Part A. Relational Algebra [70 pts]

Write the following queries in the relational algebra against the TopicalBirds.com test relations. Show the parse tree and result of each query that you wrote where requested to do so. We suggest that you write your relational algebra expressions on paper first before attempting to execute them on the Relational Algebra Calculator site. Please note that you will not get any points for giving the result of a query on this assignment if your relational algebra expression is not correct (!). Since you have a “live” algebra interpreter at your disposal, this should not be an issue – you will be able to test all of your queries that way.

1. [10pts] Find all Chirps whose sentiment is greater than 0.9.
   a) [6pts] Relational Algebra
      \[ \sigma_{\text{sentiment} > 0.9} (\text{Chirp}) \]
   b) [1pt] Parse Tree
      ![Parse Tree]
   c) [3pts] Result

<table>
<thead>
<tr>
<th>Chirp.btag</th>
<th>Chirp.cno</th>
<th>Chirp.date</th>
<th>Chirp.location_latitude</th>
<th>Chirp.location_longitude</th>
<th>Chirp.parrots_btag</th>
<th>Chirp.parrots_cno</th>
<th>Chirp.sentiment</th>
<th>Chirp.text</th>
<th>Chirp.text</th>
</tr>
</thead>
<tbody>
<tr>
<td>dfowler</td>
<td>2</td>
<td>2017-02-19</td>
<td>-2.440044</td>
<td>46.853043</td>
<td>realDonaldTrump</td>
<td>5</td>
<td>1</td>
<td>Checking Surface this morning. love the size. it is really awesome</td>
<td></td>
</tr>
<tr>
<td>dfowler</td>
<td>3</td>
<td>2017-02-05</td>
<td>-46.253588</td>
<td>83.33612</td>
<td>realDonaldTrump</td>
<td>1</td>
<td>1</td>
<td>Just got iPaone this morning. love its size. it is really good</td>
<td></td>
</tr>
<tr>
<td>HillaryClinton</td>
<td>0</td>
<td>2017-02-03</td>
<td>-54.338044</td>
<td>-90.433995</td>
<td>null</td>
<td>null</td>
<td>1</td>
<td>At 103 Ruline Steininger had an energy &amp; vibrancy all should aspire to. My thoughts &amp; prayers are w/ her family. <a href="https://t.co/LQ1qozY3NH">https://t.co/LQ1qozY3NH</a></td>
<td></td>
</tr>
<tr>
<td>HillaryClinton</td>
<td>3</td>
<td>2017-01-23</td>
<td>-77.975923</td>
<td>160.49942</td>
<td>null</td>
<td>null</td>
<td>1</td>
<td>.@MichaelNutter got a lot of great points into 140 characters here. We have to keep the</td>
<td></td>
</tr>
</tbody>
</table>
2. [10pts] Print the tag, first name, last name, and gender of Birds whose last name is ‘Trump’.

a) [6pts] Relational Algebra

\[ \pi \text{btag, first_name, last_name, gender} (\sigma \text{last_name = 'Trump'} (\text{Bird})) \]

b) [1pt] Parse Tree

```
\Pi \text{btag, first_name, last_name, gender}

\sigma \text{last_name = 'Trump'}

\text{Bird}
```

c) [3pts] Result

```
Bird.btag  Bird.first_name  Bird.last_name  Bird.gender
realDonaldTrump  Donald  Trump  M
```

3. [10pts] Print the tag, email address, signup date, first name, and last name of Birds whose first name is ‘Hillary’.

a) [6pts] Relational Algebra
4. [10pts] Find the btag, chirp number, chirp date, and text of all Chirps uttered by a Bird whose email address is 'realDonaldTrump@gibson.info'.

a) [6pts] Relational Algebra

\[ \pi \text{btag, cno, date, text} ((\sigma \text{email} = 'realDonaldTrump@gibson.info' (User)) \bowtie \text{User.tag = Chirp.btag} (\text{Chirp})) \]

b) [1pt] Parse Tree

```
\Pi \text{btag, cno, date, text}
    \bowtie \text{User.tag = Chirp.btag}
\downarrow
\sigma \text{email = 'realDonaldTrump@gibson.info'} \text{User}
```

4. [10pts] Find the btag, chirp number, chirp date, and text of all Chirps uttered by a Bird whose email address is 'realDonaldTrump@gibson.info'.

a) [6pts] Relational Algebra

\[ \pi \text{btag, cno, date, text} ((\sigma \text{email} = 'realDonaldTrump@gibson.info' (User)) \bowtie \text{User.tag = Chirp.btag} (\text{Chirp})) \]

b) [1pt] Parse Tree

```
\Pi \text{btag, cno, date, text}
    \bowtie \text{User.tag = Chirp.btag}
\downarrow
\sigma \text{email = 'realDonaldTrump@gibson.info'} \text{User}
```

c) [3pts] Result

<table>
<thead>
<tr>
<th>Bird.btag</th>
<th>User.email</th>
<th>User.signup_date</th>
<th>Bird.first_name</th>
<th>Bird.last_name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hillary</td>
<td>Clinton</td>
<td>2000-06-05</td>
<td>Hillary</td>
<td>Clinton</td>
</tr>
</tbody>
</table>
5. [10pts] Find the tag, email address, gender, and varieties of all of the Peacocks.

