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La Fragmentation Horizontale Revisitée: Prise en Compte de l'Interaction de Requêtes

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EDA
Blois – June 13rd 2013

Data warehousing: Star Schema

- ❑ One fact table (volume)
- ❑ Many dimension tables

Star Join Queries

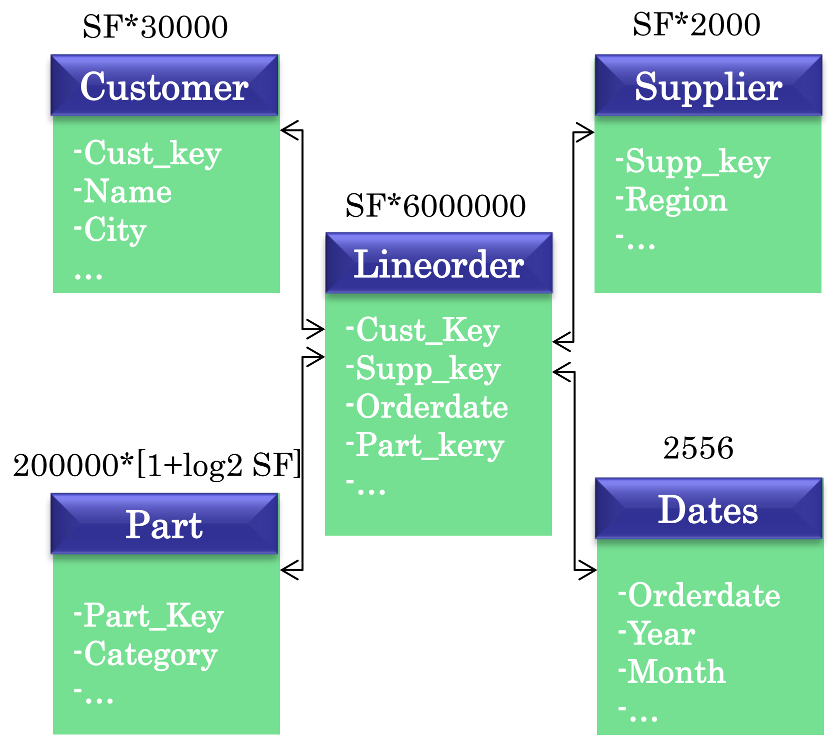
Selections on dimension tables

⇨ Multiple joins (between fact and dimension tables)

⇨ No direct joins between dimensions

Requirements

⇨ Lowering response time



Star Schema

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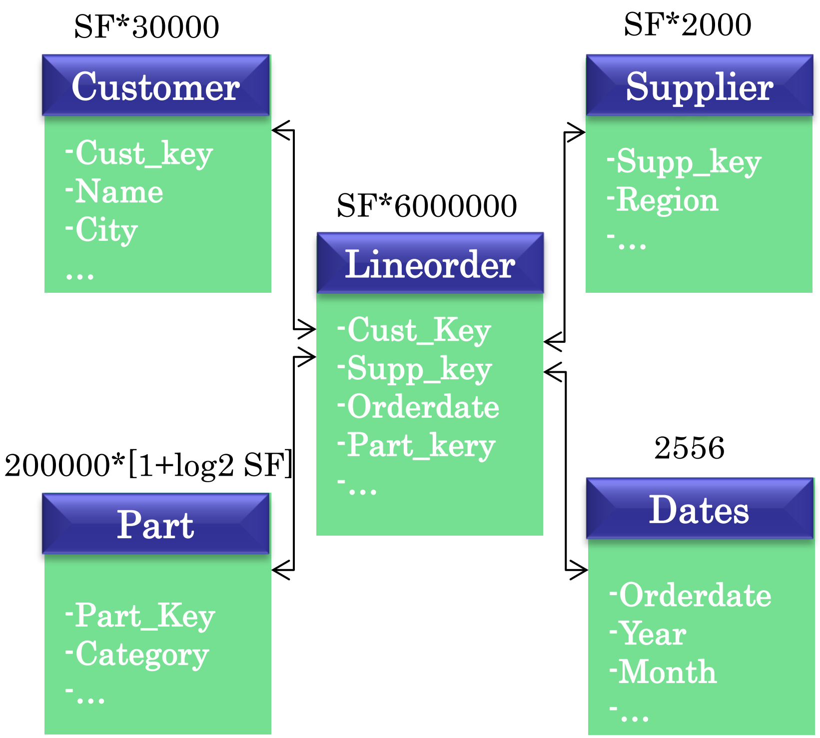

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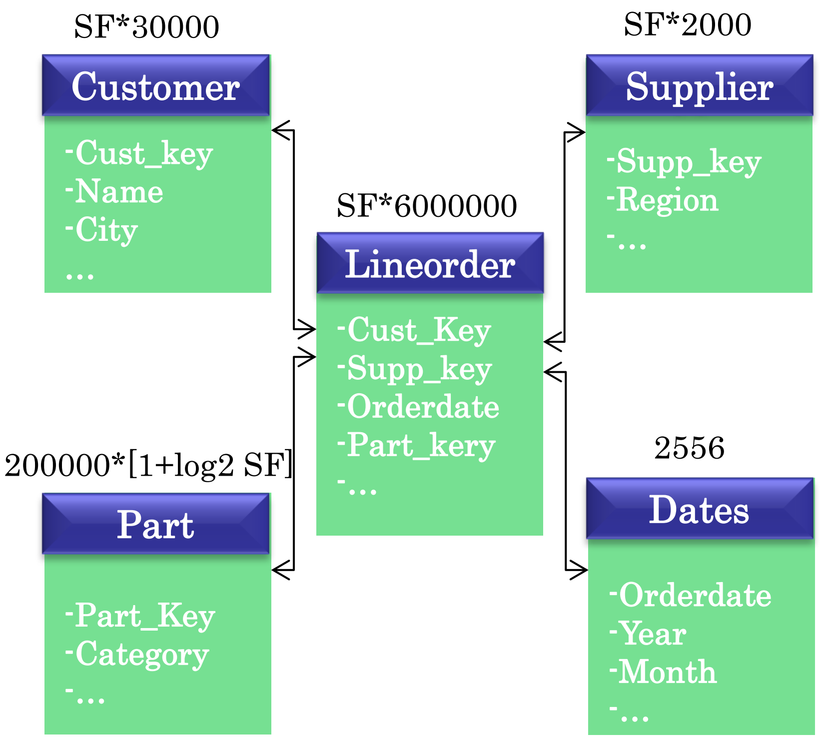


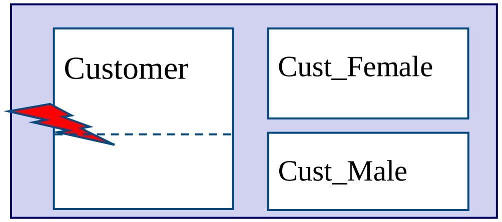
Star Schema

Horizontal Partitioning is well adapted for Star Join Queries

Horizontal Data Partitioning

❑Objective

Decompose table instances into disjoint groups of instances

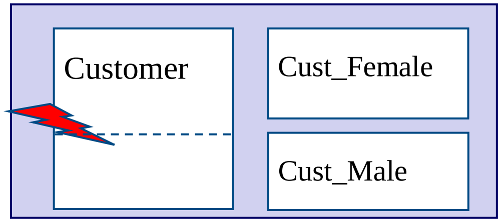


❑Two types :

Primary [Ceri'82]

Derived [Ceri'82]

Horizontal Data Partitioning



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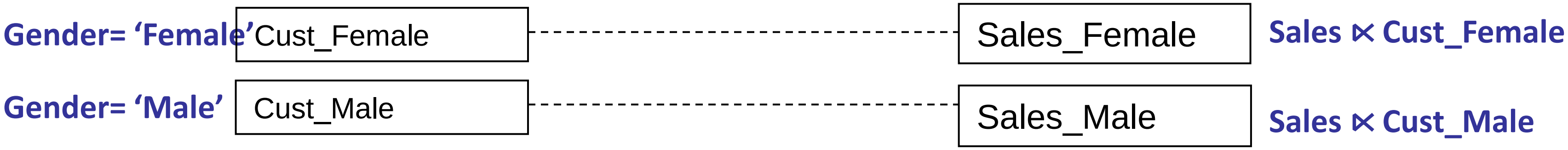

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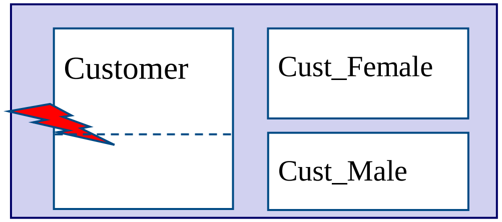

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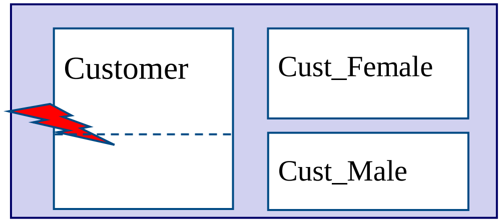
Gender= 'Female' Cust_Female — Sales_Female **Sales $\ltimes$ Cust_Female**

Gender= 'Male' Cust_Male — Sales_Male **Sales $\ltimes$ Cust_Male**

⇨Optimizing selections and joins

Horizontal Data Partitioning



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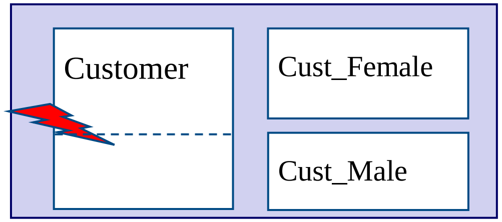

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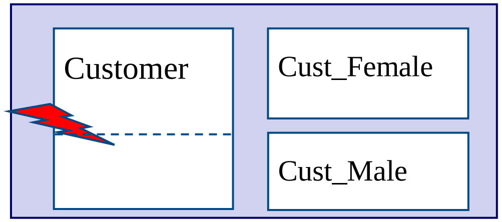

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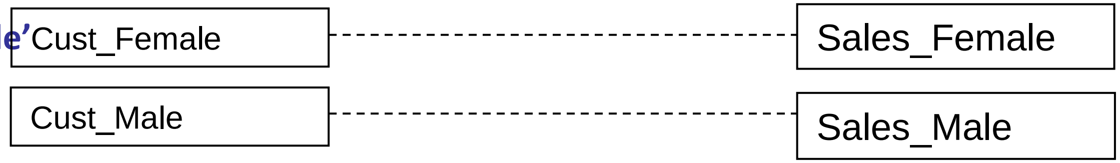

Sales ⋉ Cust_Female

Sales ⋉ Cust_Male

Input :

Data warehouse {Fact, D_1, D_2, …, D_d}

⇨ Optimizing selections and joins

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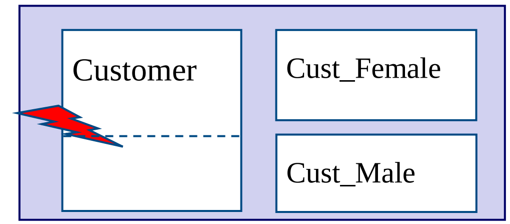

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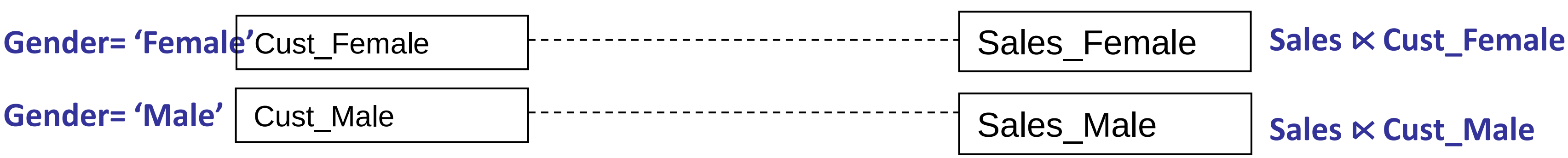

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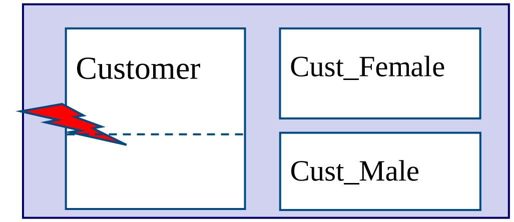

