GRewriter: Practical Query Rewriting with Automatic Ruleset Expansion in GaussDB (Appendix)

ABSTRACT

This document contains the appendix of SIGMOD'25 industrial track submission #76. Section 1 presents the proof of the theorem about rule verification in the paper. Section 2 describes the G-DSL in detail. Section 3 lists the rewrite rules discovered by our work.

1 PROOF THE VERIFICATION ALGORITHM

This section provides the detailed proof of the following theorem in the paper, which enables us to prove rules by proving concrete SQL query pairs via existing verifiers, such as SQLSolver [1].

Theorem 1.1. *For each enumerated rewrite rule, if each representative pair of queries is equivalent, the rule is correct.*

Before proving the above theorem, we will first prove several lemmas, which are required to prove the theorem. Then, we will present the proof of the theorem.

Lemma 1.2. *For each non-representative pair of queries p_1, it always belong to one of the following cases: 1) p_1 is the same as some representative pair of queries p_2 after renaming its attributes and tables. 2) p_1 is almost the same as some representative pair of queries p_2 after renaming its attributes and tables except for expressions and schemas. Note that renaming there means that there is a one-to-one name mapping between names used in p_1 and another representative query pair.*

Proof. The lemma can be proved based on the construction method of representative query pairs and non-representative query pairs. Both types of query pairs are generated by assigning symbols in the rule to concrete attributes, tables, and expressions. Thus, these generated query pairs all satisfy the same syntax structures specified by plan templates and constraints. They can only differ in 1) concrete names of attributes and tables; 2) concrete expressions; 3) concrete schemas. Therefore, after renaming, the non-representative query pair p_1 can always be transformed into a representative query pair p_2 except for the concrete expressions and schemas. In conclusion, the lemma is proved. □

Lemma 1.3. *If a query pair p_1 is the same as another query pair p_2 after renaming the attributes and tables, then the equivalence of p_2 can imply the equivalence of p_1.*

Proof. Whether two queries are equivalent depends on the syntax structures of queries and constraints rather than the concrete names. If two queries are equivalent, renaming of attributes and tables via a one-to-one names mapping will not corrupt the equivalence. Therefore, since queries in p_1 are the same as queries in p_2 after renaming, the equivalence of p_2 can imply the equivalence of p_1. In conclusion, the lemma is proved. □

Lemma 1.4. *If a query pair p_1 is the same as another query pair p_2 after renaming the attributes and tables except for expressions, then the equivalence of p_2 can imply the equivalence of p_1.*

Proof. According to the construction method of representative query pairs, the expressions in p_2 are uninterpreted user-defined functions. When verifying p_2, the verifier will treat these functions as random functions. Thus, if p_2 is equivalent, replacing these functions with any concrete expressions will not change the equivalence. The equivalence of p_2 can imply the equivalence of p_1 after renaming. Furthermore, according to Lemma 1.3, the equivalence of p_1 after renaming can imply the equivalence of p_1. In conclusion, the lemma is proved. □

Lemma 1.5. *If a query pair p_1 is the same as another query pair p_2 after renaming the attributes and tables except for schemas, then the equivalence of p_2 can imply the equivalence of p_1.*

Proof. According to the construction method of representative query pairs, the schemas of p_1 and p_2 differ in two aspects. First, the difference comes from some attributes not used in queries. Since these attributes are not used in queries, the equivalence of p_2 can imply the equivalence of p_1 after renaming. Then, according to Lemma 1.3, the equivalence of p_1 after renaming can further imply the equivalence of p_1. Second, the difference comes from the size of attribute lists in some schemas. These attribute list correspond to the symbolic attribute lists in the rule. Since existing verifiers for concrete queries treat such attribute lists as a whole, the sizes of such concrete attribute lists will not affect the equivalence of queries. Therefore, the equivalence of p_2 can imply the equivalence of p_1 after renaming. Then, according to Lemma 1.3, the equivalence of p_1 after renaming can further imply the equivalence of p_1. In conclusion, the lemma is proved. □

Lemma 1.6. *For each non-representative query pair p_1, there exists a representative query pair p_2 such that the equivalence of p_2 can imply the equivalence of p_1.*

Proof. According to Lemma 1.2, each non-representative query pair p_1 belongs to one of the following cases: 1) p_1 is the same as some representative pair of queries p_2 after renaming its attributes and tables. 2) p_1 is almost the same as some representative pair of queries p_2 after renaming its attributes and tables except for expressions and schemas. For case 1, the lemma is proved by Lemma 1.3. For case 2, the lemma is proved by Lemma 1.4 and Lemma 1.5. Therefore, the lemma is proved. □

Based on the above lemmas, we can finally prove the following theorem in the paper.

Theorem 1.7. *For each candidate rewrite rule, if each representative pair of queries is equivalent, the rule is correct.*

Proof. According to the definition of rule correctness, we prove the theorem by proving that each pair of queries before and after the rewrite are equivalent. All query pairs can be classfied into two types: representative query pairs and non-representative query pairs. The premise indicates that all representative query pairs are equivalent. For each non-representative query pair, Lemma 1.6 indicates that there exists a representative query pair such that the equivalence of the representative query pair can imply the equivalence of the non-representative query pair. Therefore, all non-representative query pairs are equivalent. In conclusion, all query pairs are equivalent, which means that the rule is correct. □

Example. Take the rule below as an example, which simply removes redundant projections.

```
Proj<_ a0 r2>(Proj<_ a0 r1>(Input<r0>))|
Proj<_ a0 r1>(Input<r0>)|
AttrsSub(a0, r0);
```

We can verify it by the following steps. First, we enumerate all possible schemas. We know that the columns represent by `a0` is a subset of table `r0`. Thus we have to enumerate if `r0` has other columns except columns in `a0`.

```
CREATE TABLE R0(C0 INT);
CREATE TABLE R0(C0 INT, C1 INT);
```

Second, according to each enumerated schemas, we generate the SQL pair by simply assign concrete columns to the symbols.

```
SELECT C0 FROM (SELECT C0 FROM R0);
SELECT C0 FROM R0;

SELECT C1 FROM (SELECT C1 FROM R0);
SELECT C1 FROM R0;
```

Finally, we use existing verifier SQLSolver [1] to verify the equivalence of each pair of queries. Since each query pair is equivalent, the rule is correct.

