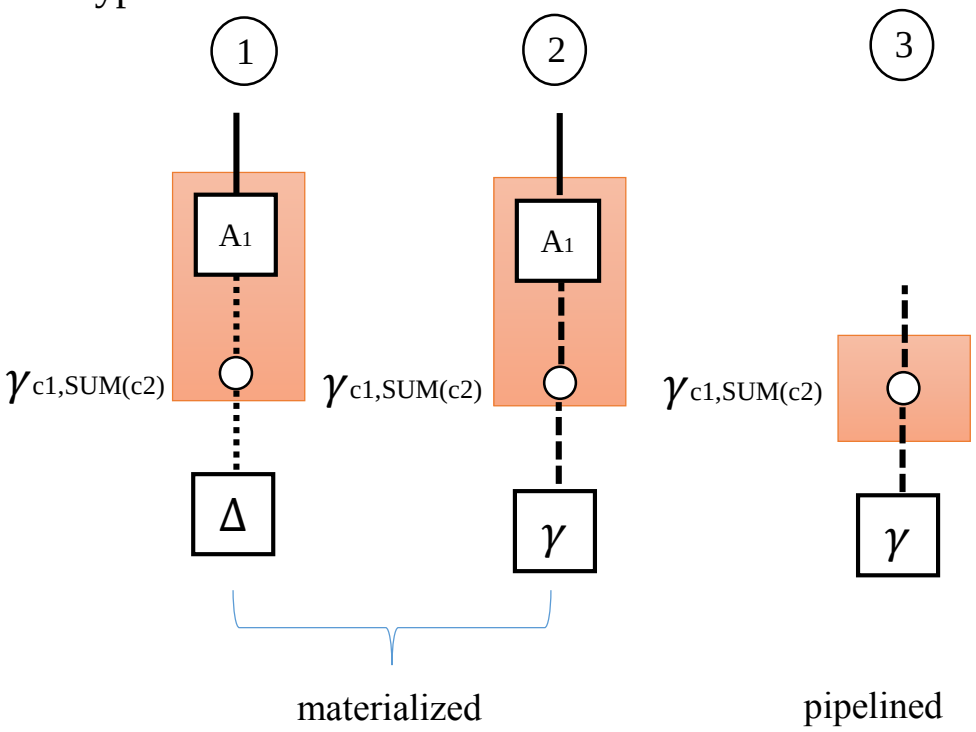
Types



Tables

PK	col1
x1	30
x2	17

PK	col1
x1	5
x2	2

PK	col1
x1	3
x2	3

PK	col1	col2
k1	x1	5
k2	x1	12
k3	x2	7
k4	x2	8
k5	x2	2
k6	x1	13

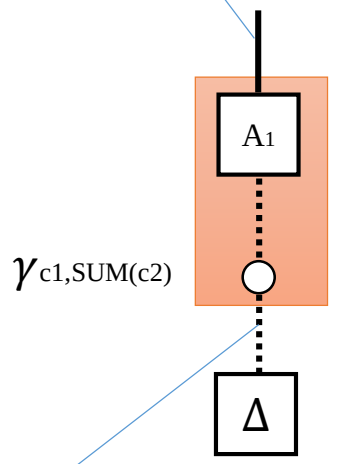
Type 1(materialized, delta input)

Output stream

Seq	Op	Tuples
1	put	(x1,15)
2	put	(x2,8)
3	delete	(x2)
	put	(x1,23)
4	put	(x1,18)
5	put	(x1,10)
6	put	(x1,38)
7	put	(x1,10)
8	delete	(x1)
	put	(x3,22)

Internal Execution

Seq	Op	Tuples
1	get, put	(x1,15)
2	get, put	(x2,8)
3	get, delete	(x2)
	get, put	(x1,23)
4	get, put	(x1,18)
5	get, put	(x1,10)
6	get, put	(x1,38)
7	get, put	(x1,10)
8	get, delete	(x1)
	get, put	(x3,22)



Input stream

Seq	Op	Tuples
1	put	(k1,(**null**, **null**), (x1,15))
2	put	(k2,(**null**,**null**),(x2,8))
3	put	(k2,(x2,8), (x1,8))
4	put	(k1, (x1,15), (x1,10))
5	put	(k2, (x1,8), (**null**,**null**))
6	put	(k3,(**null**,**null**), (x1,28))
7	put	(k3, (x1,28), (**null**,**null**))
8	put	(k1, (x1,10), (x3,22))

Gets = Insert + Update + Delete
Puts = Insert + Update(NOTZERO) + Delete(NOTZERO)
Deletes = Delete(ZERO) + Update(ZERO) + Update(AGGKEY)

