APRIORI DATA MINING IN THE CLOUD

Case study: d60 Raptor smartAdvisor

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Alexandra Institute

Agenda

- d60: A cloud/data mining case
- Cloud
- Data Mining
- Market Basket Analysis
- Large data sets
- Our solution

Alexandra Institute

The Alexandra Institute is a non-profit company that works with application-oriented IT research.

Focus is pervasive computing, and we activate the business potential of our members and customers through research-based userdriven innovation.

The case: d60

- Danish company
- A similar products recommendation engine
- d60 was outgrowing their servers (late 2010)
- They saw a potential in moving to Azure

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The setup

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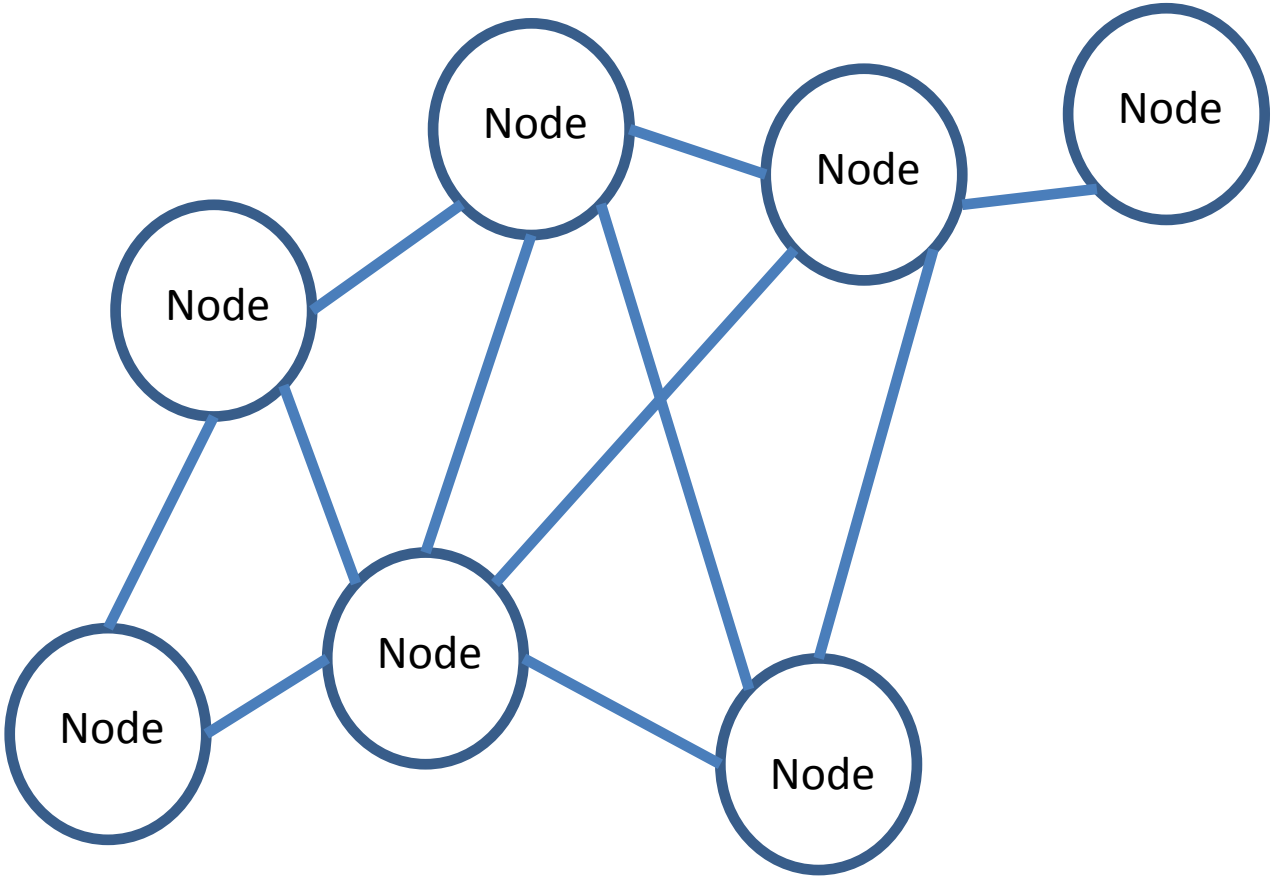
The cloud potential

- Elasticity
- No upfront server cost
- Cheaper licenses
- Faster calculations

Challenges

- No SQL Server Analysis Services (SSAS)
- Small compute nodes
- Partioned database (50GB)
- SQL server ingress/outgress access is slow

The cloud



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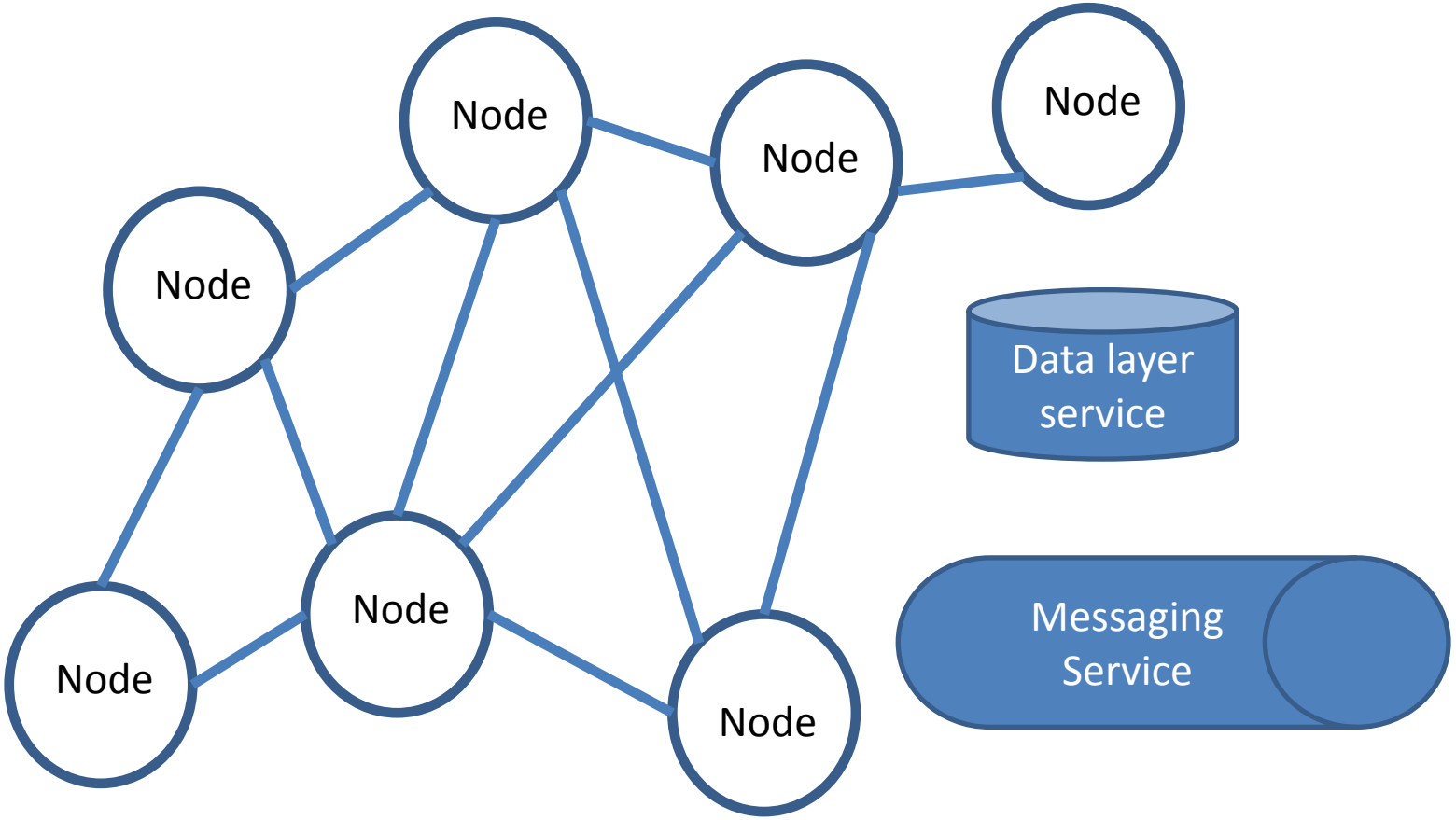
The cloud and services



