FunSQL

A library for compositional construction of SQL queries

https://github.com/MechanicalRabbit/FunSQL.jl

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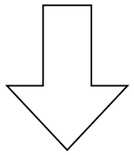
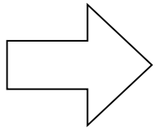
Find all patients born in or after 1970.



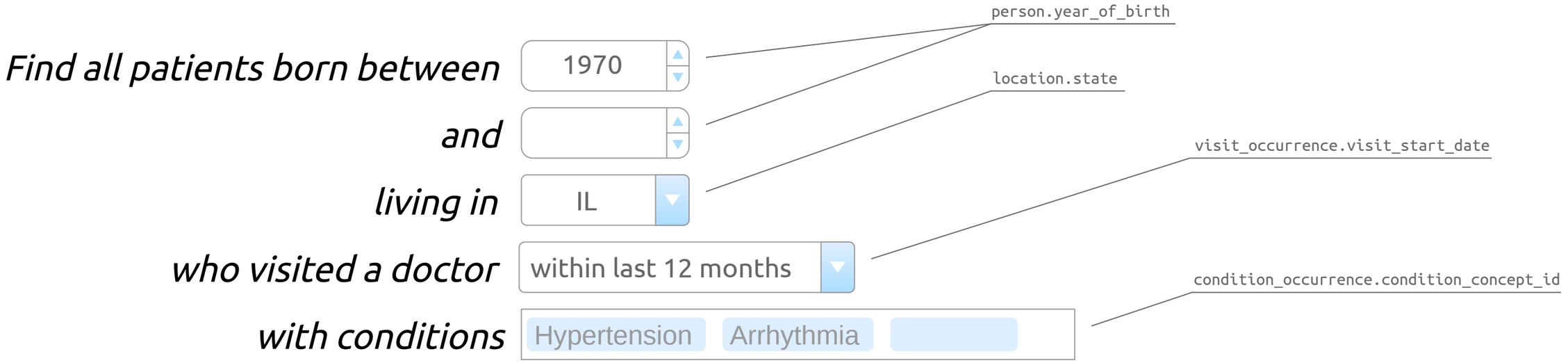
```
SELECT p.person_id
FROM person p
WHERE p.year_of_birth >= 1970
```



