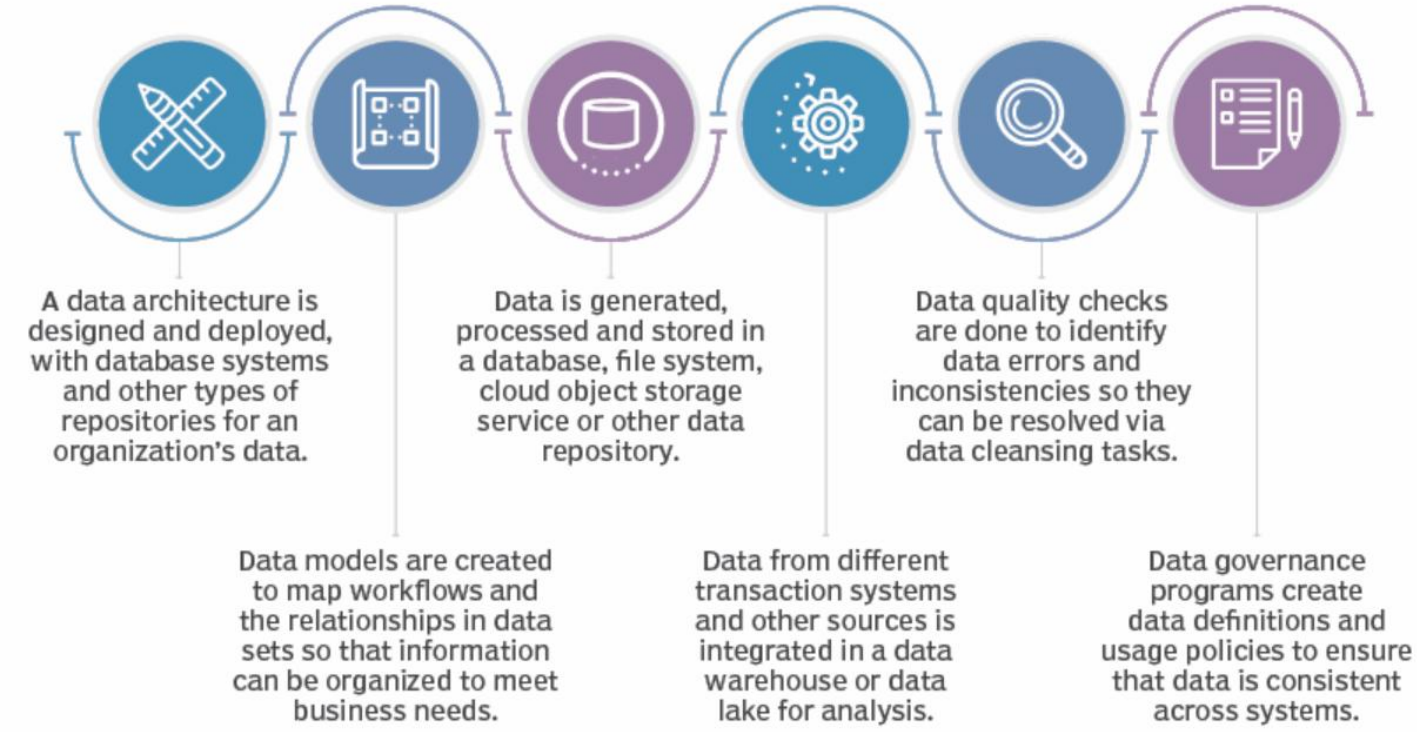
- a **business practice**
- used in **organizing** and maintaining **data processes**
- that meet ongoing **information lifecycle** needs
- within **every company**.