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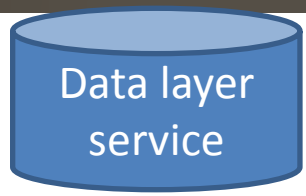
Data layer service



- Application specific (schema/layout)
- SQL, table or other
- Easy a bottleneck
- Can be difficult to scale

Messaging service
Task Queues

- Standard data structure
- Build-in ordering (FIFO)
- Can be scaled
- Good for asynchronous messages

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DATA MINING

Data mining

Data mining is the use of automated data analysis techniques to uncover relationships among data items

Market basket analysis is a data mining technique that discovers co-occurrence relationships among activities performed by specific individuals

[about.com/wikipedia.org]

Market basket analysis

Customer1	Customer2	Customer3	Customer4
Avocado	Milk	Beef	Cereal
Milk	Diapers	Lemons	Beer
Butter	Avocado	Beer	Beef
Potatoes	Beer	Chips	Diapers

Market basket analysis

Customer1	Customer2	Customer3	Customer4
Avocado	Milk	Beef	Cereal
Milk	Diapers	Lemons	Beer
Butter	Avocado	Beer	Beef
Potatoes	Beer	Chips	Diapers

Itemset (Diapers, Beer) occur 50%

Frequency threshold parameter

Find as many frequent itemsets as possible

Market basket analysis

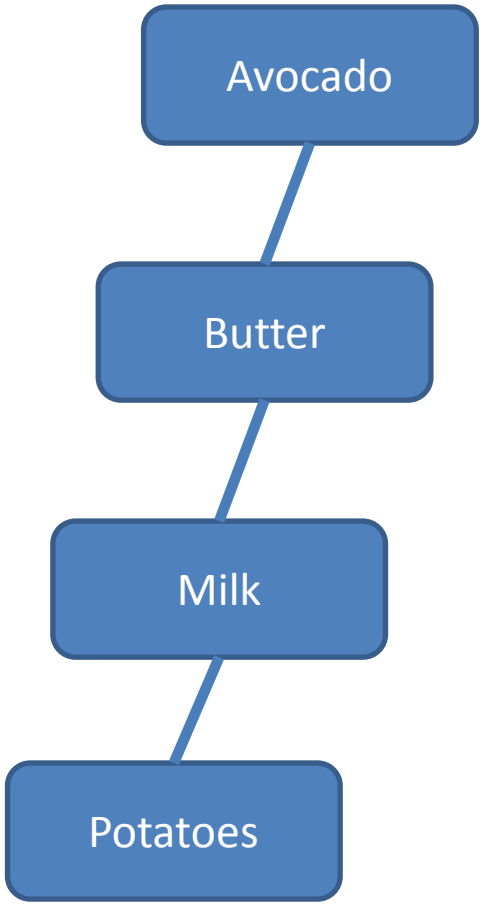
Popular effective algorithm: FP-growth ☺

Based on data structure FP-tree

Requires all data in near-memory ☹

Most research in distributed models has been for cluster setups ☹

Building the FP-tree (extends the prefix-tree structure)



Customer1

Avocado

Milk

Butter

Potatoes

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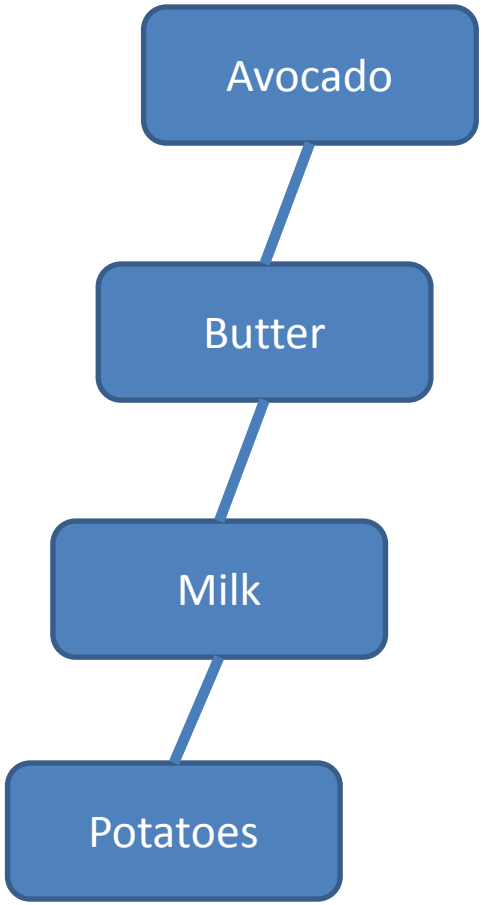
Building the FP-tree



Customer2

Milk

Diapers

Avocado

Beer

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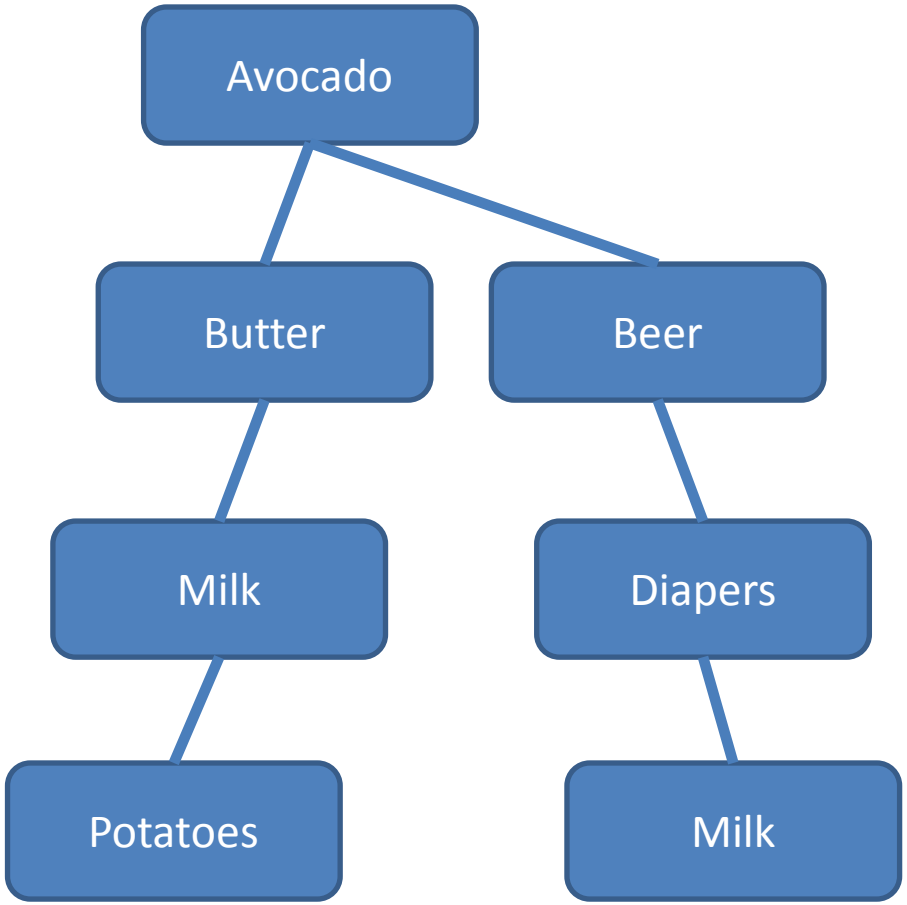
Building the FP-tree



