Problem Set #1

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Question 1

Relational Databases are far more effective than spreadsheets when multiple tables that may have dependencies are required. For example, in an attempt to fix their parking woes, the University of Central Florida may wish to track which people are parking in which lots and for what amounts of time. To get at this data, they will record the identification numbers of the cars parked in various lots around campus. Three tables will be formed to store the information: Vehicles, Garages, and Students

The table titled Vehicles contains VehID which is the primary key for the table; CarType, the type of car parked, StudentID, the NID of the student who purchased the decal, a key for the students table; GarageID, the ID of the Garage where the vehicle was parked; and Date, the timestamp of when the vehicle was recorded parked.
The table titled Garages contains GarageID, the primary key; Location, describing where the garage is located; and MaxSize, the maximum number of parking spots in the garage.
The table titled Students contains studentID, the primary key for the student; Schedule, a simplified version of their schedule showing the class they were attending; Residency, denoting if they live on campus or off.

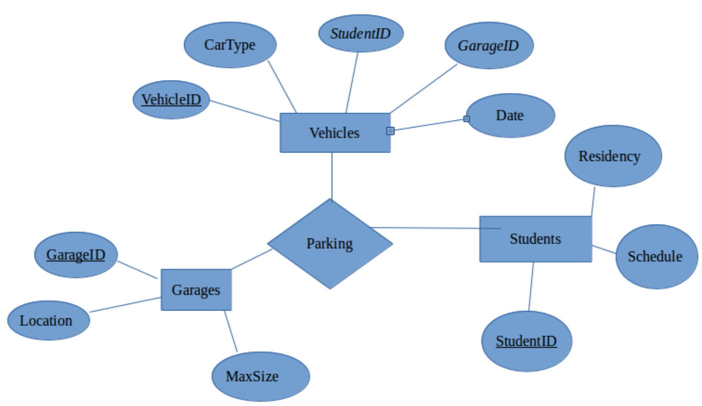

Fig. 1: ER Diagram

Dependencies are avoided by placing the data into three separate tables. If a student were to drive multiple cars to campus, all will only refer to one element in Students. Likewise, changes to the garages need only to be made in one place, and they will be altered in all parking records.

Code

```
CREATE TABLE Garages
(
GarageID            INTEGER ,
Location            TEXT NOT NULL ,
MaxSize             INTEGER NOT NULL ,
PRIMARY KEY (GarageID ) );

CREATE TABLE Students
(
StudentID                    INTEGER ,
Schedule                     TEXT NOT NULL,
Residency                    INTEGER NOT NULL,
StudentName                  TEXT NOT NULL,
PRIMARY KEY ( StudentID ) );

CREATE TABLE Vehicles
(
VehicleID                     INTEGER ,
CarType                      TEXT NOT NULL ,
StudentID                    INTEGER ,
GarageID                     INTEGER ,
DateRecorded        TEXT NOT NULL,
FOREIGN KEY ( StudentID ) REFERENCES Students (StudentID ) ,
FOREIGN KEY ( GarageID ) REFERENCES Garages ( GarageID ) ,
PRIMARY KEY ( VehicleID ) );


.separator ,
.import Students.csv Students
.import Garages.csv Garages
.import Vehicles.csv Vehicles

.mode column
.headers on
.output output.txt
```

```
SELECT * FROM Garages;
SELECT * FROM Students;
SELECt * FROM Vehicles;
```

This yeilds the following output:

GarageID	Location	MaxSize
1	North Gemini	1000
2	South Gemini	200
3	West Gemini	670

StudentID	Schedule	Residency	StudentName
346	Math Econ	0	Donald
769	Business A	0	Cody
3375	Microecono	0	Logan
3645	Math Econ	0	Timothy
45745	Business A	0	Chris
48678	Microecono	0	Joshua
56858	Accounting	1	Andrew
67987	Real Estat	1	Jorge
123457	Econometri	0	Harry
876967	Math Econ	0	Micheal

VehicleID	CarType	StudentID	GarageID	DateRecorded
1	Reliant Robin	123457	2	09/01/17
2	Porsche 911	876967	2	09/01/17
3	Ford Fusion	346	3	09/01/17
4	Hyandai Elant	48678	3	09/02/17
5	Ford Fiesta	56858	3	09/03/17
6	Ferrari LaFer	3645	1	09/04/17
7	Ford Crown Vi	3645	2	09/05/17
8	Tesla Model S	3375	1	09/06/17
9	Jaguar F Type	45745	2	09/07/17
10	Harley Iron H	67987	2	09/08/17
11	Toyota Prius	67987	1	09/09/17

Question 2

If we consider the set corresponding to TableOne as A, and the set for TableTwo to be B. The elements of both sets are tuples that areindexed by the natural numbers, such that if $a \in A$, then $a[1]$ would describe the t1_id field for the element a.

