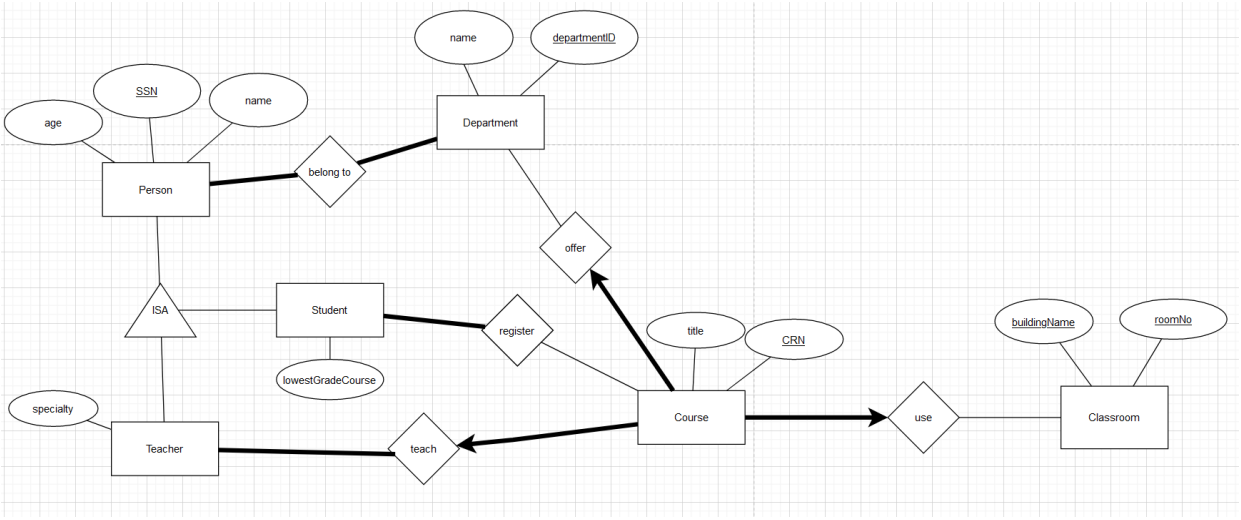
HW2A

Note:
(1)開頭大寫英文名詞是指 entity（ISA、CRN、SSN 除外，ISA 是 relationship，CRN 和 SSN 是 attribute），開頭小寫英文動詞是指 relationship，開頭小寫名詞是 attribute
(2) 我的所有 ER diagram 有給 高達烈（學號： 409410073 ） 同學參考，也已和教授說明此情況

Part 1(15%)：ER-Diagram 1張。



設計邏輯說明:
Teacher 我有設置額外 attribute: specialty, Student 我有設置額外 attribute: lowestGradeCourse 因為把 Person 抽象了出來。

```
A person has age, a name, and a unique SSN
Students are people too
```

根據以上說明，Person 可以泛指學生和老師，所以可以看到 Person 、Teacher 和 Student 有一個 ISA。既然有 ISA，那麼 Teacher 和 Student 的共同屬性可以放到 Person，例如 age、SSN、name。

```
A course should have a title and a unique CRN.
A course is offered by at most one department.
A department can offer many courses.
A teacher can also teach many courses.
Each student can register for multiple courses.
Each classroom can be uniquely identified by the combination of its building name
and its room number
A classroom can be used for more than one course.
A course uses at most one classroom.
```

根據以上說明，Course 要有 title 和 CRN。Course 和 Teacher 有 many-to-one teach relationship，Course 和 Teacher 都是 total participation 因為課必須有人教課，而 Teacher 也必須教課才能成為教師。Course 和 department 有 many-to-one offer relationship，Course 是 total participation 因為課必定由某些 Department 開班，而 Department 不一定 offer 所有的 Course。Course 和 Classroom 有 many-to-

one use relationship，Course 是 total participation 因為一定能夠要有 Classroom 才能夠上課，而 Classroom 是 partial participation 因為有些課室不一定會用到。

```
A department has a name and a unique department ID
Each person can belong to multiple departments.
Every department also has many people associated with it.
```

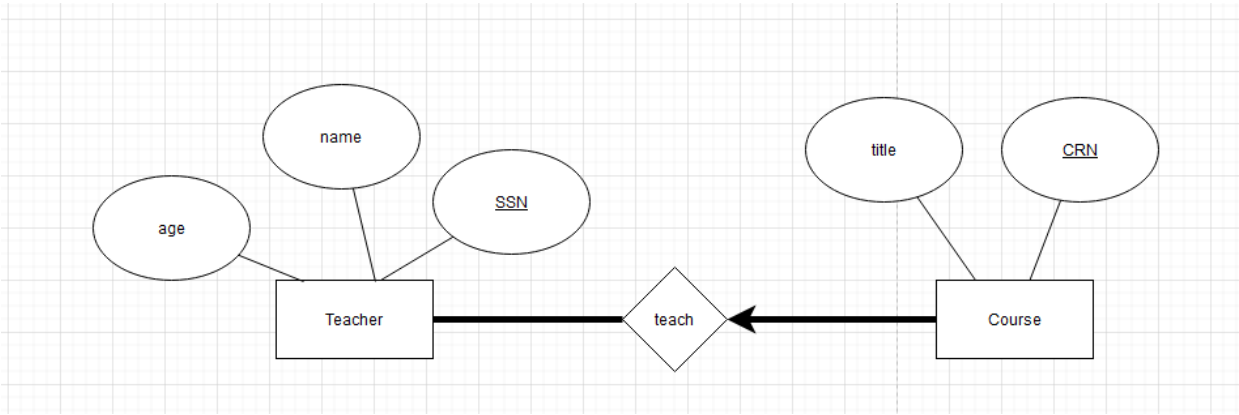
根據以上說明，Department 要有 name 和 department ID。Person 和 Department 是 many-to-many belong to relationship，Person 和 Department 都是 total participation 因為在校內 Person 必定屬於某個 Department，Department 也必定有人。

```
A course has many students registered for it.
```

我這邊假設多一句: "A student can register many courses"。Student 和 Course 就會是 many-to-many register relationship，Student 是 total participation 因為 Student 需要 register 基本數量的 Course，而 Course 是 partial participation 因為有些課可能沒 Student register。

Part 2(21%，每小題各7%)：ER-Diagram 3張(A、B、C小題)。

A.