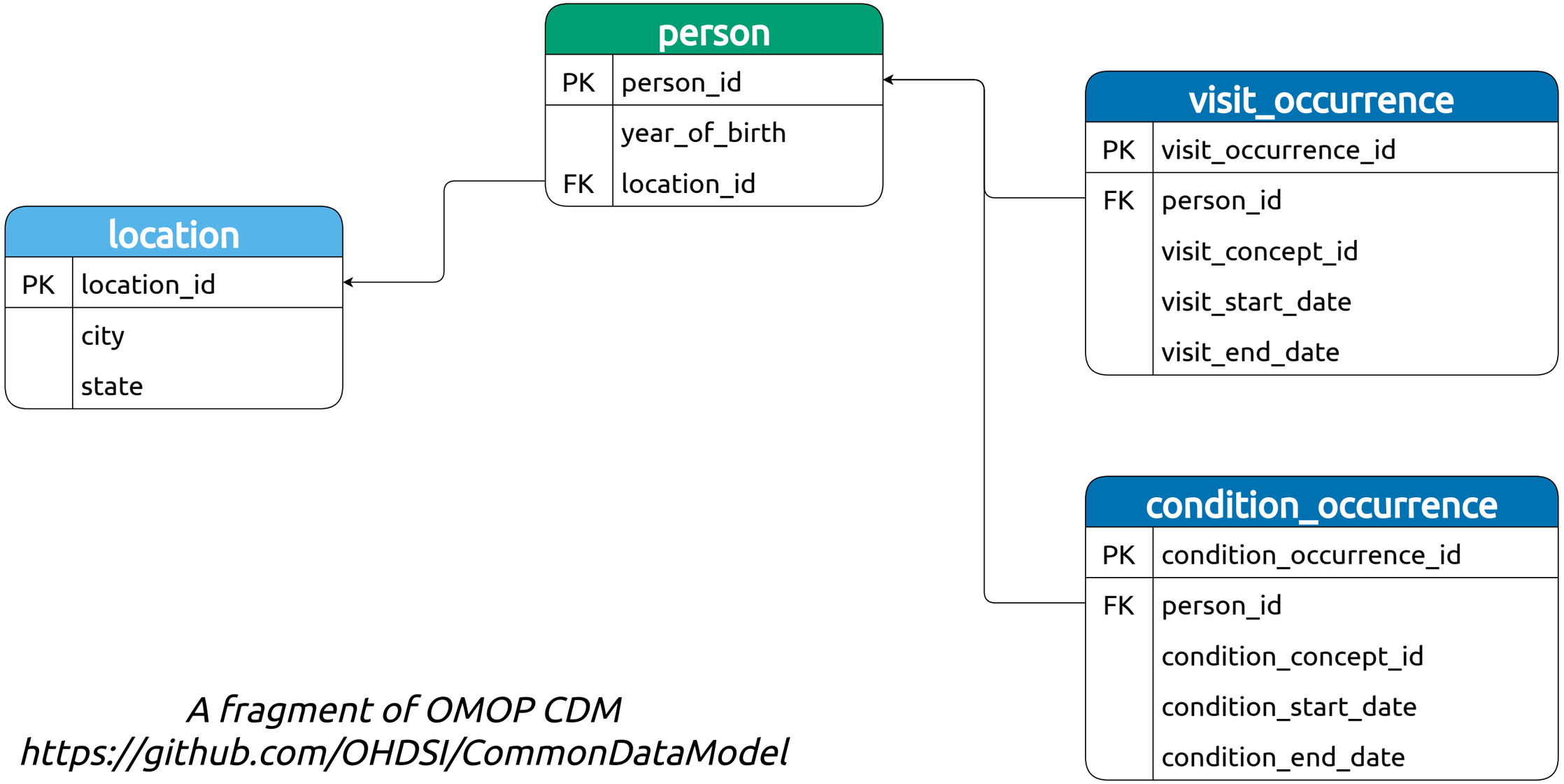
```
function find_patients(conn)
    sql = """
    SELECT p.person_id
    FROM person p
    WHERE p.year_of_birth >= 1970
    """
    DBInterface.execute(conn, sql)
end
```

Find all patients born between 1970 *and*

```
function find_patients(conn; start_year = nothing, end_year = nothing)
    sql = """
    SELECT p.person_id
    FROM person p
    """
    predicates = String[]
    if start_year !== nothing
        push!(predicates, "p.year_of_birth >= $start_year")
    end
    if end_year !== nothing
        push!(predicates, "p.year_of_birth <= $end_year")
    end
    if !isempty(predicates)
        sql *=  "\nWHERE " * join(predicates, " AND ")
    end
    DBInterface.execute(conn, sql)
end
```

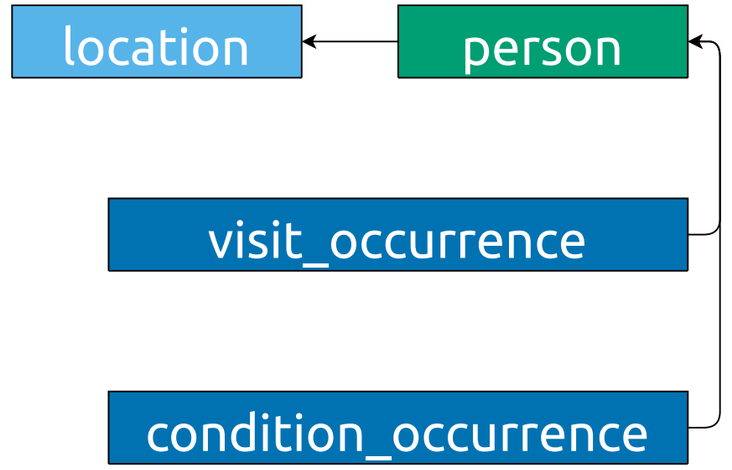



```
function find_patients(conn; start_year = nothing,
                             end_year = nothing,
                             state = nothing,
                             latest_visit_threshold = nothing,
                             condition_concepts = [])
    sql = ???
    DBInterface.execute(conn, sql)
end
```



