To: Whom It May Concern

From: Alejandro Andrade, Kyle Salitrik

Subject: Nurse Scheduling Database Final Design and Queries

Date: November 14, 2017

The purpose of the following document is to explain in depth a database for a nursing care assistance hospital or clinic. Such database was created to solve the problem of scheduling each shift and combining the available resources to meet the working constraints of each nurse.

The database model and the select examples give an overview of the relationship and capabilities of the data. It is important that data can get increasingly big and processing the select queries can exponentially increase in run time. Thus, this document also explains how the database is internally optimized to avoid long run time processing through indexing techniques. The data model that will be referenced throughout the document is attached at the end of the document.

Table Specifications

This section contains the specifications for each table used in the relational model.

Address

Field	Type	Null	Key	Default	Extra
address_ID	int(11)	NO	PRI	NULL	auto_increment
emp_ID	int(11)	YES	MUL	NULL	
street1	char(50)	YES		NULL	
street2	char(50)	YES		NULL	
city	char(50)	YES		NULL	
state	char(50)	YES		NULL	
zip	char(50)	YES		NULL	

Certification

Field	Type	Null	Key	Default	Extra
cert_ID	int(11)	NO	PRI	NULL	auto_increment
emp_ID	int(11)	YES	UNI	NULL	
role_ID	int(11)	YES	MUL	NULL	

Department

Field	Type	Null	Key	Default	Extra
dept_ID	int(11)	NO	PRI	NULL	auto_increment
min_staff	int(11)	NO		0	
max_staff	int(11)	NO		100	
beds	int(11)	NO		0	
dept_name	char(50)	NO		NULL	

Department Need

Field	Type	Null	Key	Default	Extra
need_ID	int(11)	NO	PRI	NULL	auto_increment
week_ID	int(11)	YES	MUL	NULL	
day_ID	int(11)	YES	MUL	NULL	
time_ID	int(11)	YES	MUL	NULL	
dept_ID	int(11)	YES	MUL	NULL	
role_ID	int(11)	YES	MUL	NULL	
need	int(11)	YES		NULL	

Employee

Field	Type	Null	Key	Default	Extra
emp_ID	int(11)	NO	PRI	NULL	auto_increment
home_dept	int(11)	YES	MUL	NULL	
fname	char(50)	NO		NULL	
mname	char(50)	YES		NULL	
lname	char(50)	YES		NULL	
ssn	char(12)	YES		NULL	
phone1	char(13)	YES		NULL	
phone2	char(13)	YES		NULL	
start_date	datetime	NO		CURRENT_TIMESTAMP	
end_date	date	YES		NULL	
full_time	tinyint(1)	NO		0	
salaried	tinyint(1)	NO		0	
pay_rate	double	NO		0	

Role

Field	Type	Null	Key	Default	Extra
role_ID	int(11)	NO	PRI	NULL	auto_increment
role	char(50)	NO		NULL	

Shift

Field	Type	Null	Key	Default	Extra
shift_ID	int(11)	NO	PRI	NULL	auto_increment
emp_ID	int(11)	NO	MUL	NULL	
dept_ID	int(11)	NO	MUL	NULL	
time_ID	int(11)	NO	MUL	NULL	
week_ID	int(11)	NO	MUL	NULL	
day_ID	int(11)	NO	MUL	NULL	
status_ID	int(11)	YES	MUL	NULL	
pay_modifier	double	YES		NULL	

Shift Status

Field	Type	Null	Key	Default	Extra
status_ID	int(11)	NO	PRI	NULL	auto_increment
status	char(50)	YES		NULL	

Shift Time

Field	Type	Null	Key	Default	Extra
time_ID	int(11)	NO	PRI	NULL	auto_increment
shift_start	time	NO		NULL	
shift_end	time	NO		NULL	
shift_length	int(11)	YES		NULL	

Week

Field	Type	Null	Key	Default	Extra
week_ID	int(11)	NO	PRI	NULL	auto_increment
start_date	date	NO		NULL	
end_date	date	NO		NULL	

Weekday

Field	Type	Null	Key	Default	Extra
day_ID	int(11)	NO	PRI	NULL	auto_increment
day_name	char(10)	YES		NULL	

Desired Queries

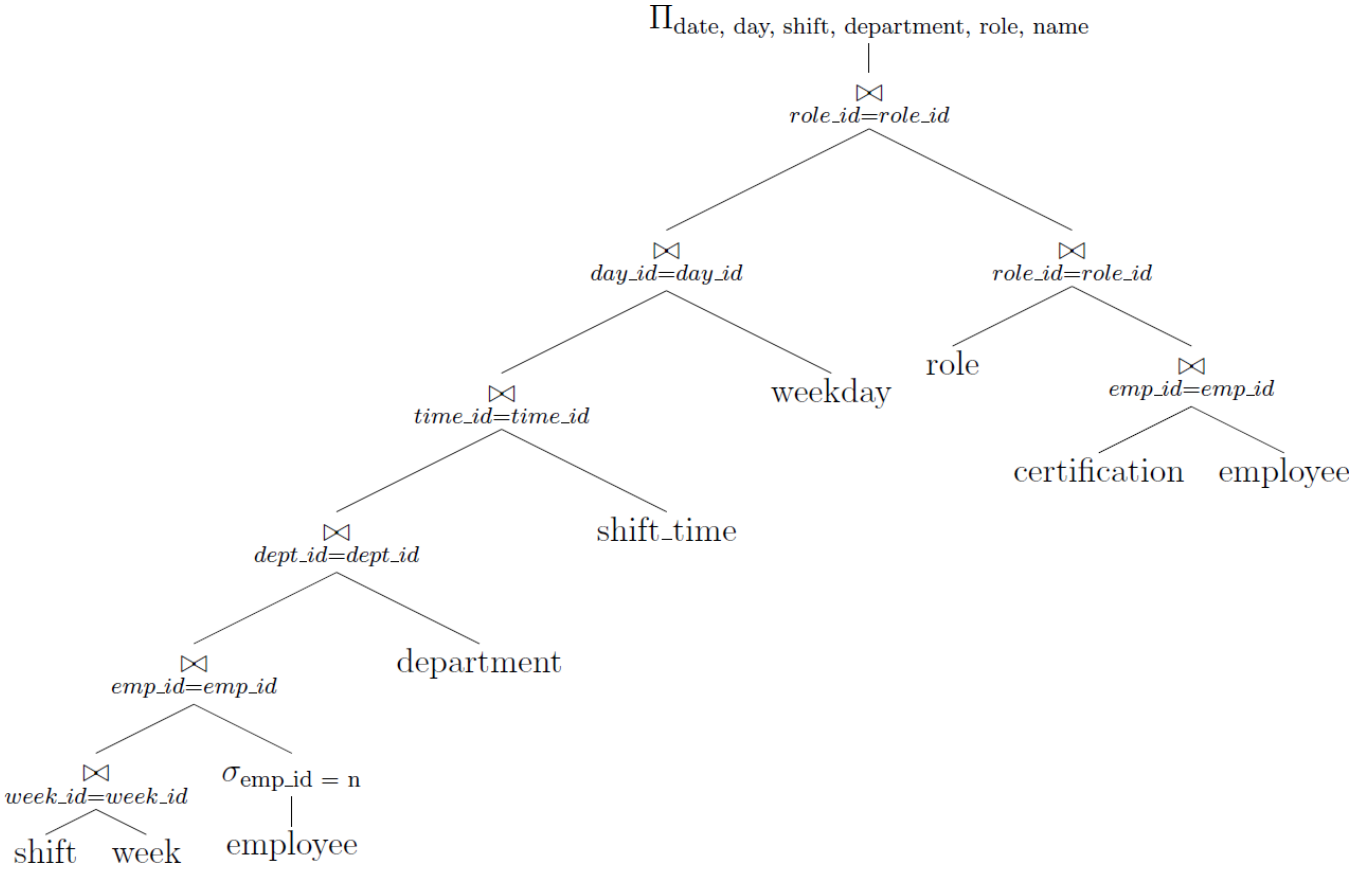
Within this section all queries are explained, the MySQL query itself is given, indexing is discussed and one weeks worth of sample data is provided. If the sample data exceeded 100 lines, the result was truncated to 100 lines for brevity.