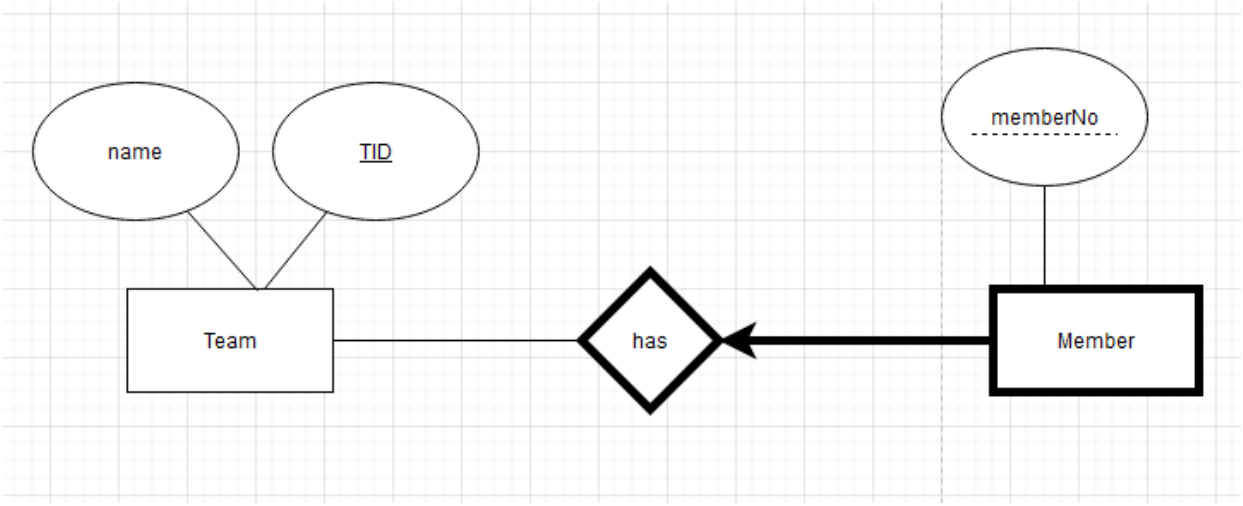


設計邏輯說明:
假設:

- Teacher 有 age、name 以及 SSN
- Course 有 title、CRN
- 老師能教多門課且必須教課

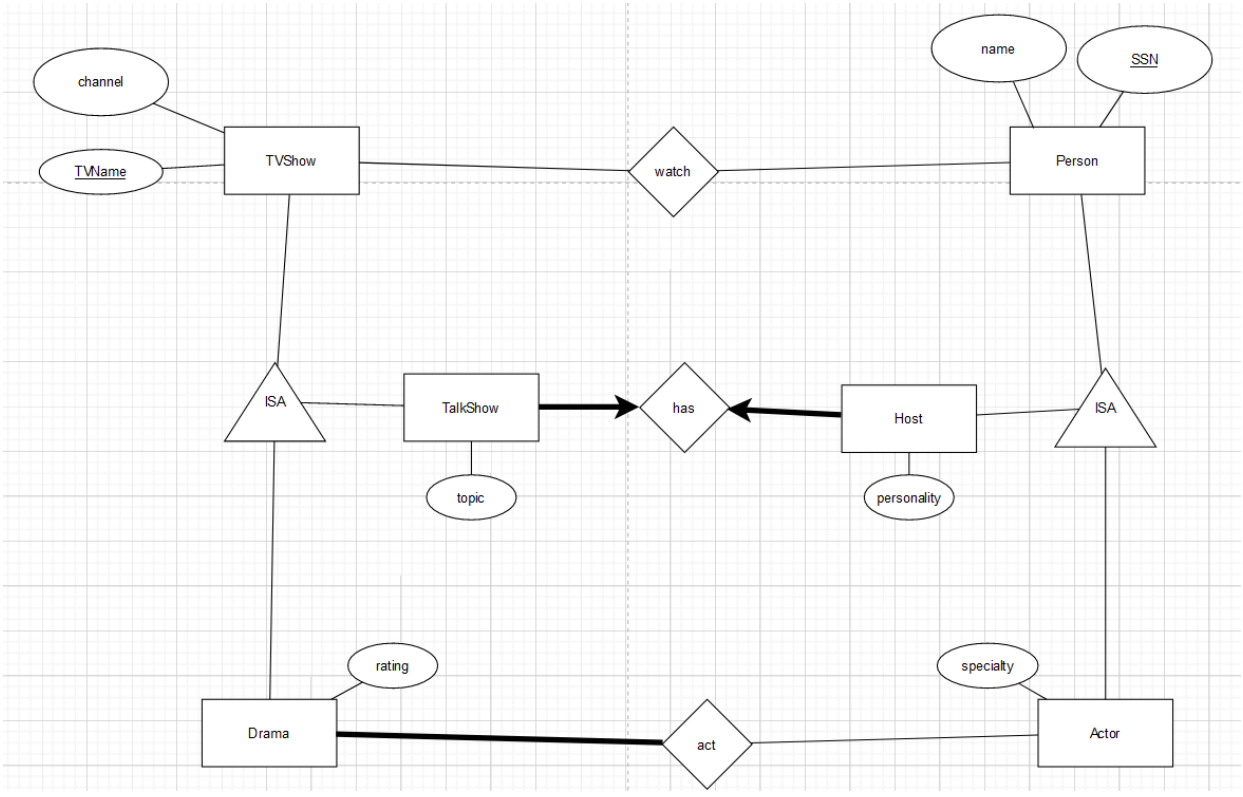
Teacher 和 Course 會是 one-to-one teach relationship, Teacher 和 Course 都是 total participation 因為沒有一門課沒有老師且老師必須教課。

B.