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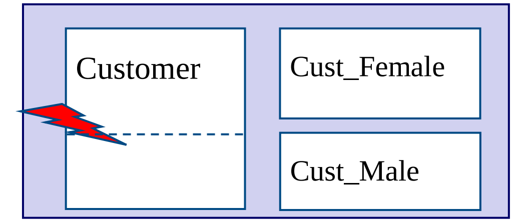

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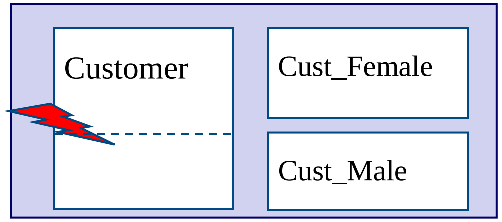

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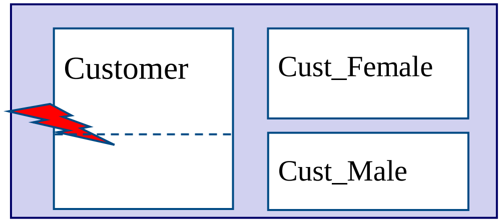

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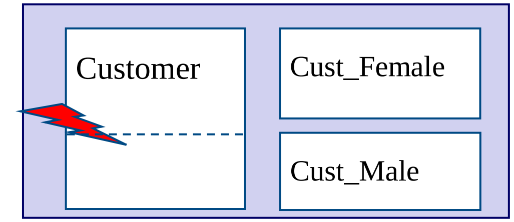
Horizontal Data Partitioning



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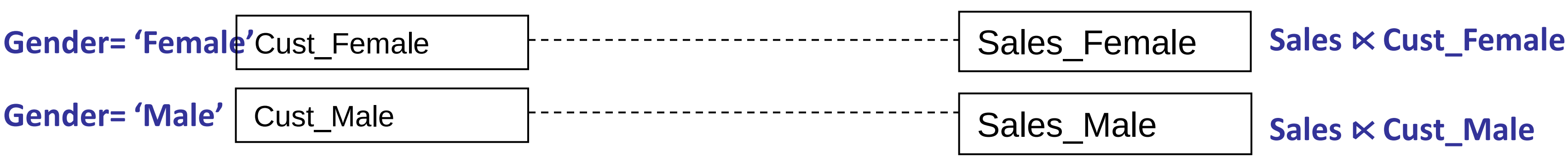

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Horizontal Data Partitioning

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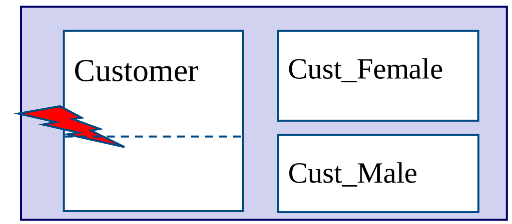

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Lowering execution cost of Q

Horizontal Data Partitioning

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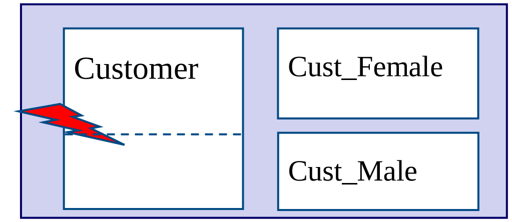

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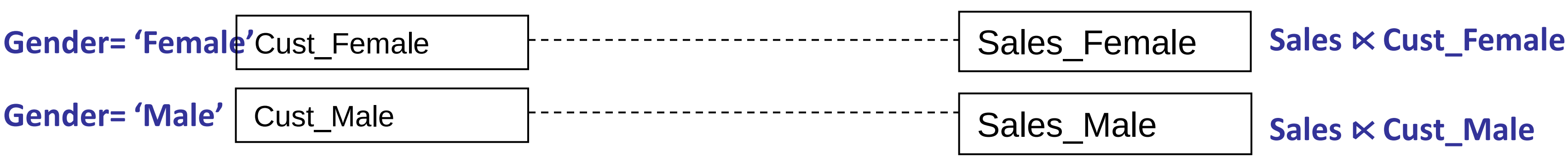

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Objectives :

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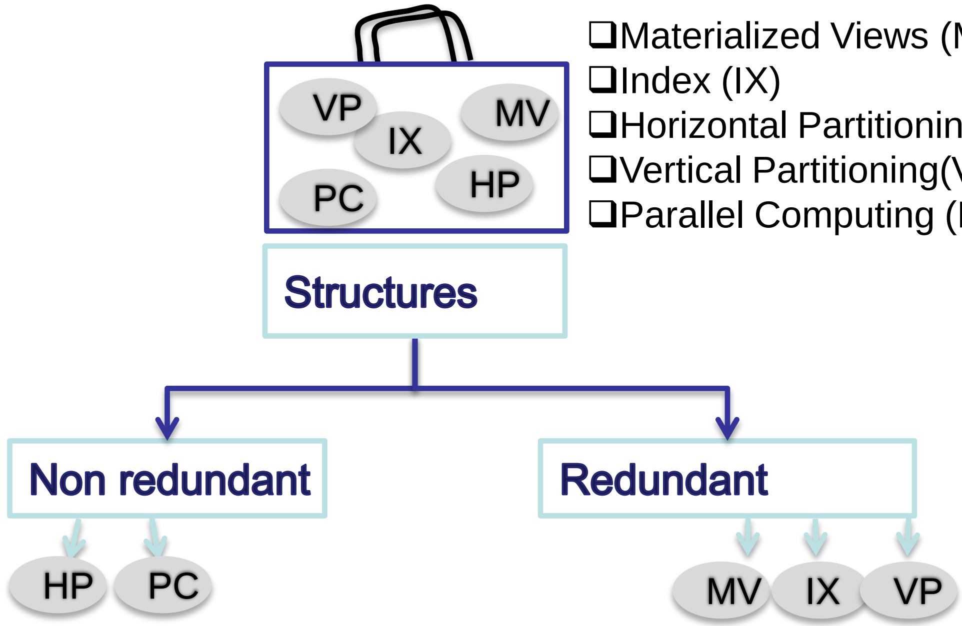
$N \leq W$

Classification of Optimization Techniques



- Materialized Views (MV)
- Index (IX)
- Horizontal Partitioning (HP)
- Vertical Partitioning(VP)
- Parallel Computing (PC)

First Classification
[DEXA'07]

Classification of Optimization Techniques

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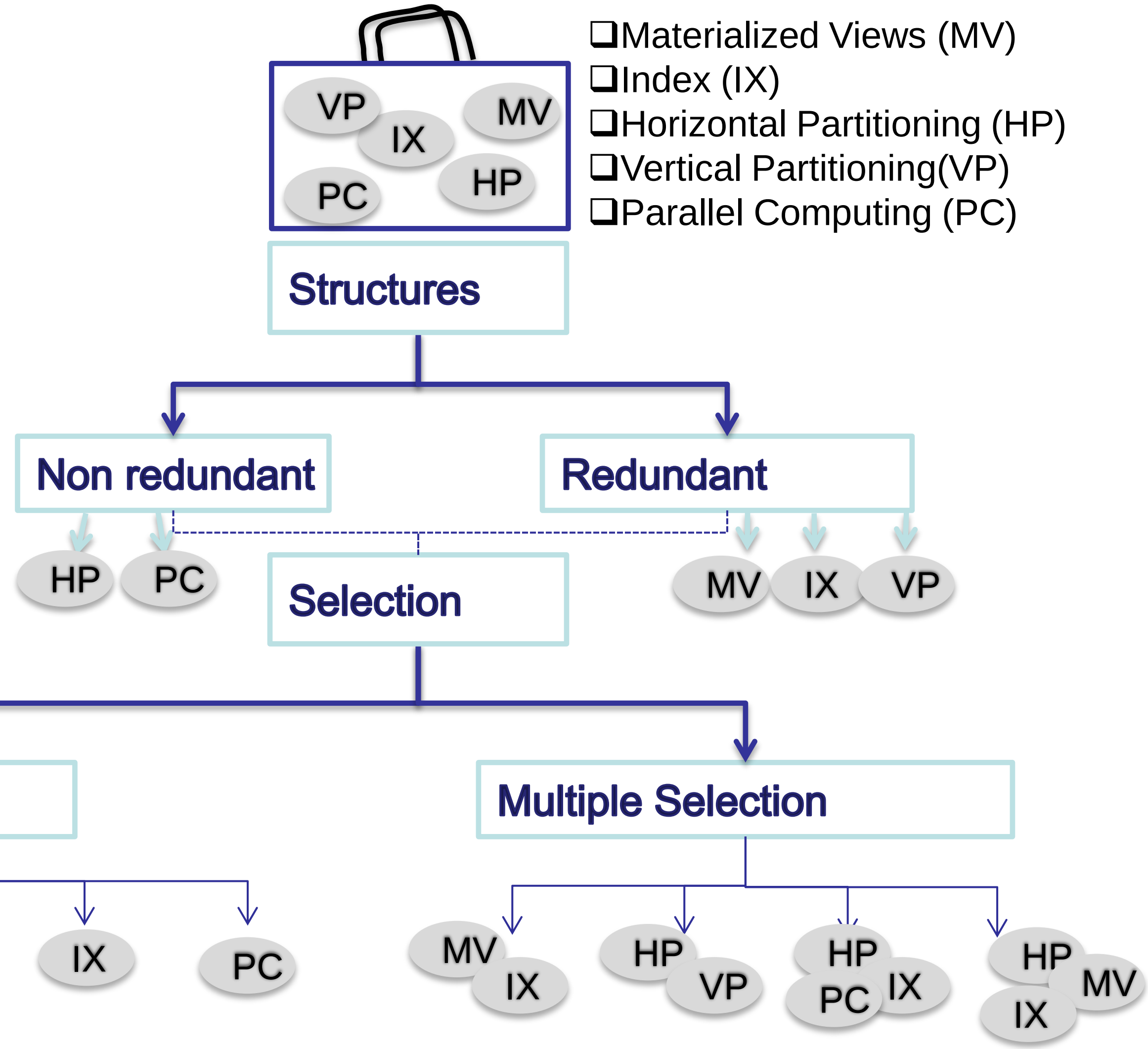
First Classification
[DEXA'07]

Second Classification
[DAWAK'08]



