**INDIVIDUAL ASSIGNMENT**

**(Weight: 40% OF THE OVERALL MODULE GRADE)**

**55-500998 DATABASE SYSTEMS FOR SOFTWARE APPLICATIONS**

**Module Leader: Kostas Domdouzis**

**Academic Year 2020/21**

**Submission Type: ELECTRONIC (through BLACKBOARD)**

**•TASK 1 – Normalize the following table using the three Rules of Normalization and showing each of the three stages of their implementation. (Weight: 12.5% of the Assignment)**

**Sheffield High School ‘The Explorer’**

Phone (0114) 225-6783

153 Ashby Rd

Sheffield

S5 2TU

Students Record

**(Unique) StudentName StudentYear Exam Date Grade Teacher TeacherID**

John 1 Physics 17/09/2016 70% Dr Jones 12

George 1 Art 11/05/2016 65% Dr Jones 12

Helen 2 Music 14/02/2017 55% Dr Johnson 15

Sarah 3 Maths 15/07/2017 54% Dr Vans 16

Paul 3 French 17/09/2016 85% Dr Pascal 17

**0NF:**

StudentName, StudentYear, Exam, Date, Grade, Teacher, TeacherID

**1NF:**

StudentName\*, Exam, Date, Grade, TeacherID\*

StudentName, StudentYear

TeacherID, Teacher

**2NF:**

StudentName\*, ExamID\*, Grade, TeacherID\*

ExamID, Exam, Date

StudentName, StudentYear

TeacherID, Teacher

**3NF:**

StudentName\*, AttemptID\*

StudentName, StudentYear

AttemptID, ExamID, Date, Grade

ExamID, Exam, TeacherID

TeacherID, Teacher

**•TASK 2 – Normalize the following table using the three Rules of Normalization and showing each of the three stages of their implementation. (Weight: 12.5% of the Assignment)**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Employer**  **Code** | **Student**  **No** | **Employer**  **Name** | **Employer**  **Specialty** | **Student Name** | **Appointment Date/Time** | **Session Code** | **Time**  **Alloc.** |
| 123 | 1414 | Stevens | Artificial Intelligence | Johnson | 12-10-2017  12:00pm | D | 50 |
| 123 | 1513 | Stevens | Artificial Intelligence | Patel | 14-10-2017  13:00pm | B | 60 |
| 123 | 1567 | Stevens | Artificial Intelligence | Jamal | 15-10-2017  13:30pm | F | 20 |
| 123 | 2010 | Stevens | Artificial Intelligence | Hope | 15-10-2017  16:00pm | A | 60 |
| 234 | 1414 | Vidal | Graphics | Johnson | 17-10-2017  08:00am | D | 60 |
| 234 | 1567 | Vidal | Graphics | Jamal | 15-10-2017  16:00pm | F | 10 |
| 234 | 1785 | Vidal | Graphics | Michaels | 17-10-2017  08:30am | A | 10 |
| 365 | 1863 | Matthews | Web Design | Wong | 20-01-2017  15:00pm | A | 30 |
| 365 | 1975 | Matthews | Web Design | Holmes | 21-02-2017  15:00pm | C | 30 |
| 456 | 1414 | Parsons | Algorithms | Jones | 22-02-2017  16:00pm | D | 10 |
| 456 | 1513 | Parsons | Algorithms | Patel | 06-06-2017  13:00pm | B | 60 |
| 456 | 1634 | Parsons | Algorithms | Peterson | 15-10-2017  16:00pm | C | 60 |
| 456 | 2011 | Parsons | Algorithms | Siddiqi | 17-10-2017  09:00am | A | 30 |
| 456 | 2160 | Parsons | Algorithms | King | 20-12-2017  10:00am | A | 30 |

**0NF:**

EmployerCode, StudentNo, EmployerName, EmployerSpecialty, StudentName, AppointmentDT, SessionCode, TimeAlloc

**1NF:**

EmployerCode\*, StudentNo\*, AppointmentDate, AppointmentTime, SessionCode, TimeAlloc