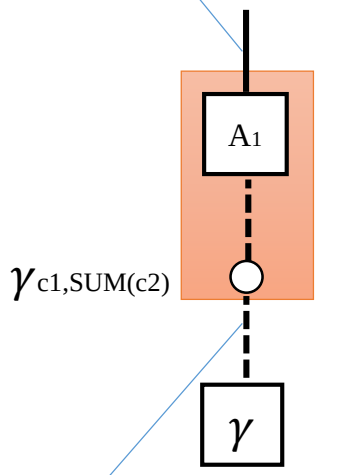
Type 2(materialized, preagg input)

Output stream

Seq	Op	Tuples
1	put	(x1,15)
2	put	(x2,8)
3	delete	(x2)
	put	(x1,23)
4	put	(x1,18)
5	put	(x1,10)
6	put	(x1,38)
7	put	(x1,10)
8	delete	(x1)
	put	(x3,22)

Internal Execution

Seq	Op	Tuples
1	put	(x1,15)
2	put	(x2,8)
3	delete	(x2)
	put	(x1,23)
4	put	(x1,18)
5	put	(x1,10)
6	put	(x1,38)
7	put	(x1,10)
8	delete	(x1)
	put	(x3,22)



preagg input

Input stream

Seq	Op	Tuples
1	put	(x1,(k1,15))
2	put	(x2,(k2,8))
3	put	(x2,**null**)
	put	(x1,(k1,15),(k2,8))
4	put	(x1,(k1,10),(k2,8))
5	put	(x1,(k1,10))
6	put	(x1,(k1,10),(k3,28))
7	put	(x1,(k1,10))
8	put	(x1, **null**))
	put	(x3,(k1,22))

Puts = Insert + Update(NOTZERO) + Delete(NOTZERO)
Deletes = Delete(ZERO) + Update(ZERO) + Update(AGGKEY)

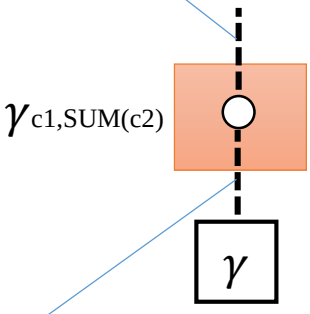
Type 3(pipelined)

Output stream

Seq	Op	Tuples
1	put	(x1,(k1,15)(sum,15))
2	put	(x2,(k2,8),(sum,8))
3	put	(x2,(sum,0))
	put	(x1,(k1,15),(k2,8),(sum,23))
4	put	(x1,(k1,10),(k2,8),(sum,18))
5	put	(x1,(k1,10),(sum,10))
6	put	(x1,(k1,10),(k3,28),(sum,38))
7	put	(x1,(k1,10),(sum,10))
8	put	(x1, (sum,0)))
	put	(x3,(k1,22),(sum,22))

Internal Execution

GROUP BY c1



pipelined

Input stream

Seq	Op	Tuples
1	put	(x1,(k1,15))
2	put	(x2,(k2,8))
3	put	(x2,**null**)
	put	(x1,(k1,15),(k2,8))
4	put	(x1,(k1,10),(k2,8))
5	put	(x1,(k1,10))
6	put	(x1,(k1,10),(k3,28))
7	put	(x1,(k1,10))
8	put	(x1, **null**)
		(x3,(k1,22))

Puts = 0
Deletes = 0

Cost Calculations:

Total Number of updates: 100
Input_I = 40
Input_U = 40
Input_D =20

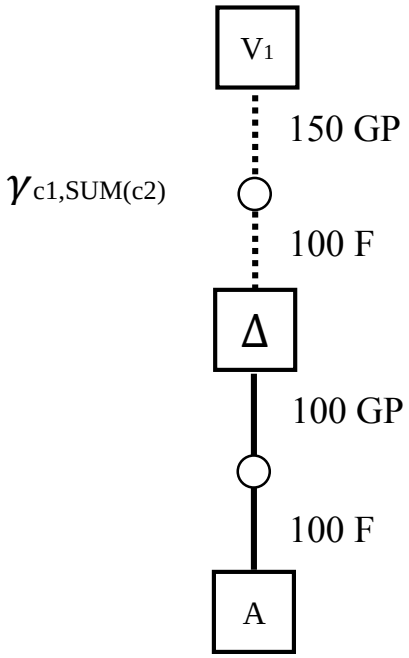
Type 1:
Gets = 100
Puts = 80
Deletes = 60

