Concept 2 of 6: Requirements Specification

BBT 3104: Advanced Database Systems

Week 2 & 3 of 13

April 2020

By Allan O. Omondi – aomondi [at] strathmore.edu
Faculty of Information Technology

Recommended citation:
Omondi, A. O. (2020). *BBT 3104 – Advanced Database Systems – Concept 2 of 6: Requirements Specification* [PDF Lecture Slides]. Retrieved from Strathmore University eLearning website https://elearning.strathmore.edu/pluginfile.php/217597/mod_resource/content/1/2.a.Concept2of6-Requirements_Specification.pdf

Strathmore UNIVERSITY

Adapted from energepic.com (2017)

Concept 2 of 6: Requirements Specification

BBT 3104: Advanced Database Systems
Week 2 & 3 of 13
April 2020

Allan O. Omondi
aomondi [at] strathmore.edu
Faculty of Information Technology

Presentation Outline

- ✓ Iterative and Non-Linear Database Design
  - Activity 1: Pre-Class Reading Assignment
  - SyRS Document
  - Critical Thinking
- ✓ Well-Formed Requirements
  - Problem-Based Learning: Group Project
- ✓ Database Constraints
  - Integrity Constraints
  - Domain Constraints
  - Interrelational and Intrarelational Constraints
  - Activity 2: Online Class Discussion
  - Static and Dynamic Constraints
  - Primary Key Constraints
  - Referential Integrity Constraints
  - Semantic Constraints
  - Activity 3: Interrogation and Listening
  - Problem-Based Learning: Group Project
  - Activity 4: Reading Assignment
  - Problem-Based Learning: Group Project

Strathmore UNIVERSITY

Iterative and Non-Linear Database Design

Strathmore UNIVERSITY

- **Creative thinking and critical thinking play major roles in design**

Figure 1: Creative and analytical thinking

Adapted from Riva (2017)

Iterative and Non-Linear Database Design

Strathmore UNIVERSITY

- **Design is the process of conceiving or inventing the forms, parts, and details of a system to achieve a specific purpose**
- **An important factor in realistic design is the total time allocated which is manifested through imposed schedules**
- **Many design teams subsequently settle for a design that may be less than ideal (not perfect), but considered "good enough"**
- **For example, your IS Project 1 which had to be finished and submitted by the end of the semester. If you assess the submitted project now, you will still find something that you can improve on.**

Iterative and Non-Linear Database Design

- **There are 4 factors that you need to be aware of when conducting the design process:**
    1. Complexity of design
    2. Trade-offs
    3. Design gaps
    4. Risk (unintended consequences)

Iterative and Non-Linear Database Design

- **Factor 1 of 4 – Complexity of design**: results from the wide range of factors or variables that need to be considered and prioritized in the design specification activity

Figure 2: Variables to be considered
Adapted from Altmann (2017)

Iterative and Non-Linear Database Design

- **Factor 2 of 4 – Trade-offs**: results from the need to have efficient compromise between desirable but conflicting criteria

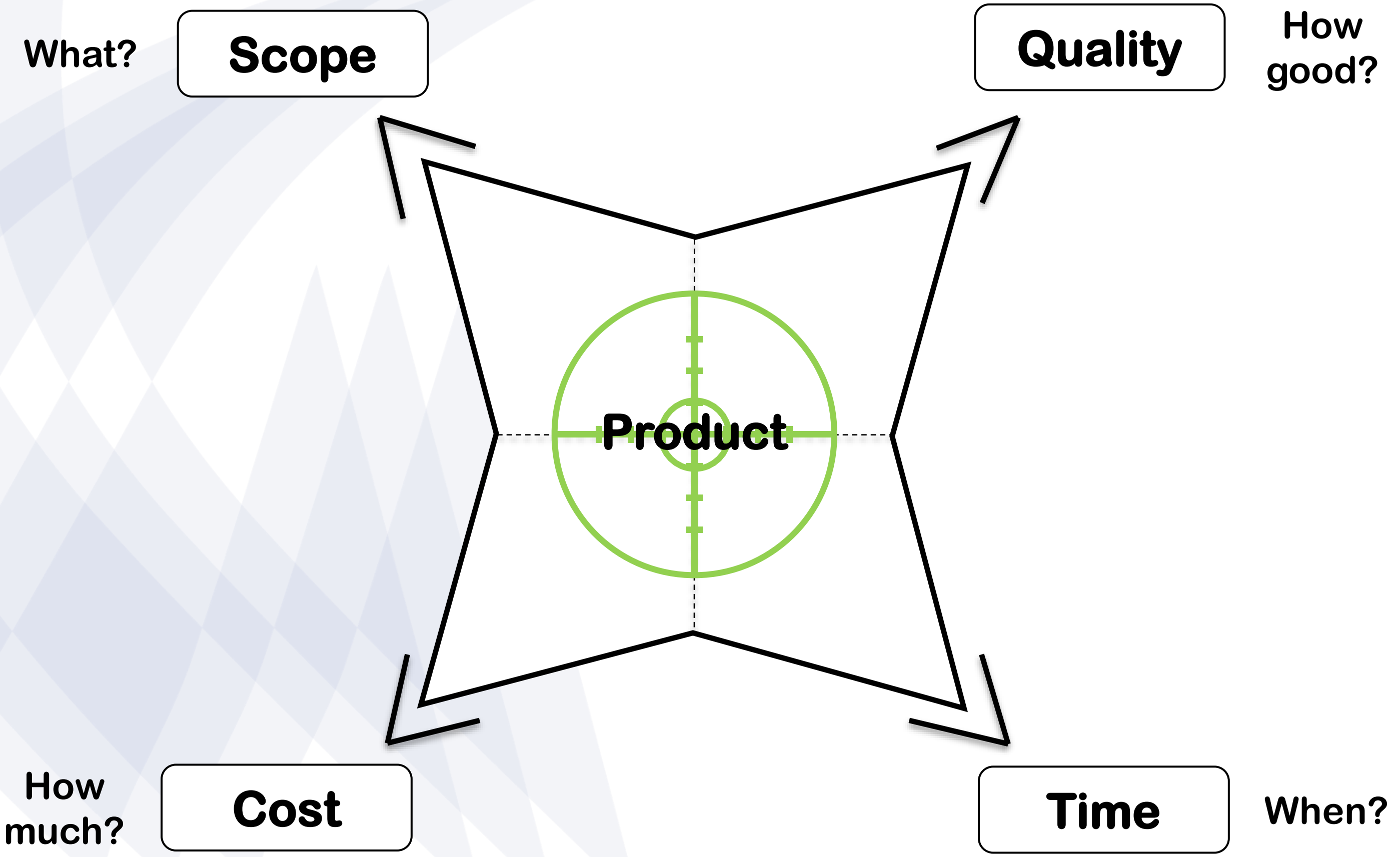

Figure 3: Trade-offs
Adapted from Clker-Free-Vector-Images (2014)