EmployerCode, EmployerName, EmployerSpecialty

StudentNo, StudentName

**2NF:**

EmployerCode\*, AppointmentID\*, StudentNo\*

AppointmentID, AppointmentDate, AppointmentTime, SessionCode, TimeAlloc

EmployerCode, EmployerName, EmployerSpecialty

StudentNo, StudentName

**3NF (no change):**

EmployerCode\*, AppointmentID\*, StudentNo\*

AppointmentID, AppointmentDate, AppointmentTime, SessionCode, TimeAlloc

EmployerCode, EmployerName, EmployerSpecialty

StudentNo, StudentName

**•TASK 3 - Produce an Entity-Relationship Diagram (ERD) for the entire system presented in the following scenario.**

***The ERD should be usable by the Royal Astronomical Society in order to understand better how MARS missions operate and to extract conclusions on how to improve these missions further.***

**(Weight: 35% of the Assignment)**

Mars is the fourth [planet](https://en.wikipedia.org/wiki/Planet) from the [Sun](https://en.wikipedia.org/wiki/Sun) and the second-smallest planet in the [Solar System](https://en.wikipedia.org/wiki/Solar_System), after [Mercury](https://en.wikipedia.org/wiki/Mercury_(planet)).

Several rovers have been dispatched to Mars:

* https://upload.wikimedia.org/wikipedia/commons/thumb/a/a9/Flag_of_the_Soviet_Union.svg/23px-Flag_of_the_Soviet_Union.svg.png [*Mars 2*](https://en.wikipedia.org/wiki/Mars_2), *Prop-M* rover, 1971, *Mars 2* landing failed taking Prop-M with it. The *Mars 2* and *3* spacecraft from the USSR had identical 4.5 kg *Prop-M* rovers. They were to move on [skis](https://en.wikipedia.org/wiki/Ski) while connected to the landers with cables.
* https://upload.wikimedia.org/wikipedia/commons/thumb/a/a9/Flag_of_the_Soviet_Union.svg/23px-Flag_of_the_Soviet_Union.svg.png [*Mars 3*](https://en.wikipedia.org/wiki/Mars_3), *Prop-M* rover, 1971, lost when *Mars 3* lander stopped communicating about 20 seconds after landing.
* https://upload.wikimedia.org/wikipedia/en/thumb/a/a4/Flag_of_the_United_States.svg/23px-Flag_of_the_United_States.svg.png [*Sojourner*](https://en.wikipedia.org/wiki/Sojourner_(rover)) rover, Mars Pathfinder, landed successfully on July 4, 1997. Communications were lost on September 27, 1997.
* https://upload.wikimedia.org/wikipedia/commons/thumb/b/b7/Flag_of_Europe.svg/23px-Flag_of_Europe.svg.png *Beagle 2*, *Planetary Under-surface Tool*, lost with Beagle 2 on deployment from Mars Express in 2003. A compressed spring mechanism was designed to allow movement across the surface at a rate of 1 cm per 5 secondsand to burrow into the ground and collect a subsurface sample in a cavity in its tip.
* https://upload.wikimedia.org/wikipedia/en/thumb/a/a4/Flag_of_the_United_States.svg/23px-Flag_of_the_United_States.svg.png *Spirit* (MER-A), Mars Exploration Rover, launched on June 10, 2003 at 13:58:47 EDTand landed successfully on January 4, 2004. Nearly 6 years after the original mission limit, Spirit had covered a total distance of 7.73 km (4.80 mi) but its wheels became trapped in sand. Around January 26, 2010, NASA conceded defeat in its efforts to free the rover and stated that it would now function as a stationary science platform. The last communication received from the rover was on March 22, 2010, and NASA ceased attempts to re-establish communication on May 25, 2011.
* https://upload.wikimedia.org/wikipedia/en/thumb/a/a4/Flag_of_the_United_States.svg/23px-Flag_of_the_United_States.svg.png *Opportunity* (MER-B), Mars Exploration Rover, launched on July 7, 2003 at 23:18:15 EDT and landed successfully on January 25, 2004. *Opportunity* surpassed the previous record for longevity of a surface mission to Mars as of May 20, 2010 and surpassed the previous record for distance travelled off-Earth as of July 28, 2014 by covering a total distance of 40.25 km (25.01 mi). *Opportunity* is still operational and mobile as of September 10, 2020.
* https://upload.wikimedia.org/wikipedia/en/thumb/a/a4/Flag_of_the_United_States.svg/23px-Flag_of_the_United_States.svg.png*Curiosity*, [Mars Science Laboratory](https://en.wikipedia.org/wiki/Mars_Science_Laboratory) (MSL), by NASA, was launched November 26, 2011 at 10:02 EST and landed in the [Aeolis Palus](https://en.wikipedia.org/wiki/Aeolis_Palus) plain near [Aeolis Mons](https://en.wikipedia.org/wiki/Aeolis_Mons) (informally "Mount Sharp") in [Gale Crater](https://en.wikipedia.org/wiki/Gale_(crater)) on August 6, 2012, 05:31 UTC. Curiosity Rover is still operational as of September 10, 2020.