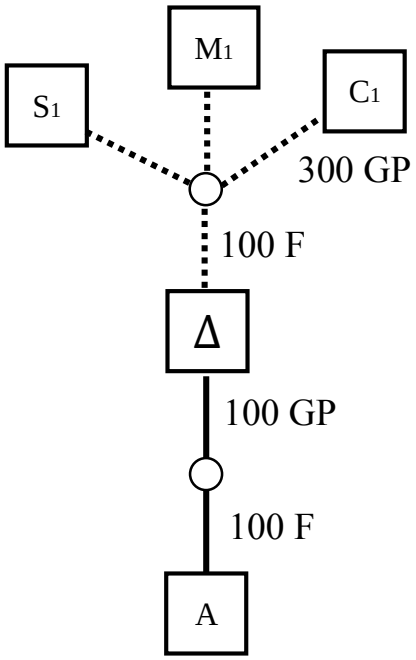
Type 2:
Puts = 80
Deletes = 60

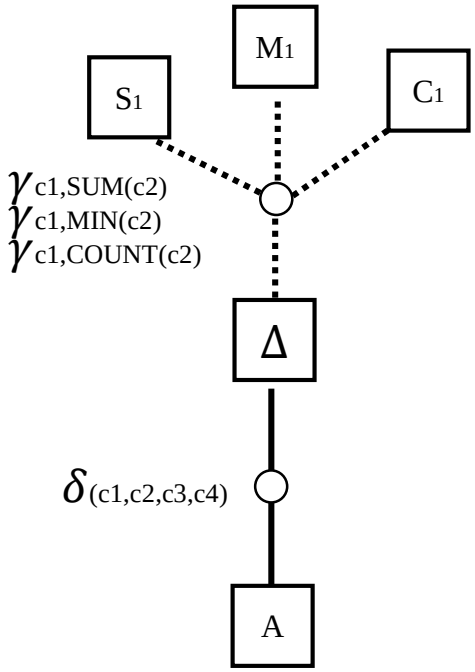
Preaggregation:
Gets = 100
Puts = 80
Deletes = 60