Query 1

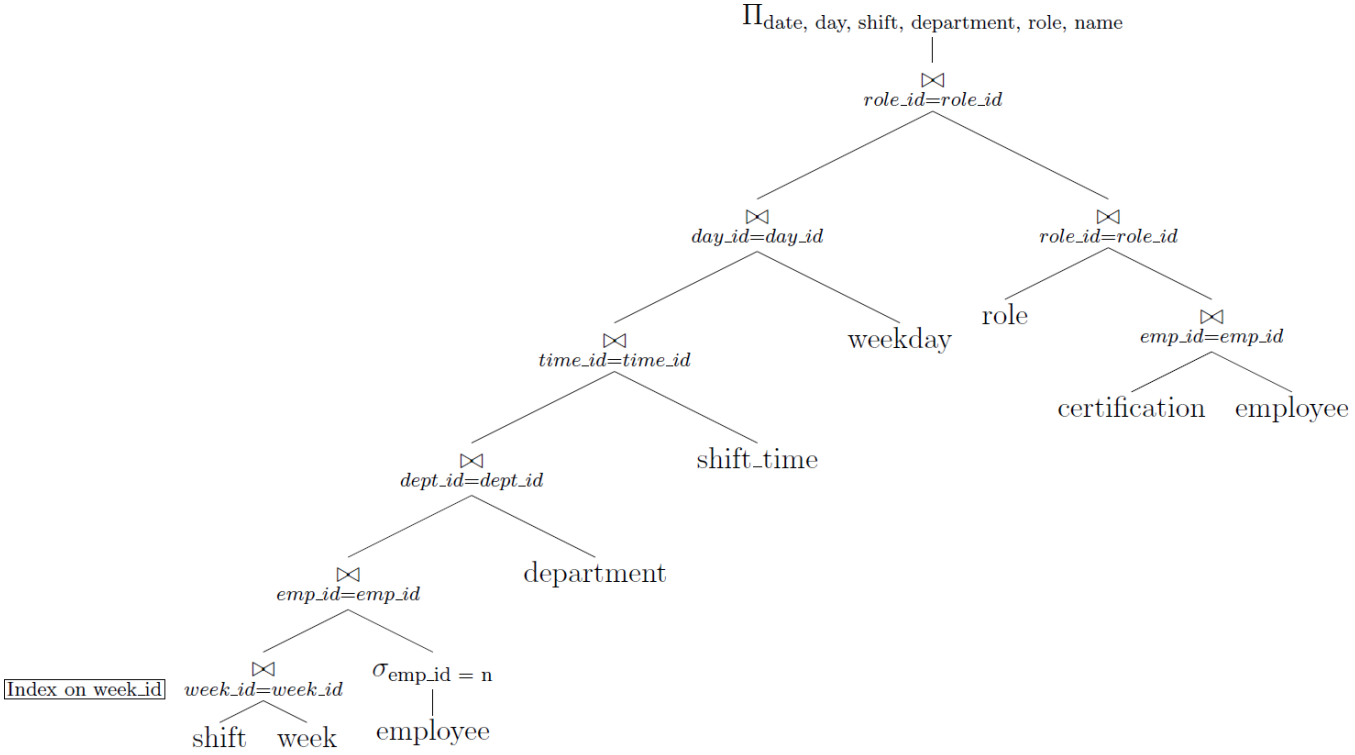
The first query is designed to return a single employee's schedule for any given 6 week period. It shall return the week start date, day of week, shift, department, and role for the employee. The input parameters to the query are the start week, end week, and ID of the employee in question.

MySQL Query

```
SELECT
  week.start_date          AS 'weekStart',
  weekday.day_name         AS 'day',
  shift_time.shift_start   AS 'start',
  shift_time.shift_end     AS 'end',
  employee.fname           AS 'firstName',
  employee.lname           AS 'lastName',
  department.dept_name     AS 'department',
  role.role                AS 'role'
FROM shift, week, weekday, shift_time, department, role, certification, employee
WHERE shift.day_ID = weekday.day_ID
      AND shift.time_ID = shift_time.time_ID
      AND shift.dept_ID = department.dept_ID
      AND shift.week_ID = week.week_ID
      AND shift.emp_ID = employee.emp_ID
      AND employee.emp_ID = certification.emp_ID
      AND certification.role_ID = role.role_ID
      AND employee.emp_ID = 1
      AND week.week_ID >= 1
      AND week.week_ID <= 6
ORDER BY weekStart, weekday.day_ID;
```



On the first query the tables indexed are the shift table on the shift_id and the employee table on employee_id. The reason of indexing these tables is because, in comparison to the other tables that are joined in this query, shits and employees have the most rows, and relationships with the fields in other tables.



For the first query, indexing employees and shifts tables the access time for each search goes to O(1), instead of the iterative approach of looking at each row and making it O(n), where n is the rows in each table. Indexing in such case is much better because we speedup the process from O(n*m) to O(n) when employees and shifts are combined, where n is the number of employees and m is the number of shifts. Such optimization then has to get added the join of the other tables, but such other tables don't have as many rows and so they won't affect the performance as much as if employees or shifts will not be indexed.

Example Data

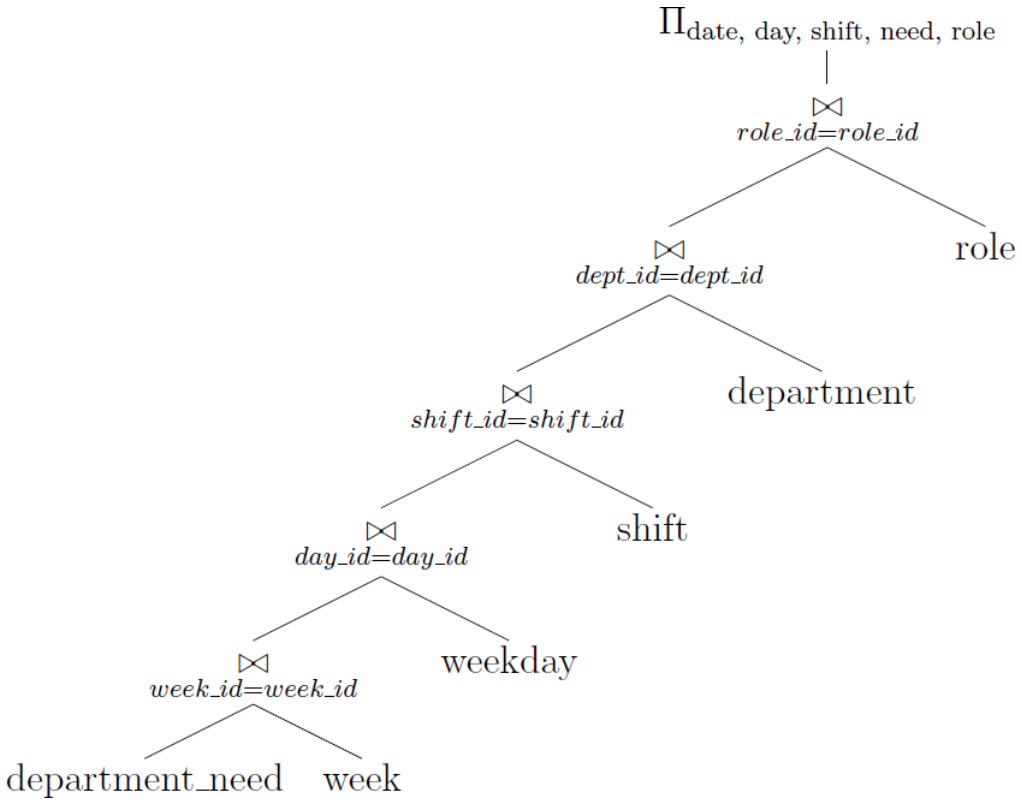
weekStart	day	start	end	firstName	lastName	department	role
2017-10-01	SUN	19:00:00	07:00:00	Adam	Apple	ICU	NP
2017-10-01	MON	23:00:00	07:00:00	Adam	Apple	ICU	NP
2017-10-01	TUE	15:00:00	23:00:00	Adam	Apple	MAT	NP
2017-10-01	WED	15:00:00	23:00:00	Adam	Apple	ER	NP
2017-10-01	SAT	19:00:00	07:00:00	Adam	Apple	OR	NP