設計邏輯說明:
球隊背號是允許重複的，因此球隊間背號重複非常常見。在以上例子，如果我們要從 Member 背號找到一名球員所屬球隊是不可能的，所以 Member 對於球隊來說是 weak entity，需要搭配 owner Team 才行。Member 在 has relationship 裡是 total participation 因為任何球員都必須有球隊，這樣才有意義。Team 在 has relationship 裡則是 partial participation 因為球隊可能沒有球員。

C.



設計邏輯說明:
假設:

- Actor 能演出多個 Drama
- Host 必須且只能是唯一一個 TalkShow 的 host
- TVShow 和 Person 有 many-to-many watch relationship，TVShow 和 Person 都是 partial participation 因為 TVShow 可能沒人看，Person 也不定看 TVShow.
- TalkShow 有 topic

- Drama 有 rating
- Actor 有 specialty
- Host 有 personality

```
A TV Show has its channel and a unique name.
A person has a name and a unique SSN.
```

根據以上，TV show 有 channel 和 TVName。Person 有 name 和 SSN。

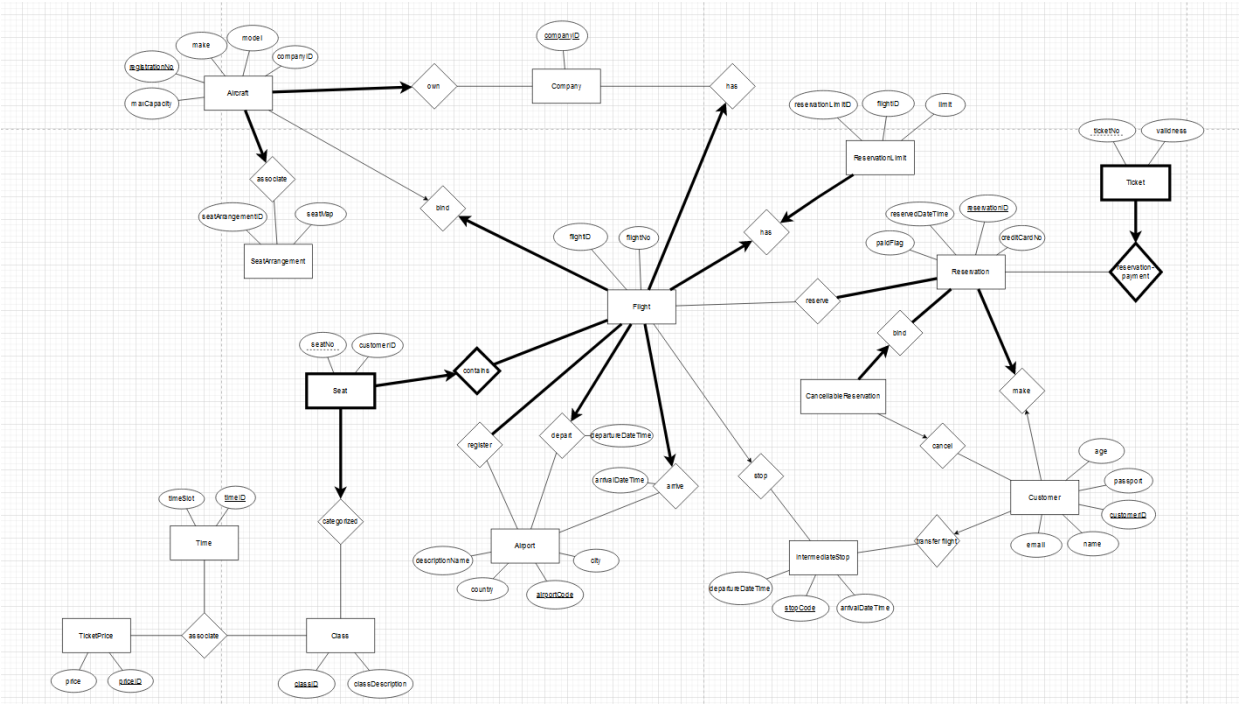
```
A Talk Show is a TV Show
A Drama is also a TV Show
A host is a person
Drama has many actors, which are all people
```

根據以上，Host 和 Actor 是 Person，Drama 和 TalkShow 是 TVShow，因此他們之間有 ISA 的繼承 relationship。

```
Every Talk Show has at most one host.
Drama has many actors.
```

TalkShow 和 Host 是 one-to-one has relationship，既然是 one-to-one 那麼他們皆是 total participation。
Actor 和 Drama 的 act relationship 是 many-to-many，Drama 是 total participation 因為 Drama 必須有 Actor 演，Actor 則是 partial participation 因為 Actor 可能沒有 Drama 可以演。

Part 5A(15%)：ER-Diagram 1張。



設計邏輯說明:

```
Each company has an ID and owns many
aircrafts. Each aircraft has a registration number,
make, model, and the maximum capacity of
passengers.
```

根據以上，Company 有 ID，跟 Aircraft 有一個 one-to-many has relationship, Company 是 partial participation 因為公司可能一架 Aircraft 都沒有，而 Aircraft 是 total participation 因為 Aircraft 一定屬於某家公司，這邊排除私人 Aircraft。Aircraft 有 registrationNo, make, model, maxCapacity。

```
Each company has many flights. Flight has a
flight number that can be classified into domestic
or international routes. Each flight departs from
and arrives at registered airports.
```

