1. SELECT count (a.name)

   FROM music_world.album a

   where a.start_date >= DATE(Y1)

   and   a.end_date <=DATE(Y2)

Π COUNT (name) σ (start_date < y2 ∧ start_date > y1 ∧ end_date < y2 ∧ end_date > y1)(album)

2. select count(t.id) sons

    from music_world.track t,

    music_world.persona m,

    music_world.musician_tracks mt,

    music_world.persona_roles pr,

    music_world.role r

    where t.id = mt.track_id

    and   m.id = mt.musician_id

    and   m.id = pr.persona_id

    and   r.id = pr.role_id

    and   r.name in ('Singer','Player')

    and   t.recording_date between DATE Y1 and DATE Y2

    and   m.name = 'Shalom Hanoch';

Π COUNT (t.id) , σ (m. name = x and t. start_date < y2 ∧ t. start_date >
y1 and t. end_date < y2 and t. end_date > y1
(track ⋈ persona ⋈ tracks ⋈ persona_roles ⋈ role))

3. select count(a.id) albums

   from music_world.track t,

    music_world.persona m,

   music_world.musician_tracks mt,

   music_world.persona_roles pr,

   music_world.role r,

   music_world.album a,

   music_world.album_tracks atr

   where t.id = mt.track_id

   and   m.id = mt.musician_id

   and   m.id = pr.persona_id

   and   r.id = pr.role_id

   and   r.name in ('`Singer','Player')

   and   a.id = atr.album_id

   and   t.id = atr.track_id

   and   ((a.start_date between DATE("2018-01-01") and DATE("2018-01-01")) OR (a.end_date between DATE("2018-01-01") and DATE("2018-01-01"))

   OR (DATE("2018-01-01") between a.start_date and a.end_date))

   and   m.name = 'Shalom Hanoch';

Π **COUNT (a.id)** σ (r. name $\subseteq$ {`Singer$'$ $\wedge'$ Player$'$} $\wedge$ ((a. start_date $<$ y2 and a. start_date $>$ y1) $\vee$ (a. end_date $<$ y2 $\wedge$ a. end_date $>$ y1)) $\vee$ (a. start_date $<$ DATE and a. end_date $>$ DATE) $\wedge$ m. name $=$ $'$Shalom Hanoch$'$)
(**track** $\bowtie$ *persona* $\bowtie$ **musician_tracks** $\bowtie$ **persona_roles** $\bowtie$ *role* $\bowtie$ **album** $\bowtie$ **album_tracks**))

4. with tracks_per_instrument as

(select ti.instrument_id, count(ti.track_id) cnt

from music_world.track_instruments ti

group by ti.instrument_id)

select i.name

from tracks_per_instrument t,

music_world.instrument i

where t.cnt = (select max(t1.cnt)

from tracks_per_instrument t1)

and   t.instrument_id = i.id;

$\rho(T1, \text{TPI})$

$\rho(T2, \text{TPI})$

$\rho(\text{TPI}, \Pi ((\text{ instrument\_id}, COUNT (\text{track\_id})((\text{track\_instruments})\gamma(\text{instrument\_id}))$

$\Pi (\text{instrument}_{\text{name}}) \sigma(\rho(T3, \pi T2.\text{i\_name}(T1 \bowtie T1.\text{cnt} > T2.\text{cnt} T2)$

$(\pi cnt T1) - T3)$ **(TPI $\bowtie$ instrument)**

5. select discint i.name

from music_world.instrument i,

music_world.album a,

music_world.track t,

music_world.track_instruments ti,

music_world.album_tracks atr

where atr.album_id = a.id

and   atr.TRACK_ID = t.id

and   ti.track_id = t.id

and   ti.instrument_id = i.id

and   a.name = x;

$\Pi \pi$ **(i.name) σ (a.name=x)(instrument $\bowtie$ album $\bowtie$ track $\bowtie$ track_instruments $\bowtie$ album_tracks)**

6. with albums_per_producer as

   (select p.name, p.id, count(a.id) album_cnt

   from music_world.album a,

   music_world.album_producers ap,

   music_world.persona p,

   music_world.role r,

   music_world.persona_roles pr

   where r.name = 'Producer'

   and   pr.role_id = r.id

   and   pr.persona_id = p.id

   and   ap.album_id = a.id

   and   ap.producer_id = p.id

   and   a.start_date between DATE("2018-01-01") and DATE("2018-01-02")

   and   a.end_date between DATE("2018-01-01") and DATE("2018-01-02")

   group by p.name, p.id)

   select t.name from albums_per_producer t

   where t.album_cnt = (select max(album_cnt) from albums_per_producer t1);

$\rho(T1, APP)$

$\rho(T2, APP)$

$\rho(APP, \Pi ((\text{p. name, p. id}, COUNT (\text{a. id})) \sigma(\text{r. name} =' \textbf{Producer}' \wedge ((\text{a. start}_{\text{date}} < \text{y2 and a. start}_{\text{date}} > \text{y1}) \wedge (\text{a. end}_{\text{date}} < \text{y2} \wedge \text{a. end}_{\text{date}} > \text{y1}) \textbf{γ(p.name, p.id)}(\textbf{album} \bowtie \textbf{album\_producers} \bowtie \textbf{persona} \bowtie \textbf{role} \bowtie \textbf{persona\_roles}))$