Query 2

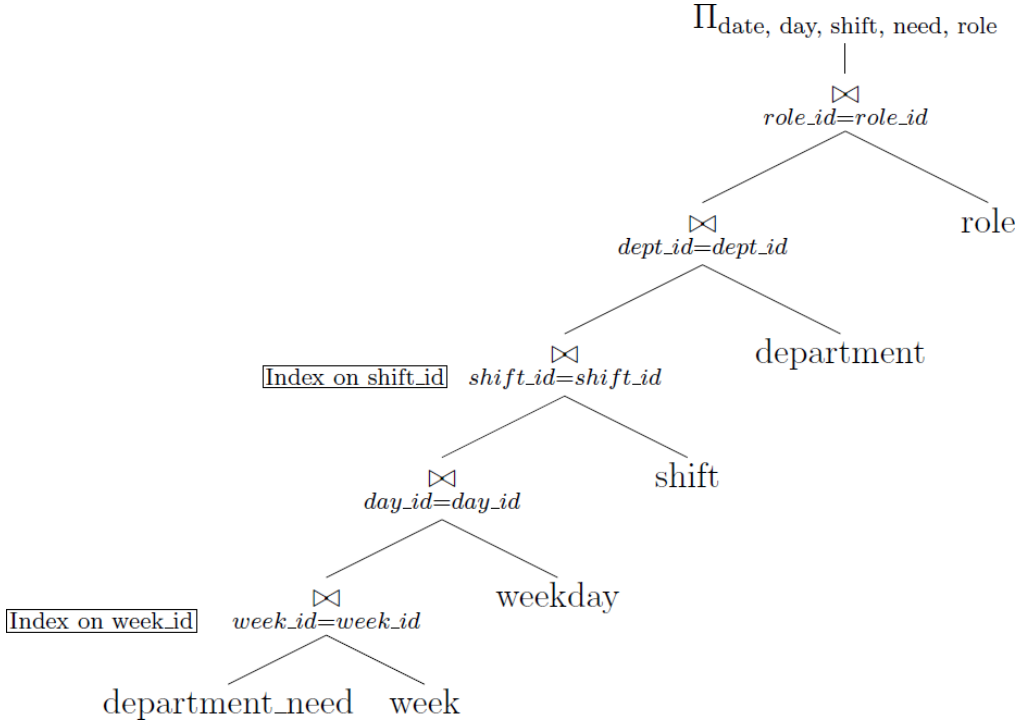
Query 2 returns a department's need for a single week including the week's start date, day of week, shift start time, shift end time, and needs per role per shift. The query can be tuned by changing the department ID and week ID.

MySQL Query

```
SELECT
   week.start_date          AS 'weekStart',
   weekday.day_name         AS 'day',
   shift_time.shift_start   AS 'start',
   shift_time.shift_end     AS 'end',
   department.dept_name     AS 'department',
   role.role                AS 'role',
   department_need.need     AS 'needs'
FROM department_need, week, weekday, shift_time, department, role
WHERE department_need.week_ID = 1
      AND department_need.week_ID = week.week_ID
      AND department_need.day_ID = weekday.day_ID
      AND department_need.time_ID = shift_time.time_ID
      AND department_need.dept_ID = department.dept_ID
      AND department_need.role_ID = role.role_ID;
```



For the second query the process is much similar to query one. The difference is that the table that is getting joined for the following select query is the departments table. Following the above principle one can optimize the run-time of the query by indexing shifts on shift_id and department_id.



Creating the indexing described above yields O(1) access for both shifts and department tables and only giving O(n) for the tables with the least elements and won't affect much the performance.

Example Data

weekStart	day	start	end	department	role	needs
2017-10-01	MON	07:00:00	15:00:00	ER	RN	3
2017-10-01	MON	07:00:00	15:00:00	ER	LPN	3
2017-10-01	MON	07:00:00	15:00:00	ER	NP	3
2017-10-01	MON	07:00:00	15:00:00	ER	CNS	2
2017-10-01	MON	07:00:00	15:00:00	ER	NA	2
2017-10-01	MON	07:00:00	15:00:00	ICU	RN	3
2017-10-01	MON	07:00:00	15:00:00	ICU	LPN	2
2017-10-01	MON	07:00:00	15:00:00	ICU	NP	2
2017-10-01	MON	07:00:00	15:00:00	ICU	CNS	3
2017-10-01	MON	07:00:00	15:00:00	ICU	NA	2
2017-10-01	MON	07:00:00	15:00:00	MAT	RN	2
2017-10-01	MON	07:00:00	15:00:00	MAT	LPN	3
2017-10-01	MON	07:00:00	15:00:00	MAT	NP	3
2017-10-01	MON	07:00:00	15:00:00	MAT	CNS	3
2017-10-01	MON	07:00:00	15:00:00	MAT	NA	2
2017-10-01	MON	07:00:00	15:00:00	OR	RN	3
2017-10-01	MON	07:00:00	15:00:00	OR	LPN	2
2017-10-01	MON	07:00:00	15:00:00	OR	NP	3
2017-10-01	MON	07:00:00	15:00:00	OR	CNS	3
2017-10-01	MON	07:00:00	15:00:00	OR	NA	2
2017-10-01	MON	07:00:00	15:00:00	QUARR	RN	3
2017-10-01	MON	07:00:00	15:00:00	QUARR	LPN	3
2017-10-01	MON	07:00:00	15:00:00	QUARR	NP	3
2017-10-01	MON	07:00:00	15:00:00	QUARR	CNS	3
2017-10-01	MON	07:00:00	15:00:00	QUARR	NA	2
2017-10-01	MON	07:00:00	15:00:00	PSYCH	RN	3
2017-10-01	MON	07:00:00	15:00:00	PSYCH	LPN	3
2017-10-01	MON	07:00:00	15:00:00	PSYCH	NP	2
2017-10-01	MON	07:00:00	15:00:00	PSYCH	CNS	2
2017-10-01	MON	07:00:00	15:00:00	PSYCH	NA	3
2017-10-01	TUE	07:00:00	15:00:00	ER	RN	2
2017-10-01	TUE	07:00:00	15:00:00	ER	LPN	2
2017-10-01	TUE	07:00:00	15:00:00	ER	NP	3
2017-10-01	TUE	07:00:00	15:00:00	ER	CNS	2
2017-10-01	TUE	07:00:00	15:00:00	ER	NA	3
2017-10-01	TUE	07:00:00	15:00:00	ICU	RN	2
2017-10-01	TUE	07:00:00	15:00:00	ICU	LPN	2
2017-10-01	TUE	07:00:00	15:00:00	ICU	NP	2
2017-10-01	TUE	07:00:00	15:00:00	ICU	CNS	2
2017-10-01	TUE	07:00:00	15:00:00	ICU	NA	3
2017-10-01	TUE	07:00:00	15:00:00	MAT	RN	2
2017-10-01	TUE	07:00:00	15:00:00	MAT	LPN	2
2017-10-01	TUE	07:00:00	15:00:00	MAT	NP	2
2017-10-01	TUE	07:00:00	15:00:00	MAT	CNS	2
2017-10-01	TUE	07:00:00	15:00:00	MAT	NA	3
2017-10-01	TUE	07:00:00	15:00:00	OR	RN	3
2017-10-01	TUE	07:00:00	15:00:00	OR	LPN	3
2017-10-01	SUN	19:00:00	07:00:00	MAT	LPN	2
2017-10-01	SUN	19:00:00	07:00:00	MAT	NP	3