Iterative and Non-Linear Database Design

- **Factor 3 of 4 – Design gaps: results from the progression from an abstract idea to its realization such that the final product does not appear as originally visualized**

Iterative and Non-Linear Database Design

- **Factor 4 of 4 – Risk**: results from **unintended consequences** because of the inability to be sure of the effects and predictions of the performance of the system designed
- Designing a system is therefore a **risk-taking activity**

Iterative and Non-Linear Database Design

- **Although complexity of design, trade-offs, design gaps, and risk can be minimized by considering all the effects of a given design, they are always present in the design process**
- **Continuous redesigning has to take place in order for them to be minimized**
- **Designing is therefore a process that may proceed in many directions before the desired design is discovered**

Figure 4: Continuous improvement
Adapted from Mediamodifier (2014)

Iterative and Non-Linear Database Design

- **Designing is therefore an iterative and nonlinear process**
- **The iterative nature of designing allows us to handle the design gap effectively while accomplishing necessary trade-offs in risk vs. reward, complexity, scope, quality, cost, and time**

Iterative and Non-Linear Database Design

- You should have the following two perspectives when designing:
  - Analysis: Attention is focused on analysis of models of the enterprise (or system) to provide insights that indicate directions for improvement. Such models are based on business processes which define a chain of events, activities, and decisions that add value to the business and/or its customers.
  - Synthesis: Attention is focused on the [creative] process by which new configurations or objects are created.

Iterative and Non-Linear Database Design

- **The iteration for continuous improvement in a business involves:**

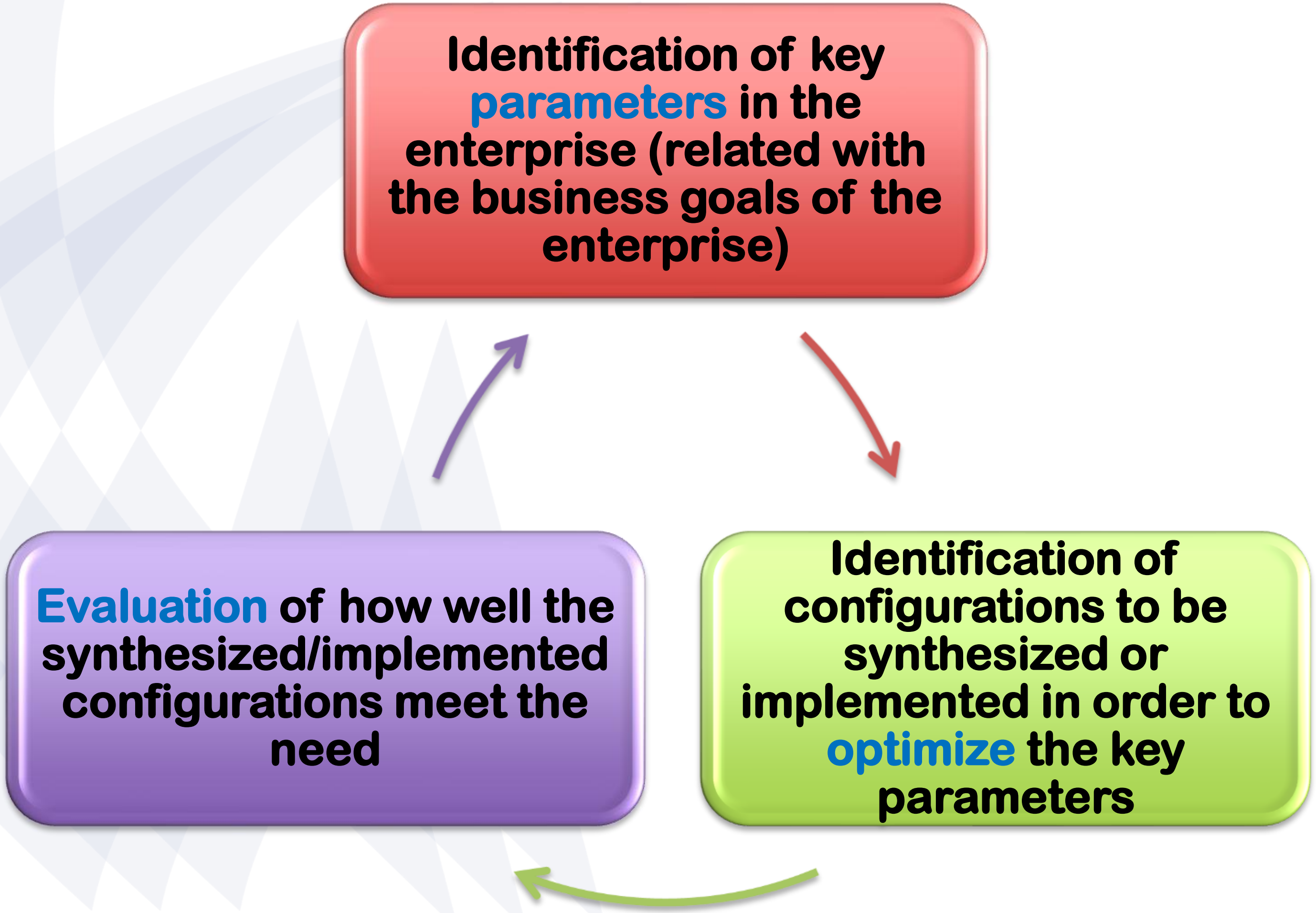

Figure 5: Iteration for continuous improvement in a business

Iterative and Non-Linear Database Design

Strathmore UNIVERSITY

- The ISO/IEC/IEEE 29148:2018 standard (latest version published on 30th November 2018) defines the construct of a well-formed requirement, provides attributes and characteristics of requirements, and discusses the iterative and recursive application of requirements processes throughout the life cycle
- The full name of the document is:
  ISO/IEC/IEEE 29148:2018 International Standard - Systems and Software Engineering -- Life Cycle Processes -- Requirements Engineering