Customer2

Milk

Diapers

Avocado

Beer

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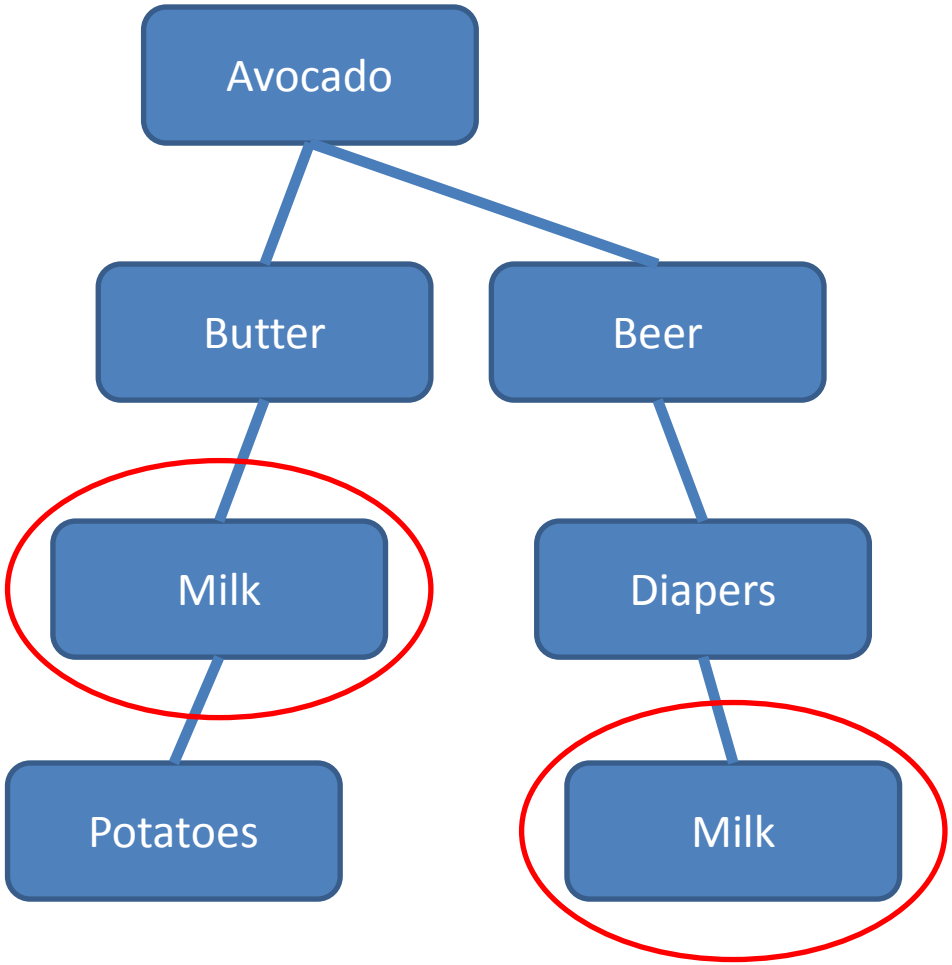
Building the FP-tree



Customer2

Milk

Diapers

Avocado

Beer

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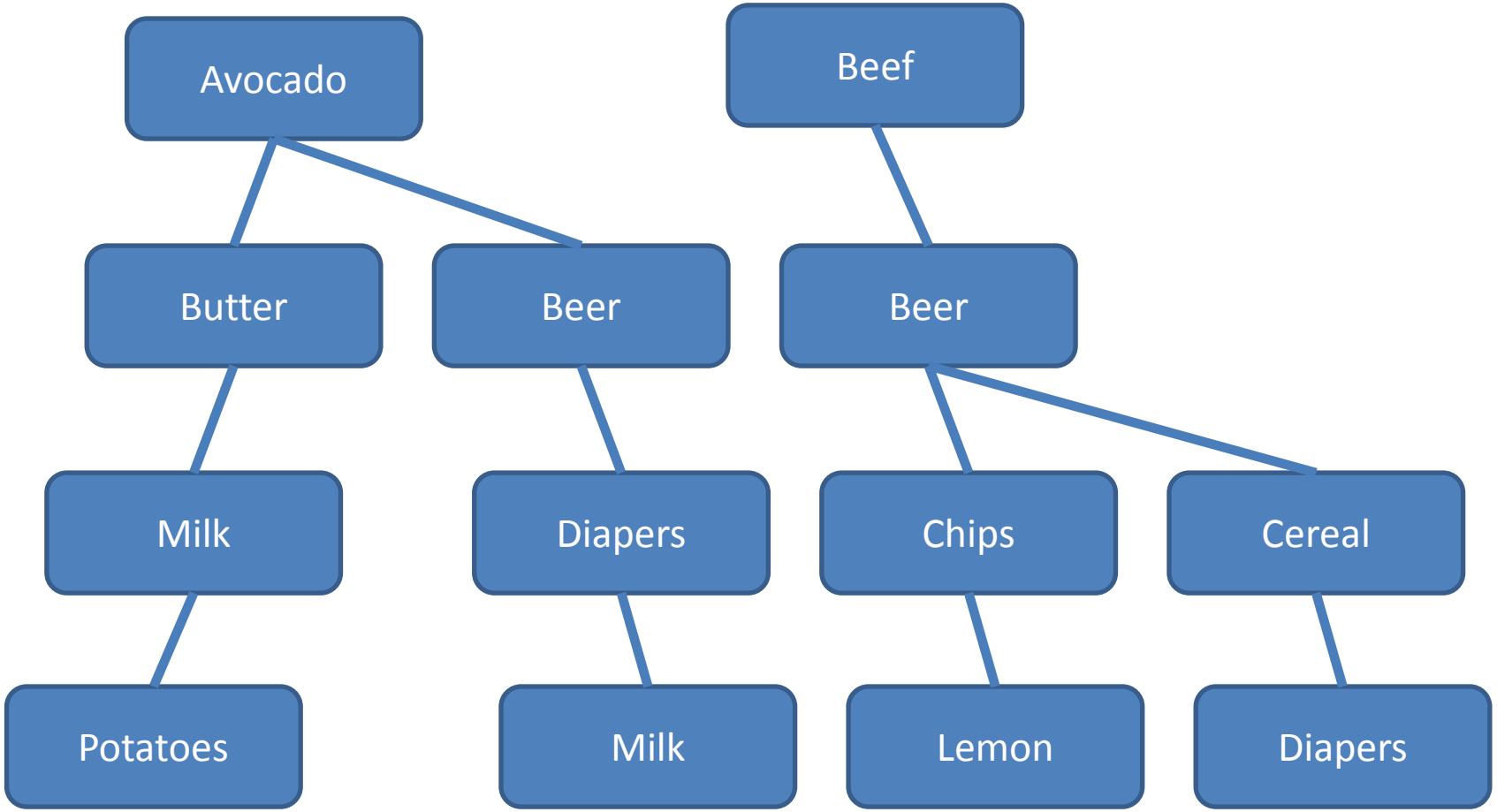
Building the FP-tree



