Dwarf: A High Performance OLAP Engine

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Features

- Complete **OLAP** engine
  - Computes, indexes, and stores highly compressed data cubes
  - Queries, Incremental Updates
- Overcomes the “dimensionality-curse”
  - Independent of the number of dimensions and hierarchical levels within
  - Scalable

Revolutionary Technology

- Highly compressed storage
  - Full Cubes: ALL views answerable
  - 100% Precision answers on all views including the fact table
  - Stores a subset of the views in very tight space
- Tremendous savings
  - Storage
  - Construction time
- Efficient Query Retrieval
  - Sub-second response

APB-1 Benchmark

- Density 1 (**1.3M**)
  - Dwarf (Thinkpad): **18 s** **57 MB**

- Density 5 (**65M**)
  - Oracle's best benchmark **4.5 hrs,** **30.0+ GB**
    (4 CPU, RAID)
  - Dwarf **65 min** **2.4 GB**
    (Single CPU Pentium 4)

- Density 40 (**496M**))
  - Dwarf: **10.3 hrs** **8.2 GB**
    (Single CPU Pentium 4)

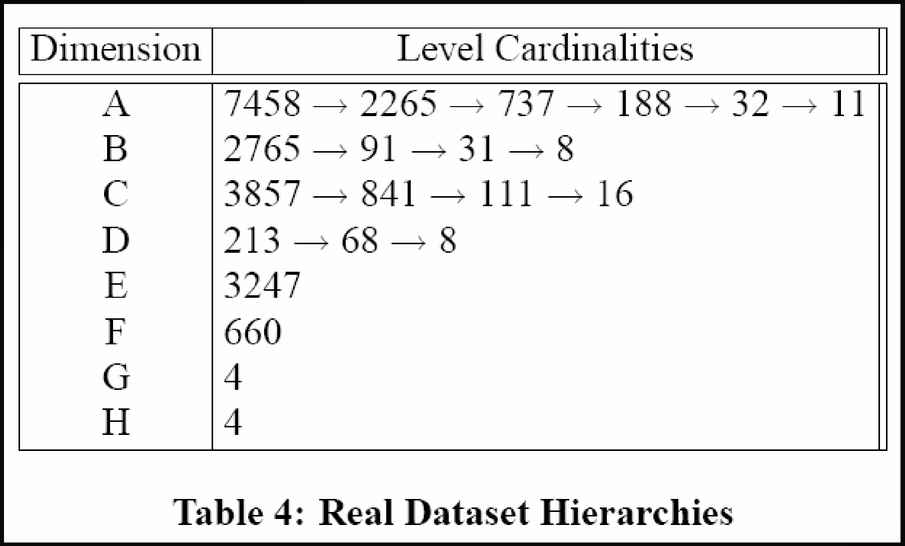
Never done before

NOTE: fact table is **32GB in ASCII, 11.8GB in Binary**

Real Data

- Real data set (13,449,327):
  - **Dimensions:** ***8***
  - **Views:** **11,200**

    (6+1)(4+1)(4+1)(3+1)(1+1)(1+1)(1+1)(1+1)
  - **Creation time:** **100 min**
  - **Size:** **6.7 GB**
  - **1000 Queries*:** **15.8 sec**



Dimension	Level Cardinalities
A	7458 → 2265 → 737 → 188 → 32 → 11
B	2765 → 91 → 31 → 8
C	3857 → 841 → 111 → 16
D	213 → 68 → 8
E	3247
F	660
G	4
H	4

Table 4: Real Dataset Hierarchies

- **Challenge by XYZ**
  - **48 hrs for a "wizard" to decide what to materialize**
  - **Several more hrs to create and index summary tables**
  - **Huge storage**

* Each query asks for 10 different values for 3 randomly selected dimensions (e.g. ***v1* | *v2* |… | *v10***) and "all" for a 4th dimension- 10*10*10 point query