Activity 1: Pre-Class Reading Assignment

Strathmore UNIVERSITY

- Download and read the ISO/IEC/IEEE 29148:2018 standard
- It is available via the following links: https://ieeexplore.ieee.org.ezproxy.library.strathmore.edu/document/8559686 or https://ieeexplore.ieee.org/document/8559686

Iterative and Non-Linear Database Design: SyRS Document

- A System Requirements Specification (SyRS) document is a structured collection of information that embodies the requirements of a system
- Developing an SyRS document includes the identification, organization, presentation, and modification of requirements
- A requirement is a statement of system functionality (a capability) that can be validated, that must be met or possessed by a system to solve a customer problem or to achieve a customer objective, and that is qualified by measurable conditions and bounded by constraints

Iterative and Non-Linear Database Design: SyRS Document

Strathmore UNIVERSITY

- The collection of requirements should have the following properties:
  - Unique set: Each requirement should be stated only once
  - No overlapping: Requirements should not overlap each other, i.e. a requirement should not refer to other requirements
  - Complete: Any SyRS should capture all the requirements defined by the client
  - Bounded: The boundaries, scope, and context for the set of requirements should be identified
  - Editable: The SyRS should be editable with version numbers indicating the changes made. Having requirements that overlap make it more difficult to edit.
  - Granular: There should be levels of abstraction for the system being defined. E.g. a level understandable by non-technical users and another level understandable by technical users.

Iterative and Non-Linear Database Design: SyRS Document

- One of the roles a BBIT graduate can have is to be a liaison between the business side of an enterprise and the IT side of the enterprise
- The SyRS essentially serves to document an agreement between the customer (possibly the non-technical, business community) and the technical community

Figure 6: Business meeting

Adapted from Morillo (2018)

Iterative and Non-Linear Database Design: SyRS Document

Strathmore UNIVERSITY

- The role of a liaison can involve analysing the business needs of a client in order to help to identify business problems and propose solutions
- The proposed solution can also be in the form of a database on top of which developers can then develop business applications
- It is therefore very important for a BBIT graduate to have system requirements specification skills
- Note that a distinction should be made between an SyRS (focuses only what the system must do) and a Statement of Work (focuses only how to develop the system)

Iterative and Non-Linear Database Design: SyRS Document

- Avoid the terrible misconception of IT as only a "reactive" function of business; whereby clients go to IT only when they have a problem that they need to be fixed
- IT should be more of a "proactive" function; one that solves problems which clients did not even know they had
- However, refrain from "forcing" a problem to appear where there is none at all. You must conduct thorough analysis in order to identify the actual root cause of business problems.

Iterative and Non-Linear Database Design: Critical thinking

- **Critical thinking skills** are vital for conducting an analysis of customer feedback required to identify business problems

Video 1: Critical thinking

URL: https://www.youtube.com/watch?v=dItUGF8GdTw

Adapted from Agoos (2016)

- Click the following link for a detailed explanation of the diagram: https://www.criticalthinking.org/ctmodel/logic-model1.htm

Figure 7: Elements of thought

Adapted from Elder and Paul (2007)

Presentation Outline

- ✓ Iterative and Non-Linear Database Design
  - Activity 1: Pre-Class Reading Assignment
  - SyRS Document
  - Critical Thinking
- ✓ Well-Formed Requirements
  - Problem-Based Learning: Group Project
- ✓ Database Constraints
  - Integrity Constraints
  - Domain Constraints
  - Interrelational and Intrarelational Constraints
  - Activity 2: Online Class Discussion
  - Static and Dynamic Constraints
  - Primary Key Constraints
  - Referential Integrity Constraints
  - Semantic Constraints
  - Activity 3: Interrogation and Listening
  - Problem-Based Learning: Group Project
  - Activity 4: Reading Assignment
  - Problem-Based Learning: Group Project

Well-Formed Requirements

- **Example 1:**
  - **Capabilities:** Move passengers from Nairobi to Malaba
  - **Condition:** Cruising speed of 120 km/h (average)
  - **Constraint:** Maximum speed of 130 km/h
  - **Well-formed requirement:** The system should move passengers between Nairobi and Malaba at an average cruising speed of 120km/h with a maximum speed of 130 km/h

Well-Formed Requirements

- According to the ISO/IEC/IEEE 29148:2018 standard, a well-formed requirement should be composed of THREE components:
  - Capabilities: Fundamental requirements of the system that represent the features or functions of the system needed or desired by the client
  - Conditions: Measurable qualitative or quantitative characteristics that are stipulated for a capability
  - Constraints: Requirements that are imposed on the solution by circumstance, force, or compulsion
- Note that a single capability can have multiple conditions and multiple constraints

Well-Formed Requirements

- **Example 2:**

Chapter 2: System Capabilities

B. Client Data

The database should be capable of storing data about the hotel's guests and for each guest, the following data should be stored:

1. **A client identification number**
2. **The client's name**
3. **The client's contacts**

Well-Formed Requirements

- **Example 2:**

Chapter 3: System Conditions

B. Client Data

The database should contain the following measurable characteristics for each capability specified in Section 2.B.