根據以上，Flight 和 Company 有一個 many-to-one has relationship，Flight 是 total participation 因為航班應該都要屬於某家公司，Company 是 partial participation 因為公司可能基於某些原因沒有任何航班。Flight 有 flightNo，敘述只說明 flightNo 可以用來分辨國內或國外航班，所以這邊增加了一個 flightID 用來當作 flight 的 primary key。Flight 和 Airport 有一個 many-to-one depart、many-to-one arrive、many-to-many register relationship。在 depart relationship 中，Flight 是 total participation 因為 Flight 一定要在某個 airport 起飛，Airport 則是 partial participation 因為 Airport 可能一架飛機都沒有。在 arrive relationship 中，Flight 是 total participation 因為 Flight 最終一定要在某個 airport 降落，Airport 則是 partial participation 因為 Airport 可能不接受航班降落。在 register relationship 中，Flight 是 total participation 因為 Flight 一定要和某些 Airport 註冊後才能起飛或降落，Airport 則是 partial participation 因為 Airport 可能沒有一家航班註冊。

```
An airport also has an airport code, description
name, city and country information. Flight may
stop at some intermediate stops. Customers
could take a transfer flight from intermediate
stops
```

根據以上，Airport 有 airportCode，descriptionName, city, country。Flight 和 intermediateStop 有一個 many-to-one stop relationship，Flight 和 intermediateStop 都是 partial participation 因為 Flight 可能是直飛航班，intermediaStop 不一定需要有任何航班使用。Customer 和 intermediateStop 有一個 many-to-one transfer flight relationship，Customer 和 intermediateStop 都是 partial participation 因為 Customer 可能預訂的航班是直飛航班，intermediateStop 不一定支援所有轉機航班。

```
Each flight has three seat classes: First Class,
Business Class, and Economy class.
For each flight, the system should store a list of
available seats. The seat arrangements are
associated with aircrafts. Each seat can only be
reserved to one customer. Ticket prices are
associated with classes and time.
```

根據以上，我把 Seat 當作是 Flight 的 weak entity 因為 Seat 在多個航班看來是重複的東西比如座位1號、2號、3號等等。Flight 和 Seat 有一個 one-to-many contains relationship，Flight 和 Seat 都是 total participation 因為 Flight 一定要有座位給乘客搭乘且這是 weak entity 的特性，Seat 一定屬於某些航班。此外，Seat 和 Class 有一個 many-to-one categorized relationship 因為 Seat 分為了三種等級，分別是 First Class, Business Class 和 Economy Class，Seat 是 total participation 因為 Seat 一定被分類到其中一個等級，Class 則是 partial participation 因為有些航班只有三種等級中的兩種比如經濟艙。再來，Class 的價位會隨著時間不同而有所不同，所以 Class、Time、TicketPrice 有一個 many-to-many associate relationship，Class、Time、TicketPrice 都是 partial participation 因為某些 Class 可能沒有提供預訂，Time 可能不涵蓋24小時，TicketPrice 有些價位可能沒有用到。Aircraft 和 SeatArrangement 有 many-to-one associate relationship，Aircraft 是 total participation 因為 Aircraft 一定有對應的座位分佈圖，而 SeatArrangement 是 partial participation 因為不是所有座位分佈圖都會被使用。這邊我有幫 SeatArrangement 設置兩個屬性，分別是 seatArrangementID 和 seatMap，seatMap 就是分佈圖。

```
Customer can make reservation without
reserving seats.
```

根據以上，我幫 Seat 新增一個 customerID attribute，這個 attribute 可為 null，null 表示乘客在預訂航班的時候沒有選擇座位，非 null 則有選擇座位。

```
Each flight allows 20% overbooking.
```

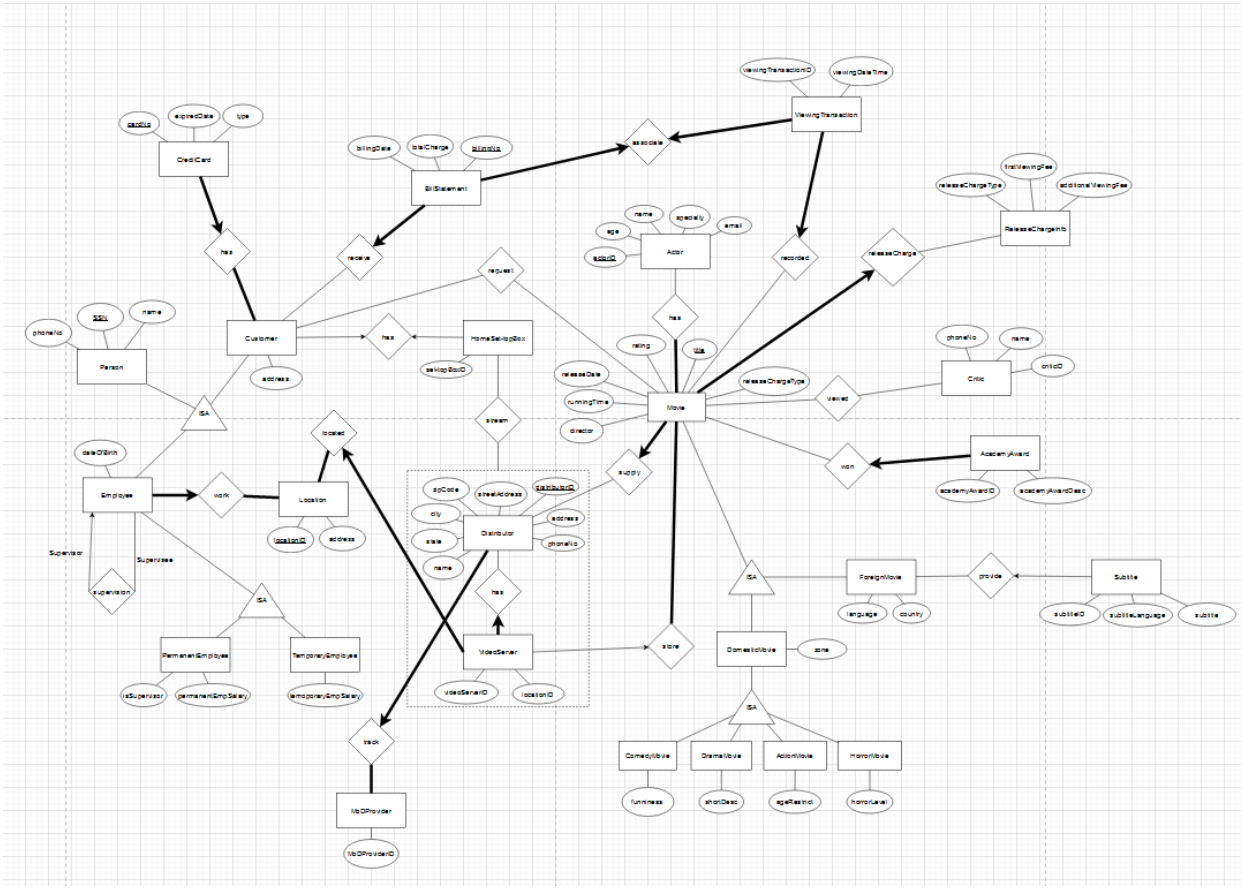
根據以上，Flight 和 ReservationLimit 有一個 one-to-one has relationship，Flight 和 ReservationLimit 都是 total participation 因為每一個 Flight 都應該支援超過 20% 的預訂。

```
The reservation system should keep the
following information: 1) a unique identifier for
each customer. This identifier is assigned
automatically once customers make a new
reservation in the system; 2) customer
information; 3) flight information; 4) the time that
reservation was made; 5) a credit-card number
associated with the reservation;6) A flag which indicates whether this particular
reservation is paid or not. When a reservation is
paid it is transformed automatically to a ticket.
The reservation can be cancelled before flight
departure, however, the ticket is still valid (to
exchange some products).
Each reservation might be associated with many
flights.
```