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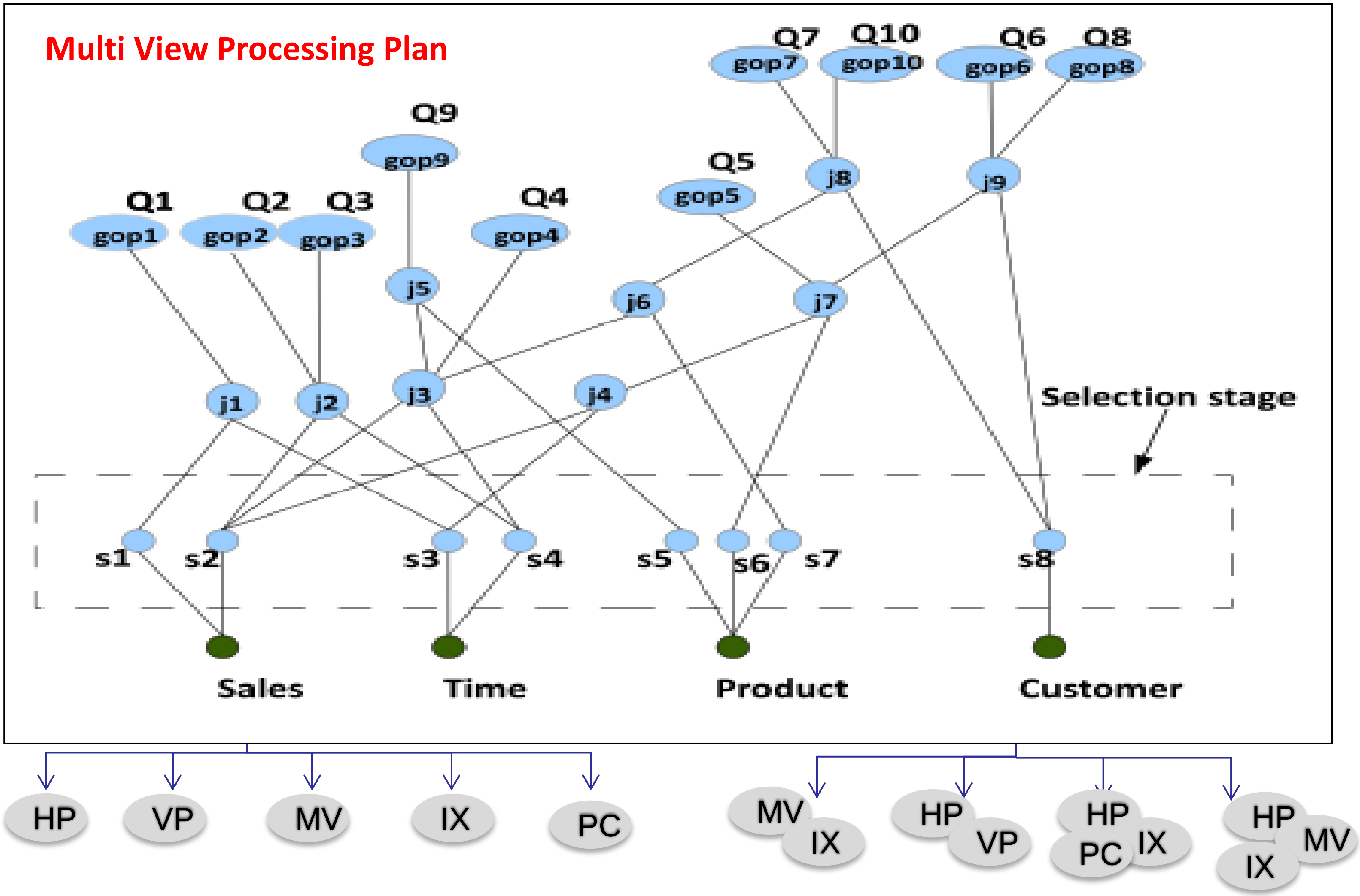
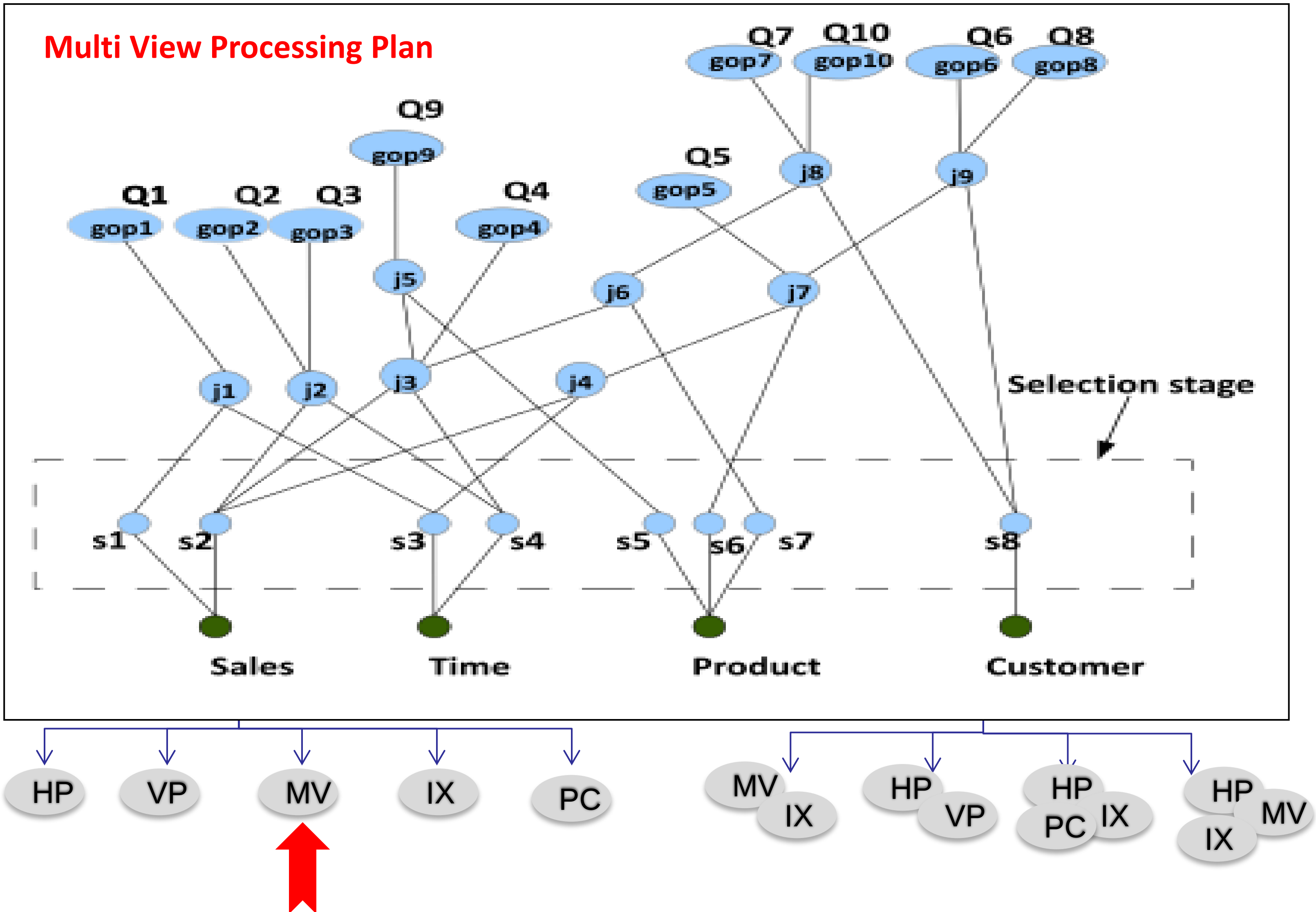


Query Interaction [Sellis'88]

Classification of Optimization Techniques



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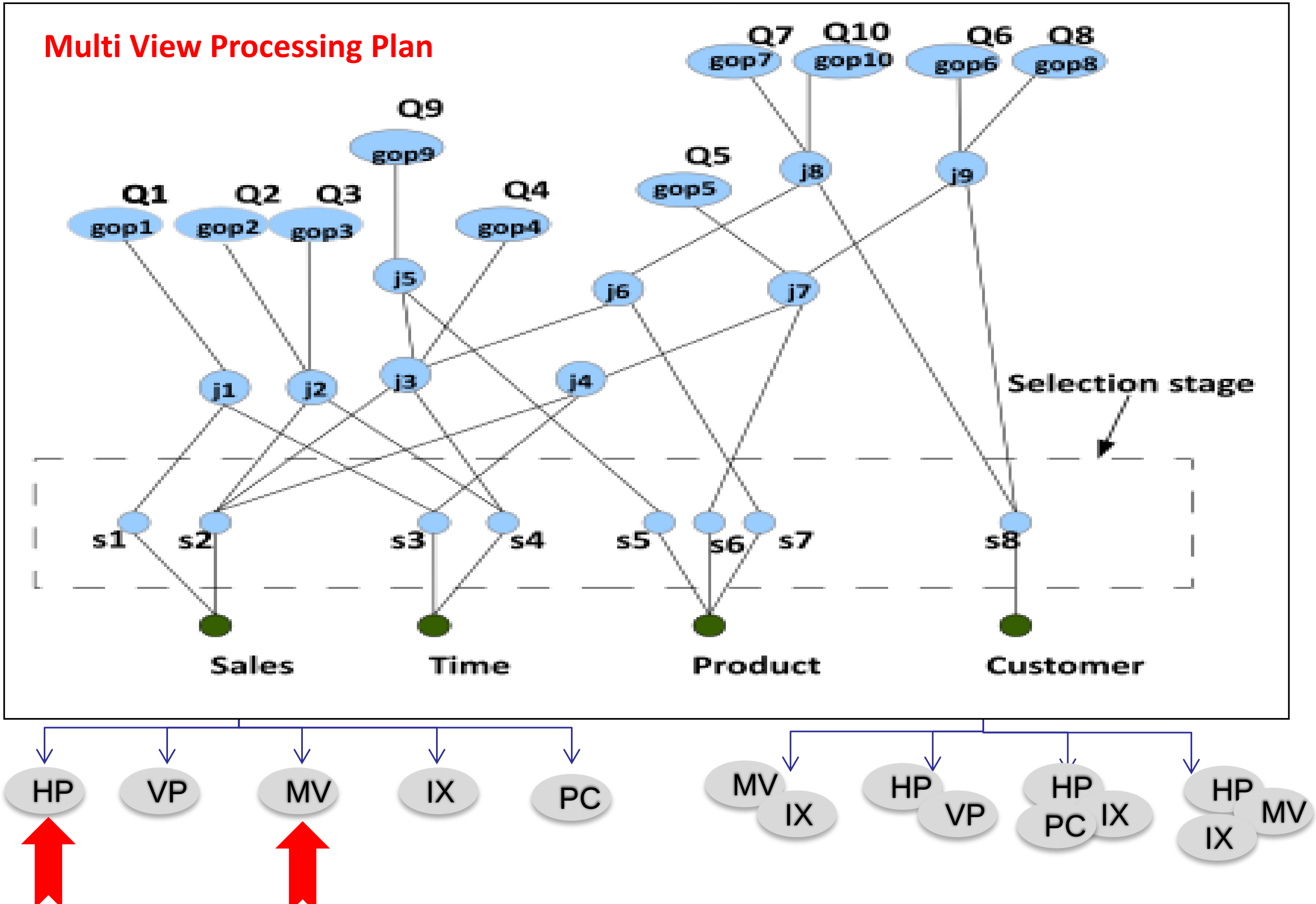

Query Interaction [Sellis'88]

Horizontal Data Partitioning Evolution

Classification of HDP approaches

- Horizontal Data Partitioning
  - Unconstrained
    1. Affinity [Karlapalem, 1996]
    2. Minterms [Ozsu and Valduriez, 1999]
  - Constrained
    1. Cost Model [Bellatreche *et al.* 2000]
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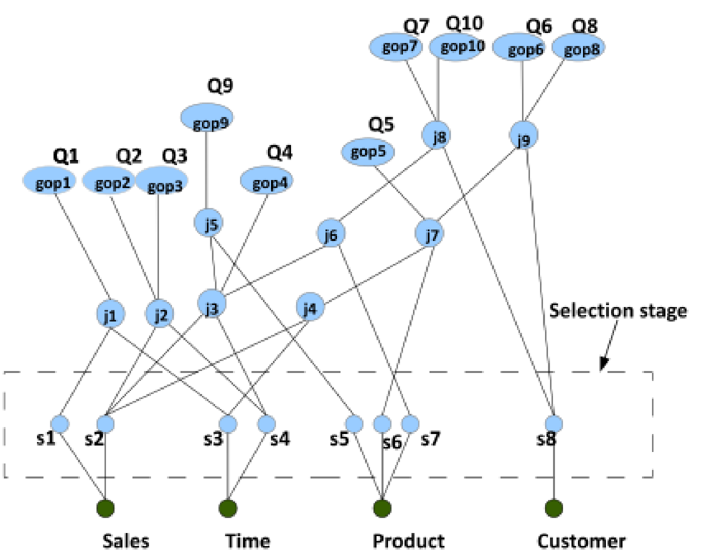

Horizontal Data Partitioning Evolution

Classification of HDP approaches

- Horizontal Data Partitioning
  - Ignoring Interaction
    - Algorithmic Level
      - Unconstrained
        1. Affinity [Karlapalem, 1996]
        2. Minterms [Ozsu and Valduriez, 1999]
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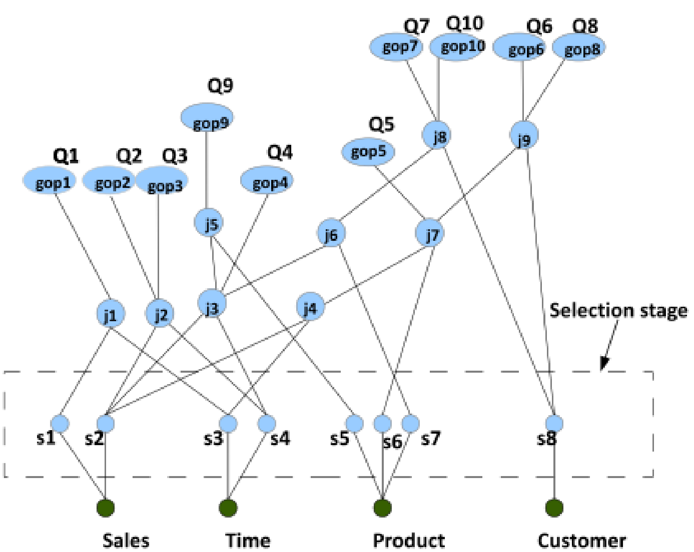
        1. Cost Model [Bellatreche *et al.* 2000]
        2. Data Mining [Mahboubi and Darmont, 2009]
  - Intercation-Aware
    1. Cost Model Level [Bellatreche *et al.* 2000]
    2. Algorithmic Level ?
    3. Data Structure Level ?