Dream DataCube

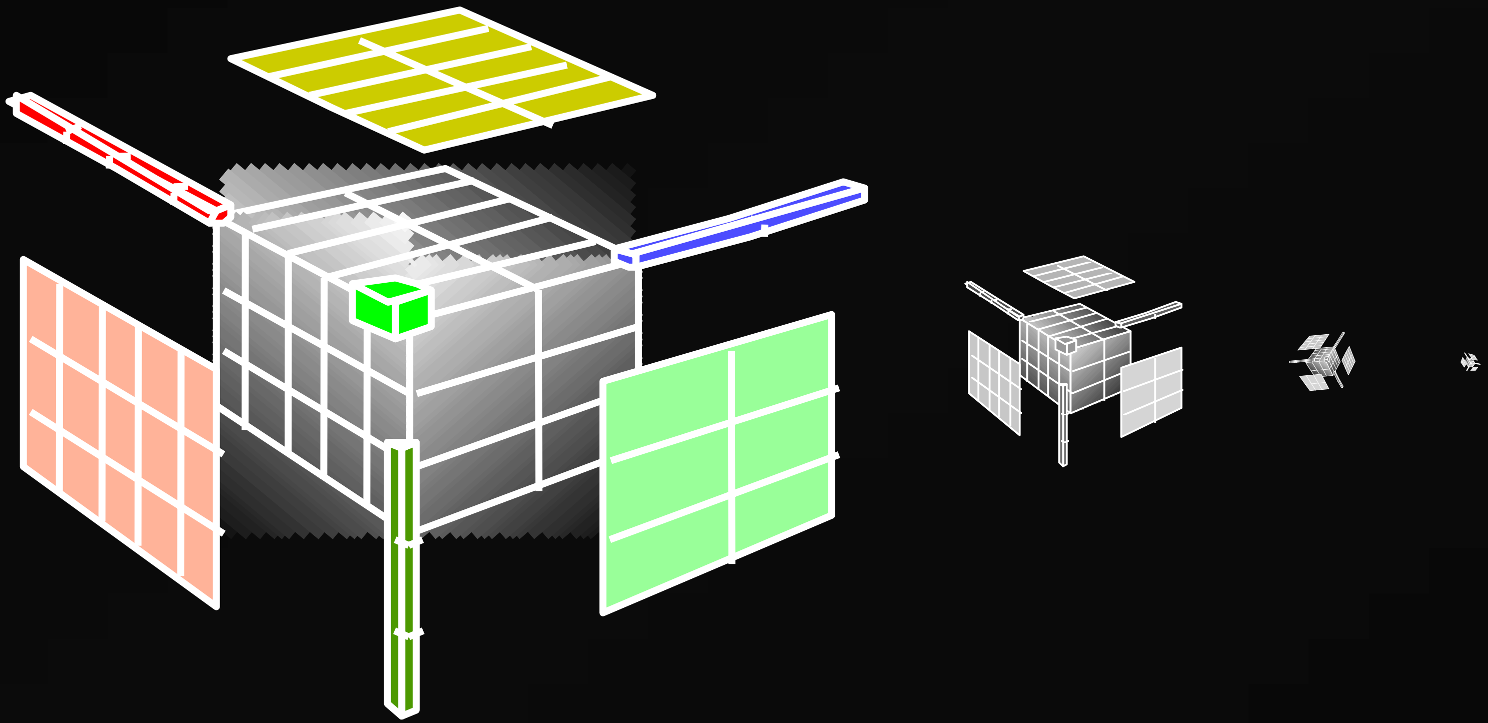
- Fact table (5,000,000):

Dimensions:	*10 (3x9L, 4x4L, 3x2L)*
Views:	16,875,000
Creation:	123 min
Size:	6.3 GB
1000 Queries*:	325 sec

Never done before

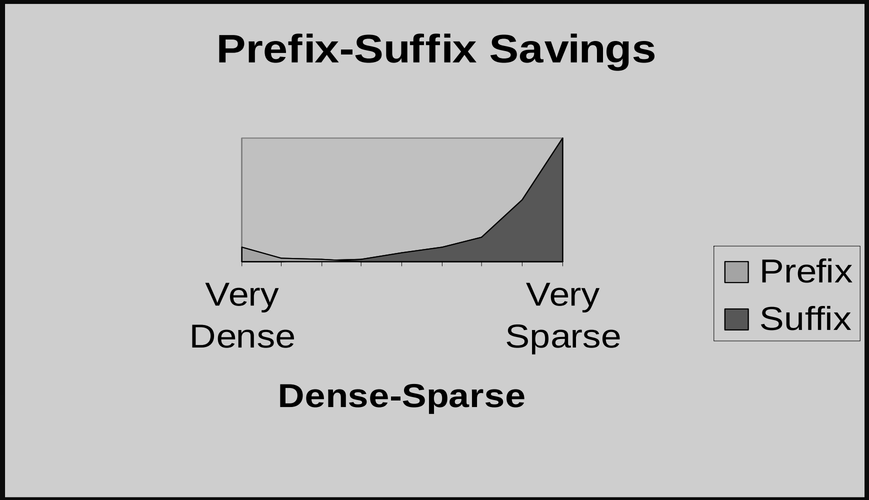
- **Challenge by XYZ**
  - **This cube can never be built!**

Dwarf Demo



What Makes Dwarf Tick

- Two breakthrough discoveries
  - Suffix redundancy
  - Fusion of prefix and suffix redundancy



- Identifies and factors out these redundancies ***before*** computing any aggregates for them