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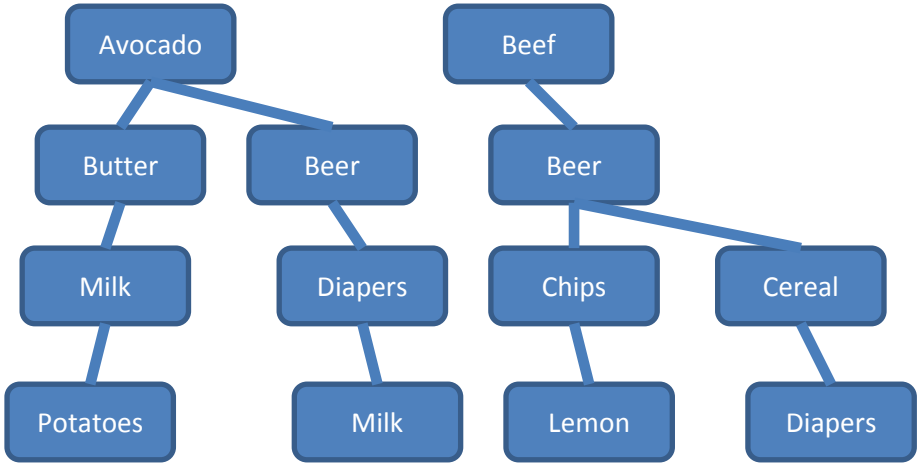
FP-growth

Grows the frequent itemsets, recusively

```
FP-growth(FP-tree tree)
{
      …
      for-each (item in tree)
            count =CountOccur(tree,item);
            if (IsFrequent(count))
            {
                  OutputSet(item);
                  sub = tree.GetTree(tree, item);
                  FP-growth(sub);
            }
```

FP-growth algorithm
Divide and Conquer

Traverse tree



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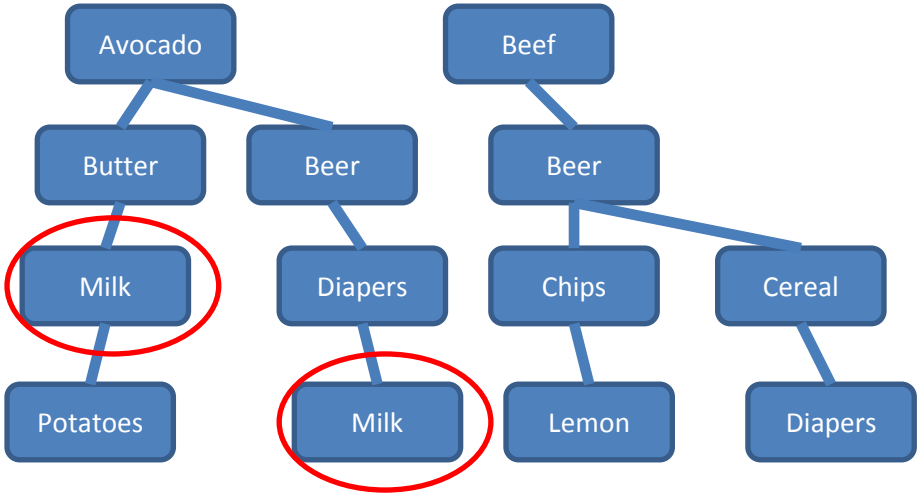
FP-growth algorithm
Divide and Conquer

Generate sub-trees



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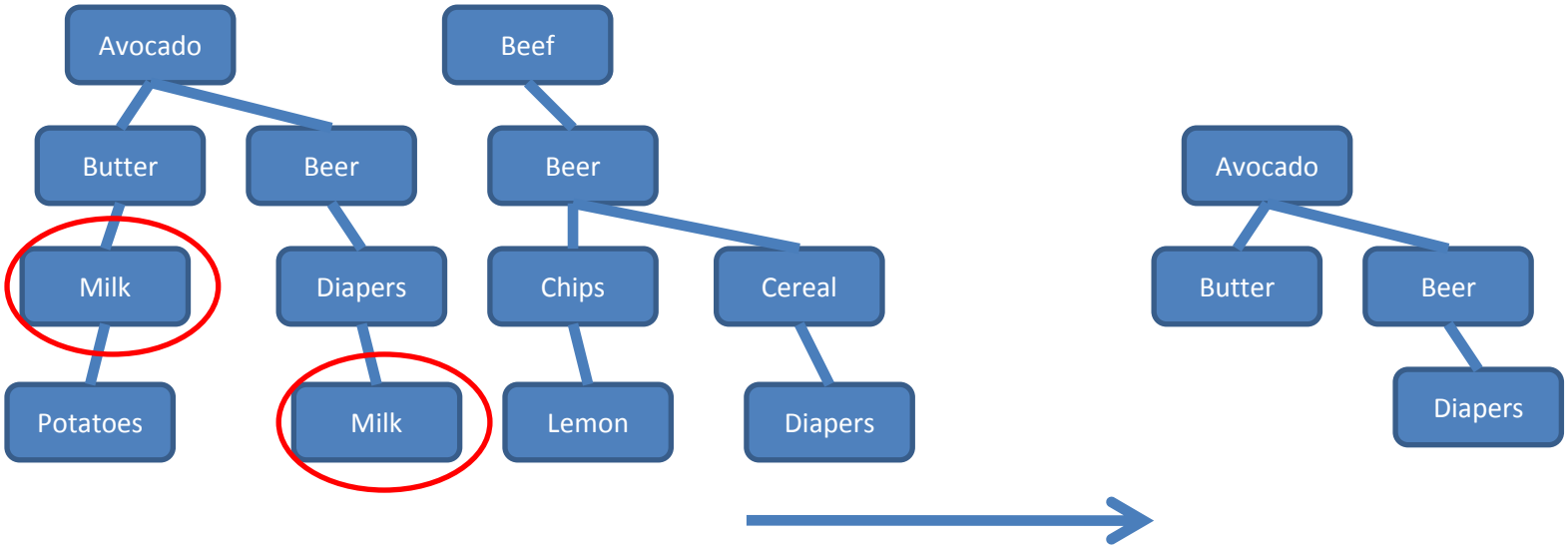
FP-growth algorithm
Divide and Conquer