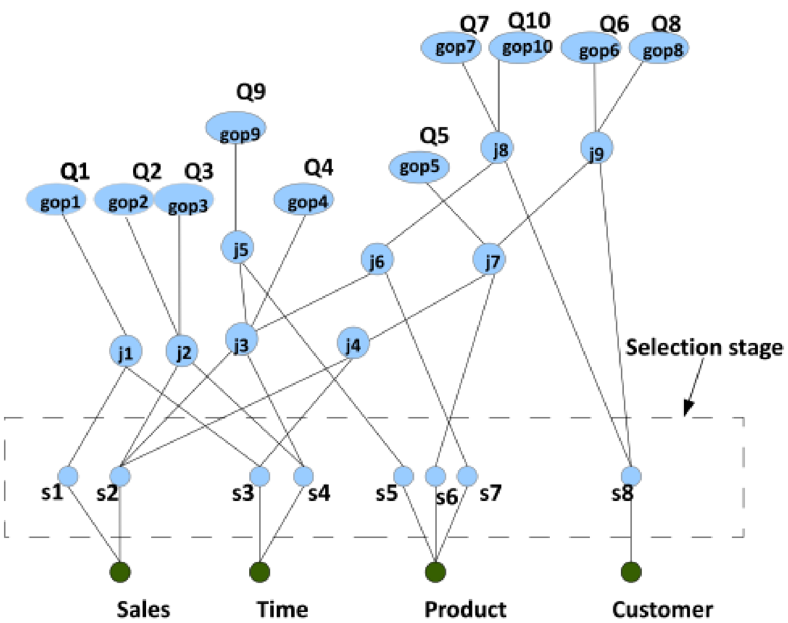
Query Interaction



Outlines

- **Motivating example**
- **Algebra**
- **EQHDP**
- **Experiments**
- **Conclusion & perspectives**

Motivating example

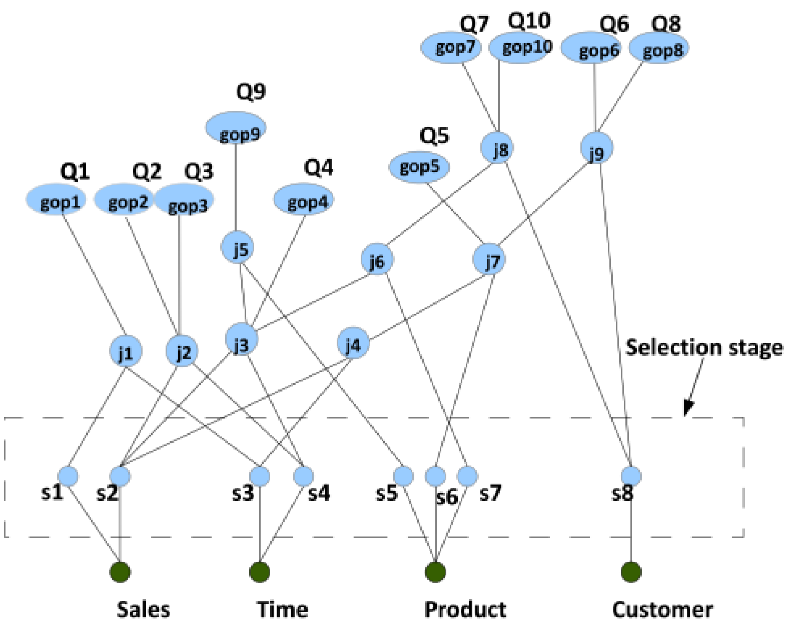


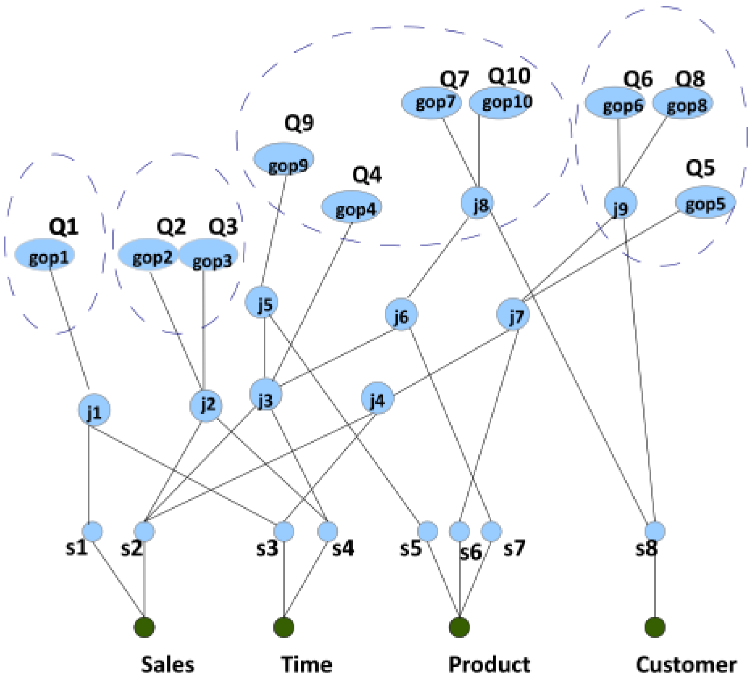
First join very expensive and needs optimization

➔ Selection stage (HDP)

➔ Spread benefit through the workload…

Motivating example





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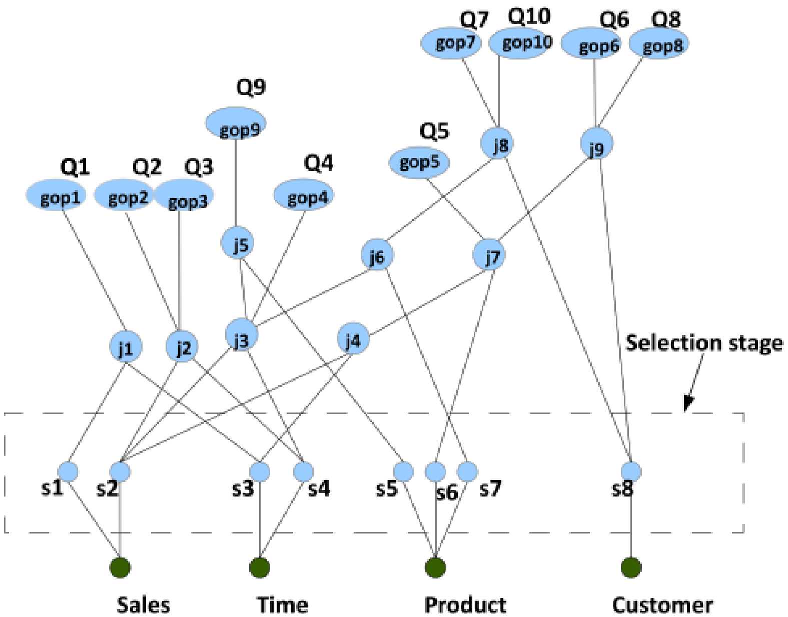

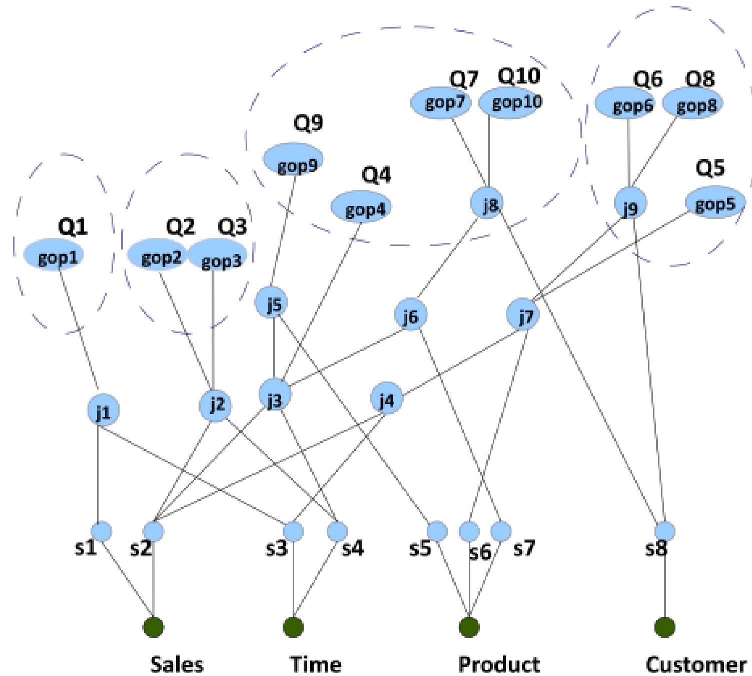

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1) Group queries
2) Elect one query in each group
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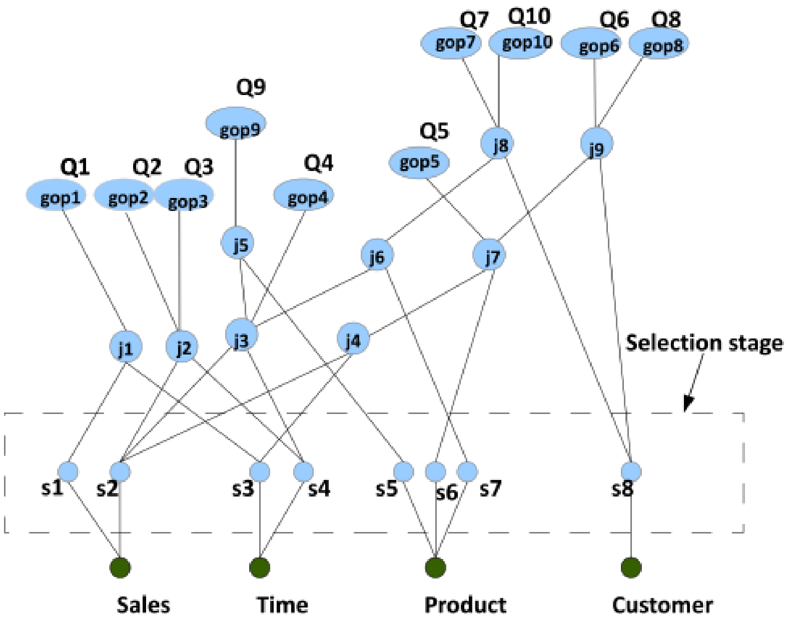

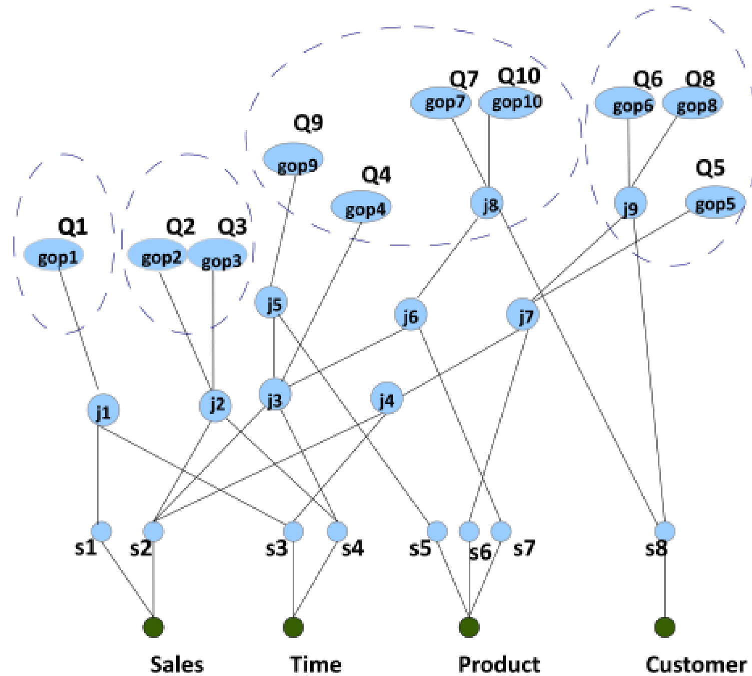

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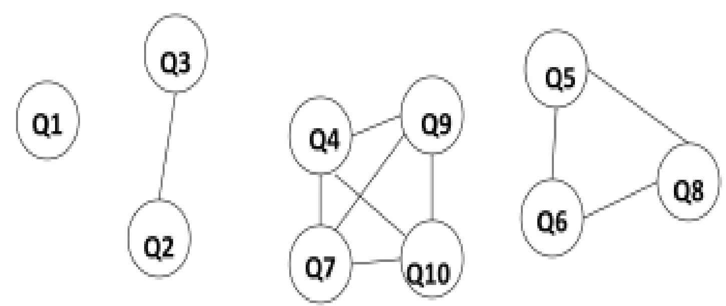