2 G-DSL

2.1 Syntax in YAML

```
Rule : SourceTemplate '|' DestinationTemplate
    '|' G-Constraints

SourceTemplate: Node
TargetTemplate: Node

Node : NodeType '<' Symbols '>' '(' SubNodes ')'

NodeType : 'Filter' | 'Proj' | 'Input' | 'Join_left'
    | 'Join_inner' | 'Union' | 'Union_all' | 'Limit'
    | 'Agg_max' | 'Agg_min' | 'Agg_count' | 'Agg_avg'
    | 'Agg_sum' | 'Agg' | 'Sort_asc' | 'Sort_desc'
    | 'Insub' | 'Exists' | 'Except' | 'Intersect'
    | 'Join_cross' | 'Join_right'

Symbols : Symbol | Symbol ' ' Symbols |

Symbol : [a-z][0-9]+

SubNodes :  Node  |  Node ',' SubNodes |

G-Constraints : G-Constraint
    | G-Constraint ';' G-Constraints |

G-Constraint : Destructure | Definition | Constraint
Destructure : Expression ':=' Symbol
Definition : Symbol ':=' Expression
Constraint : ConstraintType '(' Symbols ')'
    | '!' ConstraintType '(' Symbols ')'

Expression: Symbol
    | ExpressionType '<' Infos '>' '(' Expressions ')'
Expressions:  Expression
    | Expression, Expressions |
ExpressionType: 'Sublink' | 'Eq' | 'And' | 'Const'
    | 'CTE' | 'Or' | 'Plus' | 'Minus' | 'Div'
   | 'Mul' | 'Target' | 'List' | 'IsNull' | 'IsNotNull'
    | 'LT' | 'GT' | 'LE' | 'GE' | 'Like' | 'Star'
    | 'FuncCall'

ConstraintType: 'AttrsSub' | 'AttrsEq' | 'ExpressionEq'
    | 'Unique' | 'NotNull' | 'Indexed' | 'TableEq'
    | 'ExpressionSub' | 'Reference'
```

2.2 Node Types

Filter. The Filter operator is used to apply a condition (typically a WHERE clause) to a dataset, filtering out rows that do not satisfy the condition. It is responsible for selecting only those rows that meet specific criteria.

Proj (Projection). The Proj operator refers to the projection operation in relational algebra, which is used to select specific columns from a dataset. It reduces the number of columns in the output, keeping only the ones required by the query.

Input. The Input operator represents the input or source data in a query plan. It can be thought of as the starting point or base relation in a query, from which further operations (like filtering, joining, etc.) are performed.

Join_left (Left Join). The Join_left operator performs a left outer join between two tables. It returns all rows from the left table and the matching rows from the right table. If no match is found, NULL values are returned for the columns from the right table.

Join_inner (Inner Join). The Join_inner operator performs an inner join between two tables, returning only the rows that have matching values in both tables. If no match exists, those rows are excluded from the result.

Union. The Union operator combines the result sets of two queries, eliminating duplicate rows from the final result. It returns the distinct rows from both input datasets, assuming the datasets have the same number of columns with compatible data types.

Union_all. The Union_all operator is similar to Union, but it does not remove duplicates. It returns all rows from both input datasets, including duplicate rows.

Limit. The Limit operator is used to restrict the number of rows returned in a query result. It is often used to paginate large datasets or to retrieve a fixed number of records from the query result.

Agg_max (Aggregate Maximum). The Agg_max operator computes the maximum value of a specified column for a given group of rows. It is commonly used in aggregate functions like MAX() in SQL.

Agg_min (Aggregate Minimum). The Agg_min operator computes the minimum value of a specified column for a given group of rows. It is used in aggregate functions like MIN() to find the smallest value in a set of values.

Agg_count (Aggregate Count). The Agg_count operator counts the number of rows in a dataset or the number of non-null values in a specified column. It is used in aggregate functions like COUNT() to determine the total number of records or specific values.

Agg_avg (Aggregate Average). The Agg_avg operator computes the average value of a specified column for a group of rows. It is used in the AVG() aggregate function to calculate the mean value of a set of values.

Agg_sum (Aggregate Sum). The Agg_sum operator computes the sum of the values in a specified column for a group of rows. It is used in aggregate functions like SUM() to calculate the total of numeric values.

Agg (General Aggregation). The Agg operator represents general aggregation operations that compute values (like sum, count, average, etc.) based on specific columns or groups of rows. It groups rows based on certain criteria and applies aggregate functions.

Sort_asc (Sort Ascending). The Sort_asc operator sorts the rows in ascending order based on a specified column. The sorting places the smallest values first and the largest values last.

Sort_desc (Sort Descending). The Sort_desc operator sorts the rows in descending order based on a specified column. It places the largest values first and the smallest values last.

Insub (Subquery with IN). The Insub operator represents the use of a subquery in an IN condition, checking if a value is present in a set of values returned by a subquery.

Exists. The Exists operator is used to check if a subquery returns any results. It returns true if the subquery produces one or more rows, and false if the subquery returns no rows.

Except. The Except operator returns the rows from the first query that are not present in the second query. It eliminates any rows that appear in both queries, effectively subtracting one result set from another.

Intersect. The Intersect operator returns the common rows from both queries. It finds the intersection of two result sets, returning only the rows that are present in both datasets.

Join_cross (Cross Join). The Join_cross operator performs a cross join between two tables, producing a Cartesian product of the rows from both tables. Each row from the first table is paired with every row from the second table, resulting in all possible combinations of rows.