A global need for data management began with the electronics era or digital age of data processing […]

- […] **acquiring, storing, protecting**, and in-depth **processing** required data
- to ensure the required **accessibility**, **reliability**, and **timeliness** of all data for its users

https://www.dataentryoutsourced.com/blog/data-management-best-practices/

What is data management? (2)

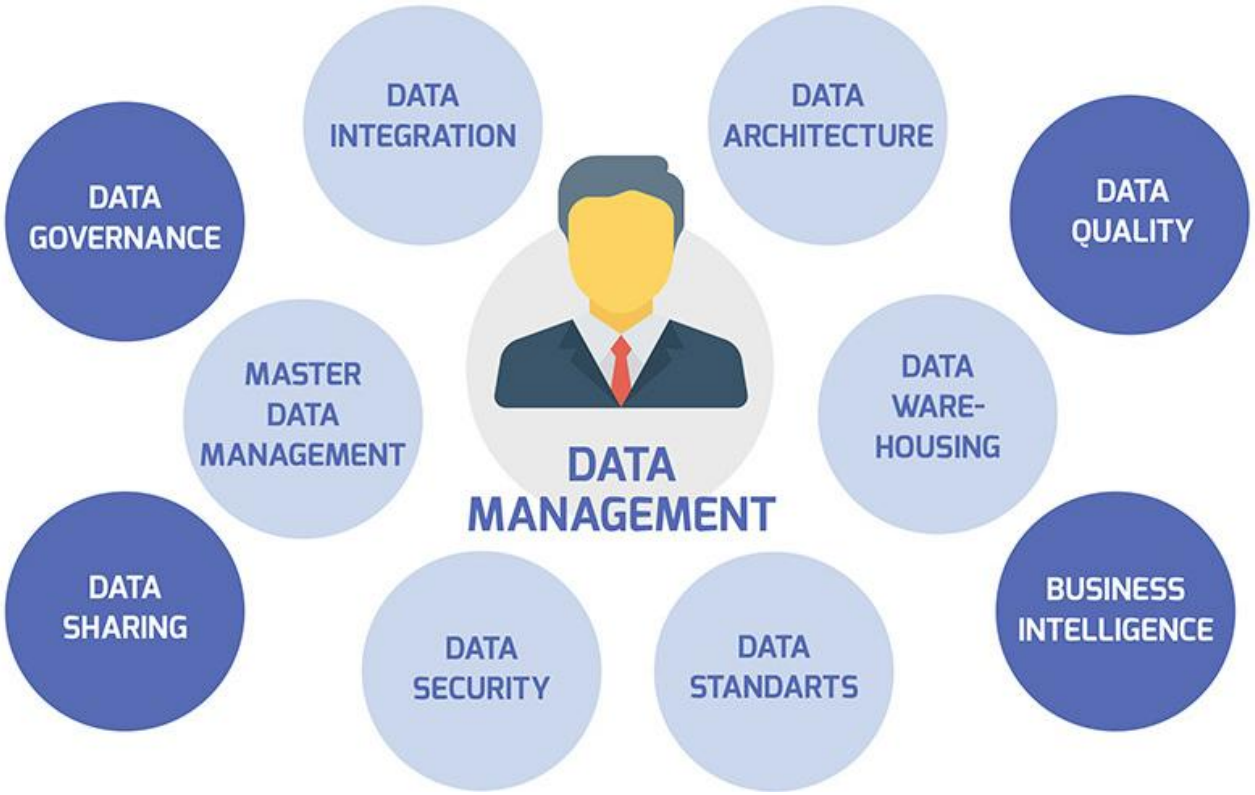


Data management is

- the process of **ingesting**, **storing**, **organizing** and **maintaining** the data created and collected by an organization.
- […] deploying the **IT systems** that run business applications and provide **analytical information** to help drive operational **decision-making** and strategic planning by corporate executives, business managers and other end users.
- make sure that the data in corporate systems is **accurate**, **available** and **accessible**.

https://searchdatamanagement.techtarget.com/definition/data-management

Why data management? (1)