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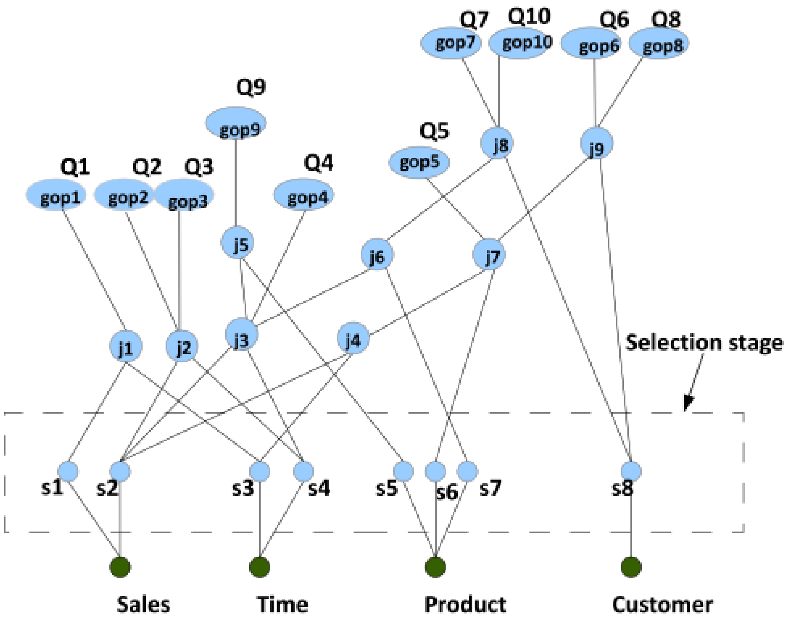

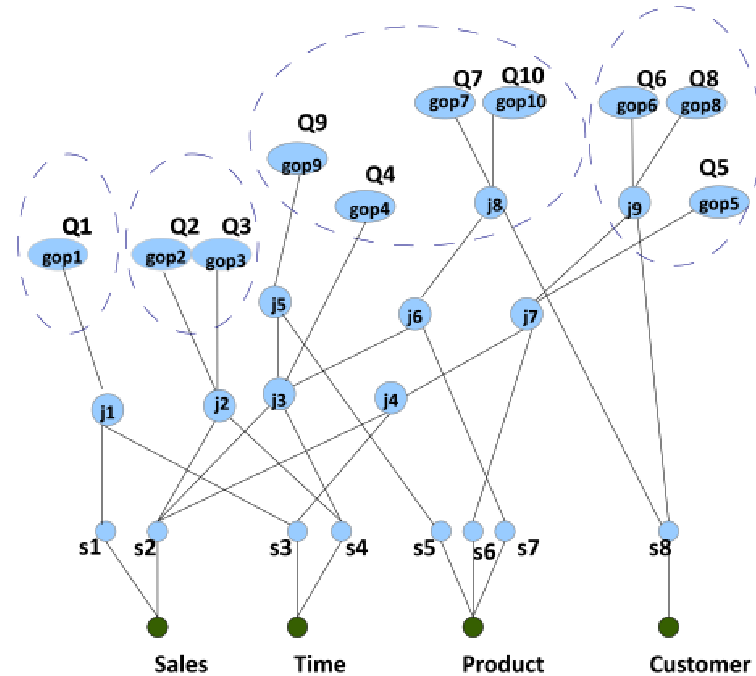

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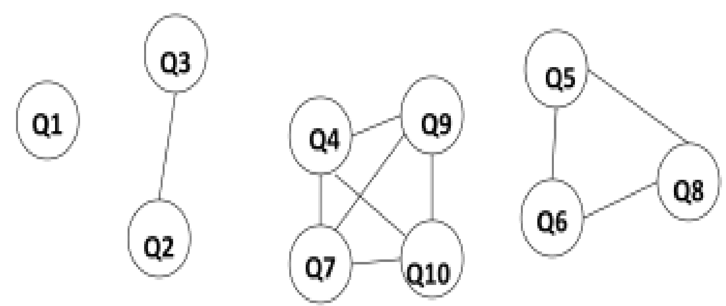

➔ How to elect query (criterion)?

➔ Algebra to handle generate HDP schema?

➔ Prune predicates and steer HDP by query interaction?

Algebra

Algebra allows to generate an encoding and a HDP schema

Generating incremental encoding

Att1	val1	else

→

Att1	val1	val2	Else

Horizontal Split

Att1	val1	val2	Else

→

Att1	val1	val2	Else
Att2	val1	else	

Vertical Split

Generating HDP schema

Quantity	1	1	1	
Season	1	2	1	3
Type	1	2	3	
Color	1	2		
Gender	1	1		

→

Quantity	1	1	1	
Season	1	2	4	3
Type	1	2	2	
Color	1	2		
Gender	1	2		

Merge

Split

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Algebra allows to generate an encoding and a HDP schema

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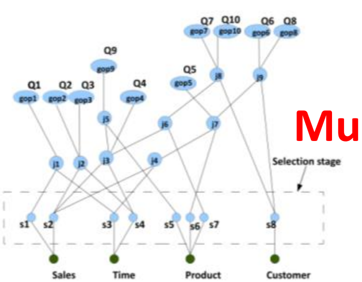
Merge

Split



Multiple View Processing Plan

Algebra

Algebra allows to generate an encoding and a HDP schema

Generating incremental encoding

Att1	val1	else	→	Att1	val1	val2	Else

Horizontal Split

Att1	val1	val2	Else	→ Att1	val1	val2	Else
				Att2	val1	else	

Vertical Split

Generating HDP schema

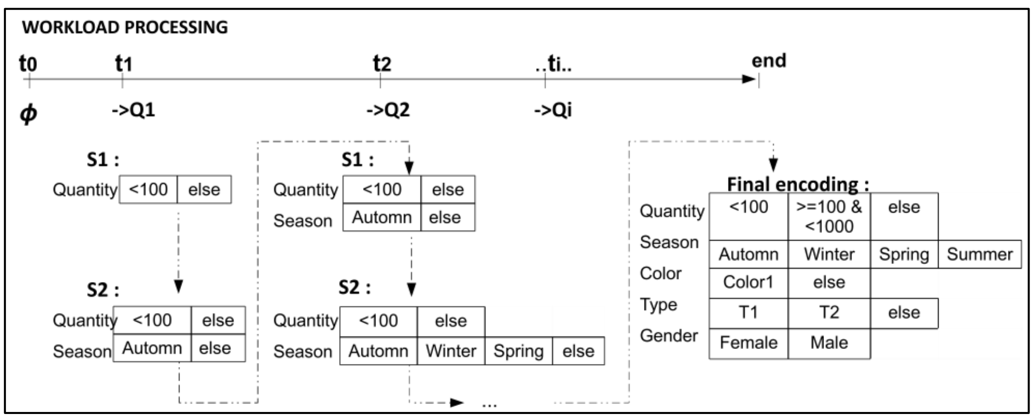
Quantity	1	1	1	
Season	1	2	1	3
Type	1	2	3	
Color	1	2		
Gender	1	1		

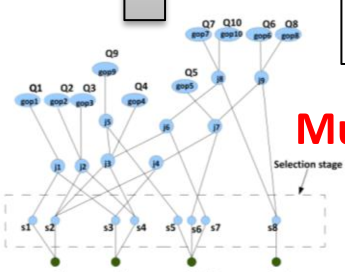
→

Quantity	1	1	1	
Season	1	2	4	3
Type	1	2	2	
Color	1	2		
Gender	1	2		

Merge

Split





Multiple View Processing Plan

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Vertical Split

Generating HDP schema

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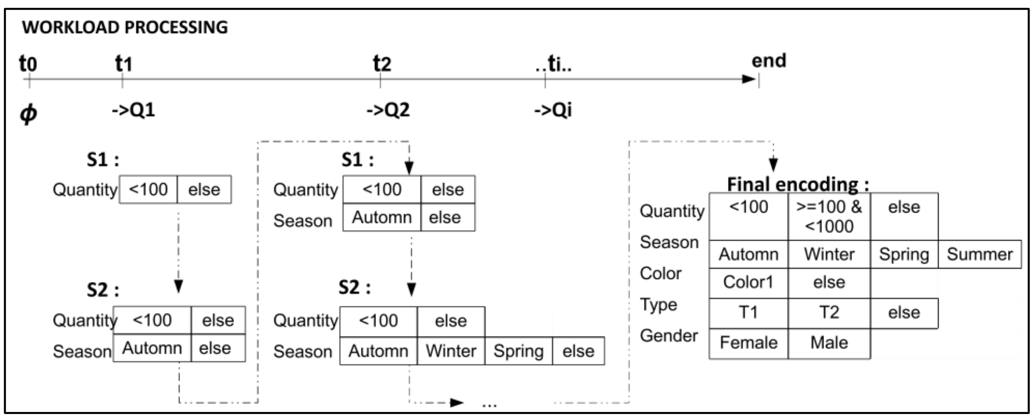
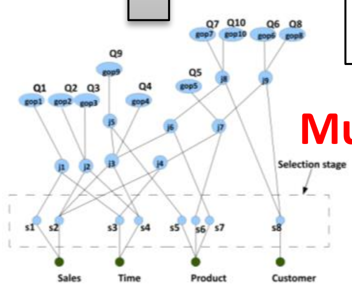
Color	1	2		
Gender	1	2		

Merge

Split

Encoding Predicates





Multiple View Processing Plan

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Horizontal Split

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Vertical Split

Generating HDP schema

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Quantity	1	1	1	
Season	1	2	4	3
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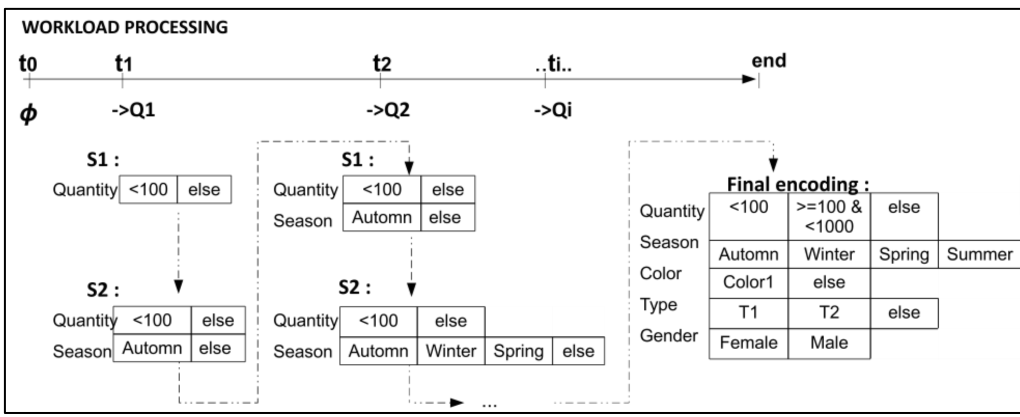
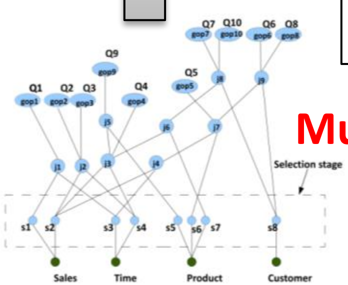
Color	1	2		
Gender	1	2		

Merge

Split

Encoding Predicates





Multiple View Processing Plan

Quantity	1	1	1	
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Type	1	2	3	
Color	1	2		
Gender	1	1		

→

Quantity	1	1	1	
Season	1	2	4	3
Type	1	2	2	
Color	1	2		
Gender	1	2		

Algebra

Algebra allows to generate an encoding and a HDP schema

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Horizontal Split

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→

Att1	val1	val2	Else
Att2	val1	else	

Vertical Split

Generating HDP schema

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Quantity	1	1	1	
Season	1	2	4	3
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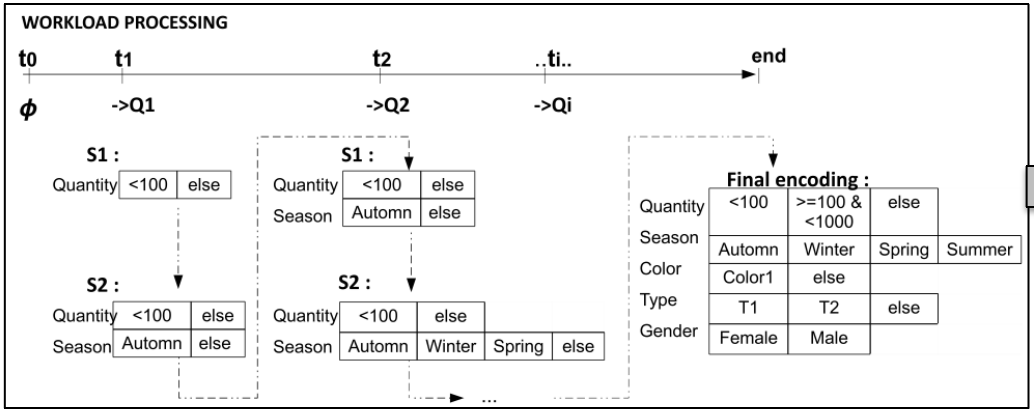
Color	1	2		
Gender	1	2		