根據以上，Reservation 有 reservationID(unique identifier)，reservedDateTime, creditCardNo. Reservation 和 Flight 有 many-to-many reserve relationship，Reservation 是 total participation 因為 Reservation 一定和某些航班綁定在一起，而 Flight 是 partial participation 因為不是所有航班都會被 reserve。Reservation 和 Customer 有 one-to-one make relationship，Reservation 是 total participation 因為 Reservation 一定是由一些 Customer 所完成，而 Customer 是 partial participation 因為 Customer 註冊航班預訂系統後可能沒有完成任何 Reservation，但 Customer 記錄還是需要被記錄。Reservation 和 CancellableReservation 有一個 one-to-many bind relationship，Reservation 和 CancallableReservation 都是 total participation 因為 Reservation 一定和某些 CancellableReservation 綁

定。 CancellableReservation 和 Customer 有 many-to-one cancel relationship，CancellableReservation 和 Customer 都是 partial participation 因為預訂的航班可能已經起飛了所以不能取消預訂，Customer 不一定會取消預訂。我把 Ticket 當作是 Reservation 的 weak entity 因為 ticketNo 是重複的，所以需要搭配 owner Reservation 才能分辨 Ticket。Reservation 和 Ticket 有 one-to-many reservation-payment relationship，Reservation 是 partial participation 因為有些 Reservation 並未付款所以沒有對應的 Ticket，而 Ticket 是 total participation 因為 ticket 一定由某個 Reservation 付款得到且這是 weak entity 的特性。我有幫 Ticket 設置一個 validness 用來判斷 Ticket 是否有效。

Part 6A(20%)：ER-Diagram 1張。



設計邏輯說明:

```
Video movie information: A movie has a title,
release date, rating, running time, director, and
one or more actors.
Movies are split between domestic and foreign
movies.
Domestic movies are further categorized into
comedy, drama, action, and horror movies.
A comedy movie has the degree of “funniness”
which ranges between 1 and 5. A drama movie
has a short description such as “love story”,
“documentary”紀錄片, “humanity”人性, etc.
```

根據以上，Movie 有 title，releaseDate, rating, runningTime, director. Movie 和 Actor 有 many-to-many has relationship, Movie 是 total participation 因為 Movie 至少有一個 Actor 來演，Actor 是 partial participation 因為有些演員沒有一部戲可以演。Movie 還被分為 DometicMovie 和 ForeignMovie，這邊是用一個 ISA relationship 連接他們。既然用了 ISA relationship，那麼 ForeignMovie 需要一些 DomesticMovie 沒有的 attribute，在這裡我設置了 language 和 country，同樣的，DomesticMovie 也需要一些獨有的 attribute，這邊我設置了 zone。DomesticMovie 再往下分裂為4種類別，分別是 Comedy, Drama, Action, Horror，這邊一樣可以用 ISA relationship 來連接他們。題目只說明了 Comedy 有 funniness 以及 Drama 有 shortDescription，因此我幫 Action 新增了 ageRestrict，Horror 新增了 horrorLevel。有了不同的 attribute 才適合使用 ISA relationship。

```
A foreign movie uses a language other than
English and may provide English subtitle.
```

根據以上，ForeignMovie 和 Subtitle 有一個 one-to-many provide relationship，ForeignMovie 和 Subtitle 都是 partial participation 因為以英語為主的 ForeignMovie 就不會提供 Subtitle，Subtitle 則未必需要提供除了英語其他的 Subtitle。

```
Each movie could be viewed by one or more
critics, each of whom evaluates it as between
zero and five stars.
A critic has a name and a phone number. He or
she might review one or more movies.
```

根據以上，Movie 和 Critic 有一個 many-to-many viewed relationship，Movie 和 Critic 都是 partial participation 因為 Movie 可能沒有 Critic，而 Critic 可能沒有對任何 Movie 做影評。 Critic 有 name，phoneNo。

```
A movie may have won one or more academy
awards (i.e., “Oscars”). If that is the case, then
the movie has a list of all the categories in which
it won, e.g., “best picture”, “best actor”, “best
actress”, etc.
```

