

1.

a) $\pi_{\text{country}}(\text{Users})$

Assume that there must be at least one record or tuple

Arity : 1

Cardinality – Min: 1 Max: 100

b) $\text{Mail} \bowtie_{\text{Mail.mailID}=\text{Recipients.mailID}} \text{Recipients}$

Arity: 9

Assume that each mail has at least 1 recipient (to meet join condition perfectly)

Cardinality – Min: 2000 Max: 3500

c) $\text{Mail} * \text{Labels}$ (Natural Join)

Arity: 8

Cardinality: 2500

2.

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

b)

$\text{table1} \leftarrow \sigma_{\text{urgent}=\text{True} \wedge \text{country} \neq \text{'USA'}} (\text{Mail} \bowtie_{\text{Mail.senderID}=\text{Users.userID}} \text{Users})$

$\text{RSLT} \leftarrow \pi_{\text{userID}} (\text{table1})$

c)

$\text{important} \leftarrow (\text{Mail} * (\sigma_{\text{label}=\text{'important'}} \text{Labels}))$

$\text{table1} \leftarrow \sigma_{\text{urgent}=\text{False} \wedge \text{timeSent} \geq \text{'2015-01-01 00:00:00'} \wedge \text{timeSent} < \text{'2016-01-01 00:00:00'}} (\text{important})$

$\text{RSLT} \leftarrow F_{\text{count mailID}}(\text{table1})$

d)

$$\text{AdaUserID} \leftarrow \pi_{\text{userID}}(\sigma_{\text{fname}='Ada' \wedge \text{lname}='Lovelace'}(\text{Users}))$$

$$\text{AdaMails} \leftarrow \text{AdaUserID} \bowtie_{\text{AdaUserID.userID}=\text{Mail.senderID}} \text{Mail}$$

$$\text{RecFromAda} \leftarrow \pi_{\text{Recipient.recipientID}}(\text{Recipients} * \text{AdaMails})$$

$$\text{EveryoneExceptAda} \leftarrow \pi_{\text{mailID}}(\text{Recipients} * \text{RecFromAda}) - \pi_{\text{mailID}}(\text{AdaMails})$$

$$\text{SendersExceptAda} \leftarrow \pi_{\text{senderID}}(\text{Mail} * \text{EveryoneExceptAda})$$

$$\text{RSLT} \leftarrow \pi_{\text{Rfname, lname}}(\text{SendersExceptAda} \bowtie_{\text{SendersExceptAda.senderID}=\text{Users.userID}} \text{Users})$$

e)

$$\text{senderInUSA} \leftarrow \pi_{\text{mailID}}(\sigma_{\text{country}='USA'}(\text{Mail} \bowtie_{\text{Mail.senderID}=\text{Users.userID}} \text{Users}))$$

$$\text{recipientInUSA} \leftarrow \pi_{\text{mailID}}(\sigma_{\text{country}='USA'}(\text{Recipients} \bowtie_{\text{Recipients.recipientID}=\text{Users.userID}} \text{Users}))$$

$$\text{senderRecipientInUSA} \leftarrow \text{senderInUSA} \cup \text{recipientInUSA}$$

$$\text{RSLT} \leftarrow \pi_{\text{mailID}}(\text{senderRecipientInUSA} * (\sigma_{\text{replyTo}=\text{NULL}} \text{Mail}))$$