SELECT * FROM tableone JOIN tabletwo; is equivalent to A x B

SELECT * FROM tableone JOIN tabletwo WHERE tableone.t1_id = tabletwo.t2_id is equivalent to $\{(a, b)|a \in A, b \in B, a[1] = b[1]\}$

SELECT * FROM tableone JOIN tabletwo WHERE tableone.t1_subid = tabletwo.t2_subid is equivalent to $\{(a, b)|a \in A, b \in B, a[2] = b[2]\}$

SELECT * FROM tableone JOIN tabletwo WHERE tableone.t1_var1 = tabletwo.t2_var1 is equivalent to $\{(a, b)|a \in A, b \in B, a[3] = b[3]\}$

Question 3

a.

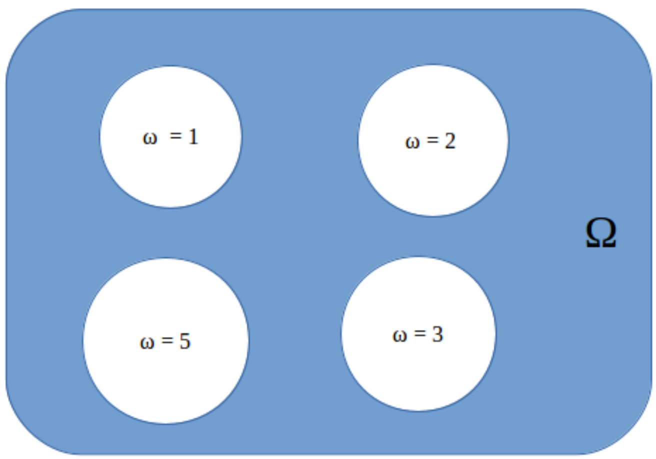

Fig. 2: Venn Diagram of Primary Events

Since there is only one dice toss in our universe, it only allows for four possible outcomes:

$$\Omega = \{1, 2, 3, 5\}$$

In this universe, the simple events are disjoint because the die can only land on one of the possible sides. Thus the probability of rolling an intersection between these simple events is zero. This implies that the probability of rolling a union between the events is just the sum of the probability of those events.

$$P(\omega = 1 \cup \omega = 3) = P(\omega = 1) + P(\omega = 3)$$

b.

$$X : \Omega \to \mathbb{R} = \begin{cases} 1 & \omega = 1 \\ 2 & \omega = 2 \\ 3 & \omega = 3 \\ 5 & \omega = 5 \end{cases}$$

c.

$$p_X(x) = \frac{1}{4} \text{ for x} = 1, 2, 3, 5; p_X(x) = 0 \text{ otherwise}$$

$$F_X(x) = \sum_{i=1}^{x} p_X(i) = \begin{cases} 0 & x < 1 \\ \frac{1}{4} & x = 1 \\ \frac{1}{2} & x = 2 \\ \frac{3}{4} & x = 3 \\ 1 & x > 3 \end{cases}$$