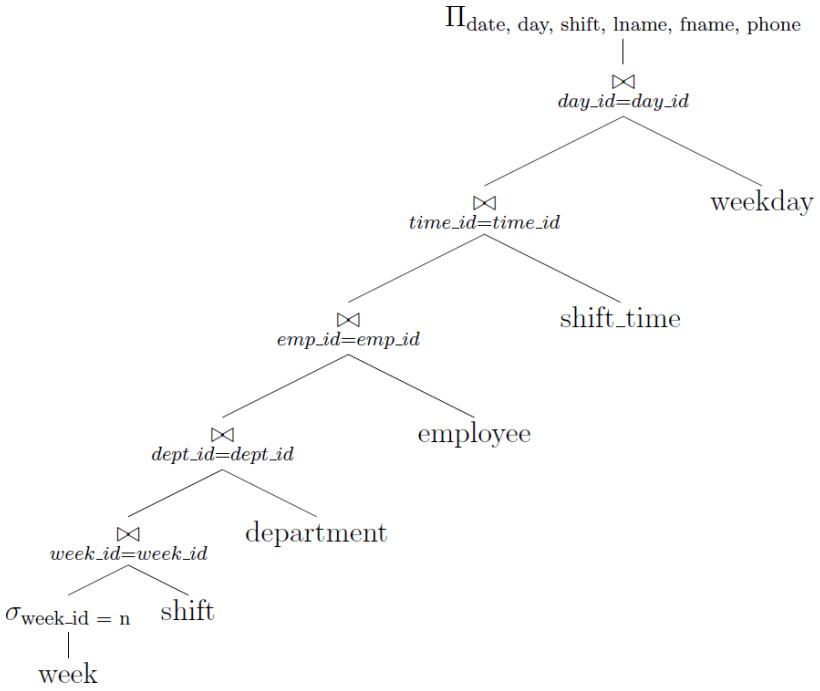
2017−10−01	SUN	19:00:00	07:00:00	MAT	CNS	3
2017−10−01	SUN	19:00:00	07:00:00	MAT	NA	3
2017−10−01	SUN	19:00:00	07:00:00	OR	RN	2
2017−10−01	SUN	19:00:00	07:00:00	OR	LPN	3
2017−10−01	SUN	19:00:00	07:00:00	OR	NP	3
2017−10−01	SUN	19:00:00	07:00:00	OR	CNS	3
2017−10−01	SUN	19:00:00	07:00:00	OR	NA	2
2017−10−01	SUN	19:00:00	07:00:00	QUARR	RN	2
2017−10−01	SUN	19:00:00	07:00:00	QUARR	LPN	2
2017−10−01	SUN	19:00:00	07:00:00	QUARR	NP	3
2017−10−01	SUN	19:00:00	07:00:00	QUARR	CNS	2
2017−10−01	SUN	19:00:00	07:00:00	QUARR	NA	2
2017−10−01	SUN	19:00:00	07:00:00	PSYCH	RN	2
2017−10−01	SUN	19:00:00	07:00:00	PSYCH	LPN	2
2017−10−01	SUN	19:00:00	07:00:00	PSYCH	NP	2
2017−10−01	SUN	19:00:00	07:00:00	PSYCH	CNS	2
2017−10−01	SUN	19:00:00	07:00:00	PSYCH	NA	3
2017−10−01	SAT	19:00:00	07:00:00	ER	RN	3
2017−10−01	SAT	19:00:00	07:00:00	ER	LPN	3
2017−10−01	SAT	19:00:00	07:00:00	ER	NP	2
2017−10−01	SAT	19:00:00	07:00:00	ER	CNS	3
2017−10−01	SAT	19:00:00	07:00:00	ER	NA	2
2017−10−01	SAT	19:00:00	07:00:00	ICU	RN	2
2017−10−01	SAT	19:00:00	07:00:00	ICU	LPN	2
2017−10−01	SAT	19:00:00	07:00:00	ICU	NP	3
2017−10−01	SAT	19:00:00	07:00:00	ICU	CNS	3
2017−10−01	SAT	19:00:00	07:00:00	ICU	NA	3
2017−10−01	SAT	19:00:00	07:00:00	MAT	RN	3
2017−10−01	SAT	19:00:00	07:00:00	MAT	LPN	2
2017−10−01	SAT	19:00:00	07:00:00	MAT	NP	2
2017−10−01	SAT	19:00:00	07:00:00	MAT	CNS	3
2017−10−01	SAT	19:00:00	07:00:00	MAT	NA	3
2017−10−01	SAT	19:00:00	07:00:00	OR	RN	3
2017−10−01	SAT	19:00:00	07:00:00	OR	LPN	3
2017−10−01	SAT	19:00:00	07:00:00	OR	NP	2
2017−10−01	SAT	19:00:00	07:00:00	OR	CNS	2
2017−10−01	SAT	19:00:00	07:00:00	OR	NA	3
2017−10−01	SAT	19:00:00	07:00:00	QUARR	RN	3
2017−10−01	SAT	19:00:00	07:00:00	QUARR	LPN	3
2017−10−01	SAT	19:00:00	07:00:00	QUARR	NP	3
2017−10−01	SAT	19:00:00	07:00:00	QUARR	CNS	2
2017−10−01	SAT	19:00:00	07:00:00	QUARR	NA	2
2017−10−01	SAT	19:00:00	07:00:00	PSYCH	RN	2
2017−10−01	SAT	19:00:00	07:00:00	PSYCH	LPN	3
2017−10−01	SAT	19:00:00	07:00:00	PSYCH	NP	2
2017−10−01	SAT	19:00:00	07:00:00	PSYCH	CNS	2
2017−10−01	SAT	19:00:00	07:00:00	PSYCH	NA	2