2.B.1	A client identification number shall be a national identity number or a company PIN. If the clients are in a group, then 1 of them shall take the lead role and make the reservation on behalf of the whole group. Therefore, only 1 national identity number or 1 company PIN shall be recorded per reservation.
2.B.2	The client's name shall contain the first name, the middle name, and the last name only. A company name will be used in the case of a company.
2.B.3	The client's contacts shall include the client's email and telephone number(s)

Well-Formed Requirements

- **Example 2:**

Chapter 4: System Constraints

The database must satisfy the following constraints:

B. Client Data

2.B.1	The national identity number and company PIN shall together have a key constraint. This will be in the form of an intrarelational, static, composite key constraint to form the primary key. The national identity number should have an INT domain constraint and the company PIN should have a VARCHAR domain constraint.
2.B.2	The data contained in the client's name field must conform to the intrarelational, static, VARCHAR domain constraint
2.B.3	The data contained in the client's email field must conform to the intrarelational, static, VARCHAR domain constraint and be in the form of a valid email address

Well-Formed Requirements

- **Each requirement should have the following properties:**
  - **Unambiguous:** Each requirement should be **interpreted in only one way**
  - **Validatable:** Each requirement should have the means to prove that the system satisfies the requirements

Problem-Based Learning: Group Project

Strathmore UNIVERSITY

- In groups of 3, assume the role of liaison officers as you develop an IT-based solution to address the root cause of the identified business problem(s) in the case study
  - Use the "SyRS Template" provided on eLearning to specify the system capabilities for each category of data that needs to be stored (Chapter 2)
  - Use the "SyRS Template" provided on eLearning to specify the system conditions associated with each system capability (Chapter 3)
  - Use Chapter 5 to state the assumptions you have made as you identified the capabilities and conditions. Stating the assumptions is important to avoid any misinterpretation, especially given the fact that you do not have full access to the business details.

- Approximate time required (outside class activity): 25 minutes

Presentation Outline

- ✓ Iterative and Non-Linear Database Design
  - Activity 1: Pre-Class Reading Assignment
  - SyRS Document
  - Critical Thinking
- ✓ Well-Formed Requirements
  - Problem-Based Learning: Group Project
- ✓ Database Constraints
  - Integrity Constraints
  - Domain Constraints
  - Interrelational and Intrarelational Constraints
  - Activity 2: Online Class Discussion
  - Static and Dynamic Constraints
  - Primary Key Constraints
  - Referential Integrity Constraints
  - Semantic Constraints
  - Activity 3: Interrogation and Listening
  - Problem-Based Learning: Group Project
  - Activity 4: Reading Assignment
  - Problem-Based Learning: Group Project

Database Constraints

- **A transaction** updates a database in order to reflect the occurrence of a real-world event that affects the enterprise state
- **By doing so, it** maintains a consistency **between the state of the business and the state of the database**

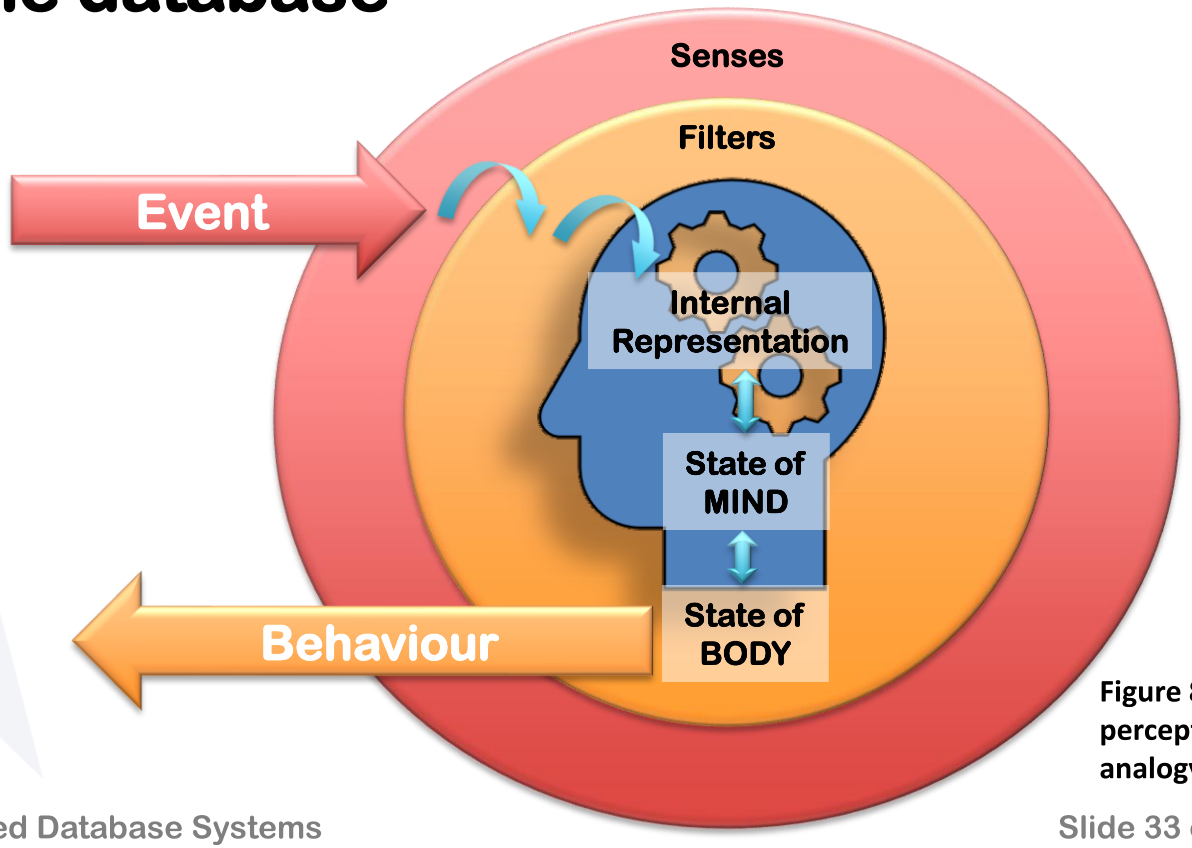

Figure 8: Human perception analogy

Database Constraints

- **A transaction updates a database in order to reflect the occurrence of a real-world event that affects the enterprise state**
- **By doing so, it maintains a consistency between the state of the business and the state of the database**