Curiosity is a car-sized [rover](https://en.wikipedia.org/wiki/Rover_(space_exploration)) designed to explore [Gale Crater](https://en.wikipedia.org/wiki/Gale_(crater)) on [Mars](https://en.wikipedia.org/wiki/Mars) as part of [NASA](https://en.wikipedia.org/wiki/NASA)'s Mars Science Laboratory mission (MSL). *Curiosity* was launched from [Cape Canaveral](https://en.wikipedia.org/wiki/Cape_Canaveral_Air_Force_Station) on November 26, 2011, at 15:02 UTC aboard the MSL spacecraft and landed in Gale Crater on Mars on August 6, 2012, 05:17 UTC. The [Bradbury Landing](https://en.wikipedia.org/wiki/Bradbury_Landing) site was less than 2.4 km (1.5 mi) from the centre of the rover's touchdown target after a 560 million km (350 million mi) journey.

Curiosity has a mass of 899 kg (1,982 lb) including 80 kg (180 lb) of scientific instruments. The rover is 2.9 m (9.5 ft) long by 2.7 m (8.9 ft) wide by 2.2 m (7.2 ft) in height. *Curiosity* is powered by a radioisotope thermoelectric generator (RTG), like the successful Viking 1 and Viking 2 Mars landers in 1976. Radioisotope power systems (RPSs) are generators that produce electricity from the decay of radioactive isotopes, such as [plutonium-238](https://en.wikipedia.org/wiki/Plutonium-238), which is a non-[fissile](https://en.wikipedia.org/wiki/Fissile) isotope of plutonium. Heat given off by the decay of this isotope is converted into electric voltage by thermocouples, providing constant power during all seasons and through the day and night.

The temperatures at the landing site can vary from −127 to 40 °C (−197 to 104 °F); therefore, the thermal system of Curiosity will warm the rover for most of the Martian year. The thermal system will do so in several ways: passively, through the dissipation to internal components; by electrical heaters strategically placed on key components; and by using the rover heat rejection system (HRS).It uses fluid pumped through 60 m (200 ft) of tubing in the rover body so that sensitive components are kept at optimal temperatures.

Curiosity uses two identical on-board rover computers, called Rover Computer Element (RCE) which contain radiation hardened memory to tolerate the extreme radiation from space and to safeguard against power-off cycles. The computers run the [VxWorks](https://en.wikipedia.org/wiki/VxWorks) real-time operating system (RTOS). Each computer's memory includes 256 [kB](https://en.wikipedia.org/wiki/Kilobyte) of EEPROM, 256 [MB](https://en.wikipedia.org/wiki/Megabyte) of DRAM, and 2 GB of flash memory.

In order to communicate with Earth, Curiosity is equipped with several telecommunication means – an [X-band](https://en.wikipedia.org/wiki/X_band) Transmitter/Receiver that can communicate directly with Earth, and a UHF [Electra](https://en.wikipedia.org/wiki/Electra_(radio))-Lite software-defined radio for communicating with Mars orbiters.

Communication with orbiters is expected to be the main path for data return to Earth, since the orbiters have both more power and larger antennas than *Curiosity*, thus allowing for faster transmission speeds. The rover has two [UHF](https://en.wikipedia.org/wiki/UHF) radios, the signals of which the [2001 Mars Odyssey](https://en.wikipedia.org/wiki/2001_Mars_Odyssey) orbiter is capable of relaying back to Earth. An average of 14 minutes, 6 seconds will be required for signals to travel between Earth and Mars. *Curiosity* can communicate with Earth directly at speeds up-to 32 kbit/s, but the bulk of the data transfer should be relayed through the [Mars Reconnaissance Orbiter](https://en.wikipedia.org/wiki/Mars_Reconnaissance_Orbiter) and [Odyssey orbiter](https://en.wikipedia.org/wiki/2001_Mars_Odyssey). Communication from and to *Curiosity* relies on internationally agreed space data communications protocols as defined by the Consultative Committee for Space Data Systems.