Query 3

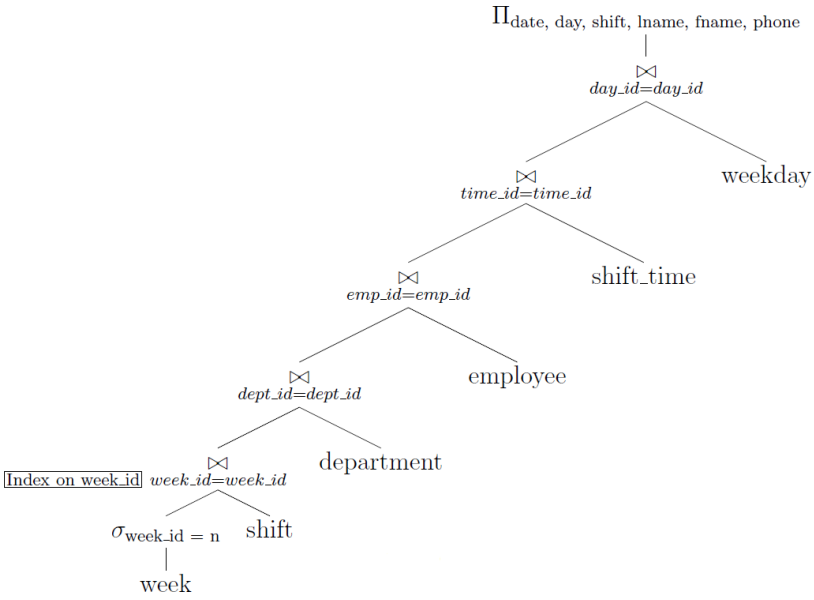
Query 3 will give a single department's schedule for a specified week, ordered by the employee's names. Included information shall contain the start date of the week, the day of the week, shift start and end times, the employee's name, and their phone number. The department and week ID values will need to be changed in order to get the desired data.

MySQL Query

```
SELECT
   department.dept_name    AS 'department',
   employee.fname          AS 'firstName',
   employee.lname          AS 'lastName',
   employee.phone1         AS 'phoneNumber',
   week.start_date         AS 'weekStart',
   weekday.day_name        AS 'day',
   shift_time.shift_start  AS 'start',
   shift_time.shift_end    AS 'end'
FROM department, week, employee, shift, shift_time, weekday
WHERE week.week_ID = 1
      AND shift.emp_ID = employee.emp_ID
      AND shift.dept_ID = department.dept_ID
      AND shift.time_ID = shift_time.time_ID
      AND shift.week_ID = week.week_ID
      AND shift.day_ID = weekday.day_ID
ORDER BY department, lastName, firstName;
```



For the third query a similar index scheme will be implemented on the shift table between the shift.week_id and week.week_id. The largest amount of comparisons occur during this table join.



The third query would experience the largest speedup in the join between the tables from O(m*n) to O(log(m*n)+c) due to the ability to conduct a binary search on the values corresponding to the correct week ID for both tables and a linear search to find the beginning and end of that week.

Example Data

department	firstName	lastName	phoneNumber	weekStart	day	start	end
ER	Adam	Apple	000-000-0001	2017-10-01	WED	15:00:00	23:00:00
ER	Derek	Davis	000-000-0004	2017-10-01	THU	07:00:00	15:00:00
ER	George	Grant	000-000-0007	2017-10-01	WED	23:00:00	07:00:00
ER	Jack	Joplin	000-000-0010	2017-10-01	SUN	19:00:00	07:00:00
ER	Kevin	Keller	000-000-0011	2017-10-01	THU	15:00:00	23:00:00
ER	Kevin	Keller	000-000-0011	2017-10-01	WED	07:00:00	15:00:00
ER	Nick	Norton	000-000-0014	2017-10-01	FRI	15:00:00	23:00:00
ER	Nick	Norton	000-000-0014	2017-10-01	MON	07:00:00	15:00:00
ER	Peter	Parker	000-000-0016	2017-10-01	SUN	19:00:00	07:00:00
ER	Robert	Rodgers	000-000-0018	2017-10-01	THU	15:00:00	23:00:00
ER	Robert	Rodgers	000-000-0018	2017-10-01	MON	23:00:00	07:00:00
ER	Sam	Saville	000-000-0019	2017-10-01	SUN	07:00:00	19:00:00
ER	Tom	Tarantino	000-000-0020	2017-10-01	TUE	07:00:00	15:00:00
ER	Tom	Tarantino	000-000-0020	2017-10-01	SUN	07:00:00	19:00:00
ICU	Adam	Apple	000-000-0001	2017-10-01	MON	23:00:00	07:00:00
ICU	Adam	Apple	000-000-0001	2017-10-01	SUN	19:00:00	07:00:00
ICU	Brad	Baker	000-000-0002	2017-10-01	SAT	19:00:00	07:00:00
ICU	Brad	Baker	000-000-0002	2017-10-01	SUN	07:00:00	19:00:00
ICU	Charles	Chaplan	000-000-0003	2017-10-01	SUN	07:00:00	19:00:00
ICU	Derek	Davis	000-000-0004	2017-10-01	TUE	07:00:00	15:00:00
ICU	Evan	Elliott	000-000-0005	2017-10-01	MON	23:00:00	07:00:00
ICU	Hank	Hamill	000-000-0008	2017-10-01	THU	15:00:00	23:00:00
ICU	Hank	Hamill	000-000-0008	2017-10-01	MON	23:00:00	07:00:00
ICU	Hank	Hamill	000-000-0008	2017-10-01	FRI	15:00:00	23:00:00
ICU	Jack	Joplin	000-000-0010	2017-10-01	THU	15:00:00	23:00:00
ICU	Jack	Joplin	000-000-0010	2017-10-01	TUE	07:00:00	15:00:00
ICU	Kevin	Keller	000-000-0011	2017-10-01	TUE	15:00:00	23:00:00
ICU	Lenny	Landman	000-000-0012	2017-10-01	WED	15:00:00	23:00:00