Call recursively



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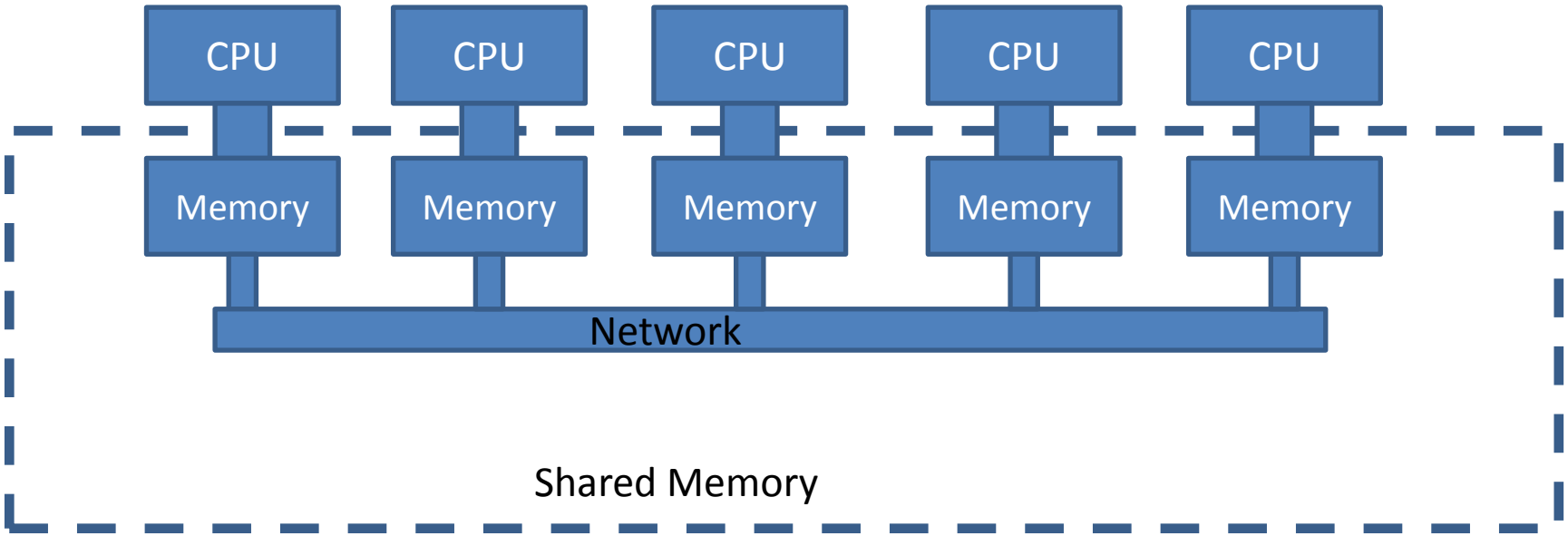
FP-growth algorithm
Memory usage

The FP-tree does not fit in local memory; what to do?

- Emulate Distributed Shared Memory

Distributed Shared Memory?



- To add nodes is to add memory
- Works best in tightly coubled setups, with low-lantency, high-speed networks

FP-growth algorithm
Memory usage

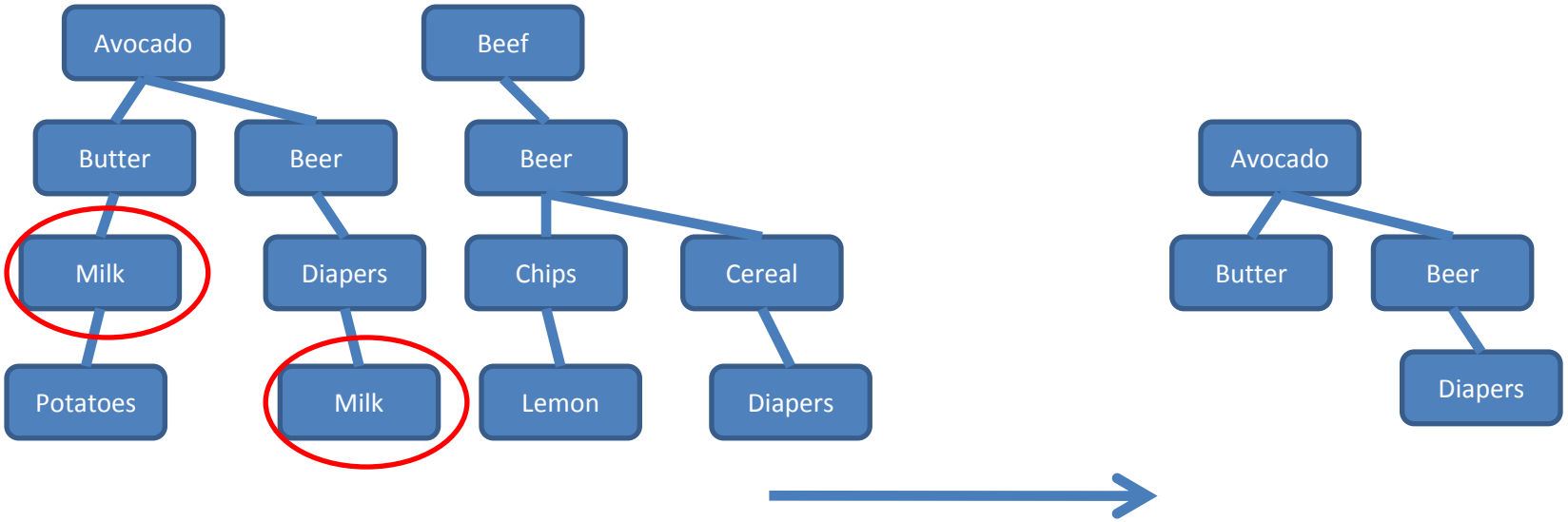
The FP-tree does not fit in local memory; what to do?

- Emulate Distributed Shared Memory
- Optimize your data structures
- Buy more RAM
- Get a good idea

Get a good idea

- Database scans are serial and can be distributed
- The list of items used in the recursive calls uniquely determines what part of data we are looking at

