Effective Utilization of the Database in Web Development

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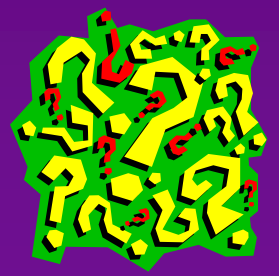
Background

- Fusion technology stack is large and complex.
- Hard to make the transition into the J2EE environment.
- Host of different tools, programming languages, architectures, and technologies
- Projects often have the illusion of progress.
- Building functioning, scalable production software often becomes an impossible task.



Why do OO people avoid the database?

- Culture?
- Lack of knowledge?
- Clinical pathology?

"Frameworkaphobia"

- Definition:
  - An irrational avoidance of frameworks (particularly non-open source)
- Diagnostic Indications:
  - Desire to build everything him/herself
  - "If I don't build it, it must stink."
  - "If Oracle built it, it must really stink."
  - Irrational avoidance of Application Development Framework – Business Components (ADF BC)
- Symptoms:
  - Higher than expected project cost
  - Project failure
- Treatment
  - No known cure
  - Some success with short leashes and large bats
- Related conditions
  - Megalomania
  - Paranoid delusions

“Database Avoidance Syndrome”

- Definition:
  - An aversion to placing any logic in the database
- Diagnostic Indications:
  - “We should be database-independent.”
  - “Databases are old fashioned. Everyone is coding this way.”
- Symptoms:
  - Twice as much code as is necessary
  - Performance is 10 times slower.
  - Network traffic is 100 times as great.
  - Four times the load on the database server
  - Three times the development time

- Treatment
  - Direct application of logic (restraints probably required)
- Related conditions
  - Technical conformity

“SOAphilia”

- Definition:
  - Irrational desire to refactor small systems to use web services and BPEL
- Diagnostic Indications:
  - Ownership of 72 BPEL books
  - Desire to use BPEL for data-centric processes

- Symptoms:
  - Projects only succeed with excessive time and funding.
- Treatment
  - Load testing
  - Limit funding
- Related conditions
  - Herd mentality

“Thick Database” Defined (1)

- Micro-Service-Oriented-Architecture (M-SOA) approach
- Service Component Architecture (SCA)
- Division between the database and user interface (UI) portions.
- Two key features involved in "thick database thinking":
  - Nothing in the UI ever directly interacts with a database table. All interaction is accomplished through database views or APIs.
  - Nearly all application behavior (including screen navigation) is handled in the database.
- Thick database does not simply mean stuffing everything into the database and hoping for the best.

“Thick Database” Defined (2)

- Creating a thick database makes your application UI technology-independent.
  - Creates reusable, UI technology-independent views and APIs.
  - Reduces the complexity of UI development.
  - Database provides needed objects.
  - Reduces the burden on the UI developer

Thick Database Benefits

- Minimizes development risk
- Helps build working applications that scale well.
- Benefit Metrics:
  - Better performance (10X)
  - Less network traffic (100X)
  - Less code (2X)
  - Fewer application servers (3X)
  - Fewer database resources (2X)
  - Faster development (2X)

Easier to Refactor

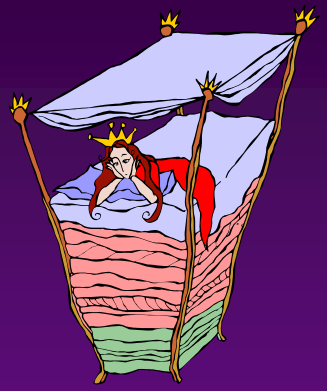
- UI technology stack changes are common.
- The .Net vs. Java EE battle rages on.
- Web architecture is more volatile than the database platform.

- Defense against the chaos of a rapidly evolving standard.
- Test: What is the probability that your web UI standards will be the same in 18 months?

Answer 0%

How Thick is too Thick?

- What would happen if 100% of all UI logic were placed in the database?
  - Tabbing out of a field
  - LOV populated from database
  - Page navigation



- Pathologically complete way to implement the thick database approach.
- A system built this way would be sub-optimal.
  - But it works

How Thin is too Thin?

