



CREW_MEMBER	SSN	Name	Bdate
	123-45-678	John Doe	5-Jul-75
	997-65-432	Jane Smith	1-Mar-45

FLIGHT_INSTANCE	FlightID	FlightNum	Date	Plane_ID	Actual_Dep_Time	Actual_Arr_Time
	AA11091006	AA11	9-Jul-06	55555	0930	1300
	JB234090806	JB234	8-Sep-06	55558	1600	1730

FLIGHT_TEMPLATE	FlightNum	Schedule	Departure_Time	Arrival_Time	Arrival_Code	Departure_Code	Airline_Name
	AA11	Weekly	0930	1300	JFK	LAX	American
	JB234	Weekend	1700	1830	BWI	JFK	JetBlue

AIRPORT	Code	City	State	Miles_to_City	Airplane_Weight_Limit
	BWI	Baltimore	MD	20	100
	JFK	New York	NY	15	200

Certified_to_Fly	Crew SSN	Aircraft_Type
	997-65-432	B747
	927-35-432	A67

AIRCRAFT_TYPE	TypeID	Model	Manufacturer	Seating Capacity	Weight	Crew
	B747	747	Boeing	45	30	5
	A67	67	Airbus	200	100	10

PHYSICAL_AIRCRAFT	ID Number	Aircraft_Type
	55555	A67
	55558	B23

Works_on_Flight	Crew SSN	FlightID	Role
	997-65-432	AA11091006	Pilot
	997-65-432	JB234090806	CoPilot

PHYSICAL_AIRCRAFT	ID Number	Aircraft_Type
	55555	A67
	55558	B23

FLIGHT_INSURANCE	FlightID	FlightNum	Date	Plane_ID	Actual_Dep_Time	Actual_Arr_Time
	AA11091006	AA11	9-Jul-06	55555	930	1300
	JB234090806	JB234	8-Sep-06	55558	1600	1730

AIRPORT	Code	City	State	Miles_to_City	Max_Aircraft_Weight
	BWI	Baltimore	MD	20	100
	JFK	New York	NY	15	200

CREW_MEMBER	SSN	Name	Bdate
	123-45-678	John Doe	7/5/1975
	997-65-432	Jane Smith	3/1/1945

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	997-65-432	AA11091006	Pilot
	997-65-432	JB234090806	CoPilot

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### 1.3

**GIVEN:**  $\sigma_{\langle \text{condition} \rangle} (A \times B) = A \leftrightarrow_{\langle \text{condition} \rangle} B$

**A) List the city, airport-code and miles from the city of all airports in Iowa:**

$\pi_{\text{City, Code, Miles\_to\_city}} (\sigma_{\text{State}=\text{"IA"}} (\text{AIRPORT}))$

**B) For each Delta airline flight that is scheduled to depart BWI weekdays before 0900 hours, list the scheduled arrival time and arrival city code.**

$\pi_{\text{Arrival Time, Destination Code}} (\sigma_{\text{Airline Name}=\text{"Delta"} \wedge \text{Departure Code}=\text{"BWI"} \wedge \text{Schedule}=\text{"Weekdays"} \wedge \text{Departure\_Time} < 0900} (\text{FLIGHT\_TEMPLATE}))$

**C) List the actual arrival time, arrival city code, and airplane ID number for all flights on 17-JUL-09.**

$\pi_{\text{Actual Arr Time, Arrival Code, Plane ID}} ((\sigma_{\text{Date}=\text{"17-JUL-09"}} (\text{FLIGHT\_INSTANCE})) \leftrightarrow \text{FLIGHT\_TEMPLATE})$

Note: implicit join criteria: only FlightNum in common (will follow this convention).

**D) List airport code, city and state of the destination of all flights that are scheduled to depart BWI on weekends.**

$\text{FLTBWIWKND} \leftarrow \sigma_{\text{Departure Code}=\text{"BWI"} \wedge (\text{Schedule}=\text{"Weekend"} \vee \text{Schedule}=\text{"Daily"})} (\text{FLIGHT\_TEMPLATE})$

$\pi_{\text{Code, City, State}} (\text{FLTBWIWKND} \leftrightarrow \text{Arrival\_Code}=\text{Code} \text{ AIRPORT})$

**E) List name, SSN, birth date and position working of all flights on 14-AUG-09 that actually arrived in BWI before 2200 hours.**

$\text{FLT14AUG09} \leftarrow \pi_{\text{FlightID, FlightNum}} (\sigma_{\text{Actual Arr Time} < 2200 \wedge \text{Date}=\text{"14-AUG-09"}} (\text{FLIGHT\_INSTANCE}))$

Make sure they are from BWI (FlightNum in common.)