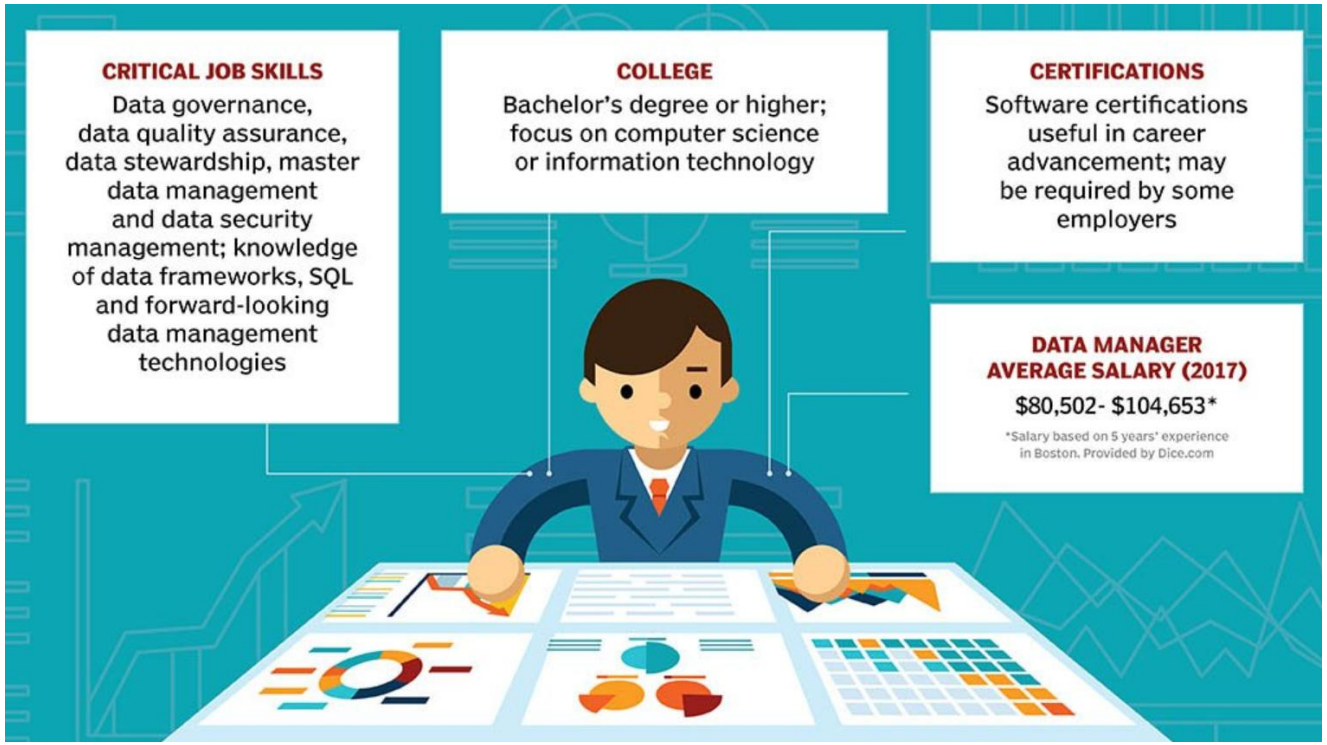
- […] in the digital age, **data is king**.

That is why it is seen as

- **one of the most important assets** of an organization;
- it is the foundation of information and the basis on which people **make decisions**.
- hence it would follow that if the data are **accurate**, **complete**, **organized** and **consistent**,
- it will contribute to the **growth** of the organization.