Get a good idea



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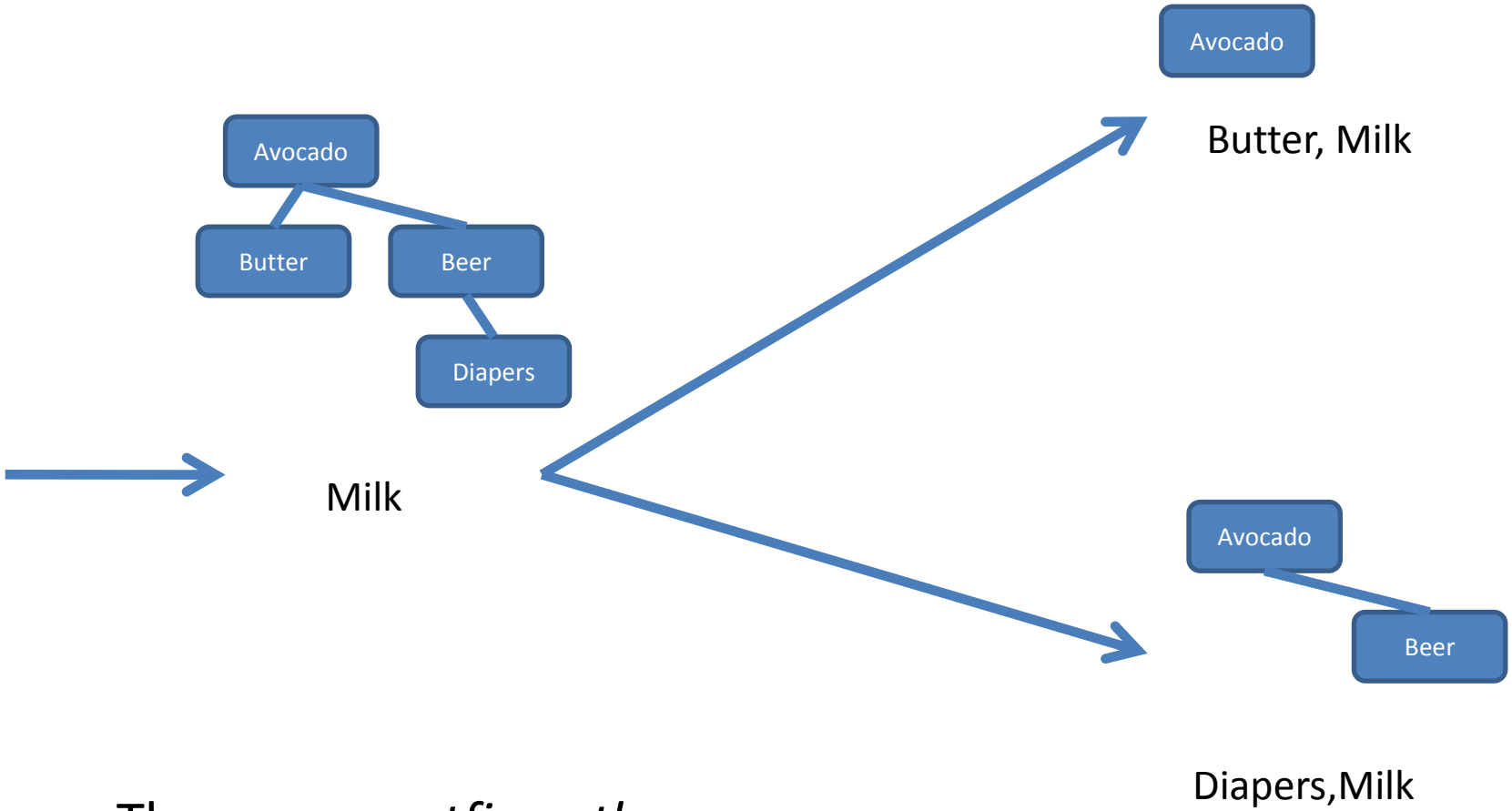
Get a good idea

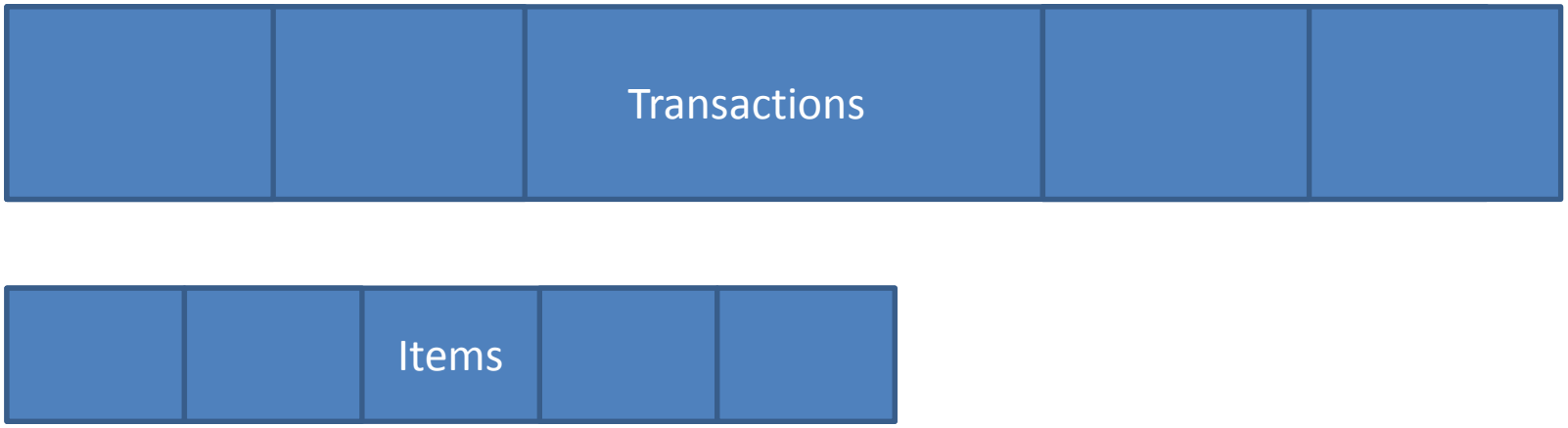


These are *postfix paths*

BRINGING IT ALL TOGETHER

Buckets

- Use postfix paths for messaging
- Working with *buckets*



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FP-growth revisited

```
FP-growth(FP-tree tree)
{
        foreach (item in tree)
            count =CountOccur(tree,item);
            if (IsFrequent(count))
            {
                OutputSet(item);
                sub = tree.GetTree(tree, item);
                FP-growth(sub);
            }
```