$\text{FLT14AUG09BWI} \leftarrow \pi_{\text{FlightID}} (\sigma_{\text{Arrival Code}=\text{"BWI"}} (\text{FLT14AUG09} \leftrightarrow \text{FLIGHT\_TEMPLATE}))$

$\pi_{\text{Name, SSN, BDate, Role}} (\text{FLT14AUG09BWI} \leftrightarrow \text{Works\_On\_Flight} \leftrightarrow \text{CrewSSN}=\text{SSN} \text{ CREW\_MEMBER})$

**F) List all flight crew members that are certified to fly Boeing 737's that actually flew Boeing 737 on 29-SEP-09.**

$B737 \leftarrow \pi_{typeID} (\sigma_{Model=737 \wedge Manufacturer="Boeing"} (AIRCRAFT\_TYPE))$

$FLTS29SEP09 \leftarrow \pi_{FlightID, Plane\_ID} (\sigma_{Date="29-SEP-09"} (FLIGHT\_INSTANCE))$

This finds all the flights that used 737 yesterday:

$B73729SEP09 \leftarrow \pi_{FlightID, typeID} (FLTS29SEP09 \leftrightarrow Plane\_ID=ID\_Number$   
 $PHYSICAL\_AIRCRAFT \leftrightarrow B737)$

This finds all the crew on those flights that are certified to fly:

$\pi_{Name} ((FLTS29SEP09 \leftrightarrow Works\_On\_Flight \leftrightarrow Certified\_To\_Fly) \leftrightarrow CrewSSN=SSN$   
 $CREW\_MEMBER)$

**G) List the types of aircraft (manufacturer, model, weight, seats) that are small enough to land in one of the airports in Delaware**

Find all the airplane types that can land on an airport, for every airport in Delaware.

$\pi_{Manufacturer, Model, Weight, Seating\ Capacity} (AIRCRAFT\_TYPE \leftrightarrow Weight \leq Max\ Aircraft\ Weight$   
 $(\sigma_{State="D"} AIRPORT))$

**H) List the airlines that have flights from some city in Maryland to some city in California.**

$MDCODES = \pi_{Code} (\sigma_{state="MD."} AIRPORT)$

$CALCODES = \pi_{Code} (\sigma_{state="Cal"} AIRPORT)$

$\pi_{Airline} (MDCODES \leftrightarrow MDCODES.Code=Departure\ Code\ FLIGHT\_TEMPLATE \leftrightarrow$   
 $Arrival\_Code=CALCODES.Code\ CALCODES)$

## PART 2.

1. List the name of every bar that Joe Biden has visited more than once.

$VISITEDBARS \leftarrow \pi_{BNO} (\sigma_{DName='Joe Biden' \wedge NumberOfTimes > 1} (DRINKER \leftrightarrow VISIT))$

BNO in common:

$\pi_{BarName} (VISITEDBARS \leftrightarrow BARS)$

### *Tuple Relational Calculus:*

$\{ t \mid \exists b \in BAR ( t [ BarName ] = b [ BarName ]$   
 $\wedge \exists u \in VISIT ( u [ BNO ] = b [ BNO ]$   
 $\wedge \exists d \in DRINKER ( d [ DLicNo ] = u [ DLicNo ]$   
 $\wedge d [ DName ] = "Joe Biden"$   
 $\wedge u [ NumberOfTimes ] > 1 ) ) ) \}$

2. List the names of bars in Maryland that are not in the Baltimore and do not serve Bud Lite.

$MDBARS \leftarrow \pi_{BNO} (\sigma_{BState='MD' \wedge BCity \neq Baltimore} (BAR))$

$MDBARSNOBUD \leftarrow (MDBARS) - \pi_{BNO} (\sigma_{BeerName='Bud Lite'} (MDBARS \leftrightarrow SERVES))$

BNO in common:

$\pi_{BarName} (MDBARSNOBUD \leftrightarrow BAR)$

### *Tuple Relational Calculus:*

$\{ t \mid \exists b \in BAR ( t [ BarName ] = b [ BarName ]$   
 $\wedge b [ BState ] = "MD"$   
 $\wedge b [ BCity ] \neq "Baltimore"$   
 $\wedge \neg \exists s \in SERVES ( b [ BNO ] = s [ BNO ] \wedge s [ BeerName ] = "Bud Lite" ) ) \}$

3. List the names of all people under 30 who have visited at least one bar in Georgetown and like Bud Lite and do not like Miller Lite.

$PEOPLEU30 \leftarrow \pi_{DLicNo, DName} (\sigma_{Age < 30} (DRINKER))$

$VISITEDGBAR \leftarrow \pi_{DLicNo, DName} ((PEOPLEU30 \leftrightarrow VISIT) \leftrightarrow (\sigma_{BCity = "Georgetown"} (BAR)))$

$\pi_{Name} (\sigma_{BeerName='Bud Lite'} (VISITEDGBAR \leftrightarrow LIKES)) - \pi_{Name} (\sigma_{BeerName='Miller Lite'} (VISITEDGBAR \leftrightarrow LIKES))$