https://www.dataentryoutsourced.com/blog/data-management-best-practices/

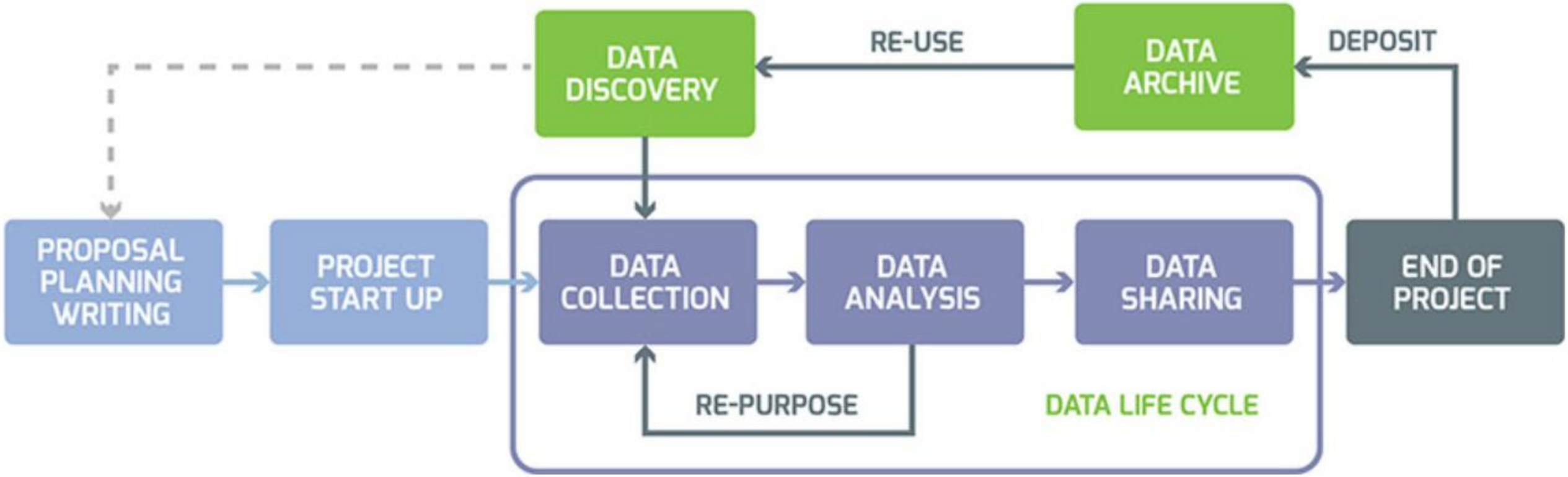
Why data management? (2)



- Data are increasingly seen as a **corporate asset**
- used to make more-informed **business decisions**, […], **optimize** business operations and reduce costs, all with the goal of **increasing revenue and profits**.
- a lack of proper data management can saddle organizations with incompatible **data silos**, **inconsistent** data sets and data **quality** problems […] or, worse, lead to **faulty findings**.
- grown in importance as businesses are subjected to an increasing number of **regulatory compliance** requirements, e.g., data privacy and protection laws (GDPR)

https://searchdatamanagement.techtarget.com/definition/data-management

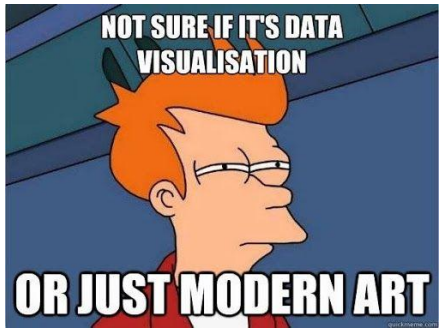
A sample data-management process



https://www.dataentryoutsourced.com/blog/data-management-best-practices/

Data Visualization

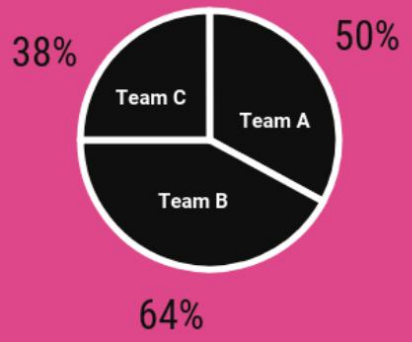
- Data visualization is the **visual presentation of data** or information.
- The goal of data visualization is to **communicate data** or information **clearly** and **effectively** to readers.
- It combines both **art** and **data science**: it should be creative, **pleasing** to look at, and **functional** in its visual communication of the data.

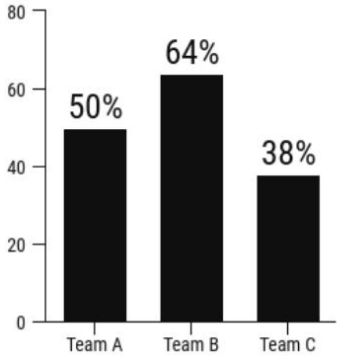


https://venngage.com/blog/data-visualization/

USING THE WRONG GRAPH

The type of graph you use should depend on the type of data you want to visualize. Using the wrong type of graph can skew the data. Writers will sometimes use the wrong type of graph on purpose.





