

1. Give all the ages of clients from Sweden or Norway.

**1. Select Clients from Sweden or Norway from Client table:**

$\sigma_{\text{country}='Sweden' \text{ OR } \text{country}='Norway'}(\text{Client})$

**2. Project age:**

"Ages of clients from Sweden or Norway" =  $\pi_{\text{age}}(\sigma_{\text{country}='Sweden' \text{ OR } \text{country}='Norway'}(\text{Client}))$

2. Give all the urls of pages owned by Ving that have been visited.

**1. Get all pages owned by Ving**

$\sigma_{\text{owner}='Ving'}(\text{Page})$

**2. Get all pages that have been visited and are owned by Ving**

$(\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \sigma_{\text{owner}='Ving'}(\text{Page}))$

**3. Project all urls**

"urls of visited pages owned by Ving" =  $\pi_{\text{url}}((\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \sigma_{\text{owner}='Ving'}(\text{Page})))$

3. Give all the countries of clients who have visited a web page with the owner 'Ving'

**1. Get pages owned by Ving**

$\sigma_{\text{owner}='Ving'}(\text{Page})$

**2. Get all visited pages with owner Ving**

$\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} (\sigma_{\text{owner}='Ving'}(\text{Page}))$

**3. Get all clients that have visited the pages**

$\text{Client} \bowtie_{\text{Client.id}=\text{Visits.client}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} (\sigma_{\text{owner}='Ving'}(\text{Page})))$

**4. Project country:**

"Countries of clients who have visited a page owned by Ving" =

$\pi_{\text{country}}(\text{Client} \bowtie_{\text{Client.id}=\text{Visits.client}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} (\sigma_{\text{owner}='Ving'}(\text{Page}))))$

4. Give the ids of pages that have been visited more than once

**1. Get visited pages**

$\sigma_{\text{Visits.page}=\text{Page.id}}(\text{Visits} \times \text{Page})$

**2. Get pages with more than one visit**

$(\rho_{\text{timestamp1,client,page,id,url,owner}}(\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page})) \bowtie (\sigma_{\text{Visits.page}=\text{Page.id}}(\text{Visits} \times \text{Page}))$

**3. Do select operation to entries with more than one visit**

$\sigma_{\text{timestamp} \neq \text{timestamp1}}((\rho_{\text{timestamp1,client,page,id,url,owner}}(\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page})) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$

**3. Project id**

"id of pages visited more than once" =

$\pi_{\text{id}}(\sigma_{\text{timestamp} \neq \text{timestamp1}}((\rho_{\text{timestamp1,client,page,id,url,owner}}(\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page})) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page})))$

5. Give the ids of pages that have been visited exactly twice

### 1. Get visited pages

$\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}$

### 2. Get pages with more than one visit

$(\sigma_{\text{timestamp} \neq \text{timestamp1}} (\rho_{\text{timestamp1}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$

### 3. Get pages with more than two visits

$(\sigma_{\text{timestamp} \neq \text{timestamp3}} (\rho_{\text{timestamp3}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie$   
 $(\sigma_{\text{timestamp} \neq \text{timestamp2}} (\rho_{\text{timestamp2}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$

### 3. Get entries with more than one and less than three visits

$(\sigma_{\text{timestamp} \neq \text{timestamp1}} (\rho_{\text{timestamp1}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$   
—  
 $(\sigma_{\text{timestamp} \neq \text{timestamp3}} (\rho_{\text{timestamp3}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie$   
 $(\sigma_{\text{timestamp} \neq \text{timestamp2}} (\rho_{\text{timestamp2}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$

### 4. Project id

“id of pages visited two times” =

$\pi_{\text{id}} ((\sigma_{\text{timestamp} \neq \text{timestamp1}} (\rho_{\text{timestamp1}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))$   
—  
 $(\sigma_{\text{timestamp} \neq \text{timestamp3}} (\rho_{\text{timestamp3}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie$   
 $(\sigma_{\text{timestamp} \neq \text{timestamp2}} (\rho_{\text{timestamp2}, \text{client}, \text{page}, \text{id}, \text{url}, \text{owner}} (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page}))) \bowtie (\text{Visits} \bowtie_{\text{Visits.page}=\text{Page.id}} \text{Page})))$

6. Give all the ages of clients from Sweden or Norway (Tuple calculus).

$\{x.age \mid \text{Client}(x) \text{ AND } (x.country = \text{'Sweden'} \text{ OR } x.country = \text{'Norway'})\}$

7. Give all the urls of pages owned by Ving that have been visited. (Tuple calculus)

$\pi_{url}((Visits \bowtie_{Visits.page=Page.id} \sigma_{owner='Ving'}(Page)))$

$\{x.url \mid Page(x) \text{ AND } Visits(y) \text{ AND } y.page=x.id \text{ AND } x.owner='Ving'\}$

8. Give all the countries of clients who have visited a web page with the owner 'Ving' (Tuple calculus)



9. Give the ids of pages that have been visited more than once  
(Tuple calculus)

10. Give the ids of pages that have been visited exactly twice  
(Tuple calculus)