Patented

Dwarf Technology

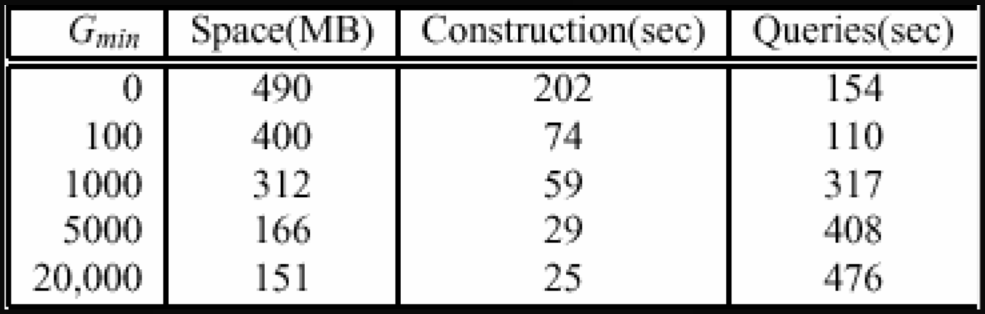
- Complete solution
  - Extends to high dimensionality
  - Deep hierarchies
  - Queries the full cube- any dimension & level
  - Incremental updates
  - Indexing is inherent – all in one structure
  - Dwarf holds in the fact table too!
- No gotchas
  - No expensive preprocessing (just a single sort)
  - No TEMP space required for construction
  - No hidden post-construction costs
  - No information loss (100% precision)

Dwarf Software

- Lean optimized code
- Tools for discovery
  - Data correlation
  - Optimizing dwarfs
- A dozen of tuning knobs including
  - Gmin
  - The Knob

Data Driven Tuning

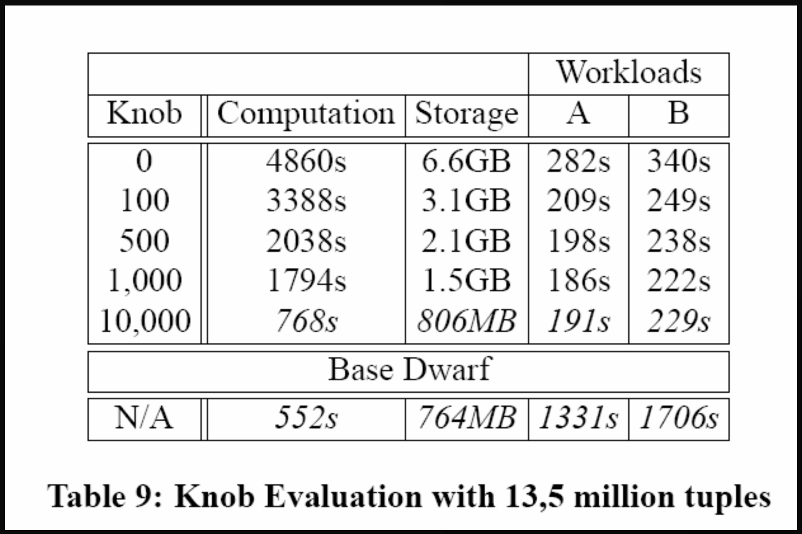
- Gmin



G_{min}	Space(MB)	Construction(sec)	Queries(sec)
0	490	202	154
100	400	74	110
1000	312	59	317
5000	166	29	408
20,000	151	25	476

Patented

- “The Knob”



			Workloads	
Knob	Computation	Storage	A	B
0	4860s	6.6GB	282s	340s
100	3388s	3.1GB	209s	249s
500	2038s	2.1GB	198s	238s
1,000	1794s	1.5GB	186s	222s
10,000	*768s*	*806MB*	*191s*	*229s*
Base Dwarf				
N/A	*552s*	*764MB*	*1331s*	*1706s*

Table 9: Knob Evaluation with 13,5 million tuples

Patented

Target Markets: High-Dimensional Data

- Business Intelligence
- Security
- Telecom
- Scientific and sensor data
- Weather data
- Bioinformatics
- Web data (click statistics)

Dwarf's Value

- Puts any OLAP engine on "steroids" and Delivers substantial performance improvement

- Dwarf is a fast and effective substitute of indexing for ROLAP products
  (supports SQL API)

Summary of Dwarf

- Practical all in one structure
- Remarkable Full Cube Size Reduction
- Unprecedented performance
  (construction and query retrieval)
- Scalable
  (number of dimensions, hierarchy
  depth, data size)

Dwarf Technology

- Math behind the scene
  - Exploit data dependencies & correlations
  - Probabilistic counting
- Dimension scalability
  - Savings/performance increases exponentially with sparseness (and dimensions)
  - Independence of # of dimensions

Product Status

- US Patent 7,133,876
- Metadata management
  - Mapping between external values and internal binaries
  - Can deal with partial cubes
- Implementation
  - Cross platform (Unix, MS)
  - Connects with all RDBMs
  - Dwarf Browser

ACT's Experience

- UMD Group established materialized views and incremental access methods (over 50 publications since 1982)
- Data warehouse Cubetree Storage Organization started in 1997 (over 12 publications, ACM Best paper Award)
- Dwarf in 2001-2006