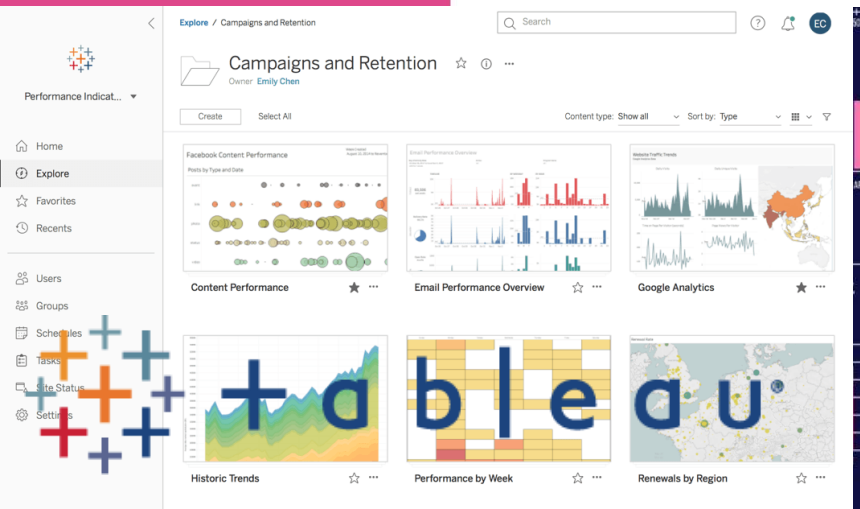
MISLEADING

- Pie charts are used to compare parts of a whole, not the difference between groups
- A different type of graph should be used to compare the three teams

VS

ACCURATE

- Bar graphs are better for showing the differences between groups
- This chart is a better visualization of the data