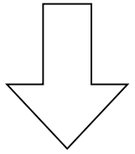
A fragment of OMOP CDM
https://github.com/OHDSI/CommonDataModel

```
using FunSQL: SQLTable

const person =
    SQLTable(name = :person,
             columns = [:person_id, :year_of_birth, :location_id])

const location =
    SQLTable(name = :location,
             columns = [:location_id, :city, :state, :zip])

const visit_occurrence =
    SQLTable(name = :visit_occurrence,
             columns = [:visit_occurrence_id, :person_id, :visit_concept_id,
                        :visit_start_date, :visit_end_date])

const condition_occurrence =
    SQLTable(name = :condition_occurrence,
             columns = [:condition_occurrence_id, :person_id, :condition_concept_id,
                        :condition_start_date, :condition_end_date])
```

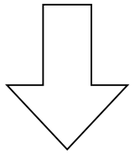


Find all patients born in or after 1970.

```
FROM person p
```



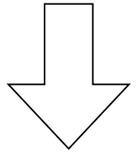
```
FROM person p
WHERE p.year_of_birth >= 1970
```



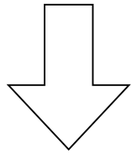
```
SELECT p.person_id
FROM person p
WHERE p.year_of_birth >= 1970
```

```
using FunSQL: From, Get, Select, Where, render
```

```
q = From(person)
```



```
q = From(person) |>
    Where(Get.year_of_birth .>= 1970)
```

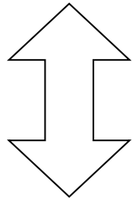


```
q = From(person) |>
    Where(Get.year_of_birth .>= 1970) |>
    Select(Get.person_id)
```

```
sql = render(q, dialect = :postgresql)
```

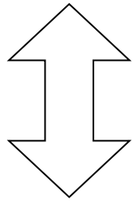
```
q₁ = From(person)
q₂ = q₁ |> Where(q₁.year_of_birth .>= 1970)
q  = q₂ |> Select(q₂.person_id)
```

bound references



```
q = From(person) |>
    Where(Get.year_of_birth .>= 1970) |>
    Select(Get.person_id)
```

unbound references



```
BornInOrAfter(Y) = Get.year_of_birth .>= Y

q = From(person) |>
    Where(BornInOrAfter(1970)) |>
    Select(Get.person_id)
```

person	
PK	person_id
	year_of_birth
FK	location_id

```
SELECT p.person_id
FROM person p
WHERE p.year_of_birth >= 1970
```

```
using FunSQL: Fun
```

"Fun" notation

```
Fun.">="(Get.year_of_birth, 1970)
```

or

```
Get.year_of_birth .>= 1970
```

broadcasting

```
WHERE p.year_of_birth >= 1970 AND
      p.year_of_birth <= 2000
```

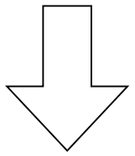
```
Fun.and(Get.year_of_birth .>= 1970,
        Get.year_of_birth .<= 2000)
```

```
WHERE p.year_of_birth
      BETWEEN 1970 AND 2000
```

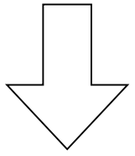
```
Fun.between(Get.year_of_birth, 1970, 2000)
```

Show patients with their state of residence.

```
FROM person p
```



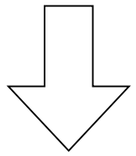
```
FROM person p
JOIN location l
  ON (p.location_id = l.location_id)
```