Curiosity is equipped with six 50 cm (20 in) diameter wheels in a rocker-bogie suspension. The suspension system also serves as landing gear for the vehicle, unlike its smaller predecessors. Each wheel has cleats and is independently actuated and geared, providing for climbing in soft sand and scrambling over rocks. Each front and rear wheel can be independently steered, allowing the vehicle to turn in place as well as execute arcing turns. Each wheel has a pattern that helps it maintain traction but also leaves patterned tracks in the sandy surface of Mars.

Curiosity has 17 cameras: HazCams (8), NavCams (4), MastCams (2), MAHLI (1), MARDI (1), and ChemCam (1). Each MastCam includes the Medium Angle Camera (MAC) which has a 34 mm (1.3 in) focal length, a 15° field of view, and can yield 22 cm/pixel (8.7 in/pixel) scale at 1 km (0.62 mi). The other camera in the MastCam is the Narrow Angle Camera (NAC), which has a 100 mm (3.9 in) focal length, a 5.1° field of view, and can yield 7.4 cm/pixel (2.9 in/pixel) scale at 1 km (0.62 mi). A pair of MastCams were developed which include zoom lenses, but these were not included in the rover because of the time required to test the new hardware and the looming November 2011 launch date. Each MastCam has eight gigabytes of flash memory, which is capable of storing over 5,500 raw images, and can apply real time lossless data compression.

ChemCam is actually two different instruments combined as one: a laser-induced breakdown spectroscopy (LIBS) and a Remote Micro Imager (RMI) telescope. The purpose of the LIBS instrument is to provide elemental compositions of rock and soil, while the RMI will give ChemCam scientists high-resolution images of the sampling areas of the rocks and soil that LIBS targets. ChemCam has the ability to record up to 6,144 different wavelengths of ultraviolet, visible, and infrared light.

MAHLI is a camera on the rover's robotic arm and acquires microscopic images of rock and soil. MAHLI can take [true-colour](https://en.wikipedia.org/wiki/True-color) images at 1600×1200 [pixels](https://en.wikipedia.org/wiki/Pixel) with a resolution as high as 14.5 micro-meters per pixel. MAHLI has an 18.3 to 21.3 mm (0.72 to 0.84 in) focal length and a 33.8–38.5° field of view. MAHLI has both white and ultraviolet [LED](https://en.wikipedia.org/wiki/LED) illumination for imaging in darkness or fluorescence imaging. MAHLI also has mechanical focusing in a range from infinite to millimetre distances.

Curiosity stores the images generated by MastCams, the ChemCam and MAHLI in three different databases. Field-Programmable Gate Arrays (FPGAs) are used by Curiosity in order to categorize these images based on their significance and store them in the respective database. The significance of an image is defined by image processing algorithms that identify specific features of each image (e.g. density, contrast) and produce a decision about them. For example, if the image processing algorithms identify the significance of an image to be above 70%, then they store the image in Database A. If the significance of the image is between 45% to 69%, it is stored in Database B while for significance below 45%, then the image is stored in Database C. It is possible that an image is elevated to Database A from Database B or even from Database C depending on the conditions of the mission of Curiosity on the surface of Mars or inversely, an image can be downgraded to Database C from Database A.

The most significant pictures are emitted by FPGAs through the UHF Electra-Lite software-defined radio to the Mars orbiters and then back to earth. All the images though are used for obstacle track identification on the Mars surface and coordinates definition for the rover. These coordinates are sent directly to Earth through Curiosity's X band transmitter so that NASA knows exactly the route followed by the rover.

