Relational algebra
Answers to exercises
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Q1: $\pi_{dno,name}(Driver \bowtie \sigma_{date='14-2-2017'}(Schedule))$

Q2:
$\pi_{dno,name}(Driver \bowtie \sigma_{date='14-2-2017'}(Schedule) \bowtie \sigma_{cap>60}(Bus))$
or
$\pi_{dno,name}(\sigma_{(cap>60 \wedge date='14-2-2017')}(Driver \bowtie Schedule \bowtie Bus))$

While this alternative approach leads to the same result, it requires more space and time resources (without optimization).

Q3:
$\pi_{dno,dname}((\pi_{dno}(Driver) -$
$\pi_{dno}(Schedule \bowtie (\sigma_{type='A'}(Bus)))) \bowtie Driver)$

Q4:
$\pi_{dno,dname}((\pi_{dno}(Driver) -$
$\pi_{dno}(Schedule \bowtie (\sigma_{type\neq'A'}(Bus)))) \bowtie Driver)$

Q5: $\pi_{dno,name,rtid}(Driver \bowtie Schedule) \div \pi_{rtid}(\sigma_{nr-of-stops>10}(Route))$

Note that we make use of the convention that unary operators have a higher precedence than binary operators.

Q6:
$S1 := \sigma_{date='14-2-2017'}(Schedule)$;
$S2 := \sigma_{date='14-2-2017'}(Schedule)$;

$Result := \pi_{S1.dno}(S1 \bowtie_\theta S2)$
with $\theta : S1.dno = S2.dno \wedge S1.rtid \neq S2.rtid$

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$R \cap S \equiv R - (R - S))$

$R[X, Y] \div S[Y] \equiv \pi_X(R) - \pi_X((\pi_X(R) \times S) - R)$

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(i) No. The NOT can be expressed using a minus. The AND and OR can be expressed by intersection and union.

(ii) The algebra also serves as an intermediate language for query processing. For this purpose, the operators should reflect the physical operations to some extent. A selection is calculated basically by a single table scan, also in the case of more complicated selection predicates with AND, OR and NOT. We do not need minus, intersection or union to calculate a selection of this kind.

The same argument explains why we distinguish the (equi) join from a cartesian product followed by a selection. It can be calculated much more efficiently

than a cartesion product.

(iii) Again, if we did, the evaluation of a selection would require in general more complicated physical operations than a single scan, for instance a join with other tables.