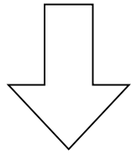
```
SELECT p.person_id, l.state
FROM person p
JOIN location l
  ON (p.location_id = l.location_id)
```

```
using FunSQL: Join
```

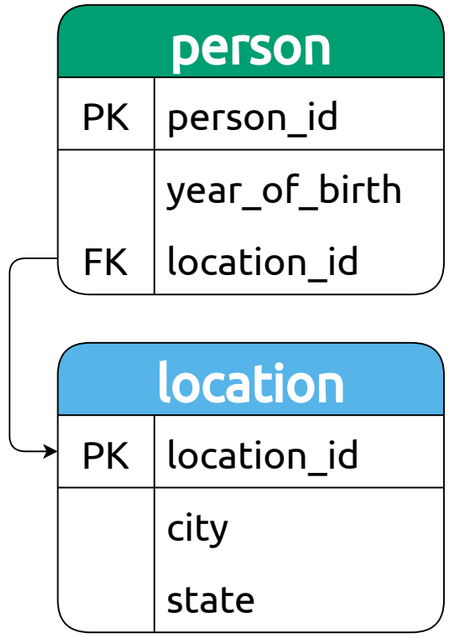
```
q = From(person)
```



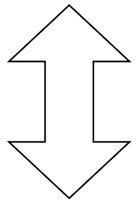
```
q = From(person) |>
    Join(:location => location,
         Get.location_id .==
         Get.location.location_id)
```

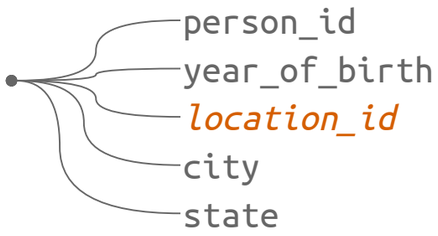


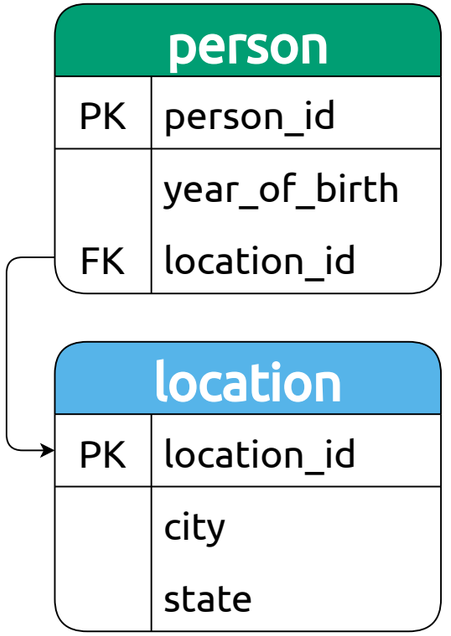
```
q = From(person) |>
    Join(:location => location,
         Get.location_id .==
         Get.location.location_id) |>
    Select(Get.person_id, Get.location.state)
```



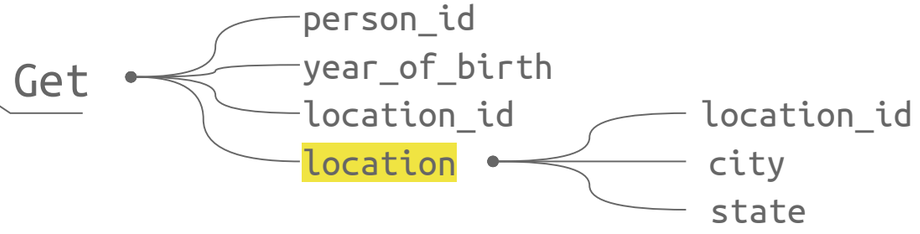
```
q_p = From(person)
q_l = From(location)
q   = q_p |> Join(q_l, q_p.location_id .== q_l.location_id)
```