Database on missions:

**0NF:**

RoverName, LaunchDate, LandingSuccess, LandingDate, Failure, FailureDate, Transport, TotalDistance, Weight

**3NF (no change past 1NF):**

RoverName, LaunchID\*, Failure, FailureDate, Transport, TotalDistance, Weight

LaunchID, LaunchDate, LandingSuccess, LandingDate

Databases on images from Curiosity:

Database A

ImageID, Image, FocalLength, FieldOfView, Scale, Significance (S>=70%)

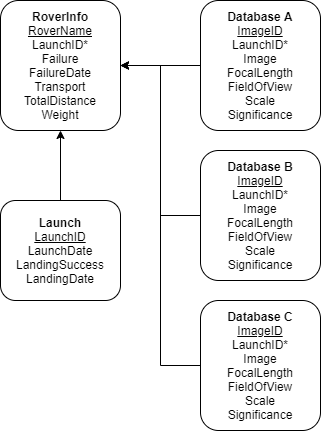
Database B

ImageID, Image, FocalLength, FieldOfView, Scale, Significance (45<=S>70%)

Database B

ImageID, Image, FocalLength, FieldOfView, Scale, Significance (S<45%)

Shown below is the ERD I have developed based on this extraction of data fields and normalisation.



**•TASK 4**

Identify characteristics of your ER diagram that make the database efficient.

When designing this ERD I first ensured that all significant data outlined in the scenario would be represented in the database, even if in a simplified form as this opens many analytical doors. Next, I laid out the entities and their fields, and normalised the planned database to 3NF to ensure integrity of data and a great balance between storage and speed of operation, thinking of the infamous time-space trade-off.

I believe that the simplistic design I have presented represents all significant information brought forth as easily accessible and queryable data in a well-formed database system. While not all explicit details are included, I believe this is a strength as it allows for the database to serve its true purpose – displaying patterns in *data*, not lengthy write-ups about technical details.

[*Max Number of Words: 400*]

[Weight: 15%]

**•TASK 5**

For each of the following questions, provide one PL/SQL procedure, one function or one cursor that will check the following:

5A) How many images are stored in Database B based on their significance?

SELECT COUNT(ImageID)

FROM DATABASE\_B

GROUP BY ImageID

HAVING Significance >= 45 AND Significance < 70

[Weight: 8%]

5B) How many images are elevated from Database C to Database A?

SELECT COUNT(ImageID)

FROM DATABASE\_C

GROUP BY ImageID

HAVING Significance >= 70

[Weight: 9%]

5C) How many coordinates collected by the images of Databases B & C are sent directly to Earth through Curiosity’s X band

transmitter?

SELECT COUNT(ImageID)

FROM DATABASE\_A A

INNER JOIN DATABASE\_B B

ON A.Significance = B.Significance

INNER JOIN DATABASE\_C C

ON B.Significance = C.Significance

GROUP BY ImageID

HAVING Significance >= 70

[Weight: 8%]

**LEARNING OUTCOMES**

|  |  |
| --- | --- |
| **LO Ref** | **Learning Outcome** |
| 1 | Design databases for non-complex scenarios using appropriate notations and theories, |
|  | including underlying set notations. |
| 2 | Implement, manipulate and query these databases using standard approaches. |
| 3 | Identify and discuss issues relating to databases, such as query optimisation, data |
|  | integrity, security, reliability, data protection and curation. |

**MARKING OF THE INDIVIDUAL ASSIGNMENT**

**TASKS 1 & 2 Marking**

Tasks 1 & 2 are Normalization exercises that show the level of comprehension by the students of the Normalization Rules. The distribution of the marks for each of Tasks 1 and 2 is the following:

***The marker should consider even small things that the student does when he/she normalizes the table and should also consider the overall logic.***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **0-19%** | **20-33%** | **34-49%** | **50-59%** | **60-69%** | **70-79%** | **80-89%** | **90-100%** |
| **Tasks 1 & 2**  **(25% of the Assignment Grade)**  **Normalization**  **Marking Grid** | Very little or no  understanding at all. | Many important  attributes missing.  Many incorrect  relationships as expressed by using keys. | Some important attributes appearing. Some correct dependencies both in terms of logic (that corresponds to the requirements of the given problem). Some correct  use of keys. | Most important attributes  present.  Dependencies  mostly correct and corresponding at a substantial degree to the logic of the problem.  Most PKs and FKs  indicated. | Some  minor discrepancies  in keys and  dependencies. | All attributes and relationships shown  correctly and  supported by all correct PKs and FKs. | A ‘perfect’ Normalization solution  with exactly the correct attributes;  primary and foreign keys will be indicated in an unambiguous,  easily read way. | All the requirements set in  the range  (80-89) satisfied plus provision of alternative solutions with appropriate explanation for the provision of these solutions. This range of grades shows that the student examined the tasks in a more-in-depth manner and provided more work than what the assignment was asking for. |