(2) Business applications are used to record business events using transactions

(1) The business has various events that affect and determine its state

(3) The database

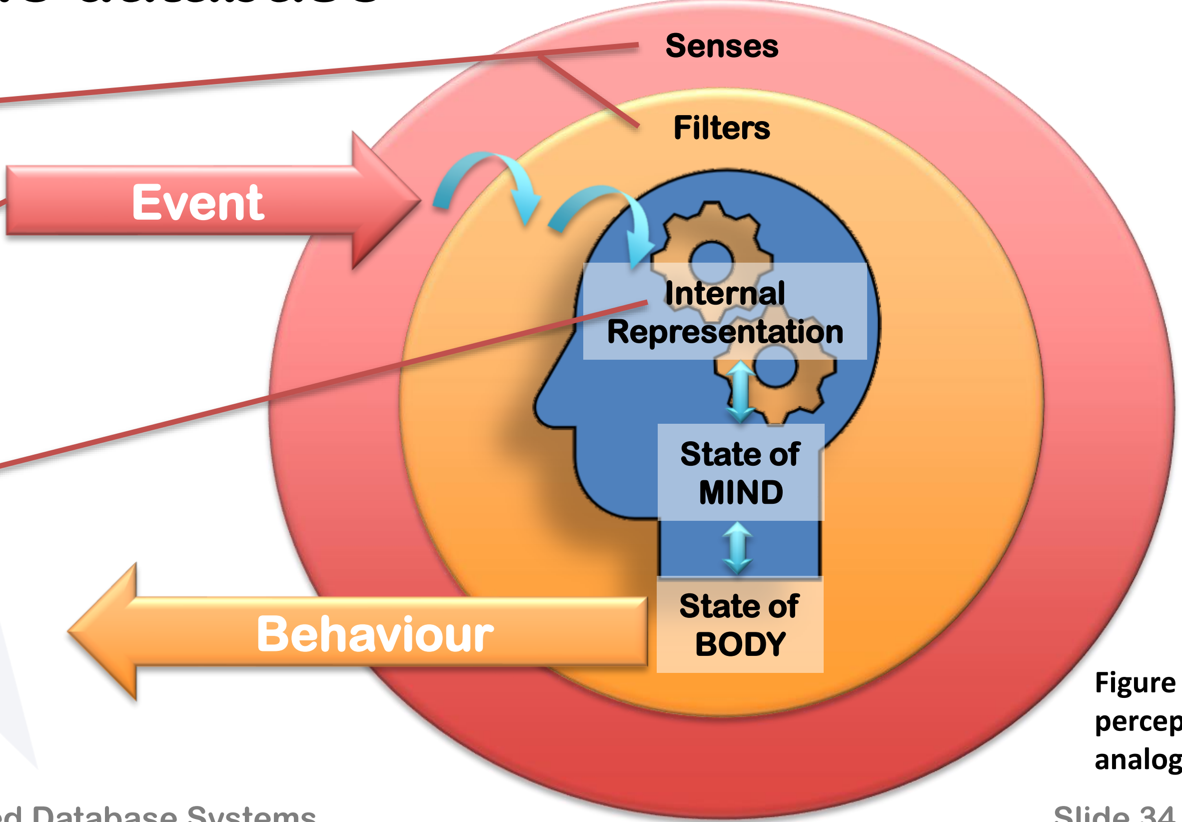

Figure 8: Human perception analogy

Database Constraints

- **Please refer to the following tutorial for a recap of how to implement transactions in a business application (this is very important): http://www.mysqltutorial.org/mysql-transaction.aspx**

Database Constraints: Integrity Constraints

- **Several requirements are placed on how transactions are executed**
- **One of the requirements is that a transaction must update the database in such a way that it allows only those values that have been defined as acceptable to be stored in the database** (this guarantees that data values are consistent with the state of the business)
- **An integrity constraint (IC) is an application-based restriction on the values that can appear as entries in the database. It is also known as a consistency constraint.**

Database Constraints: Integrity Constraints

- ICs are usually based on the business rules of the enterprise
- You therefore must conduct a thorough analysis to understand the Standard Operating Procedures your client (the business) uses to conduct day to day activities
- ICs are listed in the SyRS Document

Example:

"No employee can earn more than his/her boss"

Database Constraints: Domain Constraints

- **A domain constraint is not the same as an integrity constraint**
- **A domain constraint refers to the data type, e.g. INT, VARCHAR, BOOLEAN, etc.** (Those interested in gaining a deeper understanding of this concept can refer to the seminal paper by E. F. Codd titled *"A Relational Model of Data for Large Shared Data Banks"* summarized on these slides – the enrolment key is "**BBIT3-Recap**" and the link to the eLearning page is: https://elearning.strathmore.edu/course/view.php?id=3721)
- **Domain constraints are used to specify how the database should store data**

Database Constraints: Interrelational and Intrarelational Constraints

- The SyRS document should focus on integrity constraints more than domain constraints
- An IC can be either:
  - Intrarelational: Involves only one relation
  - Interrelational: Involves more than one relation
- Analogy: Chemical compounds:

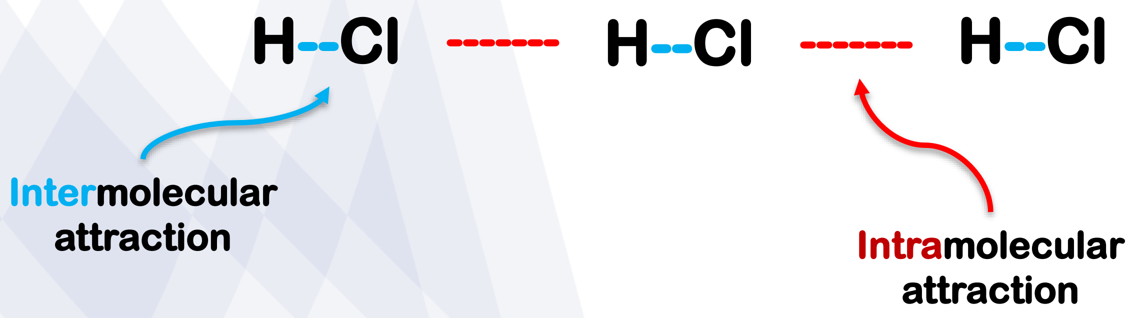

Figure 9: Intermolecular and intramolecular attraction analogy

Activity 2.a.: Online Class Discussion

- State and explain whether the following integrity constraint is intrarelational or interrelational via the links provided during the class.