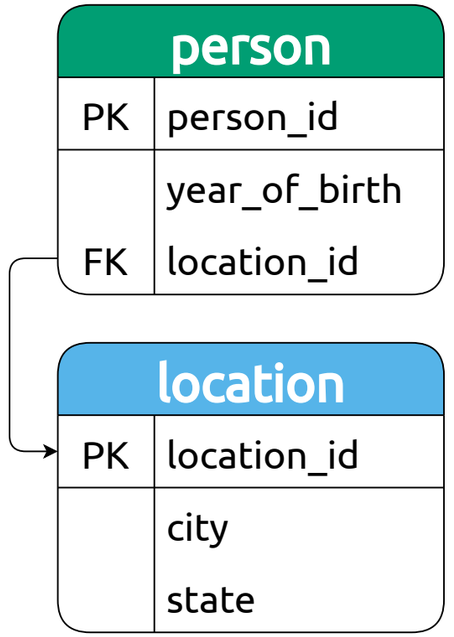



```
q = From(person) |>
    Join(:location => From(location),
         Get.location_id .== Get.location.location_id)
```



Find patients

- *born in or after 1970*
- *living in Illinois*

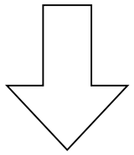



```
q_p = From(person) |>
      Where(Get.year_of_birth .>= 1970)
```

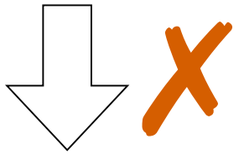
```
q_l = From(location) |>
      Where(Get.state .== "IL")
```

```
q_p |> Join(:location => q_l,
            Get.location_id .==
            Get.location.location_id)
```

```
FROM person p
```

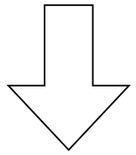


```
FROM person p
WHERE p.year_of_birth >= 1970
```

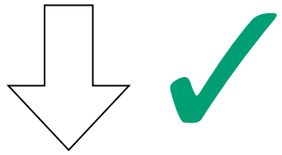


```
FROM person p
WHERE p.year_of_birth >= 1970
JOIN location l
  ON (p.location_id = l.location_id)
```

```
From(person)
```

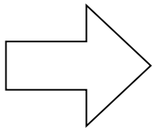


```
From(person) |>
Where(Get.year_of_birth .>= 1970)
```

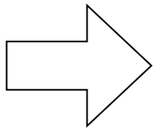


```
From(person) |>
Where(Get.year_of_birth .>= 1970) |>
Join(:location => From(location),
     Get.location_id .==
     Get.location.location_id)
```

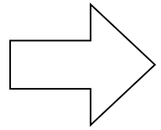
```
FROM ...
```



```
FROM ...
JOIN ...
WHERE ...
GROUP BY ...
HAVING ...
ORDER BY ...
```



```
SELECT ...
FROM ...
JOIN ...
WHERE ...
GROUP BY ...
HAVING ...
ORDER BY ...
```



```
FROM (
    SELECT ...
    FROM ...
    JOIN ...
    WHERE ...
    GROUP BY ...
    HAVING ...
    ORDER BY ...)
```

```
From(table)
```

```
SELECT ???
FROM $table
```

```
□ |>
Where(condition)
```