### Tuple Relational Calculus:

$\{ t \mid \exists d \in DRINKER ( t [ DName ] = d [ DName ]$   
 $\wedge d[Age] < 30$   
 $\wedge \exists u \in VISIT ( u [ DLicNo ] = d [ DLicNo ]$   
 $\wedge \exists b \in BAR ( b [ BNO ] = u [ BNO ]$   
 $\wedge b [ BCity ] = "Georgetown"$   
 $\wedge \exists k1 \in LIKES ( k1 [ LIKES ] = d [ DLicNo ]$   
 $\wedge k1 [ BeerName ] = "Bud Lite"$   
 $\wedge \neg \exists k2 \in LIKES ( k2 [ LIKES ] = d [ DLicNo ]$   
 $\wedge k2 [ BeerName ] = "Miller Lite" ) ) ) ) \}$

4. List the name and age of everyone who has visited at least one bar that Joe Biden has visited.

$BARSBCVISITED \leftarrow \pi_{BNO} (\sigma_{DName='Joe Biden'} (DRINKER \leftrightarrow VISITED))$

People that have visited the same bar.

$RESULT \leftarrow \pi_{DLicNo} (VISIT \leftrightarrow BARSBCVISITED)$

$\pi_{DName, Age} (RESULT \leftrightarrow DRINKER) - \pi_{DName, Age} (\sigma_{DName='Joe Biden'} (DRINKER))$

5. List the names and ages of all people who have visited every bar in Towson.

$BARSIN\_T \leftarrow \pi_{BNO} (\sigma_{BCity = Towson} (BAR))$

$\pi_{DName, Age} ((VISIT \div BARSIN\_T) \leftrightarrow DRINKER)$

6. List the names and ages of people who have visited at least every bar that Barak Obama has visited, and has visited all of these bars the identical number of times that Barak Obama has visited.

$BARS\_VISITED \leftarrow \pi_{BNO, NumberOfTimes} ((\sigma_{DName = Barak Obama} (DRINKER)) \leftrightarrow VISIT)$

$RESULT \leftarrow \pi_{DLicNo} (VISIT \div BARSBCVISITED) - \pi_{DLicNo} (\sigma_{DName = "Barak Obama"} (DRINKER))$

$\pi_{DName, Age} (RESULT \leftrightarrow DRINKER)$

**7. List the names and ages of people who have visited every bar that HL Gates has visited and have never visited a bar that James Crowley has visited.**

$$JKVISIT \leftarrow \pi_{BNO} ((\sigma_{DName = \text{"HL Gates"}} (DRINKER)) \leftrightarrow VISIT)$$

$$JEVISIT \leftarrow \pi_{BNO} ((\sigma_{DName = \text{"James Crowley"}} (DRINKER)) \leftrightarrow VISIT)$$

$$RESULT \leftarrow \pi_{DLicNo} (JKVISIT \div VISIT) - \pi_{DLicNo} (JEVISIT \leftrightarrow VISIT)$$

$$\pi_{DName, Age} (RESULT \leftrightarrow DRINKER)$$

**8. List the names of people who don't like the beer named for them (e.g. "Sam Adams" drinking a beer called "Sam Adams"), but have visited at least 1 bar named for them.**

$$BARNAMED \leftarrow \pi_{DLicNo, BNO} (DRINKER \leftrightarrow_{DName=BarName} BAR)$$

Find all the tuples that have DLicNo and BNO in common in BARNAMED  $\leftrightarrow$  VISITED which yields people that have visited the bar that is named after them.

$$VISITEDBARNAMED \leftarrow \pi_{DLicNo, DName} (BARNAMED \leftrightarrow VISITED)$$

Find the people that like the beer named after them and remove them from the list:

$$\pi_{DName} (VISITEDBARNAMED) - \pi_{DName} (\sigma_{DName=BeerName} (VISITEDBARNAMED \leftrightarrow LIKES))$$

Assumes that if the beer is not associated with the user in LIKES relation then it is not liked.

**9. List the name of every bar that serves a beer that Joe Biden doesn't like.**

First find all the beers served that are not what Joe Biden likes.

$$JDISLIKES \leftarrow \pi_{BeerName} (SERVES) - \pi_{BeerName} ((\sigma_{DName = \text{"Joe Biden"}} (DRINKER)) \leftrightarrow LIKES)$$

Now find all the bars that serve any of those beers.

$$\pi_{BarName} (JDISLIKES \leftrightarrow SERVES \leftrightarrow BAR)$$

**10. List the name of every bar in Towson that serves no beer that is served in a Bar in Timonium.**

$BEERINTIM \leftarrow \pi_{BeerName} ((\sigma_{BCity="Timonium"} (BAR)) \leftrightarrow SERVES)$

$BARINTOW\_BEER \leftarrow \pi_{BarName, BeerName} ((\sigma_{BCity="Towson"} (BAR)) \leftrightarrow SERVES)$

Now find all the beer that is only served in towson.

$BEERONLYINTOW \leftarrow (\pi_{BeerName} BARINTOW\_BEER) - BEERINTIM$

Now find the bars in towson that serve that beer. (BeerName is the equality)

$\pi_{BarName} (BEERONLYINTOW \leftrightarrow BARINTOW\_BEER)$