$\Pi (\textbf{name})\sigma((T3, \pi T2. \text{name}(T1 \bowtie \text{T1. id} > \text{T2. id T2} \wedge T1 \bowtie \textbf{T1.name} > \textbf{T2.name T2})$

$(\pi \text{id} T1) - T3) \wedge (\pi \textbf{name} T1) - T3)(\textbf{ APP) }) (\text{APP}))$

7. with tracks_per_instrument as
    (select ti.instrument_id, count(ti.track_id) cnt
    from music_world.track_instruments ti
    group by ti.instrument_id)
    select i.manufacturer_name
    from tracks_per_instrument t,
            music_world.instrument i
    where t.cnt = (select max(t1.cnt)
                                from tracks_per_instrument t1)
    and   t.instrument_id = i.id;

$\rho(TPI, \Pi \ (\text{instrument\_id}, , COUNT \ (\text{track\_id}))$ **γ(instrument_id)(track_instruments))**

$\rho(T1, TPI)$

$\rho(T2, TPI)$

$\Pi \ (i.\text{manufacturer\_name}) \ \sigma(\rho(T3, \pi T2.\text{i\_name}(T1 \bowtie T1.\text{cnt} > T2.\text{cnt T2})$

$(\pi cnt T1) - T3)$ **(TPI ⋈instrument)** $\wedge$ **t.instrument_id = i.id)(track_instruments))**

8. select count(distinct mt.musician_id) musician_cnt
    from music_world.musician_tracks mt;

Π **COUNT (π mt.musician_id) (musician_tracks))**

9. with partners as

    (select mt.musician_id, p.name, count(*) partners_cnt

    from music_world.musician_tracks mt,

     music_world.track t,

     music_world.persona p,

    music_world.role r,

    music_world.persona_roles pr,

    music_world.musician_tracks mt1,

     music_world.role r1,

    music_world.persona_roles pr1

    where mt.musician_id = p.id

```
and   mt.track_id = t.id

and   pr.persona_id = p.id

and   pr.role_id = r.id

and   r.name in ('Singer','Player')

and   mt.TRACK_ID = mt1.TRACK_ID

and   pr1.role_id = r1.id

and   r1.name in ('Singer','Player')

and   pr1.persona_id = mt1.musician_id

and mt.musician_id != mt1.musician_id

group by mt.musician_id,p.name)

select t.name from partners t

where  t.partners_cnt in (select max(partners_cnt) from partners t1);
```

$\rho(P, \Pi\ (\textbf{musician\_id}, \textbf{p. name}, COUNT(*))\ \sigma(\textbf{mt.musician\_id = p.id} \wedge$

mt.track_id = t.id $\wedge$ **pr.persona_id = p.id** $\wedge$ **pr.role_id = r.id** $\wedge$ **r.name** $\subseteq$ **{'Singer','Player'}** $\wedge$
mt.TRACK_ID = mt1.TRACK_ID $\wedge$ **pr1.role_id = r1.id** $\wedge$ **r1.name** $\subseteq$ **{'Singer','Player'}** $\wedge$

pr1.persona_id = mt1.musician_id $\wedge$ **mt.musician_id !=**
mt1.musician_id)(musician_tracks $\bowtie$ **track** $\bowtie$ **persona** $\bowtie$ **role** $\bowtie$ **persona_roles** $\bowtie$
musician_tracks $\bowtie$ **role** $\bowtie$ **persona_roles))** **γ(musician_id, name)**

$\rho(T1, P)$

$\rho(T2, P)$

$\Pi\ (\textbf{name})\sigma(\rho(T3, \pi T2.\textbf{t. name}\ (T1 \bowtie T1.\textbf{partners\_cnt} > T2.\textbf{cnt}\ T2)$

$(\pi \textbf{t. name}\ T1) - T3)\ (\textbf{P})\ )$

10. with tracks_per_genre as

    (select t.GENRE, count(*) cnt

    from music_world.track t

    group by t.GENRE)

    select t.genre from tracks_per_genre t

where t.cnt = (select max(t1.cnt) from tracks_per_genre t1);

$\rho(T1,\textbf{TPG})$

$\rho(T2,\textbf{TPG})$

$\rho(TPG, \Pi(\textbf{t.GENRE}, \textbf{count}(*) \textbf{ cnt})\gamma(\textbf{t.GENRE})(\textbf{track}))$

$\Pi(\textbf{t.GENRE}) \; \sigma()(\textbf{TPG})$

$\gamma(\textbf{musician\_id, name}) \; \Pi (\textbf{ name})\sigma(\rho(T3, \pi T2.t.\textbf{genre} T1 \bowtie T1.\textbf{cnt} > T2.\textbf{cnt } T2)$