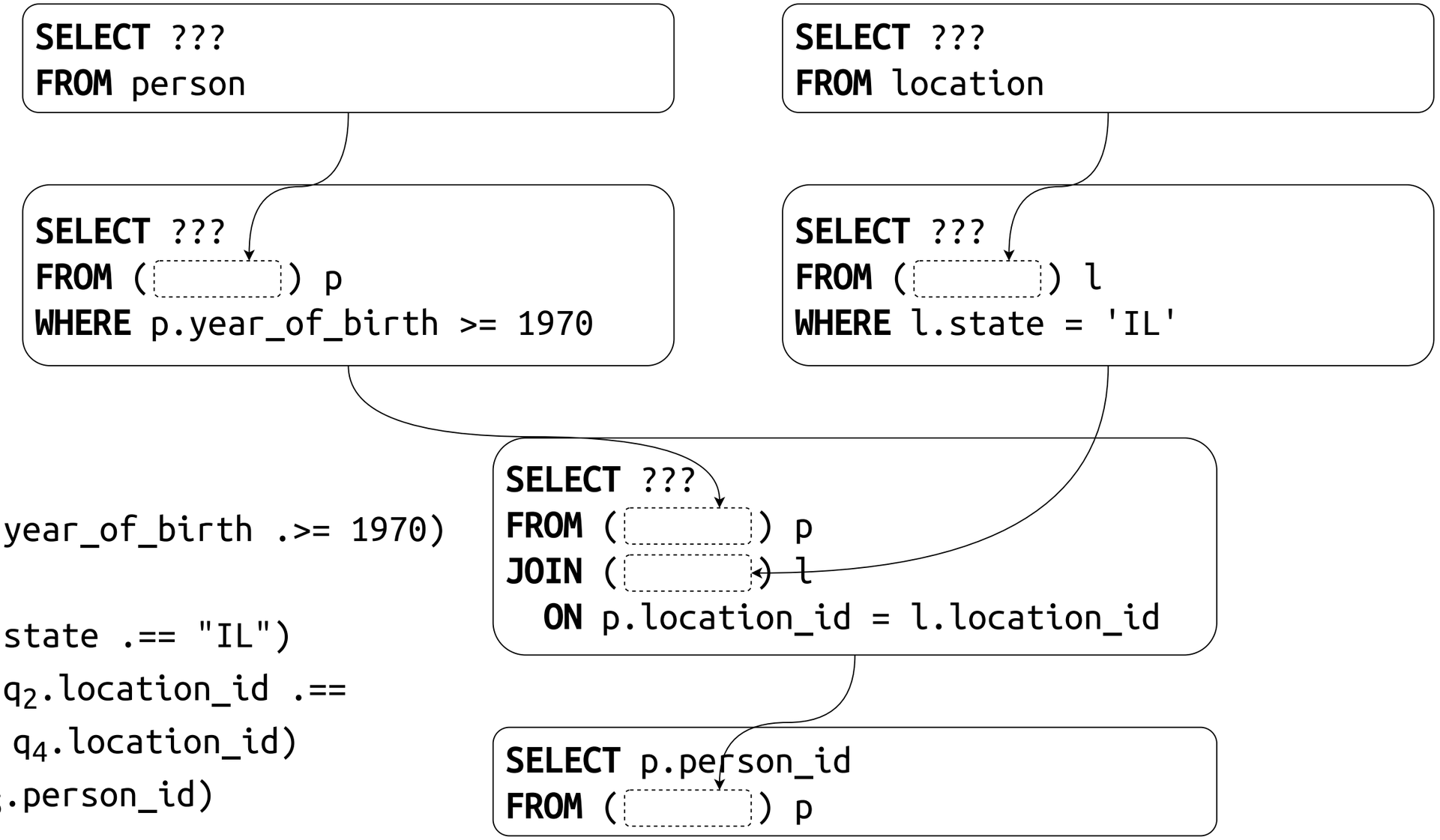
```
SELECT ???
FROM (□)
WHERE $condition
```

```
□ |>
Join(□, condition)
```