Join_right (Right Join). The Join_right operator performs a right outer join, returning all rows from the right table and the matching rows from the left table. If no match is found in the left table, NULL values are returned for the left table's columns

3 RULES

```
rule 1:
Exists(Agg_average<a4 a5 r6 e2 a6 r7>(Exists(Union
(Input<r3>,Input<r4>),Input<r5>)),Input<r8>)|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 2:
Filter<e3 _>(Filter<e4 _>(Agg<_ a3 _ e0 a4 r4 e1
a5 r5>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 3:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r6>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 4:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
TableEq(r3,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 5:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(
Union_all<>(Filter<e4 _>(Input<r3>),Input<r5>)));
e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8
>>;e4:=Sublink<EXISTS Input<r4>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
```

```
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);
TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 6:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Input<r6>,Exists(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 7:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a4 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 8:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(
Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<
avg>(a5);e3:=Sublink<EXISTS Filter<e4 _>(Input<r7
>)>;e4:=Sublink<EXISTS Input<r8>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 9:
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Exists
(Input<r4>,Union(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 10:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Exists(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 11:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Input<r3
>,Filter<e3 _>(Input<r4>)));e0:=FuncCall<avg>(a5);
e3:=Sublink<EXISTS Input<r5>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 12:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(
Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<
avg>(a5);e3:=Sublink<EXISTS Input<r7>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 13:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Union_all<>(Input<r6>,Input<r7>),Input
<r8>)>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 14:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Exists(Input<r4>,Union(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 15:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Filter<e3 _>(Input<r3>),Input<r5>),
Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<
EXISTS Input<r4>>|
```

```
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 16:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 17:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Union_all<>(Input<r4>,Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 18:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 19:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r6>,Union_all<>(Input<r7>,Input<r8>))>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 20:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 21:
Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 22:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e4 _>(Union_all<>(Input<r3>,Input<r4>))));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Input<r5>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 23:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Filter<e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 24:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<max>(a4);e3:=Sublink<EXISTS Input<r7>>|
Agg<_ a5 _ e2 a4 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 25:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4:=Sublink<EXISTS Input<r8>>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 26:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(Filter<e4 _>(Input<r3>)));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;e4:=Sublink<EXISTS Input<r4>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 27:
Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(Union_all<>(Input<r3>,Input<r4>));e0:=FuncCall<avg>(a5)|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 28:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Union_all<>(Input<r4>,Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 29:
Exists(Agg_max<a3 a4 r5 e1 a5 r6>(Union(Input<r3>,Input<r4>)),Input<r7>)|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a4);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r3,r4);TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 30:
Exists(Agg_count<a3 a4 r5 e1 a5 r6>(Exists(Input<r3>,Input<r4>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 31:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 32:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a4 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 33:
Agg_average<a4 a5 r5 e2 a6 r6>(Union(Input<r3>,Input<r4>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r3,r4);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 34:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3>,Union_all<>(Input<r4>,Union_all<>(Input<r5>,Input<r6>))));e0:=FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 35:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e1 a6 r6>(Proj<ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a6 _ e2 a4 r1 e1 a4 r2>(Input<r3>);e2:=FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a3)|
```

```
rule 36:
Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Input<r4>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 37:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Exists(Union(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 38:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Input<r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 39:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input<r6>)>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 40:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 41:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 42:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r6>,Union_all<>(Input<r7>,Input<r8>))>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 43:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3>,Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input<r6>)));e0:=FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 44:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 45:
Exists(Agg_average<a4 a5 r6 e2 a6 r7>(Union(Union(
Input<r3>,Input<r4>),Input<r5>)),Input<r8>)|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 46:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Filter<e3 _>(
Input<r5>)));e0:=FuncCall<avg>(a5);e3:=Sublink<
EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 47:
Agg_max<a3 a4 r7 e1 a5 r8>(Union(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 48:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 49:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),
Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a6);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 50:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 51:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r4>),Input<r6>)>;e4
:=Sublink<EXISTS Input<r5>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 52:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Exists(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 53:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Exists(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
```

```
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 54:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 55:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),
Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 56:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Union_all<>(Filter<
e3 _>(Input<r3>),Input<r6>));e0:=FuncCall<max>(a4)
;e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5
>)>|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 57:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Filter<
e3 _>(Input<r3>),Input<r5>));e0:=FuncCall<avg>(a5)
;e3:=Sublink<EXISTS Input<r4>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 58:
Exists(Agg_average<a4 a5 r5 e2 a6 r6>(Union(Input<
r3>,Input<r4>)),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 59:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2
a6 r5>(Input<r3>)));e0:=FuncCall<sum>(a5);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 60:
Exists(Agg_sum<a4 a5 r6 e2 a6 r7>(Exists(Input<r3
>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 61:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Input<r6>,Union(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 62:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Exists
(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 63:
Agg_count<a5 a6 r7 e2 a7 r8>(Exists(Proj_simple<_
a4 r4>(Input<r3>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsEq(a3,a5);AttrsSub(a4,r3);AttrsSub(a5,r4);
AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a4)|
```

```
rule 64:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 65:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a6 _ e1 a6 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 66:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 67:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 68:
Agg_average<a4 a5 r6 e2 a6 r7>(Exists(Union(Input<
r3>,Input<r4>),Input<r5>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 69:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 70:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Exists(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 71:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 72:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Input<r4>,Union(Input<r5>,Input<r6>))))|
```

```