根據以上，Movie 和 AcademyAward 有一個 one-to-many won relationship，Movie 是 partial participation 因為 Movie 可能沒有得過獎，而 AcademyAward 是 total participation 因為 AcademyAward 一定會有獲獎電影。AcademyAward 有 academyAwardDesc 用來描述獎項為何，例如 best picture。

```
Each movie is stored on a number of different
video servers. Each video server has a unique
ID and an address (location).
```

根據以上，Movie 和 videoServer 有一個 one-to-many store relationship，Movie 是 total participation 因為 Movie 一定上映，排除被下架的可能性，而 VideoServer 是 partial participation 因為 VideoServer 不需要 store 所有 Movie。

```
If a customer requests a movie then that movie
is delivered (streamed) from one of the video
servers to the customer's home.
Each movie can be supplied by only one
distributor.
One distributor might provide several movies.
For each distributor, the MoD provider keeps
track of information about its name, address,
and phone number.
A distributor's address can be accessed as
street address, city, state, and zip code
individually. However, the entire address of a
distributor can also be retrieved as a unit.
```

根據以上，Customer 和 HomeSet-topBox 有一個 one-to-one has relationship，Customer 和 HomeSet-topBox 都是 partial participation 因為 Customer 不一定有 HomeSet-topBox，HomeSet-topBox 不一定都會被擁有。Customer 和 Movie 有一個 many-to-many request relationship，Customer 和 Movie 都是 partial participation 因為 Customer 可能沒有 request 任何 Movie，而 Movie 則不一定需要被 request。Movie 和 Distributor 有一個 many-to-one supply relationship，Movie 是 total participation 因為之前有假設 Movie 一定上映，那麼必然要有 Distributor，而 Distributor 是 partial participation 因為 Distributor 可能沒有 supply 任何 Movie。這邊有把 Distributor 和 VideoServer 看成是一體的（aggregation）因為之前有提到 Movie 由 Distributor supply 又 Movie 儲存在 VideoServer，所以看起來是 Distributor 和 VideoServer 有一個 one-to-many has relationship，Distributor 是 partial participation 因為不是所有 VideoServer 都屬於同一個 Distributor，VideoServer 是 total participation 因為 VideoServer 一定屬於某一個 Distributor。因此該 aggregation 和 HomeSet-topBox 有一個 many-to-many stream relationship，aggregation 和 HomeSet-topBox 都是 partial participation 因為不是所有 aggregation 都會參與 stream，而 HomeSet-topBox stream。Distributor 有 streetAddress, city, state, zipCode，phoneNo 以及 （streetAddress, city, state, zipCode） 為一體的 address。VideoServer 和 Location 有一個 many-to-one located relationship，VideoServer 和 Location 都是 total participation 因為 VideoServer 必然存放在某個 Location， Location 必然存在。VideoServer 不是用 location 而是用 locationID 因為 Employee 的工作地點和一些 VideoServer 一樣，所以我為了 Employee 和 VideoServer table 的 data integrity 因此只要更換 Location table 匹配 locationID 的 address 即可改變 Employee 和 VideoServer 的 location。Distributor 和 MoDProvider 有一個 many-to-one track relationship，Distributor 和 MoDProvider 都是 total participation 因為 MoDProvider 需要知道 Distributor 的 name、address、phoneNo，Distributor 也需要被 track 因為這樣才能透過 MoDProvider 來 supply Movie。

```
Employee information: An employee has a name,
a social security number, date of birth, salary,
and a phone number.
He or she may have a supervisor.
Employees are either permanent or temporary,
but not both.
A supervisors are permanent employees.
An employee works at the location of one of the
video server.
Customer information: A customer has a social
security number, a name, a phone number, and
an address.
Each customer must have one or more credit
```

```
cards. Each credit card includes a type of credit
card (Visa / MasterCard /...), a card number,
and an expiration date.
```

根據以上，Employee 和 Customer 有共同的 attribute: name, SSN, phoneNo，因此我把 Employee 和 Customer 抽像出了 Person，Person 有 name, SSN, phoneNo。Employee 獨有的 attribute 是 dateOfBirth，Customer 獨有的 attribute 是 address。Employee 還可再分成 PermanentEmployee 和 TemporaryEmployee，因此我用了 ISA 連接了 Employee，PermanentEmployee 和 TemporaryEmployee。PermanentEmployee 獨有的 attribute 有 permanentEmpSalary，isSupervisor，isSupervisor 是為了分辨 permanentEmployee 是不是 supervisor。TemporaryEmployee 獨有的 attribute 有 temporaryEmpSalary。Employee 可能會有 Supervisor 所以 Employee 有 one-to-many recursive supervision relationsip。在該 recursive supervision relationship 中，Supervisor 和 Supervisee 是 partial participation，因為如果一人是 Supervisor 那麼他就不是 Supervisee，如果一人是 Supervisee 那麼他就不是 Supervisor。Employee 和 Location 有一個 many-to-one work relationship，Employee 和 Location 都是 total participation 因為身為 Employee 需要在其中一台 VideoServer 的所在地工作，而 Location 也必須能夠 work 因為那邊存放了 VideoServer。 Customer 和 CreditCard 有一個 one-to-many has relationship，Customer 和 CreditCard 都是 total participation 因為題目提到 Customer 必須有一張或多張 CreditCard，而 CreditCard 必須有持卡者。CreditCard 有 cardNo, type, expiredDate。

```
Viewing transaction information: Each customer
can view movies from a video server. For each
viewing transaction, the viewing date and time is
recorded.
Billing statement information: Each customer
receives one bill statement after each viewing
transaction. Each statement has a billing date, a
billing number, one or more movie titles, and a
total charge.
A billing number is unique for a particular
customer. It is not unique across different
customers.
```