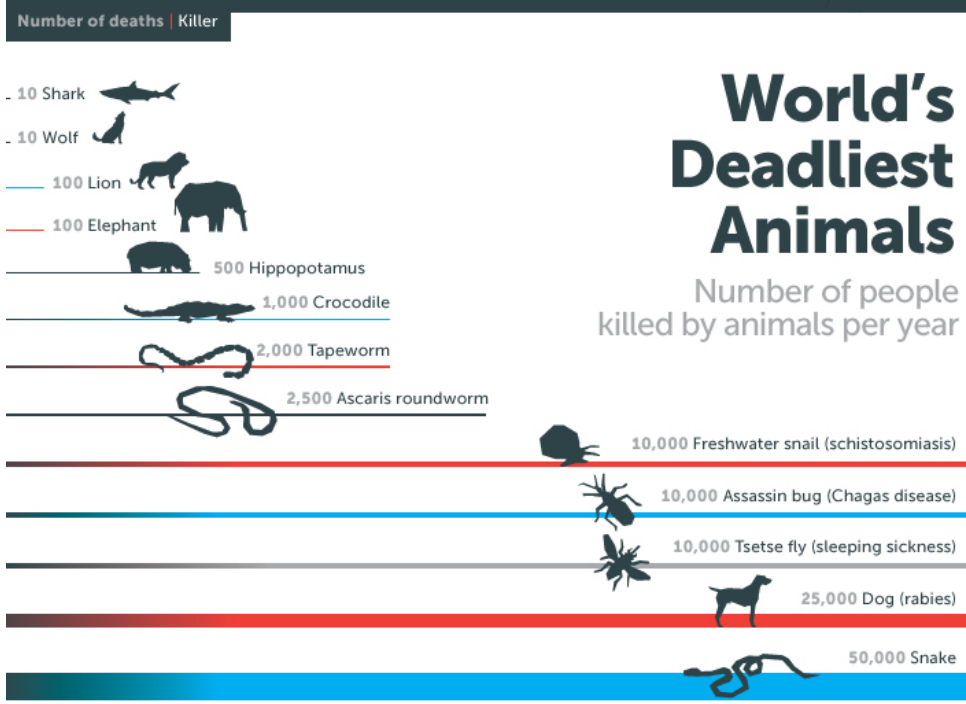


Visuals are processed

60,000 X

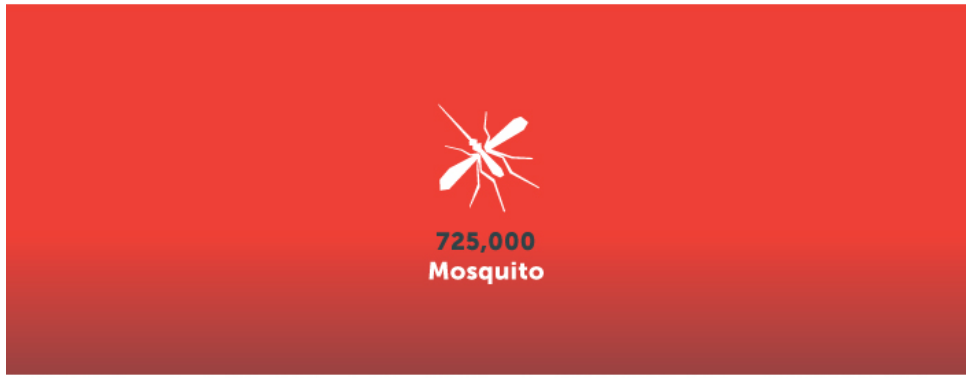
faster than text.

2



World's Deadliest Animals

Number of people killed by animals per year

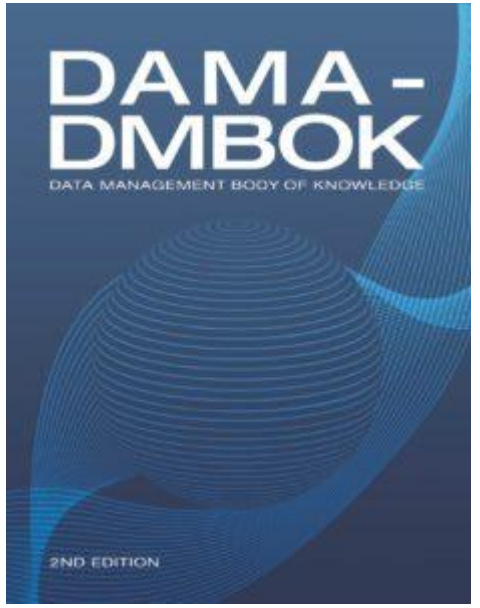


SOURCES: WHO; crocodile-attack.info; Kasturiratne et al. (doi.org/10.1371/journal.pmed.0050218); FAO (webcitation.org/6OgpS8SVO); Linnell et al. (webcitation.org/6ORL7DBUO); Packer et al. (doi.org/10.1038%2F436927a); Alessandro De Maddalena. All calculations have wide error margins.

Diving much deeper…

- **DAMA** International, the Data Governance Professionals Organization work to advance understanding of data management disciplines.
- They first published the Data Management Body of Knowledge (DMBOK) in 2009 as a comprehensive reference guide defining standard data management functions, methods, and best practices.
  - Version 2 started in 2017, with updates through 2024
  - Version 3 started in 2025
- DMBOK provides a functional framework for implementing enterprise data management, including widely adopted practices, methods, techniques, roles, deliverables, and metrics.

https://dama.org/content/body-knowledge



- Data Handling Ethics
- Data Governance
- **Data Architecture**
- **Data Modeling and Design**
- **Data Storage and Operations**
- Data Security
- **Data Integration & Interoperability**
- **Document and Content Management**
- Reference and Master Data
- **Data Warehousing** and Business Intelligence
- Metadata Management
- **Data Quality** Management
- **Big Data** and **Data Science**
- Data Management Maturity Assessment
- Data Management Organization and Role Expectations
- Data Management and Organizational Change Management

Course contents at a glance

Data Management

- OLAP (Online Analytical Processing), multi-dimensional analytical queries
- Data Warehousing
- Data retrieval (querying and indexing)
  - extended SQL
  - specific NoSQL language
- NoSQL data management
- Data modeling
- Distributed data management

Data Visualization

- Motivation and history of Data Visualization
- Visual perception and reasoning
- Graph construction principles
- Data quality

Schedule

Lectures

Daniele Apiletti, Diego Monti

- **Monday**
  13:00-16:00
  classroom R3b + online
- **Thursday**
  16:00-19:00
  classroom R4b + online

We will host some **seminars**, they will be part of the exam topics.