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 73:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r6>),Input<r8>)>;e4
:=Sublink<EXISTS Input<r7>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 74:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3
>,Union_all<>(Input<r4>,Union_all<>(Input<r5>,
Input<r6>))));e0:=FuncCall<avg>(a5)|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 75:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 76:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Exists(Input<r6>,Input<r7>),Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 77:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Filter<e3 _>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)
>|
Agg<_ a4 _ e2 a4 r1 e1 a6 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 78:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 79:
Filter<e3 _>(Filter<e4 _>(Agg<_ a3 _ e0 a4 r4 e1
a5 r5>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 80:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 81:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Input<r6>,Union(Input<r7>,Input<r8>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 82:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Filter<e4 _>(Union_all<>(Input<r6>,Input<r7>))>;e4:=Sublink<EXISTS Input<r8>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 83:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Union(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 84:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a6);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 85:
Agg_count<a4 a5 r7 e1 a6 r8>(Exists(Proj_simple<_ a3 r4>(Input<r3>),Union(Input<r5>,Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a4);AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r5);TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 86:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Union(Input<r7>,Input<r8>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 87:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 88:
Exists(Agg_average<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Union(Input<r6>,Input<r7>),Input<r8>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 89:
Agg_count<a3 a4 r6 e1 a5 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 90:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Input<r3>,Union_all<>(Input<r4>,Input<r5>)));e0:=FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 91:
```

```
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(
Union_all<>(Union_all<>(Input<r3>,Input<r4>),Input
<r5>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS
Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 92:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<
e3 _>(Filter<e4 _>(Input<r3>)),Input<r6>));e0:=
FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r5>>;e4
:=Sublink<EXISTS Input<r4>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 93:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 94:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Input<r5>));e0:=
FuncCall<avg>(a5)|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 95:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 96:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 97:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Union(
Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 98:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input
<r6>)>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 99:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 100:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r5 e2
a6 r6>(Union_all<>(Input<r3>,Input<r4>))));e0:=
FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8>>;e4
:=Sublink<EXISTS Input<r7>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
```

```
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 101:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 102:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<sum>(a5);e3:=
Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 103:
Exists(Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<
r3>),Input<r6>),Input<r7>)|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a0,a5);AttrsEq(a1,a6);
AttrsEq(a2,a4);AttrsEq(a2,a5);AttrsEq(a3,a4);
AttrsEq(a3,a5);AttrsEq(a4,a5);AttrsSub(a4,r3);
AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);
NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,
e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 104:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a4);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 105:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r6>),Input<r8>)>;e4
:=Sublink<EXISTS Input<r7>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 106:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 107:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a6 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 108:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 109:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 110:
```

```
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Union(
Input<r4>,Exists(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 111:
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Union(
Input<r4>,Union(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 112:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 113:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 114:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(
Union_all<>(Input<r3>,Filter<e4 _>(Input<r4>))));
e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6
>>;e4:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 115:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r4>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r5>,Input<r6>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 116:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Exists(Input<r6>,Input<r7>),Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 117:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Union(
Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 118:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 119:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Union_all<>(Input<r6>,Input<r7>))>;e4:=Sublink<EXISTS Input<r8>>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 120:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,Exists(Input<r4>,Union(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 121:
Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 122:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Exists(Input<r6>,Union(Input<r7>,Input<r8>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 123:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Union_all<>(Input<r4>,Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 124:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 125:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Proj<ea3 a3 r6>(Filter<e3 _>(Input<r3>)));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a6 _ e2 a4 r1 e1 a6 r2>(Input<r3>);e2:=FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3)|
```

```
rule 126:
Filter<e3 _>(Filter<e4 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Union_all<>(Input<r6>,Input<r7>)>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 127:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r6>,Input<r7>),Input<r8>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 128:
Exists(Agg_average<a4 a5 r5 e2 a6 r6>(Union(Input<r3>,Input<r4>)),Input<r7>)|
```

```
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 129:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4
:=Sublink<EXISTS Input<r6>>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 130:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2
a6 r5>(Input<r3>)));e0:=FuncCall<avg>(a5);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 131:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Input<
r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 132:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Input<r6>),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 133:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 134:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,
Exists(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 135:
Agg_max<a3 a4 r5 e1 a5 r6>(Union(Input<r3>,Input<
r4>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r3,r4);
Unique(r3,a3);Unique(r3,a4)|
```

```
rule 136:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(
Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<
avg>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r7>,
Input<r8>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 137:
Agg_sum<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,Union(
Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 138:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 139:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Proj<ea3 a3 r6>(Filter<e3 _>(Input<r3>)));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a6 _ e2 a6 r1 e1 a4 r2>(Input<r3>);e2:=FuncCall<count>(a6)|
AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3)|
```

```
rule 140:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Union_all<>(Filter<e3 _>(Input<r3>),Input<r5>),Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r4>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 141:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 142:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 143:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,Exists(Input<r4>,Union(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 144:
Agg_max<a3 a4 r7 e1 a5 r8>(Union(Exists(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 145:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,Exists(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 146:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Union(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 147:
Exists(Agg_count<a3 a4 r6 e1 a5 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
