Tutorial 7: Basic Relational Algebra

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Consider a database consisting of the relations, where the primary key of each relation is underlined.

sailors(<u>sid</u>, sname, rating, age)
boats(<u>bid</u>, bname, color)
reserved(<u>sid</u>, <u>bid</u>, date)

1. Find the names of sailors who have reserved at least two different boats with the same color.

   - **RA**
     $rb \leftarrow \pi_{sid,bid,color}(reserved \bowtie boats)$
     $good \leftarrow \pi_{sid}(rb \bowtie_{rb.sid=rb2.sid \wedge\ rb.bid \neq rb2.bid \wedge\ rb.color=rb2.color}\ (\rho_{rb2}(rb)))$
     $answer \leftarrow \pi_{sname}(good \bowtie sailors)$
   - **Datalog**
     $rb(S, B, C) \leftarrow reserved(S, B, \_),\ boats(B, \_, C)$
     $good(S) \leftarrow rb(S, B, C),\ rb(S, B', C),\ B \neq B'$
     $answer(N) \leftarrow good(S),\ sailors(S, N, \_, \_)$

2. Find the names of sailors who have reserved all red boats.

   - **RA**
     $allred \leftarrow \pi_{bid}(\sigma_{color='red'}boats)$
     $good \leftarrow (\pi_{sid,bid}reserved) \div allred$
     $answer \leftarrow \pi_{sname}(good \bowtie sailors)$
   - **Datalog**
     $allred(B) \leftarrow boats(B, \_,\ 'red')$
     $witness(S, B) \leftarrow reserved(S, B, \_),\ allred(B)$
     $bad(S) \leftarrow sailors(S, \_, \_, \_),\ allred(B),\ \neg witness(S, B)$
     $good(S) \leftarrow reserved(S, \_, \_),\ \neg bad(S)$
     $answer(N) \leftarrow sailors(S, N, \_, \_),\ good(S)$

3. Find the name and color of boats which are reserved by all sailors rated above 7.

   - **RA**
     $above7 \leftarrow \pi_{sid}(\sigma_{rating>7} sailors)$
     $witness \leftarrow \pi_{sid,bid}(above7 \bowtie reserved)$
     $bad \leftarrow \pi_{bid}(above7 \times \pi_{bid} reserved - witness)$
     $good \leftarrow \pi_{bid} reserved - bad$
     $answer \leftarrow \pi_{bname,color}(good \bowtie boats)$
   - **Datalog**
     $above7(S) \leftarrow sailors(S, \_, R, \_),\ R > 7$
     $witness(S, B) \leftarrow reserved(S, B, \_),\ above7(S)$
     $bad(B) \leftarrow above7(S),\ reserved(\_, B, \_),\ \neg witness(S, B)$
     $good(B) \leftarrow reserved(\_, B, \_),\ \neg bad(B)$
     $answer(N, C) \leftarrow good(B),\ boats(B, N, C)$

4. Find the name(s) of sailors with the lowest rating.

   - **RA**
     $notlowest \leftarrow \pi_{sailors.sid}(sailors \bowtie_{sailors.rating>sailors2.rating} (\rho_{sailors2} sailors))$
     $lowest \leftarrow \pi_{sname}((\pi_{sid} sailors - notlowest) \bowtie sailors)$
   - **Datalog**
     $notlowest(S) \leftarrow sailors(S, \_, R, \_),\ sailors(S', \_, R', \_), R > R'$
     $lowest(N) \leftarrow sailors(S, N, \_, \_),\ \neg notlowest(S)$

5. Find the name and rating of the oldest sailor(s).

   - **RA**
     $notoldest \leftarrow \pi_{sailors.sid}(sailors \bowtie_{sailors.age<sailors2.age} (\rho_{sailors2} sailors))$
     $oldest \leftarrow \pi_{sname,rating}((\pi_{sid} sailors - notoldest) \bowtie sailors)$
   - **Datalog**
     $notoldest(S) \leftarrow sailors(S, \_, \_, A),\ sailors(S', \_, \_, A'),\ A < A'$
     $oldest(N, R) \leftarrow sailors(S, N, R, \_),\ \neg notoldest(S)$

6. Find the names of sailors who have reserved every boat reserved by those with a lower rating. E.g., if Bob is a sailor rated at 6, Pete and Rick are sailors rated below 6, then Bob must have reserved every boat reserved by Pete as well as those reserved by Rick. Can you express this query using RA?s division operator? Explain your answer.

   Answer

   We cannot express this query using RA's division operator. Because the denominator is the set of boats that are reserved by those with a lower rating. For each sailor, the set of sailors that have a lower rating can vary, thus the set of boats reserved by those with a lower rating can vary. RA's division expression cannot express varying denominator.

- **RA**
  $map \leftarrow \rho_{sailors2.sid \to sid2}(sailors \bowtie_{rating > sailors2.rating} (\rho_{sailors2}(sailors)))$
  $from \leftarrow \pi_{sid,sid2,bid}(map \bowtie_{sid2=reserved.sid} reserved)$
  $witness \leftarrow \pi_{sid,sid2,bid}(map \bowtie_{sid=reserved.sid} reserved)$
  $bad \leftarrow \pi_{sid}(from - witness)$
  $good \leftarrow \pi_{sname}((\pi_{sid} reserved - bad) \bowtie sailors)$
- **Datalog**
  $witness(S, B) \leftarrow reserved(S, B, \_)$
  $bad(S) \leftarrow sailors(S, N, R, \_), sailors(S', \_, R', \_),\ R > R',\ \neg witness(S, B),\ witness(S', B')$
  $good(N) \leftarrow sailors(S, N, \_, \_),\ \neg bad(S)$