ICU	Peter	Parker	000-000-0016	2017-10-01	SAT	19:00:00	07:00:00
ICU	Quinn	Quarrick	000-000-0017	2017-10-01	FRI	15:00:00	23:00:00
ICU	Robert	Rodgers	000-000-0018	2017-10-01	WED	07:00:00	15:00:00
ICU	Robert	Rodgers	000-000-0018	2017-10-01	SAT	19:00:00	07:00:00
MAT	Adam	Apple	000-000-0001	2017-10-01	TUE	15:00:00	23:00:00
MAT	Brad	Baker	000-000-0002	2017-10-01	WED	15:00:00	23:00:00
MAT	Evan	Elliott	000-000-0005	2017-10-01	SUN	07:00:00	19:00:00
MAT	Evan	Elliott	000-000-0005	2017-10-01	FRI	07:00:00	15:00:00
MAT	George	Grant	000-000-0007	2017-10-01	SUN	07:00:00	19:00:00
MAT	George	Grant	000-000-0007	2017-10-01	SAT	19:00:00	07:00:00
MAT	Ivan	Ikarov	000-000-0009	2017-10-01	MON	23:00:00	07:00:00
MAT	Lenny	Landman	000-000-0012	2017-10-01	THU	23:00:00	07:00:00
MAT	Nick	Norton	000-000-0014	2017-10-01	SUN	07:00:00	19:00:00
MAT	Orval	Obrian	000-000-0015	2017-10-01	MON	07:00:00	15:00:00
MAT	Orval	Obrian	000-000-0015	2017-10-01	THU	07:00:00	15:00:00
MAT	Peter	Parker	000-000-0016	2017-10-01	TUE	15:00:00	23:00:00
OR	Adam	Apple	000-000-0001	2017-10-01	SAT	19:00:00	07:00:00
OR	Brad	Baker	000-000-0002	2017-10-01	THU	23:00:00	07:00:00
OR	Charles	Chaplan	000-000-0003	2017-10-01	THU	23:00:00	07:00:00
OR	Derek	Davis	000-000-0004	2017-10-01	FRI	15:00:00	23:00:00
OR	Evan	Elliott	000-000-0005	2017-10-01	SAT	07:00:00	19:00:00
OR	Frank	Farris	000-000-0006	2017-10-01	WED	15:00:00	23:00:00
OR	Ivan	Ikarov	000-000-0009	2017-10-01	FRI	07:00:00	15:00:00
OR	Jack	Joplin	000-000-0010	2017-10-01	FRI	07:00:00	15:00:00
OR	Lenny	Landman	000-000-0012	2017-10-01	TUE	23:00:00	07:00:00
OR	Mark	Morris	000-000-0013	2017-10-01	THU	07:00:00	15:00:00
OR	Nick	Norton	000-000-0014	2017-10-01	THU	07:00:00	15:00:00
OR	Orval	Obrian	000-000-0015	2017-10-01	FRI	07:00:00	15:00:00
OR	Orval	Obrian	000-000-0015	2017-10-01	WED	15:00:00	23:00:00
OR	Peter	Parker	000-000-0016	2017-10-01	FRI	15:00:00	23:00:00
OR	Quinn	Quarrick	000-000-0017	2017-10-01	SUN	19:00:00	07:00:00
OR	Quinn	Quarrick	000-000-0017	2017-10-01	MON	15:00:00	23:00:00
OR	Sam	Saville	000-000-0019	2017-10-01	WED	15:00:00	23:00:00
OR	Tom	Tarantino	000-000-0020	2017-10-01	THU	23:00:00	07:00:00
PSYCH	Charles	Chaplan	000-000-0003	2017-10-01	WED	23:00:00	07:00:00
PSYCH	Derek	Davis	000-000-0004	2017-10-01	WED	07:00:00	15:00:00
PSYCH	Derek	Davis	000-000-0004	2017-10-01	MON	23:00:00	07:00:00
PSYCH	Evan	Elliott	000-000-0005	2017-10-01	TUE	23:00:00	07:00:00
PSYCH	Frank	Farris	000-000-0006	2017-10-01	SUN	07:00:00	19:00:00
PSYCH	Frank	Farris	000-000-0006	2017-10-01	SAT	19:00:00	07:00:00
PSYCH	George	Grant	000-000-0007	2017-10-01	FRI	23:00:00	07:00:00
PSYCH	Hank	Hamill	000-000-0008	2017-10-01	SAT	19:00:00	07:00:00
PSYCH	Ivan	Ikarov	000-000-0009	2017-10-01	TUE	07:00:00	15:00:00
PSYCH	Jack	Joplin	000-000-0010	2017-10-01	WED	23:00:00	07:00:00
PSYCH	Kevin	Keller	000-000-0011	2017-10-01	SAT	19:00:00	07:00:00
PSYCH	Lenny	Landman	000-000-0012	2017-10-01	SUN	07:00:00	19:00:00
PSYCH	Lenny	Landman	000-000-0012	2017-10-01	MON	23:00:00	07:00:00
PSYCH	Mark	Morris	000-000-0013	2017-10-01	SUN	19:00:00	07:00:00
PSYCH	Mark	Morris	000-000-0013	2017-10-01	FRI	07:00:00	15:00:00
PSYCH	Mark	Morris	000-000-0013	2017-10-01	TUE	07:00:00	15:00:00
PSYCH	Mark	Morris	000-000-0013	2017-10-01	MON	23:00:00	07:00:00
PSYCH	Sam	Saville	000-000-0019	2017-10-01	THU	23:00:00	07:00:00
PSYCH	Sam	Saville	000-000-0019	2017-10-01	FRI	15:00:00	23:00:00
PSYCH	Sam	Saville	000-000-0019	2017-10-01	MON	15:00:00	23:00:00
PSYCH	Tom	Tarantino	000-000-0020	2017-10-01	WED	15:00:00	23:00:00
QUARR	Brad	Baker	000-000-0002	2017-10-01	FRI	15:00:00	23:00:00
QUARR	Charles	Chaplan	000-000-0003	2017-10-01	FRI	15:00:00	23:00:00

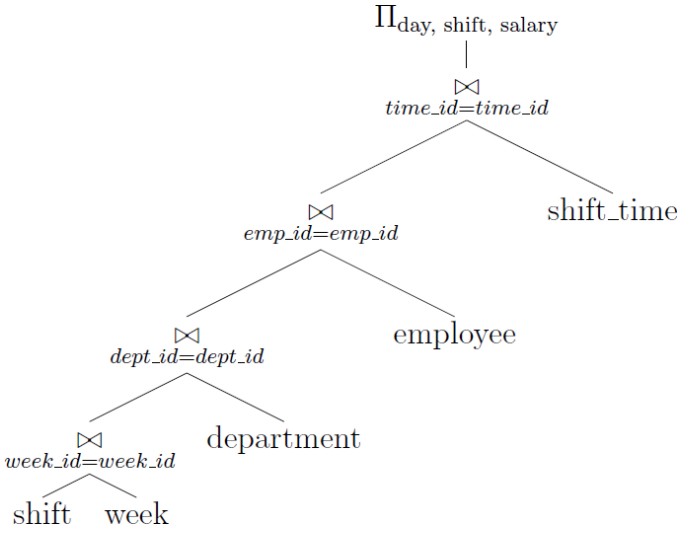
QUARR	Charles	Chaplan	000-000-0003	2017-10-01	SAT	07:00:00	19:00:00
QUARR	Frank	Farris	000-000-0006	2017-10-01	THU	15:00:00	23:00:00
QUARR	Frank	Farris	000-000-0006	2017-10-01	MON	15:00:00	23:00:00
QUARR	George	Grant	000-000-0007	2017-10-01	THU	07:00:00	15:00:00
QUARR	Hank	Hamill	000-000-0008	2017-10-01	SUN	07:00:00	19:00:00
QUARR	Ivan	Ikarov	000-000-0009	2017-10-01	WED	23:00:00	07:00:00
QUARR	Ivan	Ikarov	000-000-0009	2017-10-01	THU	07:00:00	15:00:00
QUARR	Kevin	Keller	000-000-0011	2017-10-01	FRI	23:00:00	07:00:00
QUARR	Nick	Norton	000-000-0014	2017-10-01	SAT	19:00:00	07:00:00
QUARR	Orval	Obrian	000-000-0015	2017-10-01	TUE	23:00:00	07:00:00
QUARR	Peter	Parker	000-000-0016	2017-10-01	WED	23:00:00	07:00:00
QUARR	Quinn	Quarrick	000-000-0017	2017-10-01	WED	07:00:00	15:00:00
QUARR	Quinn	Quarrick	000-000-0017	2017-10-01	SAT	07:00:00	19:00:00
QUARR	Robert	Rodgers	000-000-0018	2017-10-01	TUE	15:00:00	23:00:00
QUARR	Tom	Tarantino	000-000-0020	2017-10-01	FRI	15:00:00	23:00:00

Query 4

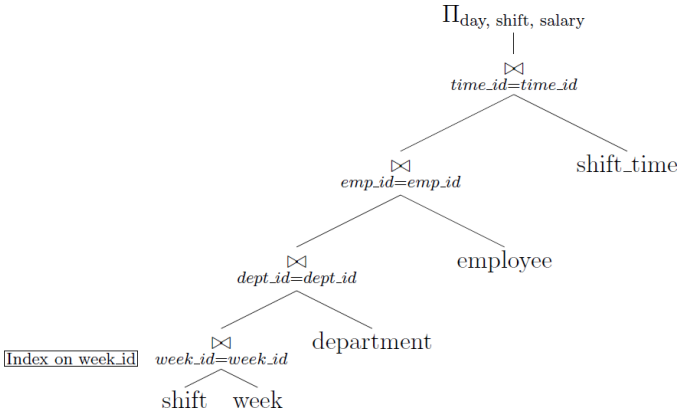
Query 4 will return an employee's pay rate, department, shift start, and shift end times per shift when given a range of dates sorted by date and then shift start time. The total cost per shift shall be calculated by the data parser supplied by you.