Preaggregation:
240 + 240
240 + 140 + 140

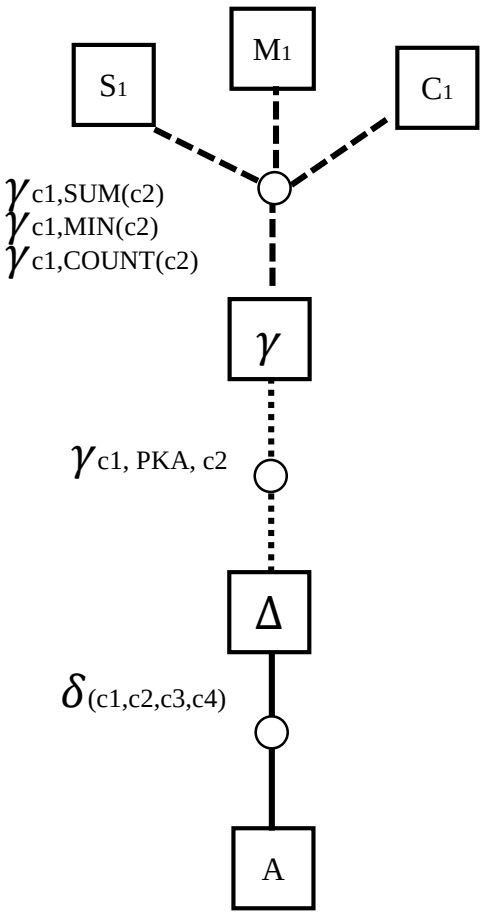
Flow diagram

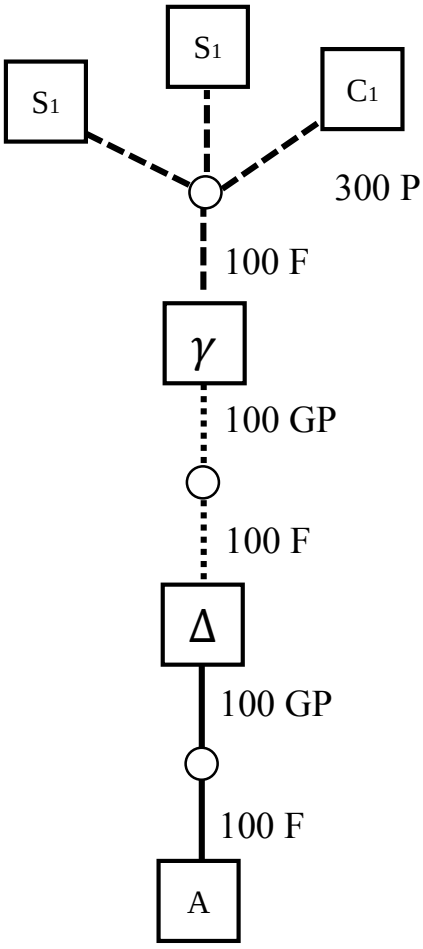




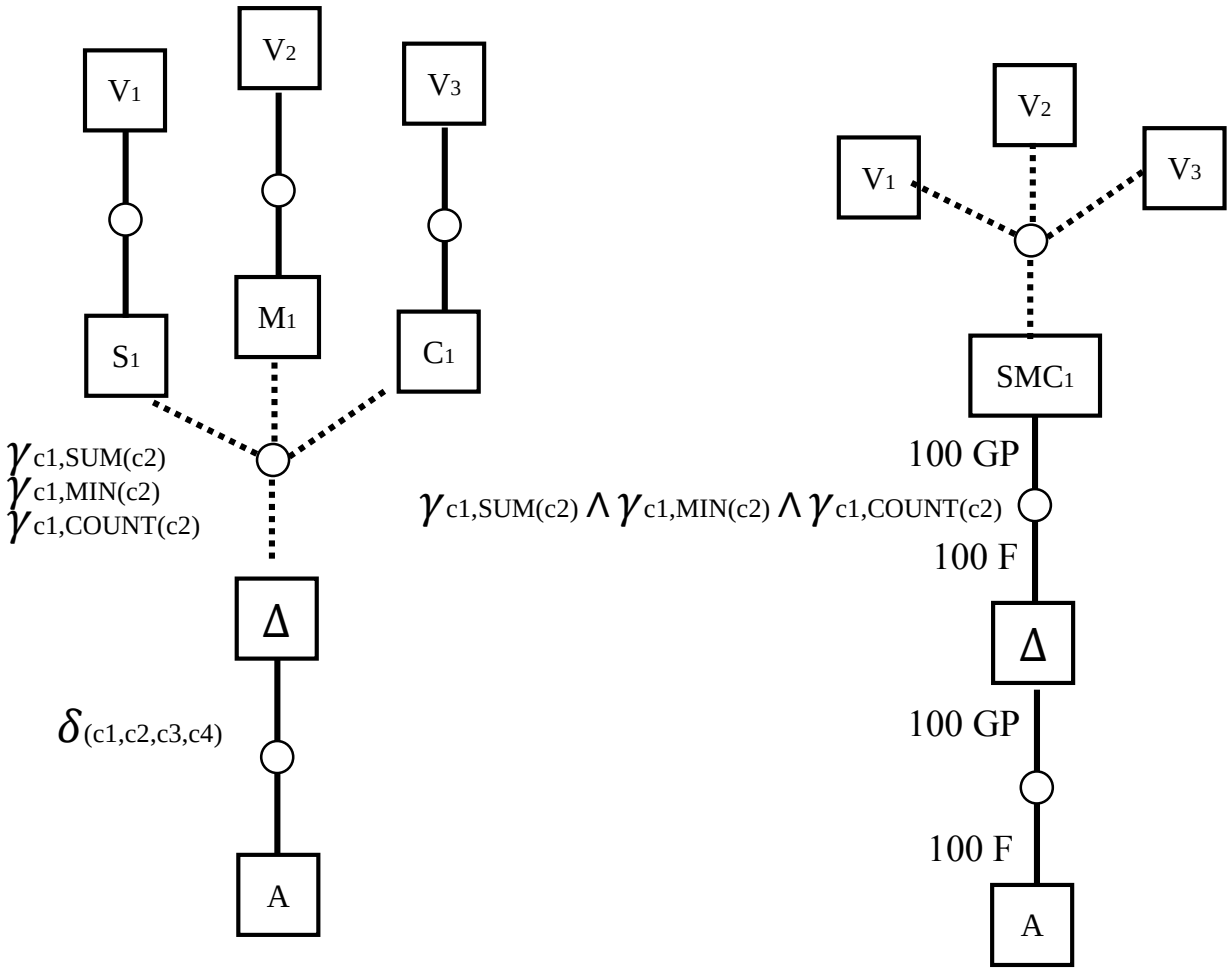


Using Preaggregation


S1
M1
C1
γc1,SUM(c2)
γc1,MIN(c2)
γc1,COUNT(c2)
γ
γc1, PKA, c2
Δ
δ(c1,c2,c3,c4)
A


S1
S1
C1
300 P
100 F
γ
100 GP
100 F
Δ
100 GP
100 F
A

Merging


V1
V2
V3
S1
M1
C1
γc1,SUM(c2)
γc1,MIN(c2)
γc1,COUNT(c2)
Δ
δ(c1,c2,c3,c4)
A
γc1,SUM(c2) ∧ γc1,MIN(c2) ∧ γc1,COUNT(c2)
SMC1
100 GP
100 F
Δ
100 GP
100 F
A