Schedule **changes** might happen: they are announced on the teaching portal. Please note that the official timetable might be updated later.

Lab practice

Simone Monaco, Diego Monti

- **Tuesday**
  11:30-13:00 team A
  13:00-14:30 team B
  14:30-16:00 team C
  @ Laib2B (no online)
- Starting on **October 14th, 2025**
  Till the end of the course
- Each student will be assigned to a single Team (**either A or B or C**)
  - based on their surname
  - changing Team is allowed upon request
- At all these times the teaching staff is available for **assistance:** make the most of it! **Don't** wait until the end of the lectures to ask for help.

Exam

- See exam policy on the official course web page on the teaching portal

Exam: Computer-based written test in class using POLITO platform;

The exam lasts 90 minutes and consists of theoretical questions and written exercises, as described in the following:

- [max 6 points] 3-6 multiple-choice questions on theoretical topics of the course, such as conceptual, logical, and physical data warehouse design, extended SQL language, technological characteristics of NoSQL databases and their usage, data management issues in distributed (non-relational) databases, data visualization techniques

- [max 12 points] exercises on data warehousing, including 2-4 open and/or multiple-choice questions on data warehouse design, and 2-3 queries for data access in extended SQL (open questions with answers to be provided in a text box)

- [max 9 points] 1-2 exercises on NoSQL database design and 1-2 queries for data access (open questions with answers to be provided in a text box)

- [max 5 points] 1 exercise on visualization analysis and design with open questions (answers to be provided in a text box)

Students are not allowed to use textbooks, notes, or additional electronic devices during the exam, besides their own notebook with Lockdown/Respondus.

Exercises are evaluated according to the correctness of the proposed solution and to the appropriateness of the adopted resolution methodologies.
Specific points for each exercise are indicated in the exam text.
Multiple-choice questions have a penalty for wrong answers, whereas no-penalty no-points in case no answer is provided.

Learning objectives assessment.
The exam will assess:
- the knowledge of data warehouse architectures and of their design methodologies (conceptual, logical, and physical)
- the ability to design a data warehouse in a provided use case
- the ability to write extended SQL queries to extract data of interest from a data warehouse
- the knowledge of the main technological characteristics of NoSQL databases
- the ability to design NoSQL databases and to query NoSQL databases
- the ability to design dashboards and KPIs
- the knowledge of the basic principles of cognitive and perceptive aspects related to visualization, and of the main visualization techniques

Exam

- See exam policy on the official course web page on the teaching portal

- Exam on Moodle (esami.polito.it)
- **Lockdown browser** strictly required
  - Check compatibility of your laptop
- Bring **your own laptop**
  - test everything in advance
  - WiFi, power plug (Italian plug adaptor!), software updates…
- Students can **fail** the exam – **no** additional exams / questions / calls are allowed besides those in the official calendar
  - Scholarship, Visa, travelling, etc.
- University exam **grades** are determined based on established criteria and are **not** open to **negotiation**
  - Questions about correctness are allowed, questions to improve the grade are not
  - Requests for clarification on exam evaluations may result (rarely) in an adjustment to the grade, either upward or **downward**, relative to the original assessment. All such reviews are conducted with a commitment to accuracy, correctness, and fairness.
- The exam is **OPEN BOOK**
  - **No** electronic devices allowed (smart glasses, smart watches, smart chatbots, smart friends, etc.)

Questions?

Data Management and Visualization

INTRODUCTION TO THE COURSE

Daniele Apiletti