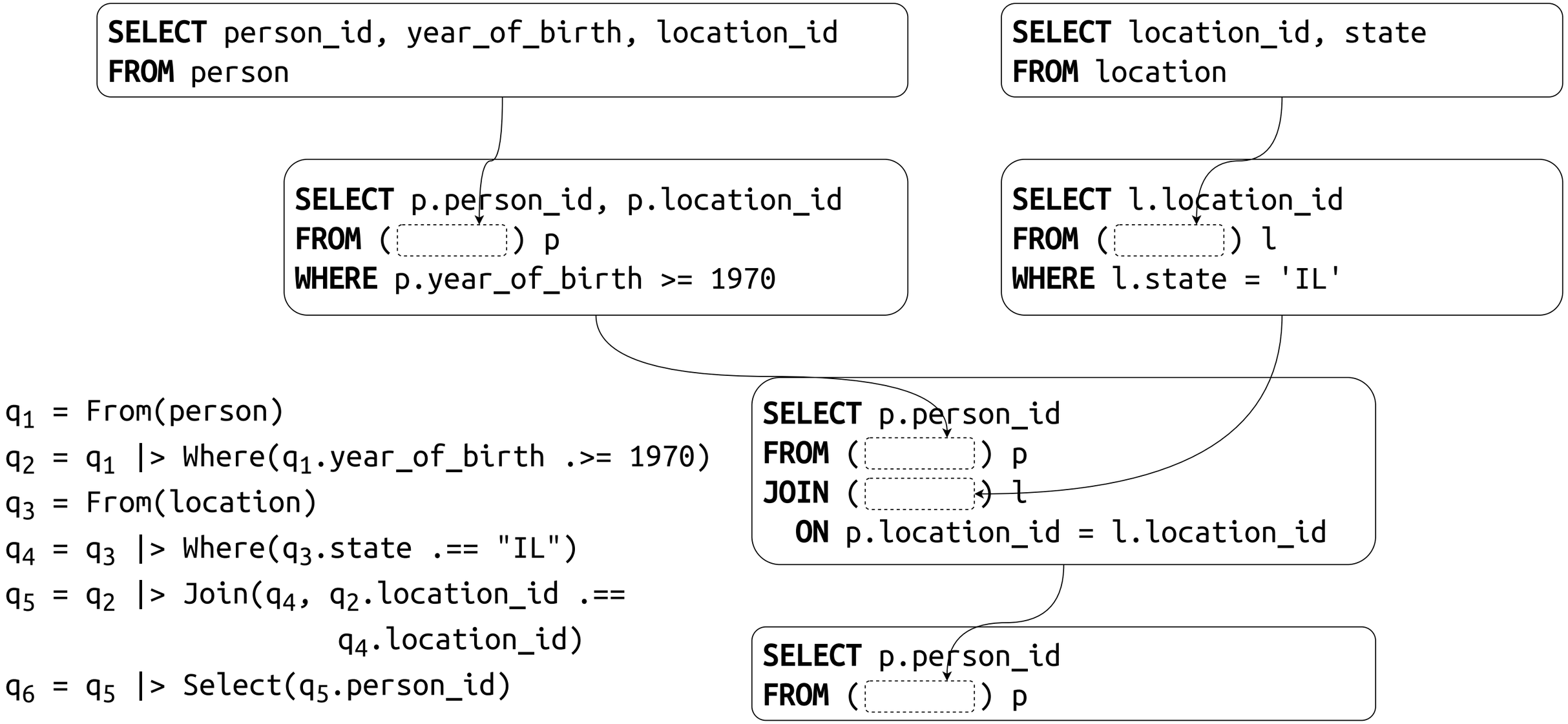
```
SELECT ???
FROM (□)
JOIN (□)
  ON $condition
```

```
□ |>
Select(list...)
```