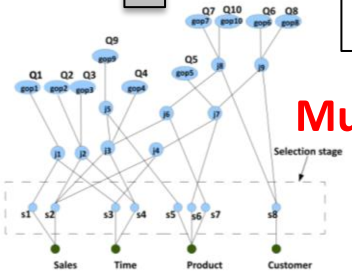
Merge

Split

Encoding Predicates



Generating HDP schema



Multiple View Processing Plan

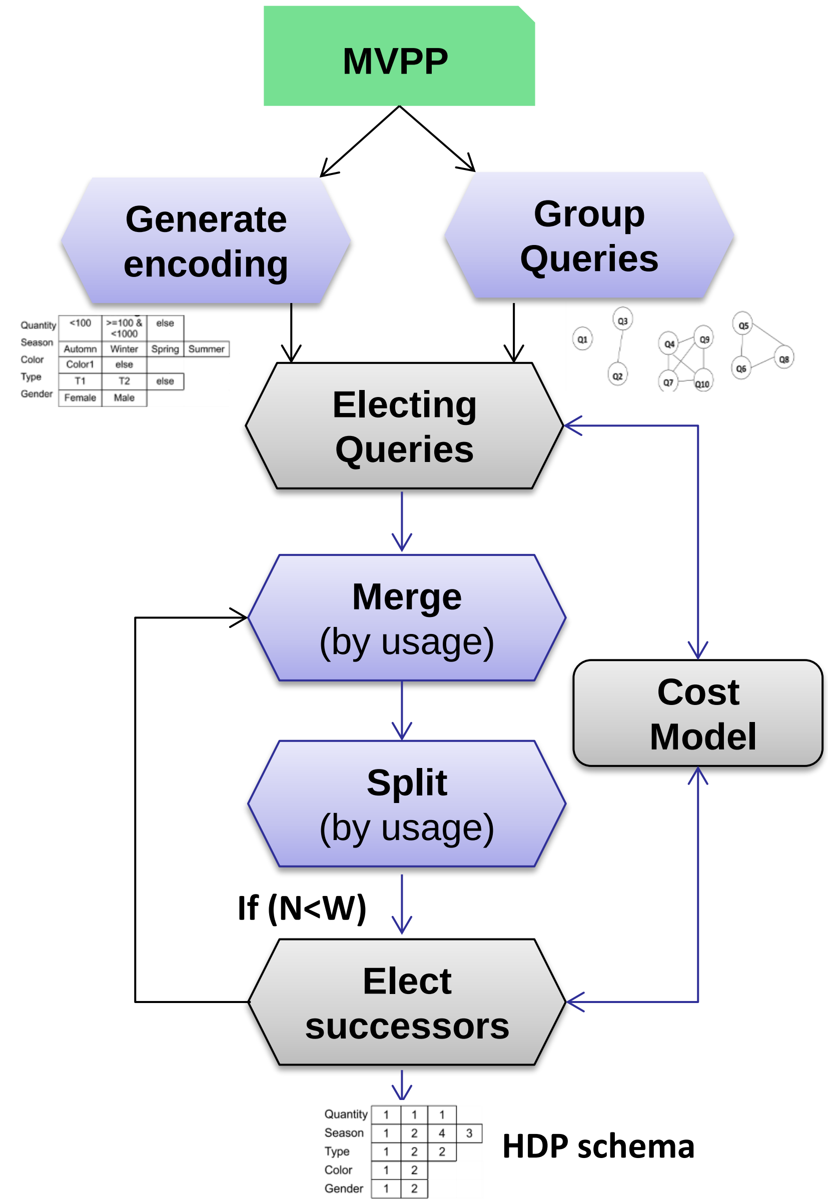
Quantity	1	1	1	
Season	1	2	1	3
Type	1	2	3	
Color	1	2		
Gender	1	1		

→

Quantity	1	1	1	
Season	1	2	4	3
Type	1	2	2	
Color	1	2		
Gender	1	2		

Electing Queries for HDP

```
Algorithm                EQHDP
generate_encoding();
EQA();
e := 1;
split_all();
E := elected(e)
while E not empty do
  prune_encoding(E);
  sort(E);
  S := required_attributes(E);
  usage(S);
  sort_attributes(S)
  for all a ∈ S do
    for all sd ∈ SubDomains(a) do
      if ((U(sd) = 0)and(N < W)) then
        merge(sd, P_0);
      end if
      if ((U(sd) = k)and(N < W)) then
        merge(sd, P_k);
      end if
    end for
  end for
  while k > 0 do
    for all a ∈ S do
      for all sd ∈ SubDomains(a) do
        if (N < W) then
          merge(sd, P_0);
        else
          merge(sd, P_k);
        end if
      end for
    end for
    k := k − 1;
  end while
  split_disjoint();
  e := e + 1;
  E := elected(e);
end while
```



Electing Queries for HDP

Algorithm EQHDP

```
generate_encoding();
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e := 1;
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    k := k − 1;
  end while
  split_disjoint();
  e := e + 1;
  E := elected(e);
end while
```
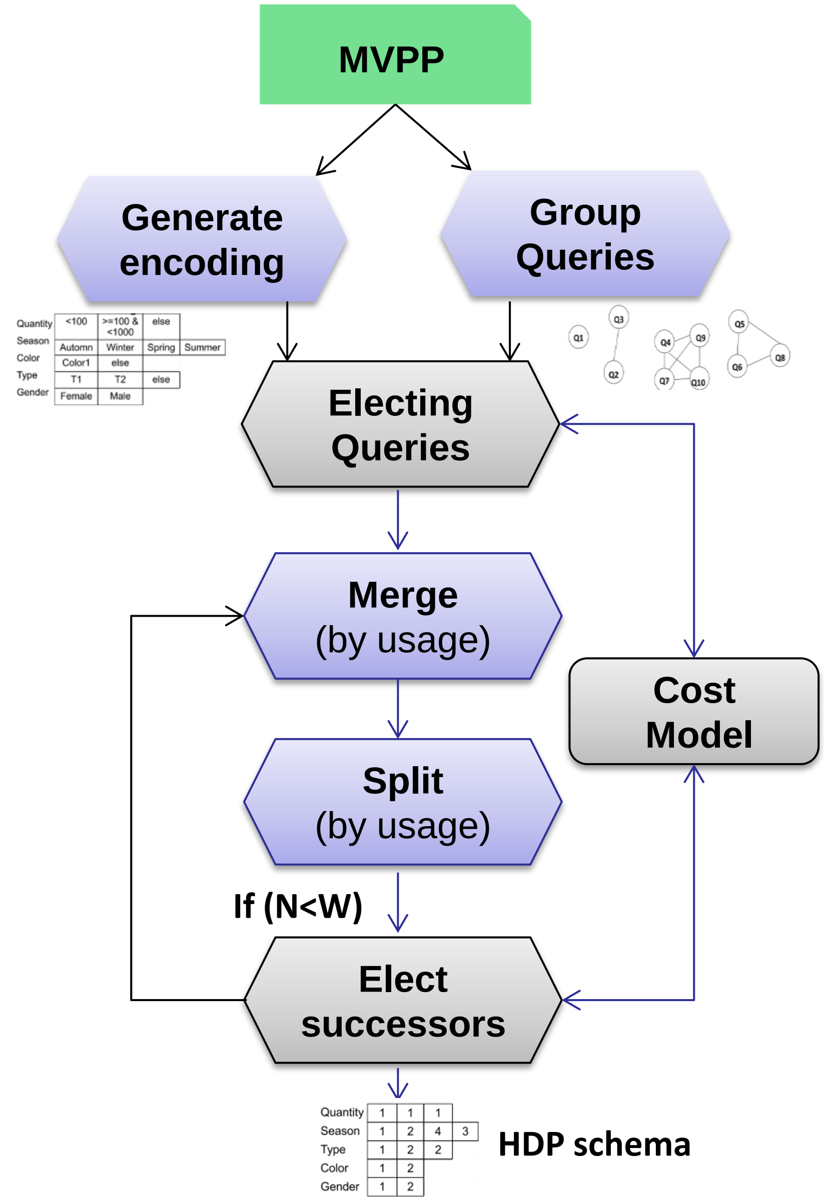

