

## CSCI-4380 Database Systems

### Homework 1

#### Relational Model

This homework will focus on the concepts of the relational model, as well as the use of relational algebra to query a relational schema.

1. You're developing a database to keep track of your video game collection. You want to store information about the gaming systems you own, including the manufacturer, the name of the system, whether it connects to the internet, and how many controllers you have for it. You want to store information about the games you own, including the name of the game, the year it was released, the publisher, which system it's for, and how much you paid for it. And you want to store information about the genres of each game, keeping in mind that some games might fall into multiple genres (for example, "Battlefield: 1942" might be in both the "historical" genre, and the "first-person shooter" genre), up to a potentially unlimited number of genres for any given game.

- (a) (6 points) Define three relations to store data about the gaming systems you own (*System*), the games you own (*Game*), and which games are which genres (*Genre*). Make sure to define keys for each relation (if appropriate).

Using Foreign Keys

System(sysID, manufacturer, name, internetConnectivity, numControllers)

Game(gameID, name, yearReleased, publisher, sysID, price)

Genre(gameID, genreType)

Using Primary Keys

System(manufacturer, name, internetConnectivity, numControllers)

Game(name, yearReleased, publisher, systemName, price)

Genre(gameName, genreType)

- (b) (2 points) Give two example tuples for the *System* relation

Using Foreign Key

(1, "Nintendo", "Switch", true, 8)

(2, "Microsoft", "XboxOne", true, 2)

Using Primary Keys

("Nintendo", "Switch", true, 8)

("Microsoft", "XboxOne", true, 2)

- (c) (3 points) Give three example tuples for the *Game* relation

Using Foreign Key (Nintendo is also a publisher)

(1, "BOTW", 2014, "Nintendo", 1, 50)

(2, "DOOM", 2014, "Ubisoft", 1, 50)

(3, "Watch Dogs", 2014, "Ubisoft", 2, 50)

Using Primary Key (Nintendo is also a publisher)

("Watch Dogs", 2014, "Ubisoft", "XboxOne", 50)

("DOOM", 2017, "Bethesda Softworks", "Switch", 50)

("BOTW", 2014, "Nintendo", "Switch", 50)

- (d) (2 points) Give example tuples from the *Genre* relation for a game that is in both the "Fantasy" and the "Adventure" genres

Using Foreign Key

(1, "Fantasy")

(1, "Adventure")

Using Primary Key

("BOTW", "Fantasy")

("BOTW", "Adventure")

- (e) (15 points) For each of the tables you created in part (a) above, write a CREATE TABLE statement in SQL to create the table, including appropriate keys. (5 points each)

For Primary Keys

```
CREATE TABLE System(  
    manufacturer VARCHAR(127),  
    name VARCHAR(127),  
    internetConnectivity BOOLEAN,  
    numControllers INT,  
    PRIMARY KEY (manufacturer, name)  
);
```

```
CREATE TABLE Game(  
    name VARCHAR(127),  
    yearReleased INT,  
    publisher VARCHAR(127),  
    systemName VARCHAR(127),  
    price INT,  
    PRIMARY KEY (name, systemName)  
);
```

```
CREATE TABLE Genre(  
    gameName VARCHAR(127),  
    genreType VARCHAR(127),  
    PRIMARY KEY (gameName, genreType)  
);
```

2. Assume the existence of a database with the following relations:

Ingredient(name, calories, cost, containsNuts)

Recipe(name, ingredientName, amount)

Menu(recipeName, season)

which is used by a restaurant to manage its menu items. Assume that Recipe.ingredientName is a foreign key to Ingredient.name, and that Menu.recipeName is a foreign key to Recipe.name. Ingredient.containsNuts is a boolean, indicating whether the given ingredient contains nuts (e.g., Peanut Oil).

Assume all amounts are in the same unit (e.g., grams).

Write relational algebra expressions for the following:

(a) (3 points) List the names of all recipes on the menu for the Fall season

$$\pi_{\text{Recipe.name}} (\sigma_{\text{Menu.season} = \text{"Fall"}} (\text{Menu}))$$

(b) (3 points) List the names of all of the ingredients in Pizza

$$\pi_{\text{Ingredient.name}} (\sigma_{\text{name} = \text{"Pizza"}} (\text{Recipe}))$$

(c) (3 points) List all of the recipes that are nut-free

$$\text{nRecipes} = \pi_{\text{Recipe.name}} (\sigma_{\text{Ingredient.containsNuts} = \text{true}} (\text{Recipe} \bowtie_{\text{Recipe.ingredientName} = \text{Ingredient.name}} \text{Ingredient}))$$
$$\pi_{\text{Recipe.name}} (\text{Recipe}) - \text{nRecipes}$$

(d) (3 points) List all of the recipes on the Spring menu that contain nuts

$$\text{nRecipes} = (\sigma_{\text{Ingredient.containsNuts} = \text{true}} (\text{Ingredient})) \bowtie_{\text{Ingredient.name} = \text{Recipe.ingredientName}} \text{Recipe}$$
$$\pi_{\text{Recipe.name}} (\sigma_{\text{Menu.season} = \text{"Spring"}} (\text{nRecipes})) \bowtie_{\text{Menu.recipeName} = \text{Recipe.name}} \text{Menu}$$