根據以上，ViewingTransaction 有 viewingDate 和 viewingTime 但我把這兩個 attributes 合併了變成 viewingDateTime。ViewingTransaction 和 Movie 有一個 many-to-one recorded relationship，ViewingTransaction 是 total participation 因為 ViewingTransaction 必然由一些 Movie 產生，而 Movie 則是 partial participation 因為不是所有 Movie 都會被 request。ViewingTransaction 和 BillStatement 有一個 one-to-one associate relationship，ViewingTransaction 和 BillStatement 都是 total participation 因為一個 ViewingTransaction 會產生一個 Billstatement。BillStatement 有 billingDate, totalCharge, billingNo。Customer 和 Billstatement 有一個 one-to-many receive relationship，Customer 是 partial participation 因為不是每個 Customer 都有 request Movie，而 BillStatement 是 total participation 因為若有 BillStatement 的話必然屬於某個 Customer。billingNo 根據題意應該是 BillStatement 的 primary key。

```
Release charge information: For each movie, a
release charge type is defined. Arbitrarily recent
movies are marked as “new release”, whereas
others are marked as “ordinary release”.
```

```
The store keeps track of different charge
information for different release types.

For newly released movies, the fee is $100 for
the first viewing and $30 for each additional
viewing.

For the other ones, the fee is $50 for the first
viewing and $15 for each additional viewing.
```

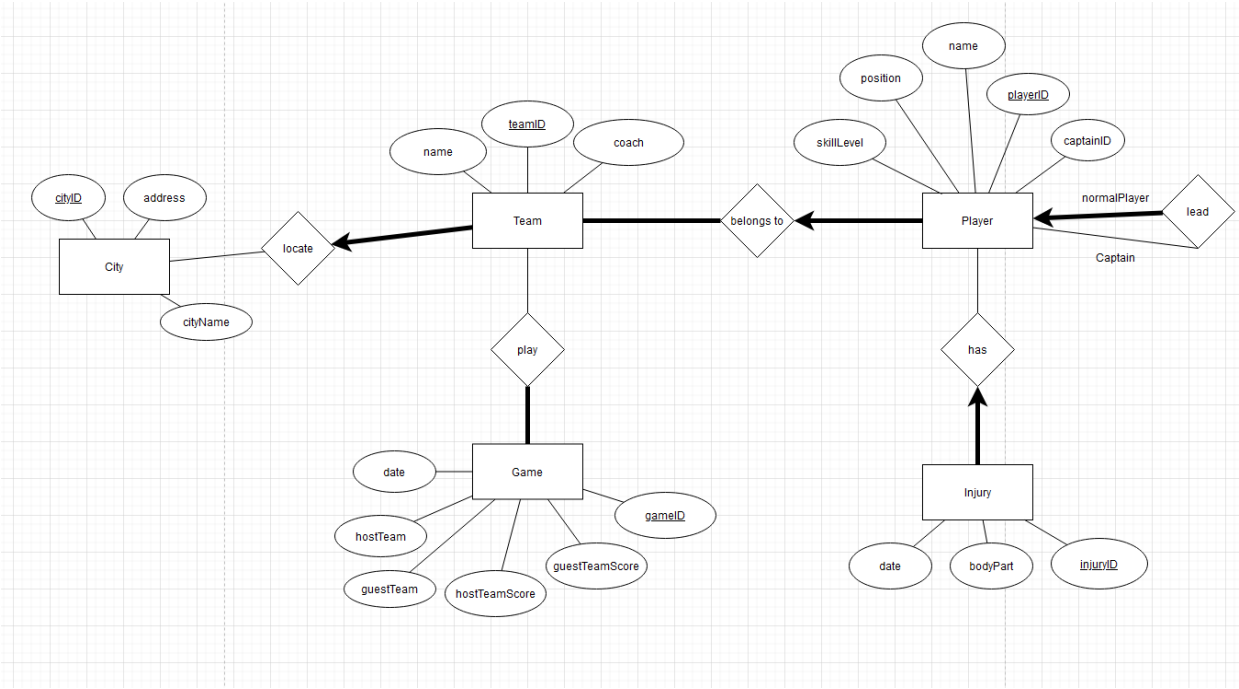
根據以上，Movie 應該新增一個 attribute: releaseChargeType，這個 attribute 的值可能是 "new release" 或 "ordinary release"。那可能日後會有更多的 releaseChargeType 出現，所以應該要新增一個 table，我這把叫作 ReleaseChargeInfo。ReleaseChargeInfo 有 releaseChargeType， firstViewingFee, additionalViewingFee。Movie 和 ReleaseChargeInfo 有一個 many-to-one releaseCharge relationship，Movie 是 total participation 因為 request Movie 一定需要有一個價位才能產生繳費單給 Customer，而 ReleaseChargeInfo 則是 partial participation 因為不是所有的 ReleaseChargeInfo 都會被 Movie 所使用到。

Part 7(4%，每小題各2%)

(a) No

(b) Yes

Part 8(10%)：ER-Diagram 1張。



設計邏輯說明:
假設:

- 一個 City 有多個 Team
- City 有 cityID、address、cityName
- Injury 有 injuryID、date、bodyPart

```
each team has a name, a city, a coach, a captain, and a set of players

each player has a name, a position (such as left wing or goalie守門員),
a skill level, and a set of injury records

a team captain is also a player

a game is played between two teams
(referredto as host_team and guest_team) and
has a date (such as May 11th, 1999) and a score(such as 4 to 2).
```

根據以上，Team 有 city、coach、name、teamID。
Player 有 playerID、captainID、name、position、skillLevel。captainID 是為了在 lead relationship 中分辨誰是 captain。
Game 有 hostTeam、guestTeam、hostTeamScore、guestTeamScore、date、gameID。
我把題目說 Team 要有的 city 換成了 cityID 否則可能會有多個 City 重複在 table。
Team 和 City 的 many-to-one locate relationship，Team 必須坐落於某一個 City 所以是 total participation，City 可能沒有 Team 所以是 partial participation。

```
each player belongs to only one team
```

根據以上， Player 和 Team 有 many-to-one belongs to relationship ， Player 必須屬於 Team 所以是 total participation，Team 必須有 Player 所以也是 total participation。

```
a game is played between two teams (referred
to as host_team and guest_team) and has a
date (such as May 11th, 1999) and a score
(such as 4 to 2).
```