**TASK 3 Marking**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **0-19%** | **20-39%** | **40-49%** | **50-59%** | **60-69%** | **70-79%** | **80-89%** | **90-100%** |
| **Task 3**  **(35% of the Assignment Grade)**  **Entity-Relationship Diagram Marking Grid** | Very little or no  understanding at all. | Many important  entities missing or  poorly described in  terms of attributes.  Many incorrect  relationships. No annotations in relationships at all. | Some important entities appearing. Some correct relationships both in terms of logic (that corresponds to the requirements of the given scenario) and Optionality & Cardinality. Some correct  use of keys. Some annotations. | Most important entities  present. Sensible and  adequate attributes shown.  Relationships (Cardinality &  Optionality)  mostly correct and corresponding at a substantial degree to the logic of the scenario.  Most PKs and FKs  indicated. | Even more important entities present. Even more sensible and adequate attributes shown. Even more correct relationships shown and corresponding even more to the logic of the scenario. Even more correct PKs and FKs.  Possibly, some  minor discrepancies  between keys and  relationships. | All entities and relationships shown  correctly and  supported by all correct PKs and FKs. All annotations present in relationships. All the aspects and logic of the scenario presented in the ER diagram. | A ‘perfect’ ERD  with exactly the correct attributes;  primary and foreign keys will be indicated in an unambiguous,  easily read way;  relationships (Cardinality  and Optionality) correct. Perfect depiction of all the aspects and logic of the scenario.  Thorough and clear annotations in every relationship. | All the requirements set in  the range  (80-89) satisfied plus provision of alternative solutions with appropriate explanation for the provision of these solutions. This range of grades shows that the student examined the task in a more-in-depth manner and provided more work than what the assignment was asking for. |

**TASK 4 Marking**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **0-19%** | **20-39%** | **40-49%** | **50-59%** | **60-69%** | **70-79%** | **80-89%** | **90-100%** |
| **Task 4**  **(15% of the Assignment Grade)**  **Identify features from your developed ER Model that are very important for the efficiency of your database.** | Missing or demonstrates little or no understanding | Some attempt, but badly flawed | A basic identification of features demonstrating understanding, or a more comprehensive solution which may be notionally or semantically flawed. | Demonstrates a clear understanding. May be some errors. | A set of features demonstrating very clear understanding. May be few errors. | A correct solution which closely models the problem domain. | A 'perfect' solution with all the necessary features.. | All the requirements set in the range (80-89) satisfied plus provision of alternative solutions with appropriate explanation for the provision of these solutions. This range of grades shows that the student examined the task in a more-in-depth manner and provided more work than what the assignment was asking for. |

**TASK 5 Marking**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Task 5**  **(25% of the Assignment Grade)**  **Distribution of Grades between Sub-Tasks:**  **Task 5A (8%)**  **Task 5B (9%)**  **Task 5C (8%)**  **[*The comments exactly on the right of this box correspond to each sub-task of Task 3*]** | Very little or no  understanding at all. | A very basic SQL Script with many errors in the syntax of its statements. | A basic SQL Script in which the syntax is semantically flawed. | A more comprehensive SQL Script which may be semantically flawed. | Demonstrates clear understanding. May be some errors in the syntax. | A comprehensive solution, which closely models the problem domain. | A complete solution which models the problem domain. | A complete solution which models exactly the problem domain plus alternative solutions. |

**INSTRUCTIONS**

**For marks equal or greater to 90% on each task, you will need to provide a perfect solution for the task plus any other alternative solution for it.**

For the realisation of Task 3, you can use any ER Drawing software program. I personally use the Gliffy editor (<https://www.gliffy.com/>) which offers a free trial period during which you can complete the assignment. There is also the Flowchart Maker in this address: <https://www.draw.io/>. You are free of course to use any software you would like to. You can even draw the ERD on paper and scan it (as the assignment requires an electronic submission). In this case though, you need to make sure that your diagram is really clear.