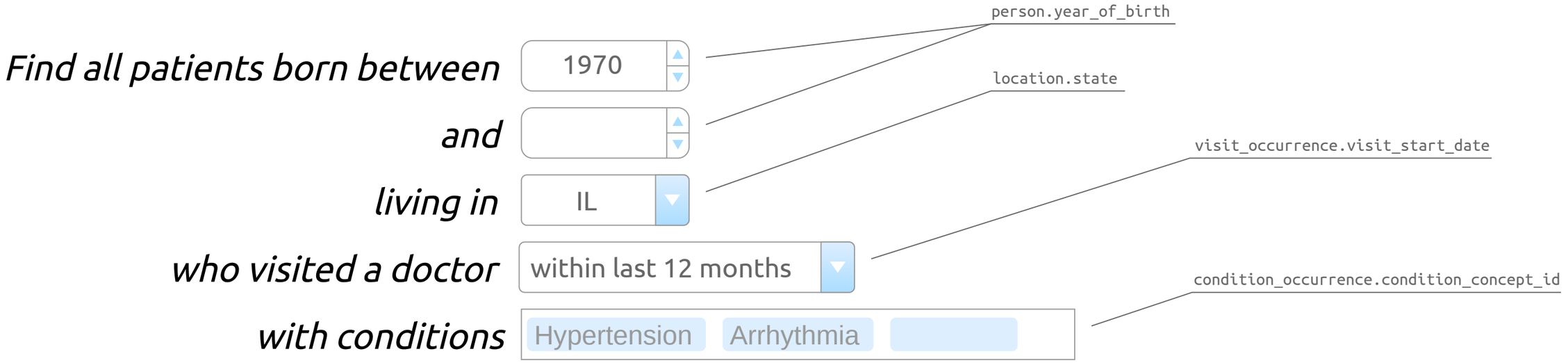
```
SELECT $(list...)
FROM (□)
```




```
q1 = From(person)
q2 = q1 |> Where(q1.year_of_birth .>= 1970)
q3 = From(location)
q4 = q3 |> Where(q3.state .== "IL")
q5 = q2 |> Join(q4, q2.location_id .==
                    q4.location_id)
q6 = q5 |> Select(q5.person_id)
```




```
q1 = From(person)
q2 = q1 |> Where(q1.year_of_birth .>= 1970)
q3 = From(location)
q4 = q3 |> Where(q3.state .== "IL")
q5 = q2 |> Join(q4, q2.location_id .==
                    q4.location_id)
q6 = q5 |> Select(q5.person_id)
```




```
function find_patients(conn; start_year = nothing,
                             end_year = nothing,
                             state = nothing,
                             latest_visit_threshold = nothing,
                             condition_concepts = [])
    q = FindPatients(; start_year, end_year, state,
                       latest_visit_threshold, condition_concepts)
    sql = render(q, dialect = :postgresql)
    DBInterface.execute(conn, sql)
end
```

```
FindPatients(; start_year = nothing,
               end_year = nothing,
               state = nothing,
               latest_visit_threshold = nothing,
               condition_concepts = []) =
    From(person) |>
    FilterByYearOfBirth(; start_year, end_year) |>
    FilterByState(; state) |>
    FilterByLatestVisit(; latest_visit_threshold) |>
    FilterByConditions(; condition_concepts) |>
    Select(Get.person_id)


FilterByYearOfBirth(; start_year, end_year) =
    start_year !== nothing && end_year !== nothing ?
        Where(Fun.between(Get.year_of_birth, start_year, end_year)) :
    start_year !== nothing ?
        Where(Get.year_of_birth .>= start_year) :
    end_year !== nothing ?
        Where(Get.year_of_birth .<= end_year) : identity
```

```
FilterByState(; state) =
    state !== nothing ?
        Join(:location => From(location) |>
                          Where(Get.state .== state),
             Get.location_id .== Get.location.location_id) :
        identity


FilterByLatestVisit(; latest_visit_threshold) =
    latest_visit_treshold !== nothing ?
        Join(:visit_group => From(visit_occurrence) |>
                             Group(Get.person_id),
             Get.person_id .== Get.visit_group.person_id) |>
        Define(:latest_visit_date => Agg.max(Get.visit_start_date, over = Get.visit_group)) |>
        Where(Fun.today() .- Get.latest_visit_date .<= latest_visit_threshold) :
        identity
```

```
ConditionsByPerson(person_id; condition_concepts) =
    From(condition_occurrence) |>
    Where(Fun.and(Fun.in(Get.condition_concept_id, condition_concepts...),
                  Get.person_id .== Var.person_id)) |>
    Bind(:person_id => person_id)


FilterByConditions(; condition_concepts) =
    !isempty(condition_concepts) ?
        Where(Fun.exists(ConditionsByPerson(Get.person_id, condition_concepts))) :
        identity
```