Replaced with postfix

Done in parallel

Done in parallel

Done in parallel

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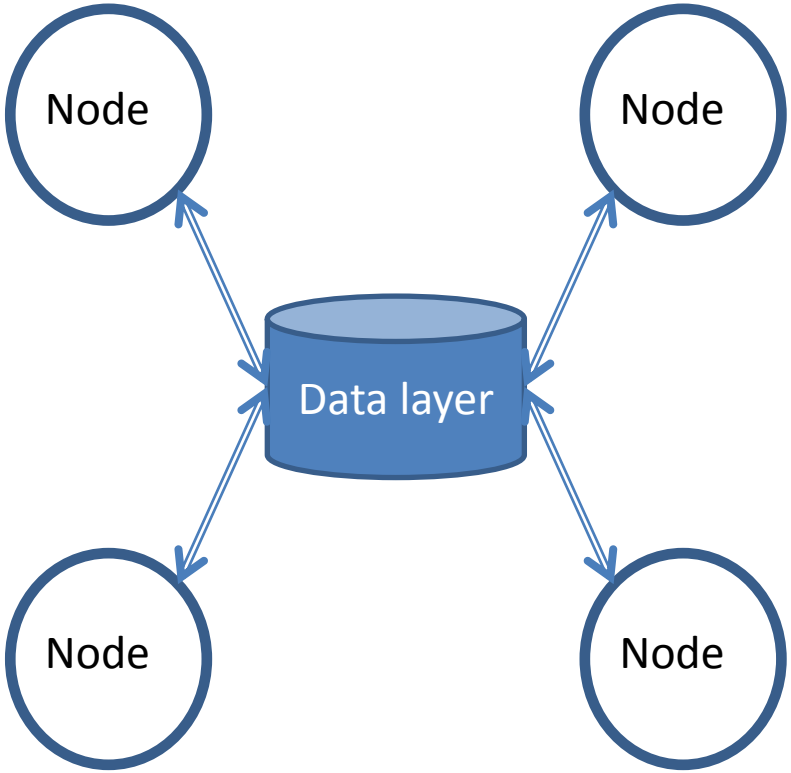
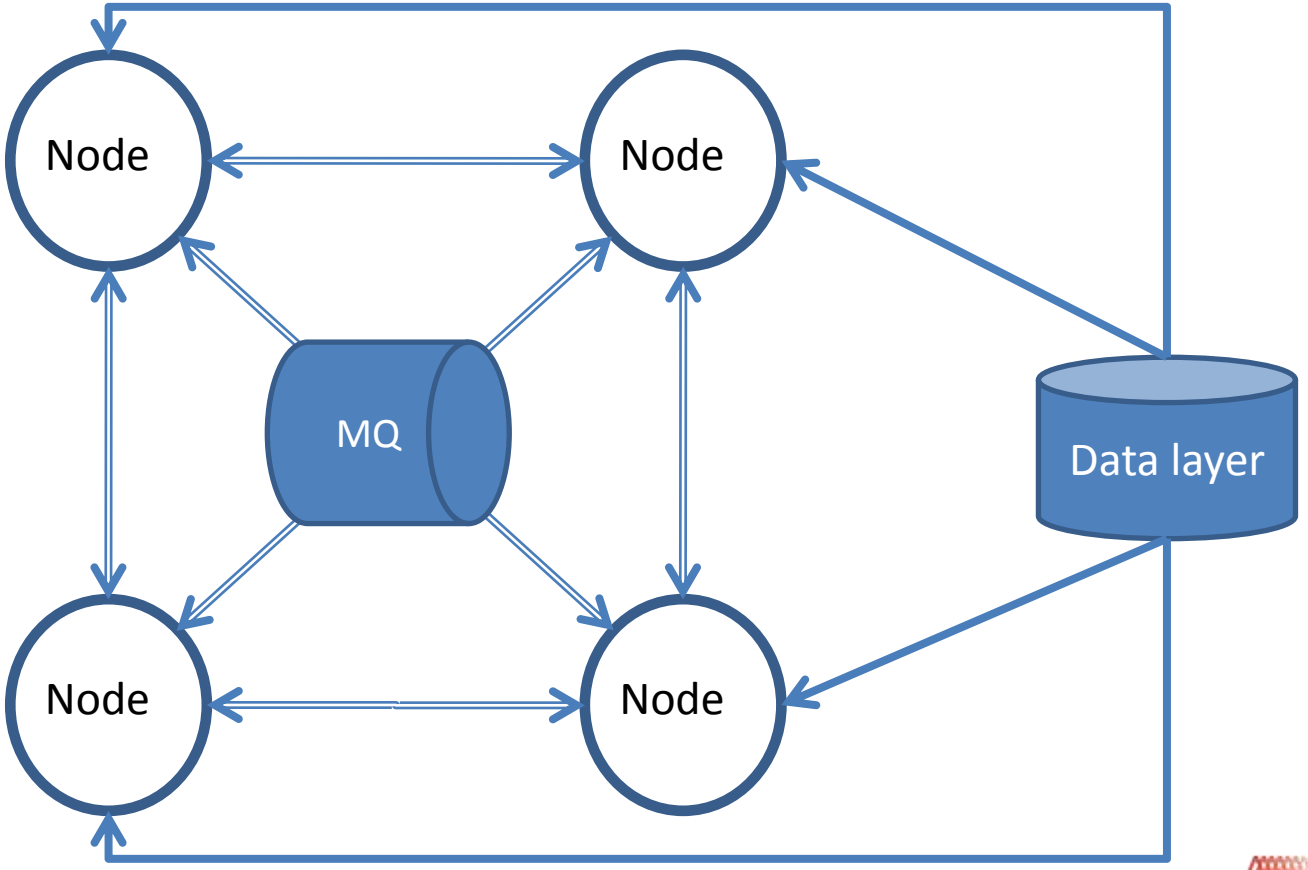
Communication



Revised Communication



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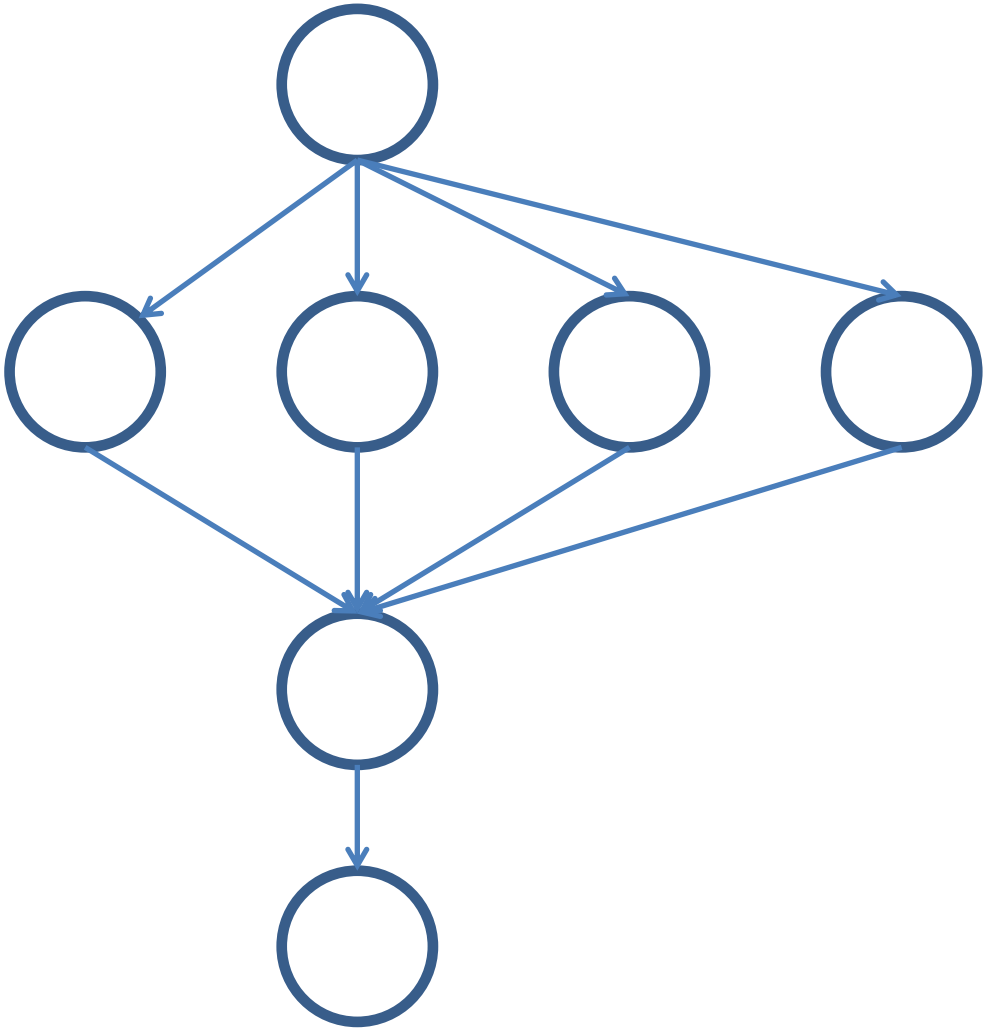
Running FP-growth