```

```
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);
TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 148:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Union_all<>(Filter<
e3 _>(Filter<e4 _>(Input<r3>)),Input<r6>));e0:=
FuncCall<max>(a4);e3:=Sublink<EXISTS Input<r5>>;e4
:=Sublink<EXISTS Input<r4>>|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 149:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 150:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Exists(Union(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 151:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4
:=Sublink<EXISTS Input<r6>>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 152:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Exists(
Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 153:
Exists(Agg_count<a3 a4 r5 e1 a5 r6>(Exists(Input<
r3>,Input<r4>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 154:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input
<r6>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 155:
Exists(Agg_max<a3 a4 r5 e1 a5 r6>(Union(Input<r3>,
Input<r4>)),Input<r7>)|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);
TableEq(r3,r4);TableEq(r3,r7);TableEq(r4,r7);
Unique(r3,a3);Unique(r3,a4)|
```

```
rule 156:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 157:
```

```
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Input<r5>));e0:=
FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 158:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Proj<ea3 a3 r6>(
Filter<e3 _>(Input<r3>)));e0:=FuncCall<count>(a5);
e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5
>)>|
Agg<_ a4 _ e2 a4 r1 e1 a4 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3)|
```

```
rule 159:
Agg_count<a4 a5 r7 e1 a6 r8>(Proj_simple<_ a3 r6>(
Exists(Input<r3>,Union(Input<r4>,Input<r5>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);
Unique(r3,a3)|
```

```
rule 160:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Exists(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 161:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 162:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3
>,Filter<e3 _>(Input<r4>)));e0:=FuncCall<avg>(a5);
e3:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6
>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 163:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Union_all<>(Input<r7>,Input<
r8>))>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 164:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 165:
Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Union_all<>(Input<r3
>,Union_all<>(Input<r4>,Input<r5>)));e0:=FuncCall<
max>(a4)|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 166:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Filter<e4 _>(Union_all<>(Input<r6>,Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 167:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Exists(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 168:
Exists(Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3
>),Input<r6>),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 169:
Exists(Agg_average<a4 a5 r6 e2 a6 r7>(Union(Exists
(Input<r3>,Input<r4>),Input<r5>)),Input<r8>)|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 170:
Exists(Agg_count<a5 a6 r5 e2 a7 r6>(Proj_simple<_
a4 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsEq(a3,a5);AttrsSub(a4,r3);AttrsSub(a5,r4);
AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a4)|
```

```
rule 171:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Filter<e3 _>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)
>|
Agg<_ a4 _ e2 a6 r1 e1 a6 r2>(Input<r3>);e2:=
FuncCall<count>(a6)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 172:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Exists(Input<r6>,Input<r7>),Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 173:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input
<r6>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 174:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Union_all<>(Input
<r5>,Input<r6>)));e0:=FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 175:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),
Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 176:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Input<r3
>,Union_all<>(Input<r4>,Input<r5>)));e0:=FuncCall<
avg>(a5)|
```

```
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 177:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 178:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Union(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 179:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 180:
Exists(Agg_count<a3 a4 r6 e1 a5 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>)))),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 181:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Union_all<>(Input<r5>,Input<r6>))>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 182:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 183:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 184:
Agg<_ a5 _ e0 a6 r7 e2 a7 r8>(Filter<e3 _>(Proj<ea4 a4 r4>(Input<r3>)));e0:=FuncCall<sum>(a6);e3:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)>|
Filter<e2 a7>(Agg<_ a5 _ e1 a6 r1 e2 a5 r2>(Input<r3>));e1:=FuncCall<sum>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r4);AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a4)|
```

```
rule 185:
Exists(Agg_max<a3 a4 r6 e1 a5 r7>(Union(Input<r3>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 186:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 187:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Union_all<>(Input<r5>,Input<
r6>))>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 188:
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Exists
(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 189:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Input<
r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 190:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 191:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Filter<e3 _>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)
>|
Agg<_ a6 _ e2 a4 r1 e1 a4 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 192:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3
>,Filter<e3 _>(Input<r4>)));e0:=FuncCall<avg>(a5);
e3:=Sublink<EXISTS Filter<e4 _>(Input<r5>)>;e4:=
Sublink<EXISTS Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 193:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Input<r6>,Union(Input<r7>,Input<r8>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 194:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a4 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 195:
Exists(Agg_count<a4 a5 r5 e1 a6 r6>(Proj_simple<_
a3 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
```

```
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a4);
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);
Unique(r3,a3)|
```

```
rule 196:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Input<r4>,Union(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 197:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,
Exists(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 198:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r6>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r7>,Input<r8>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 199:
Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Union_all<>(Input<r3
>,Input<r4>));e0:=FuncCall<max>(a4)|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
Unique(r3,a3);Unique(r3,a4)|
```

```
rule 200:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r6>),Input<r8>)>;e4
:=Sublink<EXISTS Input<r7>>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 201:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<
r3>,Input<r4>),Union(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 202:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<
e4 _>(Union_all<>(Input<r3>,Input<r4>))));e0:=
FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8>>;e4
:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);
TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 203:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);
TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 204:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Union_all<>(Filter<
e3 _>(Union_all<>(Input<r3>,Input<r4>)),Input<r6>)
);e0:=FuncCall<max>(a4);e3:=Sublink<EXISTS Input<
r5>>|
Agg<_ a5 _ e2 a4 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 205:
```

```
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input<r6>)>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 206:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input<r6>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 207:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3>,Filter<e3 _>(Filter<e4 _>(Input<r4>))));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS Input<r5>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 208:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>)));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Input<r7>>;e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 209:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r6>,Input<r7>),Input<r8>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 210:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a4 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 211:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Input<r6>)|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r3,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 212:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 213:
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Union(Input<r4>,Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 214:
Exists(Agg_count<a3 a4 r6 e1 a5 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
```

```