Grouping Queries & Generating Encoding



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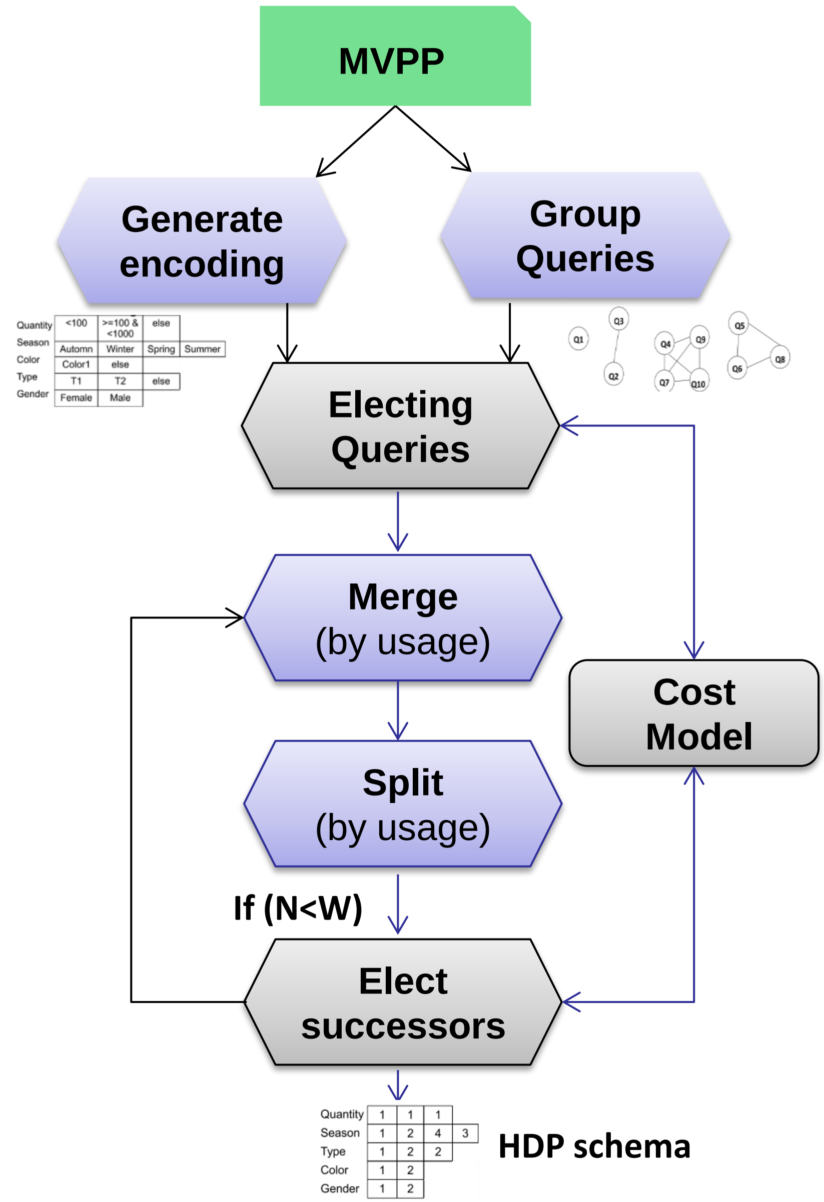
            end if
         end for
      end for
      k := k − 1;
   end while
   split_disjoint();
   e := e + 1;
   E := elected(e);
end while
```

Grouping Queries & Generating Encoding

Elect queries & Prune encoding



Electing Queries for HDP

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  end while
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  e := e + 1;
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```
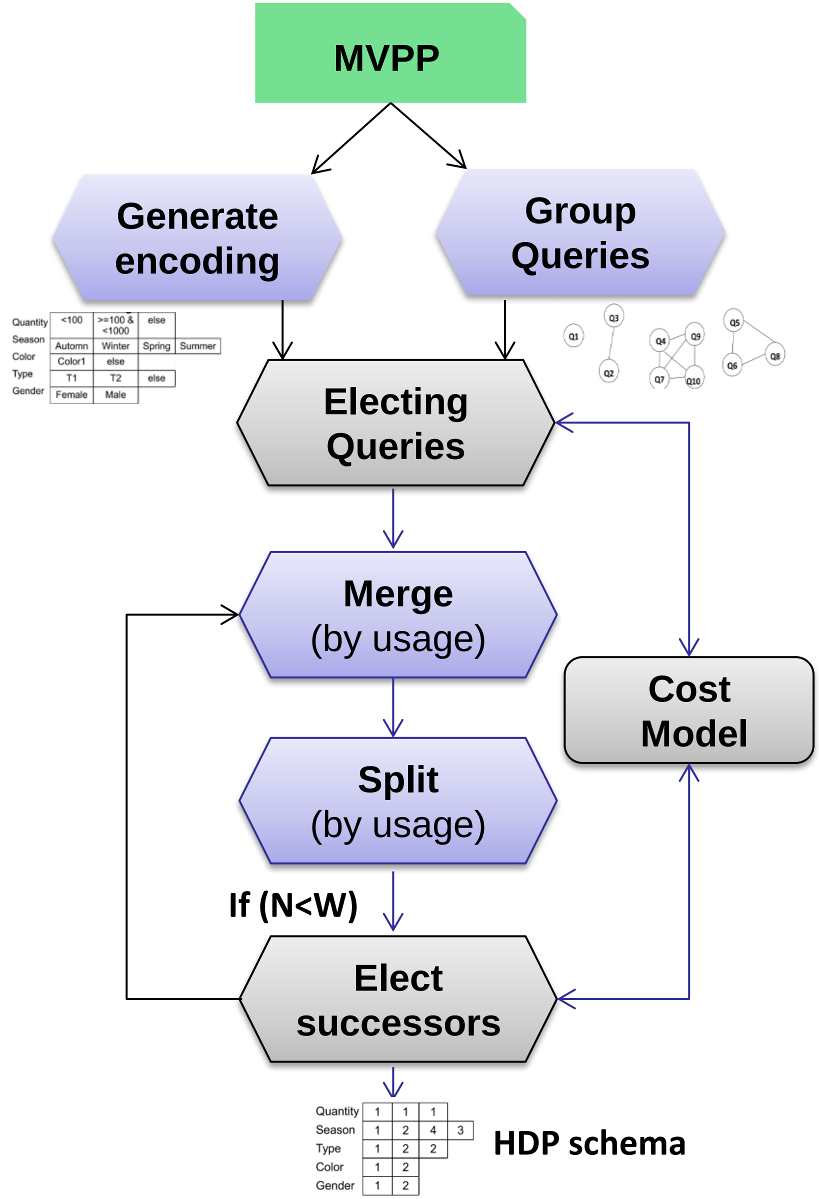

Grouping Queries & Generating Encoding

Elect queries & Prune encoding

Sort elected queries by Cost & attributes by usage



Quantity	<100	>=100 & <1000	else	
Season	Automn	Winter	Spring	Summer
Color	Color1	else		
Type	T1	T2	else	
Gender	Female	Male		

Quantity	1	1	1	
Season	1	2	4	3
Type	1	2	2	
Color	1	2		
Gender	1	2		

Electing Queries for HDP

Algorithm EQHDP

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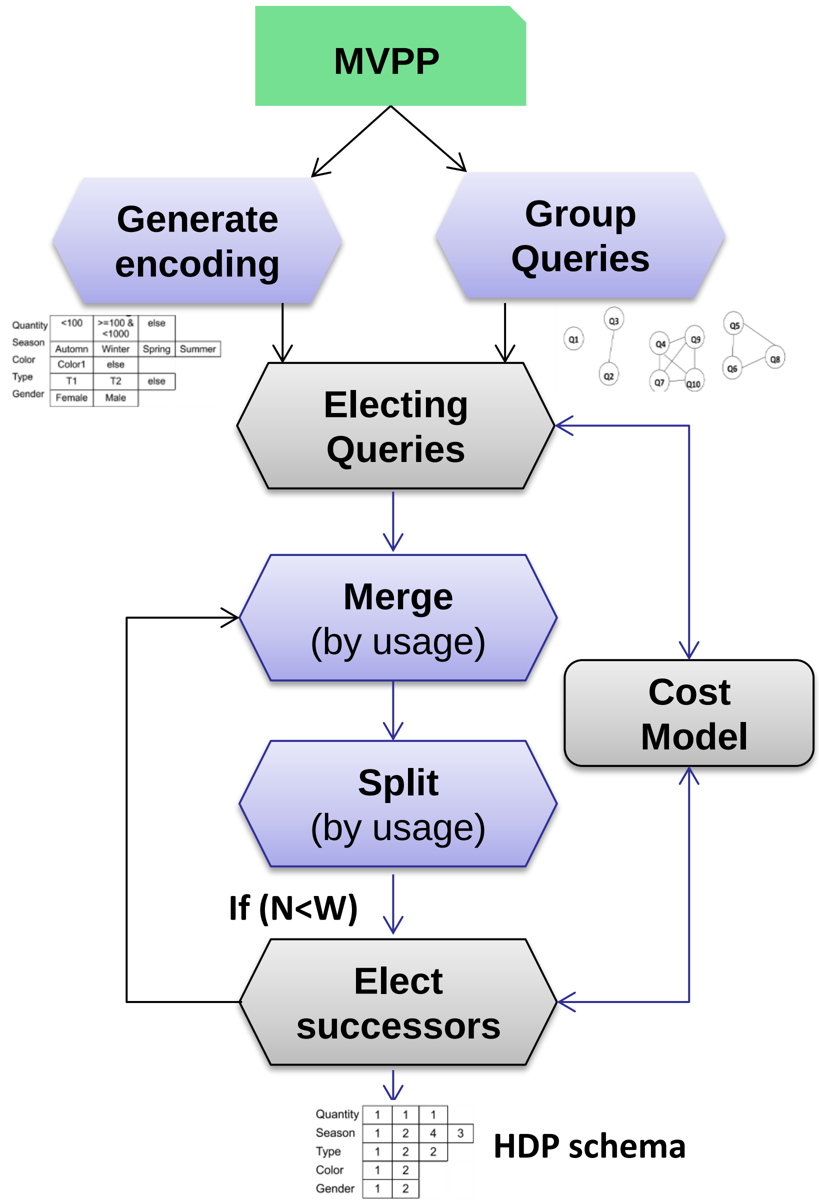
end while
```

Grouping Queries
&
Generating Encoding

Elect queries
& Prune encoding

Sort elected queries by
Cost & attributes by usage

From highest usage rate
(by elected queries):
Merge subdomains
Having the same rate



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Season	Automn	Winter	Spring	Summer
Color	Color1	else		
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Electing Queries for HDP

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```

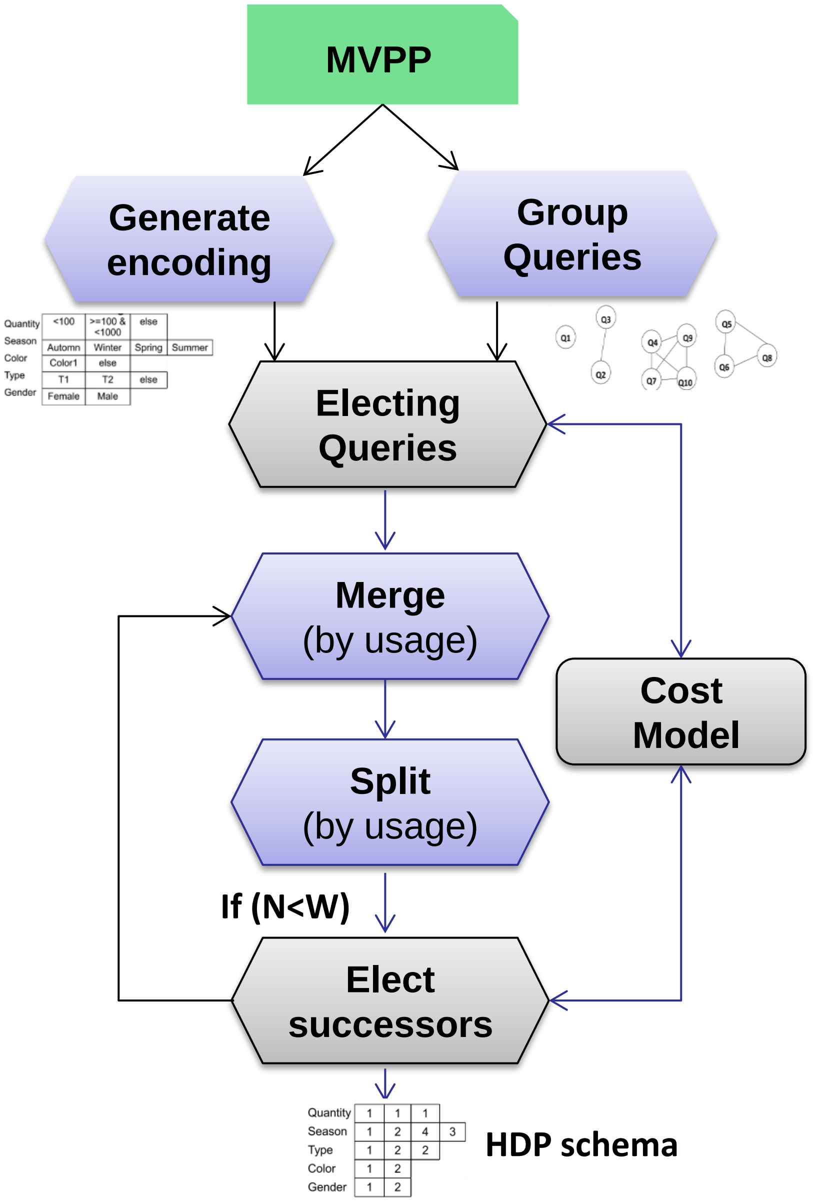
Grouping Queries
&
Generating Encoding

Elect queries
& Prune encoding

Sort elected queries by
Cost & attributes by usage

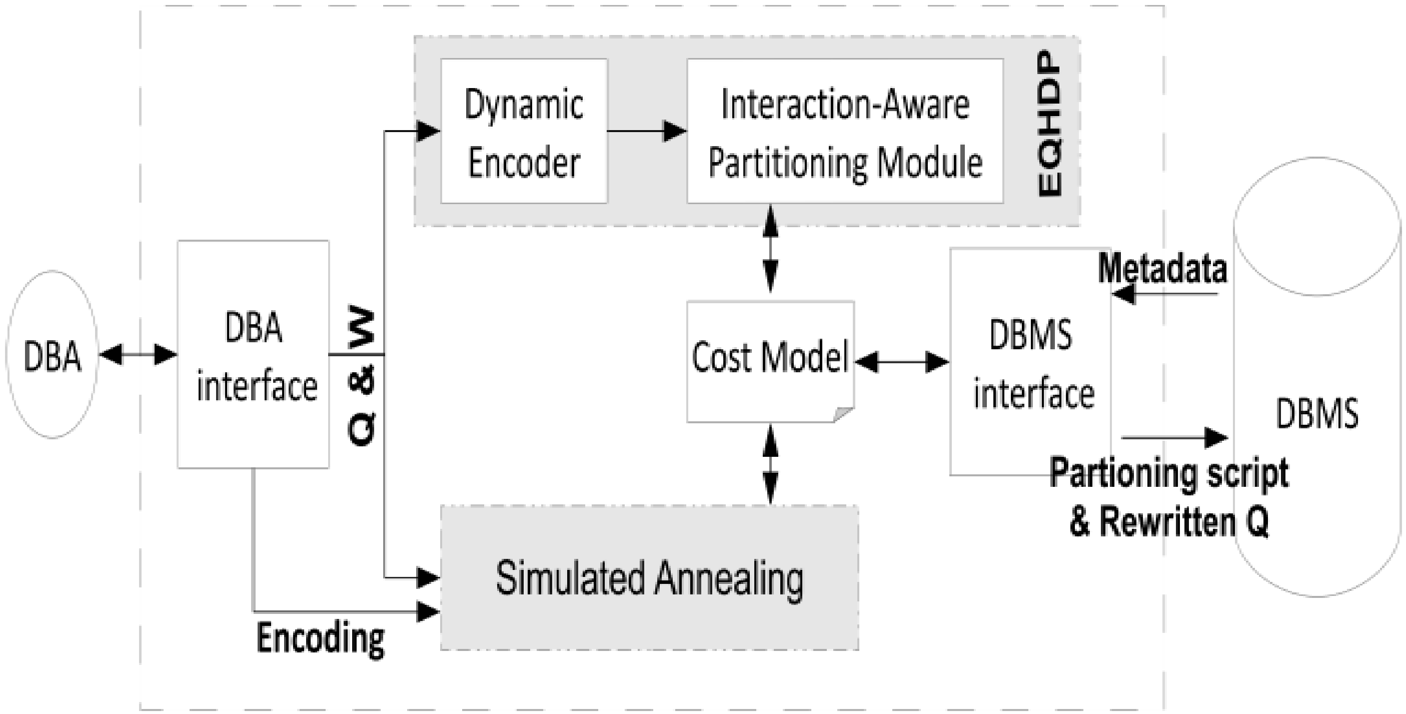
From highest usage rate
(by elected queries):
Merge subdomains
Having the same rate

