CS 1555/2055: Database Management Systems

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Sample Solution to Relational Algebra

1. [18 points: 6 points each]:

   a) $\pi_{country}(Users)$
      Arity: 1
      Cardinality Min: 1, Max: 100

   b) $Mail \; \bar{} \bowtie_{Mail.mailID=Recipients.mailID} Recipients$
      Arity: 9
      Cardinality Min: 2000, Max: 5499
      3500 is an acceptable max only if they state the assumption that each mail has at least one recipient

   c) $Mail * Labels$
      Arity: 8
      Cardinality: 2500

2. [82 points total]:

   a) [15 points] List the sender's first and last name, his/her user ID, the subject, and the time sent of all urgent mails.

   $$\pi_{senderID,fname,lname,subject,timeSent}(\sigma_{urgent=true}(Mail \bowtie_{Mail.senderID=Users.userID} Users))$$

   b) [15 points] List all user IDs of users who have sent at least one urgent mail and live outside the USA.

   $$\pi_{Mail.senderID}(\sigma_{(urgent=true \wedge \neg(country='USA'))}(Mail \bowtie_{Mail.senderID=Users.userID} Users))$$

   c) [15 points] Count the number of mails sent during the year of 2015 that have the label "important" but were not flagged as urgent.

   $$NOTURG \leftarrow Labels*(\sigma_{urgent=false \wedge timeSent \geqslant '2015-01-01\,00:00:00' \; \wedge \; timeSent < '2016-01-01\,00:00:00'}(Mail))$$
   $$\mathcal{F}_{<\text{COUNT } msgID>}(\sigma_{label='important'}(NOTURG))$$

   d) [17 points] List the first and last names of all the users who have sent mails to the everyone Ada Lovelace has sent a mail to.

   $$ADAID \leftarrow \pi_{userID}(\sigma_{fname='Ada' \; \wedge \; lname='Lovelace'}(Users))$$
   $$ADAMSG \leftarrow ADAID \bowtie_{ADAID.userID=Mail.senderID} Mail$$
   $$RecvMSGFromADA \leftarrow \pi_{Recipients.recipientID}(ADAMSG * Recipients)$$
   $$UIDS \leftarrow (Mail * Recipients) \div ADATO$$
   $$Result \leftarrow \pi_{fname, \; lname}(UIDS \bowtie_{senderID=userID} Users)$$

e) [20 points] List all mail IDs of all mails that are not replies and have either a sender or recipient that lives in the USA.

$USAU \leftarrow \sigma_{Users.country='USA'}(Users)$

$USAS \leftarrow \pi_{msgID}(Mail \bowtie_{Mail.senderID=USAU.userID} USAU)$

$USAR \leftarrow \pi_{msgID}(Recipients \bowtie_{Recipients.recipientID=USAU.userID} USAU))$

$REPS \leftarrow \pi_{msgID}(\sigma_{\neg(replyTo=NULL)}(Mail)$

$Result \leftarrow (USAS \bigcup USAR) - REPS$