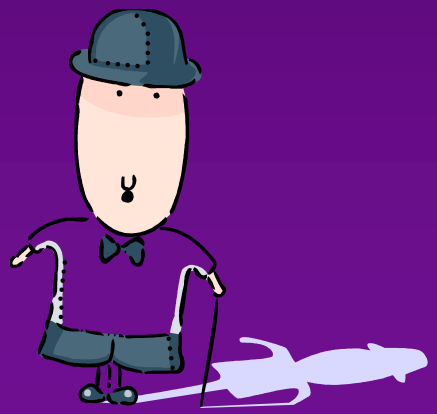
- Can a skilled team successfully build applications that are 100% database “thin”?
  - Requires a highly skilled team.
  - Minimize round trips
  - ANY middle tier technology (e.g. BPEL) can also be a performance killer.
- Possible but difficult

Thick Database Development Process

- Two portions of an application can be coded independently
  - Teams can work in isolation until substantive portions are working.
- First version of the UI is built within a few days
  - Use as testing environment for the database team
  - Feedback can be received from users.
- Use Agile process
  - Minimal design work done to produce a partially working system.
  - Additional functionality created in an iterative design process.

Interface Stubbing

- Stub out the code for the views and APIs.
  - `select <values> from dual`
  - APIs = functions that return a correct value (usually hard-coded).
- Interfaces will change as the application matures.



De-Normalized Views

- The idea:
  - Convert relational data into something that will make user interface development easier.
  - Easiest way to separate data representation in the front-end from the real model.
- The solution:
  - Use a view with a set of INSTEAD-OF triggers

De-Normalized view

```
create or replace view v_customer
as
select c.cust_id,
       c.name_tx,
       a.addr_id,
       a.street_tx,
       a.state_cd,
       a.postal_cd
from customer c
left outer join address a
   on c.cust_id = a.cust_id
```

INSTEAD-OF Insert

```
create or replace trigger v_customer_ii
instead of insert on v_customer
declare
  v_cust_id customer.cust_id%rowtype;
begin
  if :new.name_tx is not null then
   insert into customer (cust_id,name_tx)
    values(object_seq.nextval,:new.name_tx)
   returning cust_id into v_cust_id;
  if :new.street_tx is not null then
   insert into address (addr_id,street_tx,
         state_cd, postal_cd, cust_id)
   values (object_seq.nextval,:new.street_tx,
    :new.state_cd,:new.postal_cd, v_cust_id);
  end if;
end;
```

Function-Based Views: Collections

Using Function-Based Views

- Sometimes it is just not possible to represent all required functionality in a single SQL statement.
- Denormalized view cannot be built.
- Oracle provides a different mechanism:
  - Collections allow you to hide the data separation, as well as all of the transformation logic.

What is a collection?

- Definition:
  - An ordered group of elements, all of the same type, addressed by a unique subscript.
- Implementation:
  - Since all collections represent data, they are defined as data types.

Collections: Pros & Cons

Three types:

1. Nested tables
2. Associative arrays
3. Variable-size arrays (V-Arrays)

- Good news
  - Usually faster
  - Cleaner code
  - Great for UI views

- Bad news
  - Not always faster
  - Somewhat annoying syntax

Why use collections?