Improvement:
move to successors of
elected queries (e ← e+1)



Experimental Study

Configuration of experiments



SSB of 100 GB

Workload1: 12 queries (no interaction)

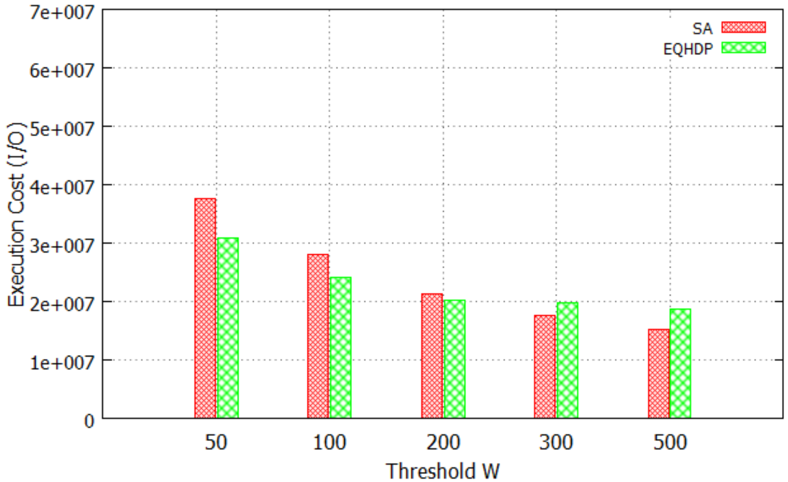
Workload2: 22 queries (with interaction)

Oracle11g DBMS

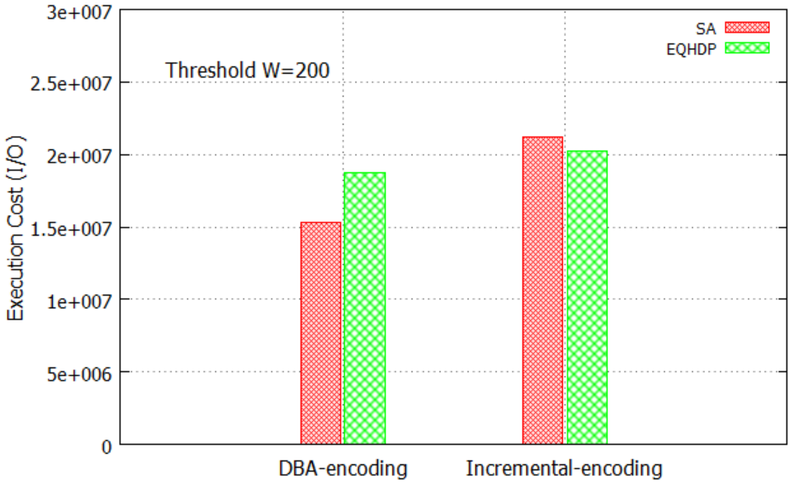
Server of 32 GB of RAM

Intel Xeon CPU : 2x2.45 GHz

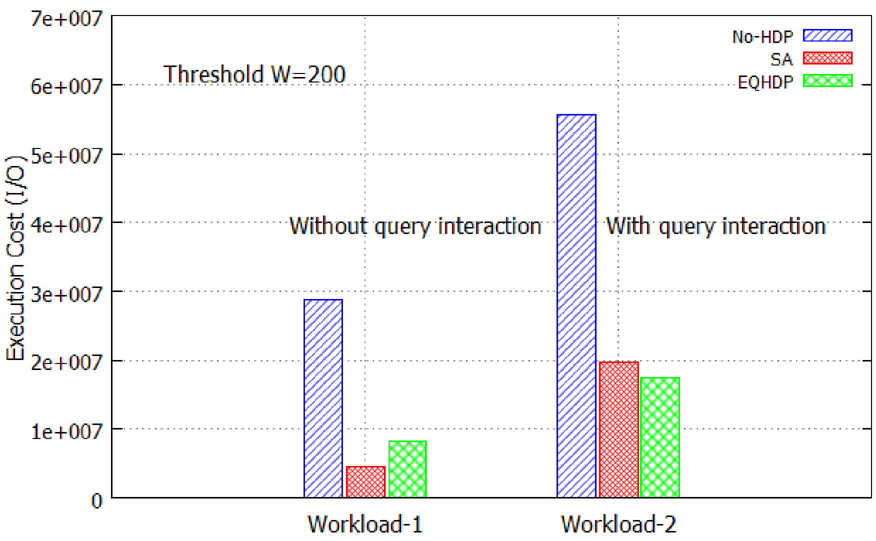
Experimental Study



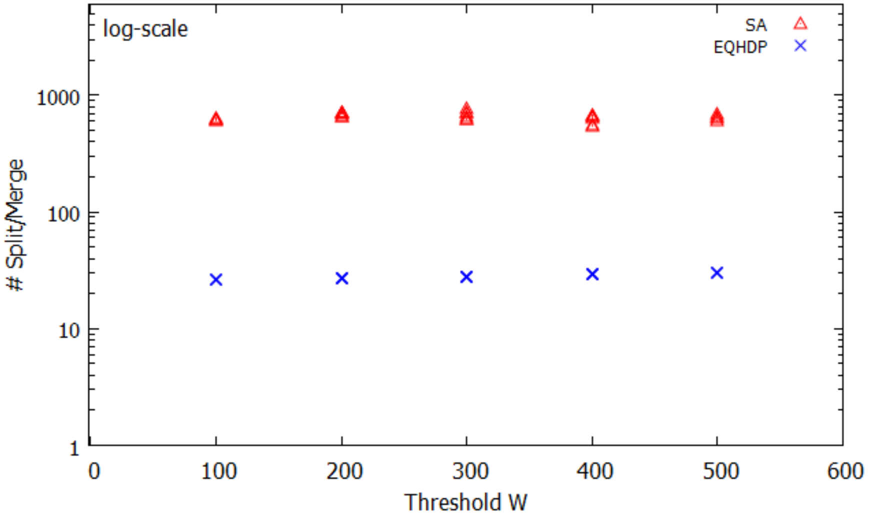
EQHDP Vs. SA



Impact of incremental encoding on performance

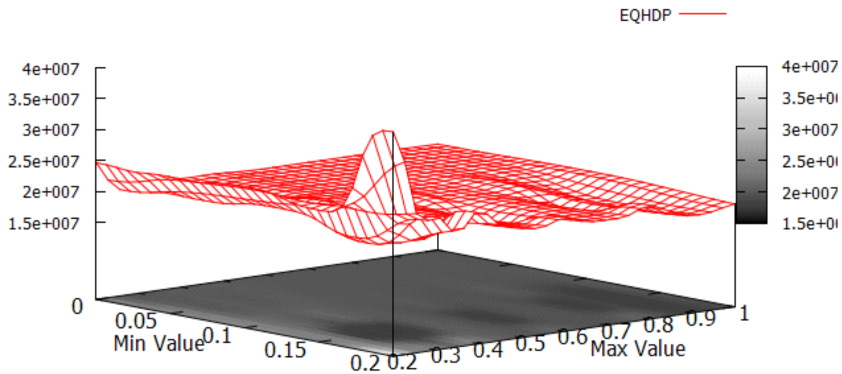


Impact of query interaction on performance

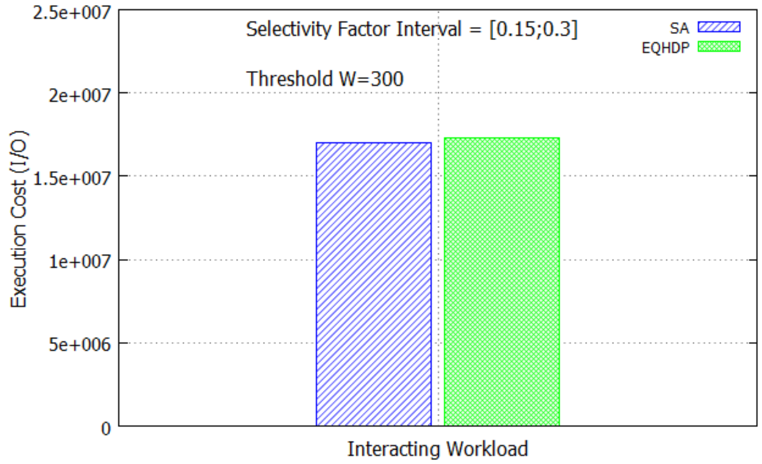


Number of Split/Merge to reach the solution

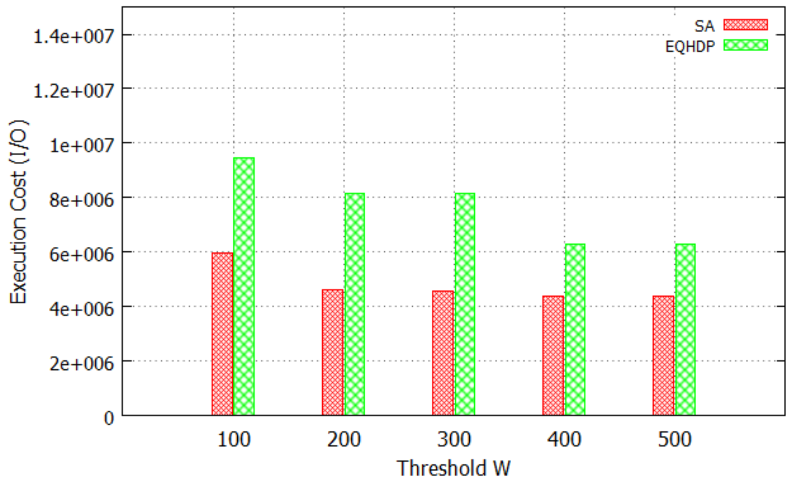
Experimental Study



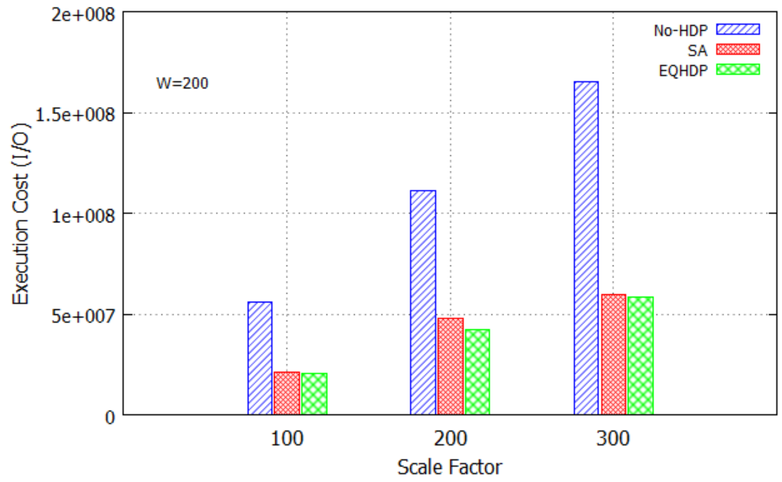
Best Selectivity Factor intervals



Improving EQHDP by SF interval



Validating algorithms' performance on Oracle11g



Scaling-Up and impact of data volume

Conclusion & Future Work

- ✓ Optimization in RDW by HDP
- ✓ Considering query interaction
- ✓ Incremental encoding for representing schemas
- ✓ Pruning predicates and steering HDP by elected queries
- ➢ Considering query interaction in other optimization techniques
- ➢ Include MVPP optimization in Physical Design
- ➢ **InterPhase** project

Thank you