"The identity of a client must be unique"

- Approximate time required (outside class activity): 5 minutes

Activity 2.b.: Online Class Discussion

- State and explain whether the following integrity constraint is intrarelational or interrelational via the links provided during the class

"The identity of the client who purchases a product must exist in the client records prior to the purchase being made"

- Approximate time required (outside class activity): 5 minutes

Activity 2.c.: Online Class Discussion

Strathmore UNIVERSITY

- State and explain whether the following integrity constraint is intrarelational or interrelational via the links provided during the class

  "No employee can earn more than his/her boss"

- Approximate time required (outside class activity): 5 minutes

Database Constraints: Static and Dynamic Constraints

- An IC can also be categorized into either:
  - Static ICs: Restrict the legal instances of a database
  - Dynamic ICs: Restrict the evolution of legal instances
- REMINDER:
  - An instance of a relation refers to the data in the relation at any point in time. For example, the instance of a relation on Monday is different from the instance of the same relation on Wednesday (if changes were made between the two days).
  - A relation schema refers to the structure of a relation together with a specification of the domain constraints and any other constraints/restrictions on possible values
  - An instance of a relation schema R (uppercase) is denoted as r (lowercase)

Activity 2.d.: Online Class Discussion

- State whether the following integrity constraint is static or dynamic via the links provided during the class

"The salary of an employee must not increase or decrease by more than 5% per transaction"

- Further state whether the integrity constraint above is interrelational or intrarelational

- Approximate time required (outside class activity): 5 minutes

Database Constraints: Static and Dynamic Constraints

Strathmore UNIVERSITY

- **Static ICs are generally easier to implement in a database than dynamic ICs**
- **In many cases, application developers need to provide additional code that enforces dynamic constraints within the transactions that update the database**
- **It is therefore common to find the Database Administration team and the Application Development team working closely together**
- **In small organizations or start-ups, one person can have the role of both a database administrator and an application developer (programmer) at the same time**

Database Constraints: Primary Key Constraints

- An instance of the student relation schema satisfies the primary key constraint (the red-coloured set) if *its instance does not contain a pair of tuples that agree (have the same values for) on the key constraint and disagree on the other attributes of the student grade relation*

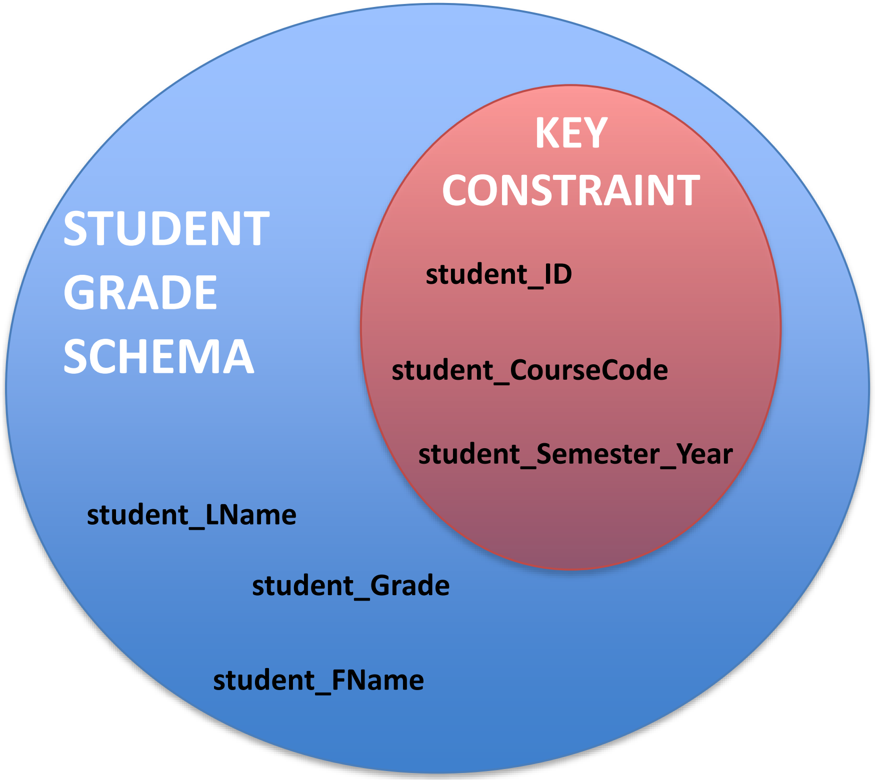

Figure 10: Student grade schema

Database Constraints: Primary Key Constraints

- **Formally:**

For each two tuples (t_1 and t_2):

$t_1 \in r, t_2 \in r$

If $t_1[K] = t_2[K]$**, then**

$t_1[A] = t_2[A]$ **for every attribute A in R**

- **K** - corresponds to the key constraint in the student relation schema
- **R** - corresponds to the student schema
- **r** - corresponds to an instance of the student schema
- **A** - corresponds to an attribute in the student schema, e.g. "student_Grade"