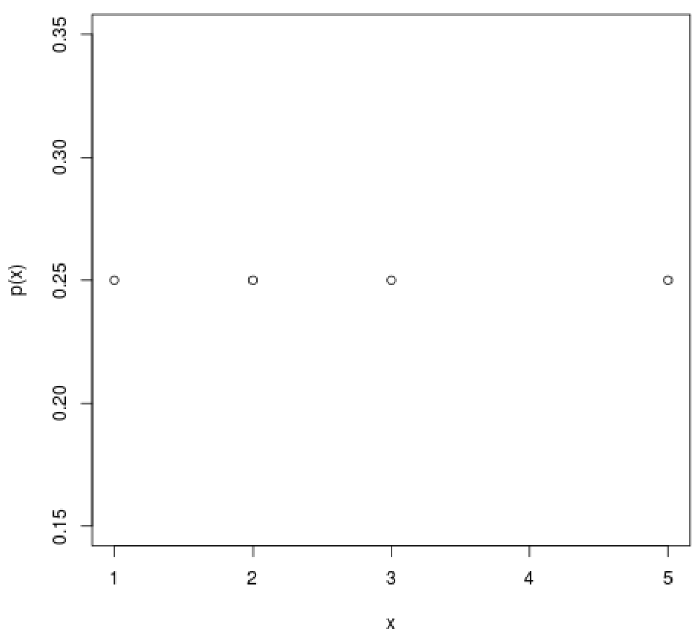

Fig. 3: $p_X(x)$

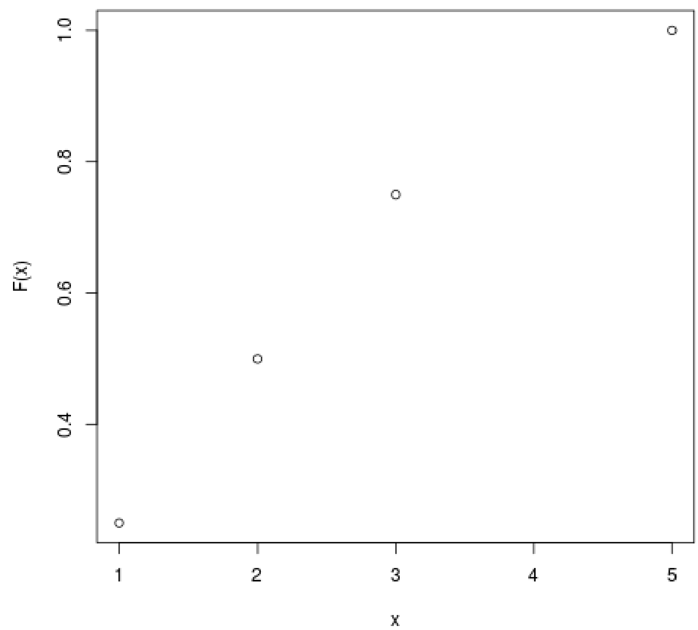

Fig. 4: $F_X(x)$

$$E[X] = \sum_{x \in \mathbb{N}} x p_X(x) = \frac{1}{4} + \frac{1}{2} + \frac{3}{4} + \frac{5}{4} = \frac{11}{4}$$

$$Var(X) = E[X^2] - E[X]^2 = \sum_{x \in \mathbb{N}} x^2 p_X(x) - \frac{121}{16} = \frac{1}{4} + 1 + \frac{9}{4} + \frac{25}{4} - \frac{121}{16} = \frac{35}{16}$$

d.

S	< 2	2	3	4	5	6	7	8	10	> 10
$p_S(s)$	0	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{8}$	$\frac{1}{8}$	$\frac{1}{16}$	0

$$E[S] = \sum_{s \in \mathbb{N}} s p_S(s) = \frac{1}{16} + \frac{1}{4} + \frac{9}{16} + \frac{5}{8} + \frac{9}{8} + \frac{7}{8} + 1 + \frac{5}{8} = \frac{41}{8}$$

$$V(S) = \sum_{s \in \mathbb{N}} s^2 p_S(s) - \frac{1681}{64} = \frac{1}{4} + \frac{9}{8} + 3 + \frac{25}{8} + \frac{27}{4} + \frac{49}{8} + 8 + \frac{25}{4} - \frac{1681}{64} = \frac{535}{64}$$

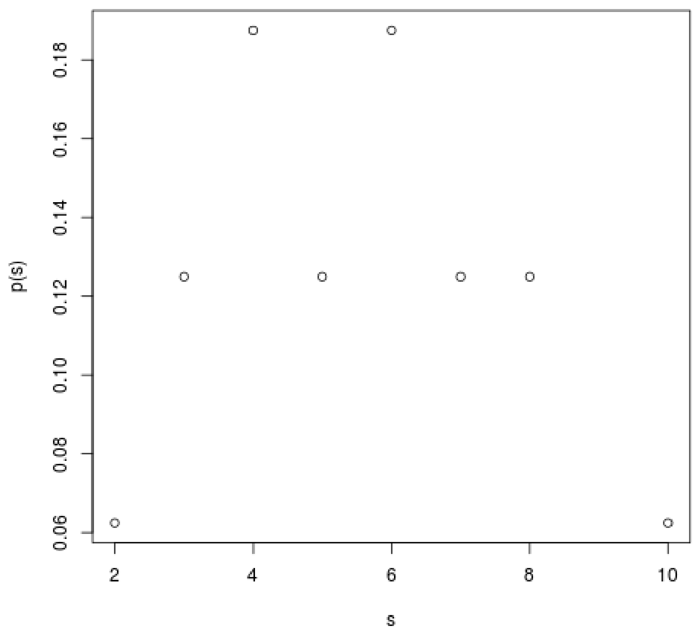

Fig. 5: $p_S(s)$

We were able to easily create the closed form for the probability mass function because we assumed independence between the rolls of the dice, if rolling the dice gave us information about the probabilities of the die, it would not be independent, and the mass function for the mass would not be so simple to calculate.

e.

The odds are given by $\frac{P(S=s)}{P(S\neq s)}$ So the odds for $S = 6$ are given by: $\frac{P(S=6)}{P(S\neq 6)} = \frac{3}{13}$

f.

For the event to be considered fair, the expected value must equal zero. So for some payoff x, the equation: $xP(S = 6) - 1P(S \neq 6) = 0$ so $x = \frac{P(S\neq 6)}{P(S=6)}$ and thus: $x = \frac{13}{3}$