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);
TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 215:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r4>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r5>,Input<r6>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 216:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 217:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Input<r6>,Union(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 218:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 219:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 220:
Exists(Agg_count<a4 a5 r5 e1 a6 r6>(Proj_simple<_
a3 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);
Unique(r3,a3)|
```

```
rule 221:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 222:
Agg_max<a3 a4 r7 e1 a5 r8>(Union(Input<r3>,Exists(
Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 223:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<
r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 224:
```

```
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 225:
Exists(Agg_count<a3 a4 r6 e1 a5 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 226:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Union_all<>(Filter<e3 _>(Union_all<>(Input<r3>,Input<r4>)),Input<r6>));e0:=FuncCall<max>(a4);e3:=Sublink<EXISTS Input<r5>>|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 227:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),Input<r6>)|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a0,a5);AttrsEq(a1,a6);AttrsEq(a2,a4);AttrsEq(a2,a5);AttrsEq(a3,a4);AttrsEq(a3,a5);AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r3,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 228:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 229:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 230:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r7>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 231:
Exists(Exists(Agg_average<a4 a5 r4 e2 a6 r5>(Input<r3>),Input<r6>),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 232:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 233:
Exists(Agg_average<a4 a5 r6 e2 a6 r7>(Union(Exists(Input<r3>,Input<r4>),Input<r5>)),Input<r8>)|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 234:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Input<
r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 235:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(
Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<
avg>(a5);e3:=Sublink<EXISTS Input<r7>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r4,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 236:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 237:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 238:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),
Union(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 239:
Agg_sum<a4 a5 r7 e2 a6 r8>(Exists(Input<r3>,Union(
Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 240:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a6);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 241:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Union(
Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 242:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<
r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 243:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(
Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<
avg>(a5);e3:=Sublink<EXISTS Filter<e4 _>(Input<r7
>)>;e4:=Sublink<EXISTS Input<r8>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 244:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Input<r6>),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 245:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a4 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 246:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);
TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 247:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Union(Input<
r3>,Input<r4>),Input<r5>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 248:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Filter<e3 _>(Input<r4>)),
Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<
EXISTS Input<r5>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 249:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Input<r3
>,Filter<e3 _>(Input<r4>)));e0:=FuncCall<avg>(a5);
e3:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 250:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Filter<e3 _>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)
>|
Agg<_ a4 _ e2 a4 r1 e1 a4 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 251:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Exists(Input<r6>,Union(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 252:
```

```
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3>,Filter<e3 _>(Input<r4>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Filter<e4 _>(Input<r5>)>;e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 253:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<e3 _>(Input<r3>),Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 254:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 255:
Agg_max<a3 a4 r5 e1 a5 r6>(Union(Input<r3>,Input<r4>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a4);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r3,r4);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 256:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Union(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 257:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Input<r6>,Exists(Input<r7>,Input<r8>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 258:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Filter<e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 259:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4:=Sublink<EXISTS Input<r8>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 260:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 261:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Union(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 262:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Union_all<>(Input
<r5>,Input<r6>)));e0:=FuncCall<avg>(a5)|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 263:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 264:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Exists(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 265:
Agg_count<a4 a5 r5 e2 a6 r6>(Exists(Input<r3>,
Input<r4>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsEq(a4,a5);AttrsSub(a4,r3);
AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);
NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,
e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r3,r4);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 266:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3
>,Filter<e3 _>(Filter<e4 _>(Input<r4>))));e0:=
FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6>>;e4
:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 267:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS
Union_all<>(Union_all<>(Input<r6>,Input<r7>),Input
<r8>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 268:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<
e3 _>(Input<r3>),Filter<e4 _>(Input<r5>)));e0:=
FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r4>>;e4
:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 269:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<
r3>,Input<r4>),Exists(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 270:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Union_all<>(Input<r4>,Input<
r5>)),Input<r6>));e0:=FuncCall<avg>(a5)|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 271:
Exists(Agg_count<a4 a5 r5 e1 a6 r6>(Proj_simple<_
a3 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);
Unique(r3,a3)|
```

```
rule 272:
Agg_count<a4 a5 r7 e1 a6 r8>(Proj_simple<_ a3 r6>(
Exists(Input<r3>,Union(Input<r4>,Input<r5>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a4);
AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);
Unique(r3,a3)|
```

```
rule 273:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Input<r4>,Union(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 274:
Filter<e3 _>(Agg<_ a5 _ e0 a6 r5 e2 a7 r6>(Proj<
ea4 a4 r4>(Input<r3>)));e0:=FuncCall<count>(a6);e3
:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)
>|
Filter<e2 a7>(Agg<_ a5 _ e1 a6 r1 e2 a5 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r4);AttrsSub(a6,r4);
AttrsSub(a7,a5);NotNull(r3,a4);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a4)|
```

```
rule 275:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Input<r6>,Exists(Input<r7>,Input<r8>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 276:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Union_all<>(Input<r3
>,Filter<e3 _>(Union_all<>(Input<r4>,Input<r5>))))
;e0:=FuncCall<max>(a4);e3:=Sublink<EXISTS Input<r6
>>|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 277:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a6 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 278:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<
e3 _>(Input<r3>),Union_all<>(Input<r5>,Input<r6>))
);e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<
r4>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 279:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Union(Input<r4>,Union(Input<r5>,Input<r6>))))|
```

```
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 280:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Input<r3>,Union_all<>(Input<r4>,Input<r5>))));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 281:
Exists(Agg_average<a4 a5 r5 e2 a6 r6>(Union(Input<r3>,Input<r4>)),Exists(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 282:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a4);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 283:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Union_all<>(Filter<e4 _>(Input<r3>),Input<r5>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6>>;e4:=Sublink<EXISTS Input<r4>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 284:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<e3 _>(Union_all<>(Input<r3>,Input<r4>)),Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r5>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 285:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Filter<e4 _>(Input<r4>),Input<r6>)>;e4:=Sublink<EXISTS Input<r5>>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 286:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Union_all<>(Input<r3>,Input<r4>)));e0:=FuncCall<max>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a3 _ e2 a4 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<max>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 287:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Union_all<>(Union_all<>(Input<r4>,Input<r5>),Input<r6>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 288:
```

```
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Input<r4>)>;e4:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 289:
Agg_max<a3 a4 r6 e1 a5 r7>(Union(Union(Input<r3>,Input<r4>),Input<r5>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 290:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 291:
Exists(Agg_average<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Input<r6>,Union(Input<r7>,Input<r8>)))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a0,a4);AttrsEq(a1,a3);AttrsEq(a1,a4);AttrsEq(a2,a3);AttrsEq(a2,a4);AttrsEq(a3,a4);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 292:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 293:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Union_all<>(Input<r3>,Filter<e3 _>(Input<r4>)),Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 294:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 295:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r5 e2 a6 r6>(Union_all<>(Input<r3>,Input<r4>))));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Input<r7>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 296:
Exists(Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 297:
Exists(Agg_count<a4 a5 r5 e1 a6 r6>(Proj_simple<_ a3 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
```

```
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);
Unique(r3,a3)|
```

```
rule 298:
Filter<e3 _>(Filter<e4 _>(Agg<_ a3 _ e0 a4 r4 e1
a5 r5>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 299:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Union_all<>(Input<r6>,Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Agg<_ a5 _ e2 a5 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 300:
Agg<_ a4 _ e0 a5 r7 e1 a6 r8>(Filter<e3 _>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)
>|
Agg<_ a6 _ e2 a4 r1 e1 a6 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a3)|
```

```
rule 301:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Union_all<>(Input<r4>,Input<r5>))>;e4
:=Sublink<EXISTS Input<r6>>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 302:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r5>,Input<r6>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 303:
Agg_max<a3 a4 r6 e1 a5 r7>(Union(Input<r3>,Union(
Input<r4>,Input<r5>)))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);
Unique(r3,a3);Unique(r3,a4)|
```

```
rule 304:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Union_all<>(Input<r3>,Input<r4>),Input
<r5>),Input<r6>));e0:=FuncCall<avg>(a5)|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 305:
Exists(Agg_max<a3 a4 r6 e1 a5 r7>(Union(Union(
Input<r3>,Input<r4>),Input<r5>)),Input<r8>)|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);
TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 306:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Union(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 307:
```

```
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Union_all<>(Filter<e3 _>(Input<r3>),Input<r5>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r4>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 308:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Union(Input<r3>,Input<r4>),Input<r5>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 309:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Exists(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 310:
Exists(Agg_average<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Input<r6>,Union(Input<r7>,Input<r8>)))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a3);AttrsEq(a2,a4);AttrsEq(a3,a4);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 311:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 312:
Exists(Agg_count<a5 a6 r5 e2 a7 r6>(Proj_simple<_ a4 r4>(Input<r3>)),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a5);AttrsEq(a1,a6);AttrsEq(a2,a5);AttrsEq(a3,a7);AttrsSub(a4,r3);AttrsSub(a5,r4);AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a4)|
```

```
rule 313:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Union(Input<r6>,Input<r7>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 314:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Input<r3>,Exists(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 315:
Filter<e3 _>(Agg<_ a5 _ e0 a6 r5 e2 a7 r6>(Proj<ea4 a4 r4>(Input<r3>)));e0:=FuncCall<count>(a6);e3:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>|
Filter<e2 a5>(Agg<_ a5 _ e1 a5 r1 e2 a7 r2>(Input<r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r4);AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a4)|
```

```
rule 316:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<r3>)));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 317:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Union(
Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 318:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(
Union_all<>(Input<r3>,Input<r4>),Filter<e3 _>(
Input<r5>)));e0:=FuncCall<avg>(a5);e3:=Sublink<
EXISTS Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 319:
Agg_average<a4 a5 r6 e2 a6 r7>(Exists(Union(Input<
r3>,Input<r4>),Input<r5>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 320:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 321:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a4 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 322:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r6>),Input<r8>)>;e4
:=Sublink<EXISTS Input<r7>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 323:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<sum>(a5);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r4>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r5>,Input<r6>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<sum>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique
(r3,a5)Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(
Input<r3>));e0:=FuncCall<count>(a5);e3:=Sublink<
EXISTS Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 324:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a4>(Agg<_ a4 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsEq(a4,a5);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 325:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Exists(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 326:
Exists(Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3
>),Union(Input<r6>,Input<r7>)),Input<r8>)|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 327:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Union_all<>(Input<r6>,Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 328:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r6>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a3 _ e2 a5 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a5)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 329:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Input<r6>,Exists(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 330:
Filter<e3 _>(Filter<e4 _>(Agg<_ a4 _ e0 a5 r4 e2
a6 r5>(Input<r3>)));e0:=FuncCall<avg>(a5);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r6>>|
Filter<e2 a4>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 331:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a4>(Agg<_ a6 _ e1 a5 r1 e2 a6 r2>(Input<
r3>));e1:=FuncCall<count>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 332:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 333:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 334:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 335:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Filter<e3 _>(Input<r3>),Input<r6>));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Filter<e4 _>(Input<r4>)>;e4:=Sublink<EXISTS Input<r5>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a6 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 336:
Agg_count<a4 a5 r7 e1 a6 r8>(Proj_simple<_ a3 r6>(Exists(Input<r3>,Union(Input<r4>,Input<r5>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a6);AttrsSub(a3,r3);AttrsSub(a4,r6);AttrsSub(a5,r6);AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a3)|
```

```
rule 337:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Input<r3>,Union_all<>(Input<r4>,Filter<e3 _>(Input<r5>))));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 338:
Exists(Agg_sum<a4 a5 r5 e2 a6 r6>(Exists(Input<r3>,Input<r4>)),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 339:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 340:
Agg<_ a4 _ e0 a5 r7 e2 a6 r8>(Union_all<>(Union_all<>(Input<r3>,Input<r4>),Filter<e3 _>(Input<r5>)));e0:=FuncCall<avg>(a5);e3:=Sublink<EXISTS Input<r6>>|