MySQL Query

```
SELECT
   department.dept_name    AS 'department',
   employee.fname          AS 'firstName',
   employee.lname          AS 'lastName',
   week.start_date         AS 'weekStart',
   shift_time.shift_start  AS 'start',
   shift_time.shift_end    AS 'end',
   employee.pay_rate       AS 'pay',
   shift_status.status     AS 'status'
FROM department, employee, shift, shift_time, week, shift_status
WHERE DATE_ADD(week.start_date, INTERVAL shift.day_ID - 1 DAY) >= '2017-10-01'
       AND DATE_ADD(week.start_date, INTERVAL shift.day_ID - 1 DAY) <= '2017-10-10'
       AND shift.emp_ID = employee.emp_ID
       AND shift.dept_ID = department.dept_ID
       AND shift.time_ID = shift_time.time_ID
       AND shift.week_ID = week.week_ID
       AND shift.status_ID = shift_status.status_ID
ORDER BY shiftDate, department, lastName, firstName;
```



Query 4 will benefit from the given indexes for a similar reason to Query 3 .



On the fourth query the run-time of the tables other than shifts won't be optimized as they aren't the focal point of the select. Thus it will only make sense to index the shifts table on shifts_id to gain any optimization or performance improvement.

Example Data

department	firstName	lastName	weekStart	start	end	pay	status
ER	Jack	Joplin	2017-10-01	19:00:00	07:00:00	21	Call-off
ER	Peter	Parker	2017-10-01	19:00:00	07:00:00	39	Call-in
ER	Sam	Saville	2017-10-01	07:00:00	19:00:00	38	Call-off
ER	Tom	Tarantino	2017-10-01	07:00:00	19:00:00	27	Req-off
ICU	Adam	Apple	2017-10-01	19:00:00	07:00:00	22.5	Req-off
ICU	Brad	Baker	2017-10-01	07:00:00	19:00:00	15	Call-off
ICU	Charles	Chaplan	2017-10-01	07:00:00	19:00:00	37	Call-off
MAT	Evan	Elliott	2017-10-01	07:00:00	19:00:00	21	Call-off
MAT	George	Grant	2017-10-01	07:00:00	19:00:00	19	Call-off
MAT	Nick	Norton	2017-10-01	07:00:00	19:00:00	23	Req-in
OR	Quinn	Quarrick	2017-10-01	19:00:00	07:00:00	15	Call-off
PSYCH	Frank	Farris	2017-10-01	07:00:00	19:00:00	32	Call-off
PSYCH	Lenny	Landman	2017-10-01	07:00:00	19:00:00	17	Req-off
PSYCH	Mark	Morris	2017-10-01	19:00:00	07:00:00	32	Call-in

QUARR	Hank	Hamill	2017-10-01	07:00:00	19:00:00	21	Req-off
ER	Nick	Norton	2017-10-01	07:00:00	15:00:00	23	Req-off
ER	Robert	Rodgers	2017-10-01	23:00:00	07:00:00	17	Call-in
ICU	Adam	Apple	2017-10-01	23:00:00	07:00:00	22.5	Req-off
ICU	Evan	Elliott	2017-10-01	23:00:00	07:00:00	21	Req-in
ICU	Hank	Hamill	2017-10-01	23:00:00	07:00:00	21	Call-off
MAT	Ivan	Ikarov	2017-10-01	23:00:00	07:00:00	24	Req-in
MAT	Orval	Obrian	2017-10-01	07:00:00	15:00:00	30	Req-in
OR	Quinn	Quarrick	2017-10-01	15:00:00	23:00:00	15	Req-in
PSYCH	Derek	Davis	2017-10-01	23:00:00	07:00:00	40	Call-in
PSYCH	Lenny	Landman	2017-10-01	23:00:00	07:00:00	17	Req-in
PSYCH	Mark	Morris	2017-10-01	23:00:00	07:00:00	32	Call-off
PSYCH	Sam	Saville	2017-10-01	15:00:00	23:00:00	38	Call-off
QUARR	Frank	Farris	2017-10-01	15:00:00	23:00:00	32	Req-in
ER	Tom	Tarantino	2017-10-01	07:00:00	15:00:00	27	Call-in
ICU	Derek	Davis	2017-10-01	07:00:00	15:00:00	40	Call-off
ICU	Jack	Joplin	2017-10-01	07:00:00	15:00:00	21	Call-in
ICU	Kevin	Keller	2017-10-01	15:00:00	23:00:00	20	Call-in
MAT	Adam	Apple	2017-10-01	15:00:00	23:00:00	22.5	Req-off
MAT	Peter	Parker	2017-10-01	15:00:00	23:00:00	39	Call-in
OR	Lenny	Landman	2017-10-01	23:00:00	07:00:00	17	Call-in
PSYCH	Evan	Elliott	2017-10-01	23:00:00	07:00:00	21	Req-off
PSYCH	Ivan	Ikarov	2017-10-01	07:00:00	15:00:00	24	Req-off
PSYCH	Mark	Morris	2017-10-01	07:00:00	15:00:00	32	Call-in
QUARR	Orval	Obrian	2017-10-01	23:00:00	07:00:00	30	Call-off
QUARR	Robert	Rodgers	2017-10-01	15:00:00	23:00:00	17	Req-in
ER	Adam	Apple	2017-10-01	15:00:00	23:00:00	22.5	Call-in
ER	George	Grant	2017-10-01	23:00:00	07:00:00	19	Call-off
ER	Kevin	Keller	2017-10-01	07:00:00	15:00:00	20	Req-in
ICU	Lenny	Landman	2017-10-01	15:00:00	23:00:00	17	Req-off
ICU	Robert	Rodgers	2017-10-01	07:00:00	15:00:00	17	Call-off
MAT	Brad	Baker	2017-10-01	15:00:00	23:00:00	15	Req-off
OR	Frank	Farris	2017-10-01	15:00:00	23:00:00	32	Call-off
OR	Orval	Obrian	2017-10-01	15:00:00	23:00:00	30	Call-off
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PSYCH	Charles	Chaplan	2017-10-01	23:00:00	07:00:00	37	Req-off
PSYCH	Derek	Davis	2017-10-01	07:00:00	15:00:00	40	Req-off
PSYCH	Jack	Joplin	2017-10-01	23:00:00	07:00:00	21	Req-off
PSYCH	Tom	Tarantino	2017-10-01	15:00:00	23:00:00	27	Req-in
QUARR	Ivan	Ikarov	2017-10-01	23:00:00	07:00:00	24	Req-off
QUARR	Peter	Parker	2017-10-01	23:00:00	07:00:00	39	Req-off
QUARR	Quinn	Quarrick	2017-10-01	07:00:00	15:00:00	15	Call-off
ER	Derek	Davis	2017-10-01	07:00:00	15:00:00	40	Call-in
ER	Kevin	Keller	2017-10-01	15:00:00	23:00:00	20	Req-in
ER	Robert	Rodgers	2017-10-01	15:00:00	23:00:00	17	Req-in
ICU	Hank	Hamill	2017-10-01	15:00:00	23:00:00	21	Call-off
ICU	Jack	Joplin	2017-10-01	15:00:00	23:00:00	21	Call-off
MAT	Lenny	Landman	2017-10-01	23:00:00	07:00:00	17	Req-off
MAT	Orval	Obrian	2017-10-01	07:00:00	15:00:00	30	Req-off
OR	Brad	Baker	2017-10-01	23:00:00	07:00:00	15	Req-off
OR	Charles	Chaplan	2017-10-01	23:00:00	07:00:00	37	Call-off
OR	Mark	Morris	2017-10-01	07:00:00	15:00:00	32	Call-in
OR	Nick	Norton	2017-10-01	07:00:00	15:00:00	23	Call-off
OR	Tom	Tarantino	2017-10-01	23:00:00	07:00:00	27	Call-off
PSYCH	Sam	Saville	2017-10-01	23:00:00	07:00:00	38	Call-in
QUARR	Frank	Farris	2017-10-01	15:00:00	23:00:00	32	Call-in
QUARR	George	Grant	2017-10-01	07:00:00	15:00:00	19	Req-off