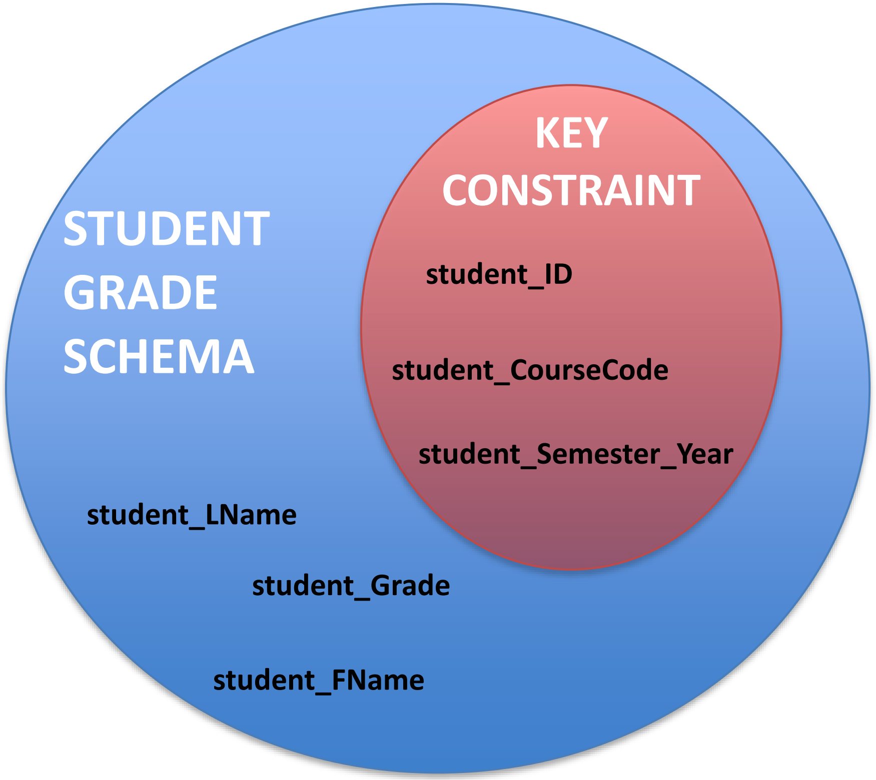

Figure 10: Student grade schema

Database Constraints: Primary Key Constraints

- **Minimality property**: No subset of a primary key can be designated as another primary key in the same relation schema
- **Uniqueness property**: a relation instance, r, satisfies the uniqueness property if it does not contain a pair of distinct tuples whose values agree on all the attributes of a constraint K

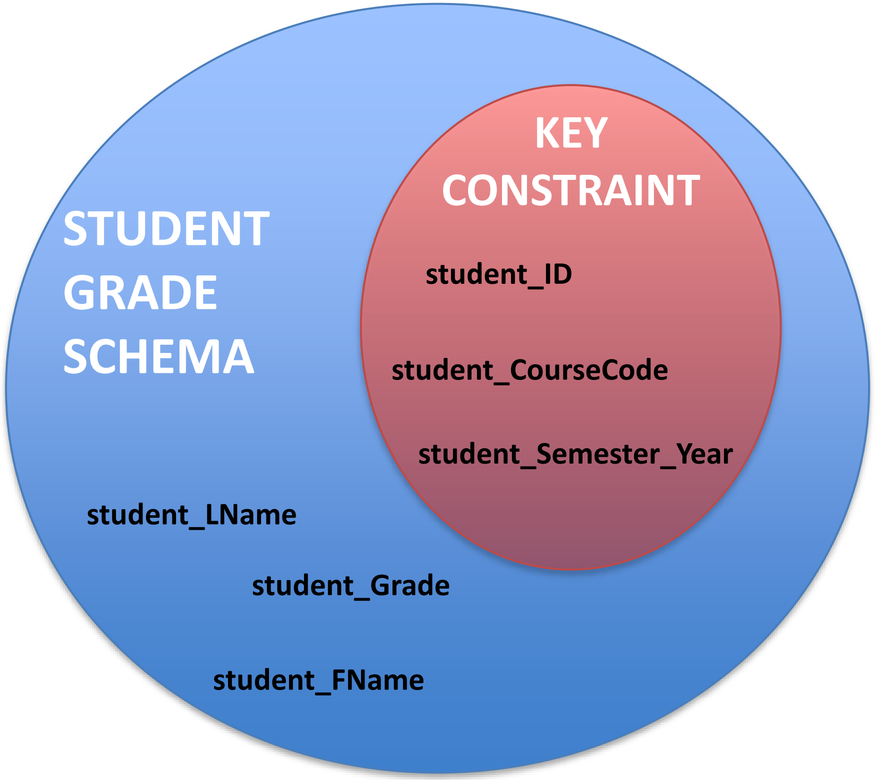

Figure 10: Student grade schema

Database Constraints: Referential Integrity Constraints

- We can have relation schemas, R_1 and R_2 (not necessarily distinct)
- We can also have an attribute or a pair of attributes, S_1 and S_2, such that:
  - $S_1 \in R_1, S_2 \in R_2$
  - S_2 is a key of R_2
  - The number of attributes and their respective domains in S_1 and S_2 are the same
- A pair of instances, r_1 and r_2, satisfies a foreign key constraint (S_1, S_2) if for every tuple $t_1 \in r_1$, $t_1[S_1] = t_2[S_2]$ for some tuple $t_2 \in r_2$ or $t_1[S_1]$ is NULL

Database Constraints: Referential Integrity Constraints

- Please refer to the following link for further reading:

  https://stackoverflow.com/questions/7573590/can-a-foreign-key-be-null-and-or-duplicate

  HLGEM (2017).

Strathmore UNIVERSITY

Database Constraints: Semantic Constraints

Strathmore UNIVERSITY

- Semantic constraints implement a business rule or convention in a business
- This is as opposed to being concerned with the structure of the data
- Semantic constraints are derived from the application domain being modeled by the database.
- Standard Operating Procedures (SOPs) of a business or department are useful sources for identifying semantic constraints
- For example: no employee can earn more than the boss (it does not talk about the employee ID being unique or referencing another attribute)

Database Constraints: Semantic Constraints

- **Another example**: The number of students registered for a unit in the same class in the Faculty of IT must not exceed the capacity of the largest computer lab

Activity 3.a.: Interrogation and Listening

- In groups of 3, choose any business idea from the following topic in the class discussion forum: https://elearning.strathmore.edu/mod/forum/discuss.php?d=11819
  - Confirm that the group behind the business idea has not yet been interviewed (one interview per group)
  - Create a list of interview questions aimed at identifying the data storage and information retrieval needs of the organization's business processes
  - Record an audio of your group interviewing another group of 3 in the class. You can use tools such as Zoom, Skype, Google Hangouts, etc. Remember to identify the interviewers and the interviewees in your audio.
- Upload your audio via the submission link provided under concept 2 of 6
- Approximate time required (outside class activity): 60 minutes