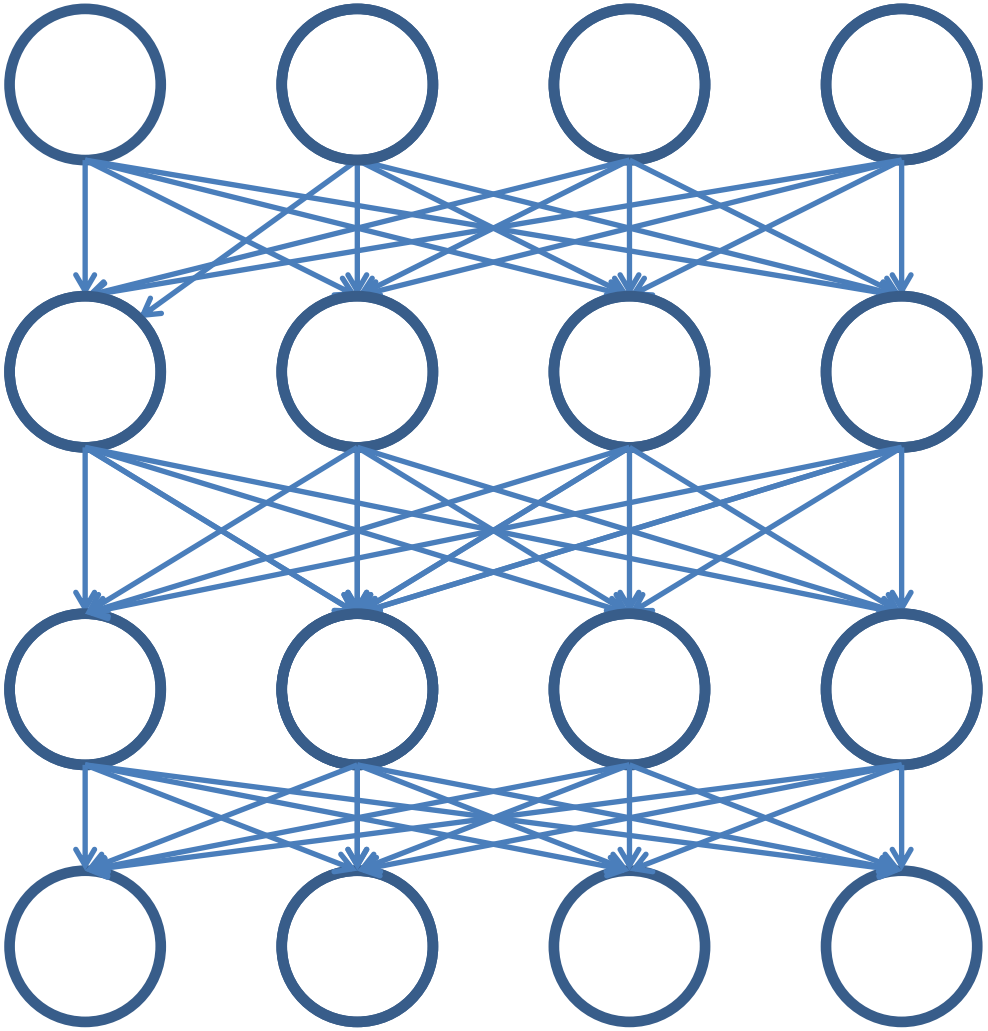
Distribute buckets

Count items
(with postfix size=n)

Collect counts
(per postfix)
Call recursive

Standard FP-growth

Running FP-growth



Distribute buckets

Count items
(with postfix size=n)

Collect counts
(per postfix)
Call recursive

Standard FP-growth

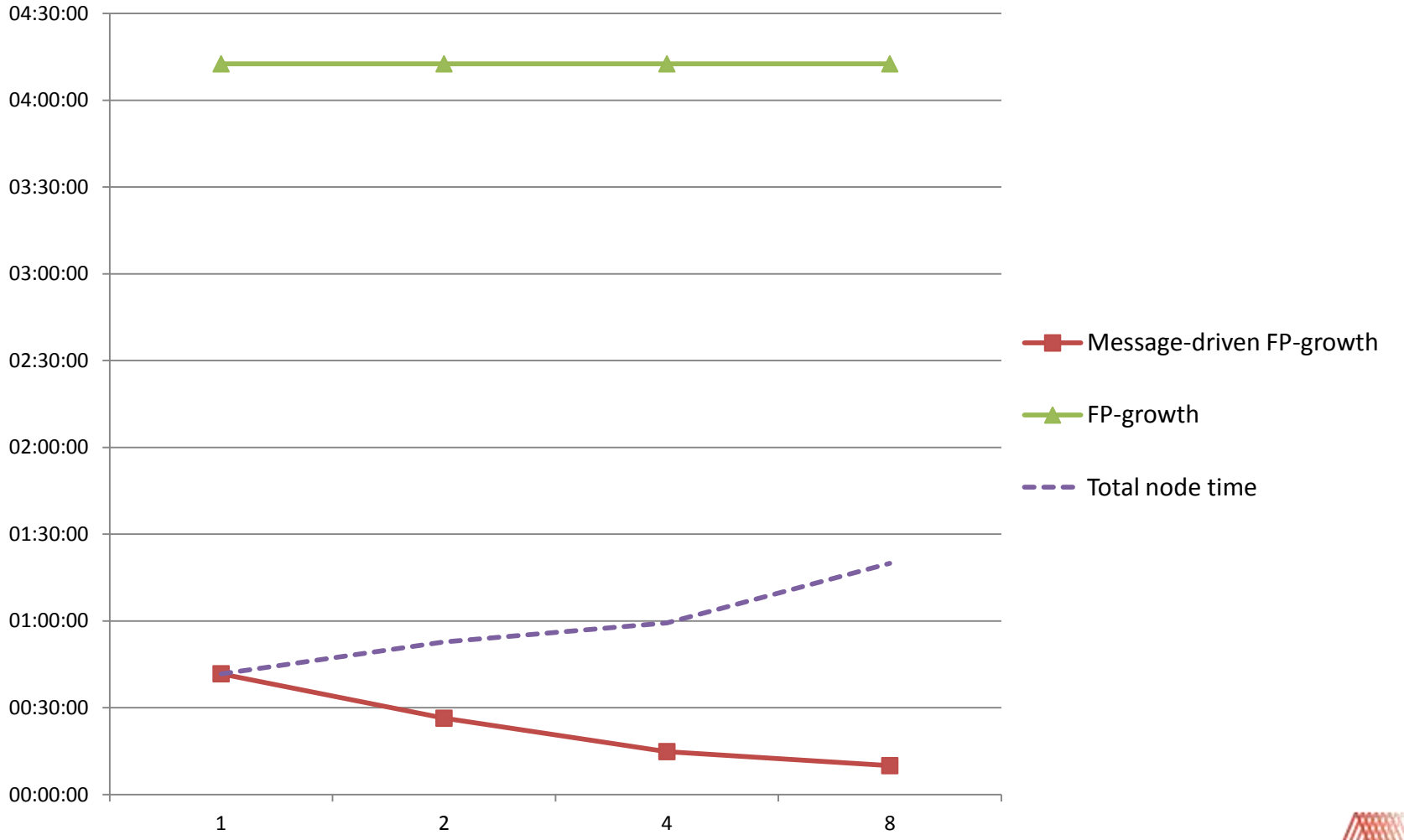
Collecting what we have learned

- Message-driven work, using message-queue
- Peer-to-peer for intermediate results
- Distribute data for scalability (buckets)
- Small messages (list of items)
- Allow us to distribute FP-growth

Advantages

- Configurable work sizes
- Good distribution of work
- Robust against computer failure
- Fast!

So what about performance?



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Thank you!

Questions?

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