Team 和 Game 有 many-to-many play relationship，Team 不一定要參賽所以是 partial participation，Game 必須由兩隻 Team 參賽才能進行比賽所以是 total participation。

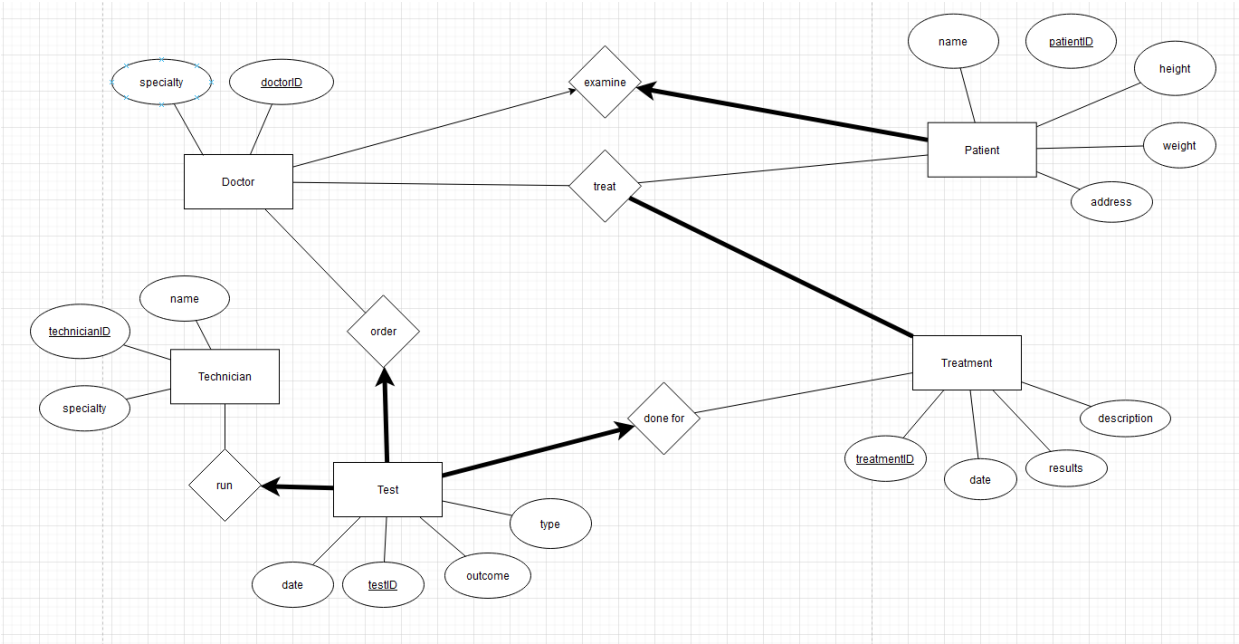
```
each player has  a set of injury records,
```

Injury 和 Player 有 many-to-one has relationship，Player 不一定會受傷所以是 partial participation，Injury 一定屬於某位 Player 所以是 total participation。

```
a team captain is also a player
```

根據以上，Player 可以是 normalPlayer 或者是 Captain，所以 Player 有一個 many-to-one recursive lead relationship，Captain 是 partial participation 因為 Captain 自己已經是 Captain(上面沒有 Captain 了)，normalPlayer 是 total participation 因為所有 normalPlayer 都有一位 Captain。

Part 9(15%)：ER-Diagram 1張。



設計邏輯說明:
假設:

- 有很多 Technician 且 Technician 有 specialty 和 name 需要被記錄，因為發現題目沒特別提到 Technician 的 attribute
- Patient 有 name、 height、weight、address 需要被記錄（看到題目提到 "some personal information needs to be stored on each patient."）

```
For each doctor we store his/her id and specialty

Each treatment is stored with date, description, and results.

For each test we need to store an identification of the test,
type of test (blood test, urine尿液 test, x-ray, etc.), date,
test technician and its outcome

In addition some personal information needs to be stored on each patient
```

根據以上，Doctor 有 doctorID 和 specialty。
Patient 有 patientID、name、doctorID、height、weight、address。
Treatment 有 treatmentID、date、results、description。
Test 有 testID、date、outcome、type。
Technician 有 technicianID、name、specialty。

```
At arrival the patients are examined by a particular doctor.
```

Doctor 和 Patient 有 one-to-one examine relationship ， 每一位 Patient 送進醫院的時候務必有一名特定 Doctor 進行檢查，所以 Patient 是 total participation，Doctor 不一定會遇到要進行檢查的 Patient，所以 Doctor 是 partial participation。

```
each patient is treated by one or more doctors
Each treatment is stored with date, description,
and results.
```

Doctor 、 Patient 和 Treatment 的 treat relationship 是 many-to-many 的三方relationship。有些 Doctor 不會幫 Patient 治療所以是 partial participation，Patient 可能只是初步檢查並不一定需要治療所以也是 parital participation，所有 Treatment 必定由 Doctor 對於 Patient 進行所以是 total participation。

```
As part of a particular treatment a doctor can order tests
done on the patient.
```

根據以上，Doctor 和 Test 有 many-to-many order relationship。Doctor 不一定需要 order Test 所以是 partial participation，Test 一定是由 Doctor order 的所以是 total participation。Test 和 Treatment 有 many-to-one done for relationship。Treatment 不一定有 Test 所以是 partial participation。Test 一定為了某些 Treatment 而做所以是 total participation。

```
For each test we need to store an identification of the test, type of
test (blood test, urine尿液 test, x-ray, etc.), date,
test technician and its outcome.
```

根據以上，既然提到要記錄 test technician，所以我就假設會有多位 test technician 且有一些 attribute 需要記錄，因此 test technician 應該當成一個 entity 而不是 attribute。 Test 和 Technician 有 many-to-one run relationship。Test 一定由一些 Technician 來 run 所以是 total participation。Technician 不一定有 Test 需要 run 所以是 partial participation。