Activity 3.b.: Interrogation and Listening

Strathmore UNIVERSITY

- In groups 3, compile a brief requirements specification report containing a data storage and information retrieval solution based on the interview responses.
- Upload your brief requirements specification report via the submission link provided under concept 2 of 6
- Approximate time required (outside class activity): 20 minutes

Problem-Based Learning: Group Project

Strathmore UNIVERSITY

- In groups of 3, assume the role of liaison officers as you develop an IT-based solution to address the root cause of the identified business problem(s) in the case study
  - Use the "SyRS Template" provided on eLearning to specify the system constraints for each category of data that needs to be stored (Chapter 4)
  - Specify all the technical details of the constraint, e.g. whether it is a static, dynamic, interrelational, intrarelational, primary key constraint, referential integrity constraint, or semantic constraint (or a combination of the aforementioned)
  - Use Chapter 5 to state the assumptions you have made as you identified the constraints. Stating the assumptions is important to avoid any misinterpretation, especially given the fact that you do not have full access to the business details.

- Approximate time required (outside class activity): 15 minutes

Activity 4: Reading Assignment

Strathmore UNIVERSITY

- Read the database design handout provided on eLearning under "Concept 2 of 6"

Problem-Based Learning: Group Project

Strathmore UNIVERSITY

- In groups of 3:
  - Create an ERD for the group project that you started in week 1
  - Create a database schema for the group project that you started in week 1
  - Create a system architecture for the group project that you started in week 1
  - Note that the above 3 items should be part of the SyRS document in Chapter 6
- Upload your work as part of the System Requirements Specification (SyRS) document via the eLearning link provided under Concept 2 of 6
- Approximate time required (outside class activity): 65 minutes

Presentation Outline

Strathmore UNIVERSITY

- ✓ Iterative and Non-Linear Database Design
  - Activity 1: Pre-Class Reading Assignment
  - SyRS Document
  - Critical Thinking
- ✓ Well-Formed Requirements
  - Problem-Based Learning: Group Project
- ✓ Database Constraints
  - Integrity Constraints
  - Domain Constraints
  - Interrelational and Intrarelational Constraints
  - Activity 2: Online Class Discussion
  - Static and Dynamic Constraints
  - Primary Key Constraints
  - Referential Integrity Constraints
  - Semantic Constraints
  - Activity 3: Interrogation and Listening
  - Problem-Based Learning: Group Project
  - Activity 4: Reading Assignment
  - Problem-Based Learning: Group Project

Recap

- Designing a complex systems is a risk-taking activity because of:
  - Complexity of design
  - Trade-offs
  - Design gap
  - Risk (unintended consequences)
- Iteration of the design process is necessary in order to minimize the negative effect of the factors above
- According to the ISO/IEC/IEEE 29148:2018 standard, a well-formed requirement contains a capability, condition(s), and constraint(s)
- Businesses must maintain consistency between the state of the business and the state of the database. This guarantees the integrity of the data. Database constraints are used to implement this.

Recap

- Database constraints can be:
  - Static
  - Dynamic
  - Interrelational
  - Intrarelational
  - Primary key constraint
  - Referential integrity constraint (foreign key constraint)
  - Semantic constraint (or a combination of the aforementioned)

Presentation Outline

- ✓ Iterative and Non-Linear Database Design
  - Activity 1: Pre-Class Reading Assignment
  - SyRS Document
  - Critical Thinking
- ✓ Well-Formed Requirements
  - Problem-Based Learning: Group Project
- ✓ Database Constraints
  - Integrity Constraints
  - Domain Constraints
  - Interrelational and Intrarelational Constraints
  - Activity 2: Online Class Discussion
  - Static and Dynamic Constraints
  - Primary Key Constraints
  - Referential Integrity Constraints
  - Semantic Constraints
  - Activity 3: Interrogation and Listening
  - Problem-Based Learning: Group Project
  - Activity 4: Reading Assignment
  - Problem-Based Learning: Group Project

Strathmore UNIVERSITY

Further Reading and References

Agoos, S. (2016). *5 tips to improve your critical thinking—Samantha Agoos*. Retrieved from https://ed.ted.com/lessons/5-tips-to-improve-your-critical-thinking-samantha-agoos

Altmann, G. (2017). *Feedback confirming businessmen. Free image on Pixabay* [Image]. Retrieved from https://pixabay.com/illustrations/feedback-confirming-businessmen-2990424/

Clker-Free-Vector-Images (2014). *Cross hairs wires. Free vector graphic on Pixabay* [Image]. Retrieved from https://pixabay.com/vectors/cross-hairs-cross-wires-311145/

Curtis, D. (2016). *Among the clouds*. https://www.darrencurtismusic.com/relaxing

Elder, L., & Paul, R. (2007). *The thinker's guide to analytic thinking: How to take thinking apart and what to look for when you do* (2nd ed.). Foundation for Critical Thinking.

energepic.com (2017). *Person Holding Gray Pen Sitting Near Laptop. Free stock photo* [Photograph]. Retrieved from https://www.pexels.com/photo/architect-composition-data-demonstration-313691/

HLGEM. (2017). *sql—Can a foreign key be NULL and/or duplicate?* Stack Overflow. Retrieved from https://stackoverflow.com/questions/7573590/can-a-foreign-key-be-null-and-or-duplicate

Mediamodifier (2014). *Growth progress graph. Free image on Pixabay* [Image]. Retrieved from https://pixabay.com/illustrations/growth-progress-graph-diagram-3078543/

Morillo, C. (2018). *Group of People Sitting in Front of Table. Free stock photo* [Photograph]. Retrieved from https://www.pexels.com/photo/group-of-people-sitting-in-front-of-table-1181405/

Riva, E. (2017). *Brain mind psychology. Free image on Pixabay* [Image]. Retrieved from https://pixabay.com/illustrations/brain-mind-psychology-idea-hearts-2062055/