$(\pi t.\textbf{genre} T1) - T3) \; (\textbf{TPG }))$

11. with tracks_per_technitian as
    (select p.id, p.name, count(t.id) track_cnt
        from music_world.track t,
        music_world.persona p
        where t.recording_technitian_id = p.id
    and   t.recording_date between DATE("2018-01-01") and DATE("2018-01-01")
    group by p.id, p.name)
    select t.name from tracks_per_technitian t
    where t.track_cnt = (select max(t1.track_cnt) from tracks_per_technitian t1);

$\rho(\textbf{TPT}, \Pi \textbf{ (p.id, p.name, count(t.id) ,track\_cnt)}$
$\sigma(\textbf{recording\_technitian\_id = p.id} \wedge(\textbf{recording\_date } = \textbf{x and a.start\_date} < \textbf{y2} \wedge$
$\textbf{a.start\_date} > \textbf{y1 and a.end\_date} < \textbf{y2 and a.end\_date} > \textbf{y1 })\gamma(\textbf{ p.id, p.name})) \textbf{ (track} \bowtie$
$\textbf{persona}))$

$\rho(T1,\textbf{TPT})$

$\rho(T2,\textbf{TPT})$

$\Pi \textbf{ (t.name) } \sigma((\rho(T3, \pi T2.\textbf{i\_name}(T1 \bowtie T1.\textbf{t.name} > T2.\textbf{track\_cnt } T2)$

$(\pi \textbf{t.name} T1) - T3) \; \textbf{(TPT))}$

12. SELECT music_world.album.name FROM music_world.album

    WHERE end_date = (SELECT MIN(end_date) FROM music_world.album);

$\rho(T1,\textbf{album})$

$\rho(T2,\textbf{album})$

$\Pi\textbf{ (name) }\sigma(\textbf{end\_date } = ((\rho(T3, \pi T2.\textbf{album}.\textbf{name}(T1 \bowtie T1.\textbf{end\_date} < T2.\textbf{end\_date T2})$

$(\pi\textbf{album}.\textbf{name}T1) - T3)\textbf{ (album))}$

13. select t.name
    from (select atr.TRACK_ID, count(atr.album_id) cnt
          from music_world.album_tracks atr
      group by atr.TRACK_ID
       having cnt >=2) t1,
      music_world.track t
    where t1.track_id = t.id;

Π (t.name)(σ(t1.track_id=t.id)
(Π (TRACK_ID), COUNT(album_id)])(γ(TRACK_ID ,COUNT(album_id)]≥2)) (album_tracks))
(track)

14. with technitian_songs_per_album as

(select p.id tecnician_id, p.name, a.id album_id, count(t.id) track_cnt

    from music_world.track t,

    music_world.persona p,

    music_world.album a,

    music_world.album_tracks s

    where t.recording_technitian_id = p.id

    and a.id = s.album_id

    and t.id = s.track_id

    group by p.id, p.name, a.id)

select count(distinct t.tecnician_id) technitian_cnt

from music_world.album a, technitian_songs_per_album t

where a.id = t.album_id

And a.num_of_songs = t.track_cnt;

$$\rho(TSPA, \Pi\ (p.id, p.name, a.id,\ COUNT(t.id))\sigma(\gamma(p.id, p.name, a.id))(\textbf{track} \bowtie \textbf{persona} \bowtie \textbf{album} \bowtie \textbf{album\_tracks}))$$

$$\Pi\ (COUNT(\pi\ (tecnician\_id)))\sigma(\textbf{num\_of\_songs}\ =\ \textbf{track\_cnt})\ (\textbf{album} \bowtie TSPA))$$

15. with genre_per_musician as

(select p.id, p.name, count(distinct t.genre) genre_cnt

from music_world.track t,

    music_world.persona p,

  music_world.role r,

  music_world.persona_roles pr,

  music_world.musician_tracks mt

where mt.musician_id = p.id

and   mt.track_id = t.id

and   pr.persona_id = p.id

and   pr.role_id = r.id

and   r.name in ('Singer','Player')

group by p.id, p.name)

select t.name from genre_per_musician t

where t.genre_cnt in (select max(genre_cnt) from genre_per_musician t1)

$\rho(GPM, \Pi(\text{p.id}, \text{p.name}, COUNT(\pi \text{ t.genre})) \sigma(\text{r.name} \subseteq$
$\{'Singer', 'Player'\} \gamma(\text{p.id}, \text{p.name})) (\text{track} \bowtie \text{persona} \bowtie \text{role} \bowtie \text{persona\_roles} \bowtie$
$\text{musician\_tracks}))$

$\rho(T1, GPM)$

$\rho(T2, GPM)$

$\Pi(\text{t.name}) \sigma((\rho(T3, \pi T2.\text{t.name} (T1 \bowtie T1.\text{genre\_cnt} > T2.\text{genre\_cnt} T2)$

$(\pi \text{t.name } T1) - T3) (GPM))$