a) [6pts] Relational Algebra

\[ \pi_{p\text{tag}, \text{email}, \text{gender}, \text{variety}} ((\text{Peacock} \bowtie_{\text{Peacock.p\text{tag} = Bird.b\text{tag}}} \text{Bird}) \bowtie_{\text{Bird.b\text{tag} = User.tag}} \text{User})) \]

b) [1pt] Parse Tree

![Parse Tree Diagram]

c) [3pts] Result

<table>
<thead>
<tr>
<th>Peacock.p\text{tag}</th>
<th>User.email</th>
<th>Bird.g\text{ender}</th>
<th>Peacock.\text{variety}</th>
</tr>
</thead>
<tbody>
<tr>
<td>HillaryClinton</td>
<td><a href="mailto:HillaryClinton@schmitt-lynch.info">HillaryClinton@schmitt-lynch.info</a></td>
<td>F</td>
<td>Politician</td>
</tr>
<tr>
<td>HillaryClinton</td>
<td><a href="mailto:HillaryClinton@schmitt-lynch.info">HillaryClinton@schmitt-lynch.info</a></td>
<td>F</td>
<td>Secretary</td>
</tr>
<tr>
<td>HillaryClinton</td>
<td><a href="mailto:HillaryClinton@schmitt-lynch.info">HillaryClinton@schmitt-lynch.info</a></td>
<td>F</td>
<td>Senator</td>
</tr>
<tr>
<td>realDonaldTrump</td>
<td><a href="mailto:realDonaldTrump@gibson.info">realDonaldTrump@gibson.info</a></td>
<td>M</td>
<td>Actor</td>
</tr>
<tr>
<td>realDonaldTrump</td>
<td><a href="mailto:realDonaldTrump@gibson.info">realDonaldTrump@gibson.info</a></td>
<td>M</td>
<td>Politician</td>
</tr>
</tbody>
</table>

6. [10pts] Find the bird tag, last name, first name, and birth date of any birds who are currently
listening to none of the birds.

a) [6pts] Relational Algebra

\[ \pi \text{ btag, last_name, first_name, birthdate} (\text{Bird} \bowtie \text{Bird.btag=User.tag} (\pi \text{ tag (User)} - \pi \text{ tag (BirdListen)})) \]

b) [1pt] Parse Tree

c) [3pts] Result

<table>
<thead>
<tr>
<th>Bird.btag</th>
<th>Bird.last_name</th>
<th>Bird.first_name</th>
<th>Bird.birthdate</th>
</tr>
</thead>
<tbody>
<tr>
<td>swansonvalerie</td>
<td>Browning</td>
<td>John</td>
<td>1995-03-16</td>
</tr>
</tbody>
</table>

7. [10pts] Find the bird tag, last name, first name, and birth date of any birds who are currently listening to all of the birds.

a) [6pts] Relational Algebra (Hint: Use Division!)

\[ \pi \text{ btag, last_name, first_name, birthdate} (\text{Bird} \bowtie \text{Bird.btag=BirdListen.tag} (\text{BirdListen} \div (\pi \text{ btag (BirdListen)}))) \]

b) [1pt] Parse Tree
Part B. Tuple Relational Calculus [30 pts]

In this part, write the same queries as above using the tuple relational calculus (TRC) against the same relations as above.

1. [2 pts] Find all Chirps whose sentiment is greater than 0.9.
   \{ t \mid t \in \text{Chirps} \ (t.\text{sentiment} > 0.9) \}

2. [3 pts] Print the tag, first name, last name, and gender of Birds whose last name is ‘Trump’.
   \{ t (btag, first_name, last_name, gender) \mid \exists b \in \text{Bird} \ (t.btag = b.btag \land t.first_name = b.first_name \\
   \land t.last_name = b.last_name \land t.gender = b.gender \land b.last_name = 'Trump') \}

3. [5 pts] Print the tag, email address, signup date, first name, and last name of Birds whose first name is ‘Hillary’.
   \{ t (btag, email, signup_date, first_name, last_name) \mid \exists b \in \text{Bird} \ (b.first_name = 'Hillary' \land \\
   \exists u \in \text{User} \ (u.btag = b.tag \land t.btag = b.btag \land t.email = u.email \land t.signup_date = u.signup_date \\
   \land t.first_name = b.first_name \land t.last_name = b.last_name) \}

4. [5 pts] Find the btag, chirp number, chirp date, and text of all Chirps uttered by a Bird whose email address is ‘realDonaldTrump@gibson.info’.
   \{ t(btag, cno, date, text) \mid \exists u \in \text{User} \ (u.email = 'realDonaldTrump@gibson.info' \land \\
   \exists c \in \text{Chirp} \ (c.btag=u.tag \land t.btag=c.btag \land t.cno=c.cno \land t.date=c.date \land t.text=c.text)) \}
5. [5 pts] Find the tag, email address, gender, and varieties of all of the Peacocks.

\{t(ptag, email, gender, variety) | \exists p \in \text{Peacock} (t.ptag=p.ptag \land t.variety=p.variety \land
\exists b \in \text{Bird} (p.ptag=b.btag \land t.gender=b.gender \land
\exists u \in \text{User} (u.tag=b.btag \land t.email=u.email) )\}\}

6. [5 pts] Find the bird tag, last name, first name, and birth date of any birds who are currently listening to none of the birds.

\{t(btag,last_name,first_name,birthdate) | \exists b \in \text{Bird} (t.btag=b.btag \land t.last_name=b.last_name \land
 t.first_name=b.first_name \land t.birthdate=b.birthdate \land \forall bl \in \text{BirdListen} (b.btag \neq bl.tag) )\}\}

7. [5 pts] Find the bird tag, last name, first name, and birth date of any birds who are currently listening to all of the birds. (Hint: Use Universal Quantification!)

\{t(btag,last_name,first_name,birthdate) | \exists b1 \in \text{Bird} (t.btag=b.btag \land t.last_name=b.last_name \land
 t.first_name=b.first_name \land t.birthdate=b.birthdate \land
\forall b2 \in \text{Bird} ( \exists BL \in \text{BirdListen} (b1.btag = BL.tag \land b2.btag = BL.btag)) )\}\}