QUARR	Ivan	Ikarov	2017-10-01	07:00:00	15:00:00	24	Req-off
ER	Nick	Norton	2017-10-01	15:00:00	23:00:00	23	Call-in
ICU	Hank	Hamill	2017-10-01	15:00:00	23:00:00	21	Call-off
ICU	Quinn	Quarrick	2017-10-01	15:00:00	23:00:00	15	Req-in
MAT	Evan	Elliott	2017-10-01	07:00:00	15:00:00	21	Req-in
OR	Derek	Davis	2017-10-01	15:00:00	23:00:00	40	Req-in
OR	Ivan	Ikarov	2017-10-01	07:00:00	15:00:00	24	Call-off
OR	Jack	Joplin	2017-10-01	07:00:00	15:00:00	21	Req-off
OR	Orval	Obrian	2017-10-01	07:00:00	15:00:00	30	Call-in
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PSYCH	George	Grant	2017-10-01	23:00:00	07:00:00	19	Call-in
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QUARR	Brad	Baker	2017-10-01	15:00:00	23:00:00	15	Call-off
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QUARR	Kevin	Keller	2017-10-01	23:00:00	07:00:00	20	Call-in
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ICU	Brad	Baker	2017-10-01	19:00:00	07:00:00	15	Call-in
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ICU	Robert	Rodgers	2017-10-01	19:00:00	07:00:00	17	Req-off
MAT	George	Grant	2017-10-01	19:00:00	07:00:00	19	Req-in
OR	Adam	Apple	2017-10-01	19:00:00	07:00:00	22.5	Call-in
OR	Evan	Elliott	2017-10-01	07:00:00	19:00:00	21	Req-off
PSYCH	Frank	Farris	2017-10-01	19:00:00	07:00:00	32	Req-in
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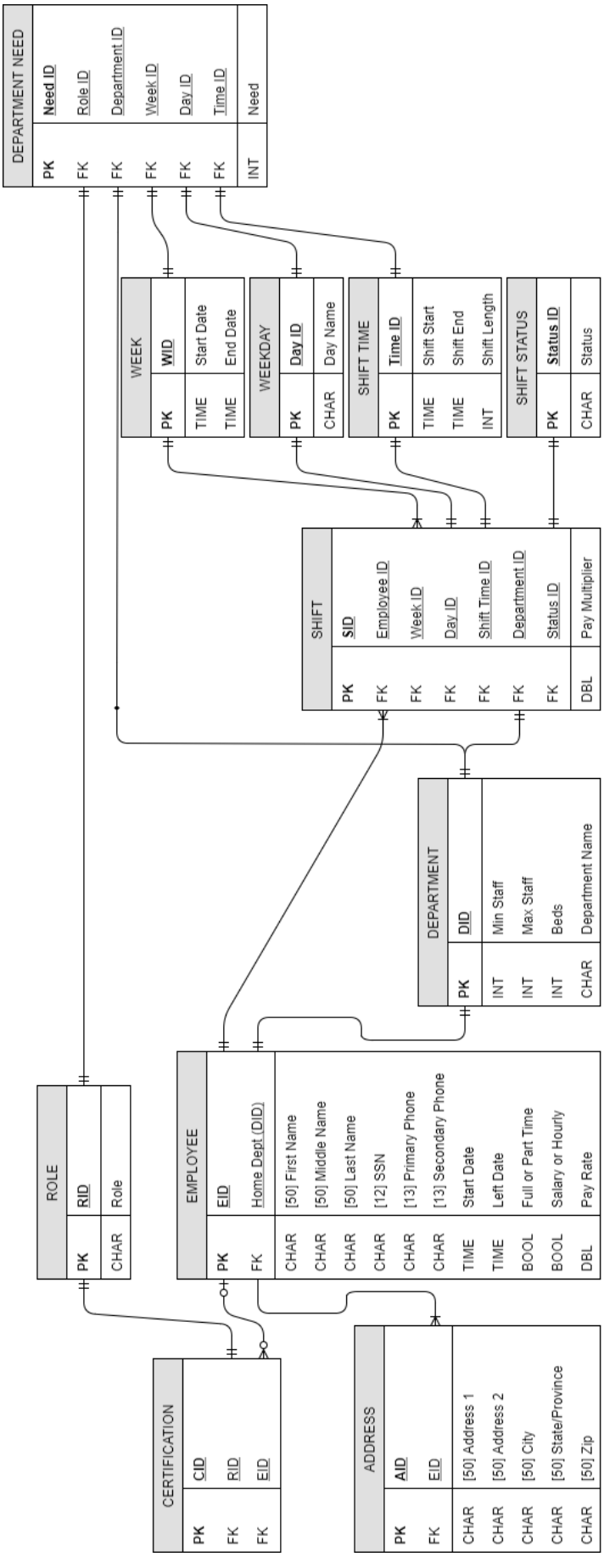
QUARR	Charles	Chaplan	2017-10-01	07:00:00	19:00:00	37	Req-off
QUARR	Nick	Norton	2017-10-01	19:00:00	07:00:00	23	Call-in
QUARR	Quinn	Quarrick	2017-10-01	07:00:00	19:00:00	15	Call-off

Final Notes

In closing, the supplied data model, table structures, and queries will return the data required by the specification documents. The indexes implemented should provide a considerable performance speedup as the database grows. Output returned by the MySQL queries shall be parse-able by the program supplied by your company in order to create the desired output formats.

Data Model


DEPARTMENT NEED
PK Need ID
FK Role ID
FK Department ID
FK Week ID
FK Day ID
FK Time ID
INT Need
WEEK
PK WID
TIME Start Date
TIME End Date
WEEKDAY
PK Day ID
CHAR Day Name
SHIFT TIME
PK Time ID
TIME Shift Start
TIME Shift End
INT Shift Length
SHIFT STATUS
PK Status ID
CHAR Status
SHIFT
PK SID
FK Employee ID
FK Week ID
FK Day ID
FK Shift Time ID
FK Department ID
FK Status ID
DBL Pay Multiplier
DEPARTMENT
PK DID
INT Min Staff
INT Max Staff
INT Beds
CHAR Department Name
ROLE
PK RID
CHAR Role
EMPLOYEE
PK EID
FK Home Dept (DID)
CHAR [50] First Name
CHAR [50] Middle Name
CHAR [50] Last Name
CHAR [12] SSN
CHAR [13] Primary Phone
CHAR [13] Secondary Phone
TIME Start Date
TIME Left Date
BOOL Full or Part Time
BOOL Salary or Hourly
DBL Pay Rate
CERTIFICATION
PK CID
FK RID
FK EID
ADDRESS
PK AID
FK EID
CHAR [50] Address 1
CHAR [50] Address 2
CHAR [50] City
CHAR [50] State/Province
CHAR [50] Zip