Filter<e2 a6>(Agg<_ a4 _ e1 a5 r1 e2 a4 r2>(Input<r3>));e1:=FuncCall<avg>(a5)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 341:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Filter<e4 _>(Input<r6>)>;e4:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 342:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,Union(Exists(Input<r4>,Input<r5>),Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a5);AttrsEq(a1,a3);AttrsEq(a2,a3);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 343:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),Exists(Union(Input<r6>,Input<r7>),Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 344:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union(Union(Input<r6>,Input<r7>),Input<r8>))|
```

```
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 345:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 346:
Agg_average<a4 a5 r6 e2 a6 r7>(Union(Input<r3>,Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 347:
Exists(Agg_max<a3 a4 r5 e1 a5 r6>(Union(Input<r3>,Input<r4>)),Union(Input<r7>,Input<r8>))|
Agg_max<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a4);AttrsEq(a2,a5);AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r7);TableEq(r0,r8);TableEq(r3,r4);TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 348:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Exists(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a4);Unique(r3,a5)|
```

```
rule 349:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r6 e1 a5 r7>(Filter<e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Input<r8>>;e4:=Sublink<EXISTS Union_all<>(Input<r4>,Input<r5>)>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 350:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4:=Sublink<EXISTS Input<r6>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 351:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS Union_all<>(Filter<e4 _>(Input<r6>),Input<r8>)>;e4:=Sublink<EXISTS Input<r7>>|
Agg<_ a5 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 352:
Agg_count<a5 a6 r7 e2 a7 r8>(Exists(Proj_simple<_ a4 r4>(Input<r3>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>))|
AttrsEq(a0,a5);AttrsEq(a1,a5);AttrsEq(a2,a7);AttrsEq(a3,a5);AttrsSub(a4,r3);AttrsSub(a5,r4);AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,r3);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r5);TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a4)|
```

```
rule 353:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,Union(Exists(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input<r0>))|
```

```
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 354:
Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3>),Union
(Input<r6>,Input<r7>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 355:
Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<r3>),
Union(Input<r6>,Exists(Input<r7>,Input<r8>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a5);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 356:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Union(Union(Input<r4>,Input<r5>),Input<r6>)))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 357:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 358:
Agg_count<a4 a5 r7 e1 a6 r8>(Exists(Proj_simple<_
a3 r4>(Input<r3>),Union(Input<r5>,Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a4);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r5,r6);
Unique(r3,a3)|
```

```
rule 359:
Agg_average<a4 a5 r7 e2 a6 r8>(Exists(Union(Exists
(Input<r3>,Input<r4>),Input<r5>),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 360:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Filter<e4 _>(Input<r5>))>;e4
:=Sublink<EXISTS Input<r6>>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 361:
Agg_sum<a5 a6 r7 e2 a7 r8>(Exists(Proj_simple<_ a4
 r4>(Input<r3>),Union(Input<r5>,Input<r6>)))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a5);AttrsEq(a1,a6);AttrsEq(a2,a5);
AttrsEq(a3,a7);AttrsSub(a4,r3);AttrsSub(a5,r4);
AttrsSub(a6,r4);AttrsSub(a7,a5);NotNull(r3,a4);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r5);TableEq(r0,r6);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r5,r6);Unique(r3,a4)|
```

```
rule 362:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r5 e1 a5 r6>(Filter<
e4 _>(Input<r3>)));e0:=FuncCall<count>(a4);e3:=
Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)>;
e4:=Sublink<EXISTS Input<r4>>|
Agg<_ a5 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
```

```
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r4,r7);
TableEq(r4,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 363:
Exists(Exists(Agg_count<a3 a4 r4 e1 a5 r5>(Input<
r3>),Input<r6>),Union(Input<r7>,Input<r8>))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a5);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r6);TableEq(r0,r7);
TableEq(r0,r8);TableEq(r3,r6);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r6,r7);TableEq(r6,r8);
TableEq(r7,r8);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 364:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r4 e2 a6 r5>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Input<r7>)>|
Filter<e2 a6>(Agg<_ a4 _ e1 a4 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a4)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r6,r7);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 365:
Filter<e3 _>(Agg<_ a4 _ e0 a5 r5 e1 a6 r6>(Proj<
ea3 a3 r4>(Input<r3>)));e0:=FuncCall<count>(a5);e3
:=Sublink<EXISTS Union_all<>(Input<r7>,Input<r8>)
>|
Agg<_ a4 _ e2 a4 r1 e1 a6 r2>(Input<r3>);e2:=
FuncCall<count>(a4)|
AttrsSub(a3,r3);AttrsSub(a4,r4);AttrsSub(a5,r4);
AttrsSub(a6,a4);NotNull(r3,a3);TableEq(r3,r7);
TableEq(r3,r8);TableEq(r7,r8);Unique(r3,a3)|
```

```
rule 366:
Agg<_ a4 _ e0 a5 r6 e2 a6 r7>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a5);e3:=Sublink<EXISTS
Union_all<>(Input<r4>,Input<r5>)>|
Filter<e2 a6>(Agg<_ a6 _ e1 a6 r1 e2 a4 r2>(Input<
r3>));e1:=FuncCall<count>(a6)|
AttrsSub(a4,r3);AttrsSub(a5,r3);AttrsSub(a6,a4);
NotNull(r3,a4);NotNull(r3,a5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 367:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 368:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Input<r6>,Filter<e4 _>(Input<r7>))>;e4
:=Sublink<EXISTS Input<r8>>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 369:
Agg<_ a3 _ e0 a4 r7 e1 a5 r8>(Filter<e3 _>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Union_all<>(Filter<e4 _>(Input<r4>),Input<r6>)>;e4
:=Sublink<EXISTS Input<r5>>|
Agg<_ a3 _ e2 a3 r1 e1 a5 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r3,r6);TableEq(r4,r5);
TableEq(r4,r6);TableEq(r5,r6);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 370:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Input<r3>,
Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 371:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Exists(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 372:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 373:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 374:
Exists(Exists(Agg_sum<a4 a5 r4 e2 a6 r5>(Input<r3
>),Input<r6>),Union(Input<r7>,Input<r8>))|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a4);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r6);TableEq(r0,r7);TableEq(r0,r8);
TableEq(r3,r6);TableEq(r3,r7);TableEq(r3,r8);
TableEq(r6,r7);TableEq(r6,r8);TableEq(r7,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 375:
Exists(Agg_sum<a4 a5 r6 e2 a6 r7>(Exists(Input<r3
>,Union(Input<r4>,Input<r5>))),Input<r8>)|
Filter<e1 a3>(Agg_sum<a0 a1 r1 e0 a2 r2>(Input<r0
>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r8);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r8);
TableEq(r4,r5);TableEq(r4,r8);TableEq(r5,r8);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 376:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Input<r3>,
Union(Input<r4>,Exists(Input<r5>,Input<r6>))))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 377:
Agg_count<a4 a5 r6 e2 a6 r7>(Exists(Input<r3>,
Union(Input<r4>,Input<r5>)))|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a4);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r3,r4);
TableEq(r3,r5);TableEq(r4,r5);Unique(r3,a4);Unique
(r3,a5)|
```

```
rule 378:
Filter<e3 _>(Agg<_ a3 _ e0 a4 r4 e1 a5 r5>(Input<
r3>));e0:=FuncCall<count>(a4);e3:=Sublink<EXISTS
Filter<e4 _>(Input<r6>)>;e4:=Sublink<EXISTS
Union_all<>(Input<r7>,Input<r8>)>|
Agg<_ a3 _ e2 a3 r1 e1 a3 r2>(Input<r3>);e2:=
FuncCall<count>(a3)|
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);TableEq(r3,r6);
TableEq(r3,r7);TableEq(r3,r8);TableEq(r6,r7);
TableEq(r6,r8);TableEq(r7,r8);Unique(r3,a3);Unique
(r3,a4)|
```

```
rule 379:
Agg_average<a4 a5 r7 e2 a6 r8>(Union(Union(Input<
r3>,Union(Input<r4>,Input<r5>)),Input<r6>))|
Filter<e1 a3>(Agg_average<a0 a1 r1 e0 a2 r2>(Input
<r0>))|
AttrsEq(a0,a4);AttrsEq(a1,a5);AttrsEq(a2,a6);
AttrsEq(a3,a4);AttrsSub(a4,r3);AttrsSub(a5,r3);
AttrsSub(a6,a4);NotNull(r3,a4);NotNull(r3,a5);
PredicateEq(e0,e2);PredicateEq(e1,e2);TableEq(r0,
r3);TableEq(r0,r4);TableEq(r0,r5);TableEq(r0,r6);
TableEq(r3,r4);TableEq(r3,r5);TableEq(r3,r6);
TableEq(r4,r5);TableEq(r4,r6);TableEq(r5,r6);
Unique(r3,a4);Unique(r3,a5)|
```

```
rule 380:
Agg_count<a3 a4 r7 e1 a5 r8>(Exists(Exists(Input<
r3>,Input<r4>),Union(Input<r5>,Input<r6>)))|
Agg_count<a0 a1 r1 e0 a2 r2>(Input<r0>)|
AttrsEq(a0,a3);AttrsEq(a1,a3);AttrsEq(a2,a3);
AttrsSub(a3,r3);AttrsSub(a4,r3);AttrsSub(a5,a3);
NotNull(r3,a3);NotNull(r3,a4);PredicateEq(e0,e1);
TableEq(r0,r3);TableEq(r0,r4);TableEq(r0,r5);
TableEq(r0,r6);TableEq(r3,r4);TableEq(r3,r5);
TableEq(r3,r6);TableEq(r4,r5);TableEq(r4,r6);
TableEq(r5,r6);Unique(r3,a3);Unique(r3,a4)|
```

```
rule 381:
Exists(Agg_count<a4 a5 r4 e2 a6 r5>(Input<r3>),
Input<r6>)|
Filter<e1 a3>(Agg_count<a0 a1 r1 e0 a2 r2>(Input<
r0>))|
AttrsEq(a0,a6);AttrsEq(a1,a6);AttrsEq(a2,a6);
AttrsEq(a3,a6);AttrsEq(a4,a5);AttrsSub(a4,r3);
AttrsSub(a5,r3);AttrsSub(a6,a4);NotNull(r3,a4);
NotNull(r3,a5);PredicateEq(e0,e2);PredicateEq(e1,
e2);TableEq(r0,r3);TableEq(r0,r6);TableEq(r3,r6);
Unique(r3,a4);Unique(r3,a5)
```

REFERENCES

[1] Haoran Ding, Zhaoguo Wang, Yicun Yang, Dexin Zhang, Zhenglin Xu, Haibo Chen, Ruzica Piskac, and Jinyang Li. 2023. Proving query equivalence using linear integer arithmetic. *Proceedings of the ACM on Management of Data* 1, 4 (2023), 1–26.