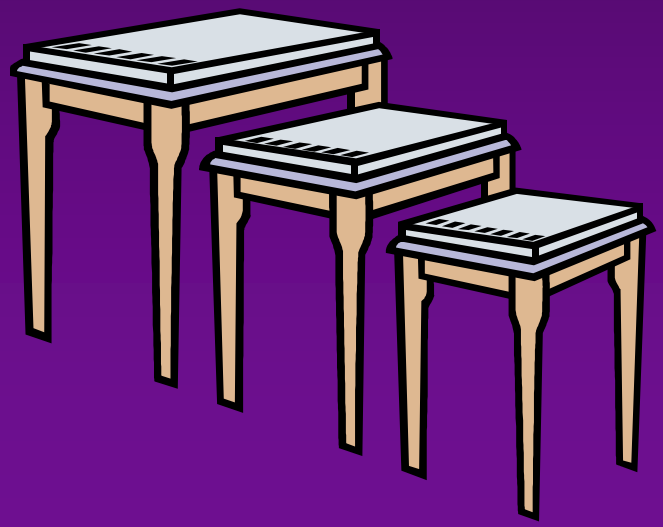
- Logical reason:
  - Collections allow you to articulate and manipulate sets of data.
- Technical reason:
  - Processing data in sets is “usually” faster than doing so one element at a time.
- Physical reason:
  - Manipulating sets in memory is “usually” 100 times faster than manipulating sets on the storage device.

Possible Issues

- Technical problem:
  - Amount of memory is limited (especially in 32-bit architecture)
- Economic problem:
  - Storage is cheap – memory is NOT.

- Learning curve:
  - People who are used to old habits of processing one row at a time (since COBOL days) will have problems working with sets.

Nested Tables



Nested Tables (1)

- Nested tables – arbitrary group of elements of the same type with sequential numbers as a subscript
  - Undefined number of elements (added/removed on the fly)
  - Available in SQL and PL/SQL
  - Very useful in PL/SQL! (but not in tables)

Nested Tables (2)

- Definition:

```
declare
   type NestedTable is
      table of ElementType;
...
create or replace type NestedTable
        is table of ElementType;
```

Nested Tables (3)

- Nested tables are NOT dense:
  - You can remove objects from inside of the array.
  - Size of the nested table MAY OR MAY NOT equal the subscript of the last element
  - Built-in NEXT and PREVIOUS can go over the gap

Nested Tables - Example 1

```
declare
    type month_nt is table of VARCHAR2(20);
    v_month_nt month_nt:=month_nt();
    i number;
begin
    v_month_nt.extend(3);
    v_month_nt(1):='January';
    v_month_nt(2):='February';
    v_month_nt(3):='March';
    v_month_nt.delete(2);
    DBMS_OUTPUT.put_line('Count:'||v_month_nt.count);
    DBMS_OUTPUT.put_line('Last:'||v_month_nt.last);
    i:=v_month_nt.first;
    loop
        DBMS_OUTPUT.put_line(v_month_nt(i));
        i:=v_month_nt.next(i);
        if i is null then exit;
        end if;
    end loop;
end;
```

More About Nested Tables

- Nested tables can be used in SQL queries with the special operator: TABLE
  - Allows hiding of complex procedural logic “under the hood”
  - Nested table type must be declared as a user-defined type (CREATE OR REPLACE TYPE…)

Nested Tables – Example 2a

- Specify exactly what is needed as output and declare the corresponding collection:

```
Create type lov_oty is object
  (id_nr NUMBER,
    display_tx VARCHAR2(256));

Create type lov_nt
              as table of lov_oty;
```

Nested Tables - Example 2b

- Write a PL/SQL function to hide all required logic

```
function f_getLov_nt
  (i_table_tx,i_id_tx,i_display_tx,i_order_tx)
return lov_nt is
   v_out_nt lov_nt := lov_nt();
begin
   execute immediate
      'select lov_oty('
            ||i_id_tx||','||i_display_tx||
                        ')'||
      ' from '||i_table_tx||
      ' order by '||i_order_tx
   bulk collect into v_out_nt;
   return v_out_nt;
end;
```

Nested Tables - Example 2c

- Test SQL statement with the following code:

```
select id_nr, display_tx
from table(
            cast(f_getLov_nt
                    ('emp',
                     'empno',
                     'ename||''-''||job',
                     'ename')
            as lov_nt)
            )
```

Nested Tables - Example 2d

- Create a VIEW on the top of the SQL statement.
  - Completely hides the underlying logic from the UI
  - INSTEAD-OF triggers make logic bi-directional
  - Minor problem: There is still no way of passing parameters into the view other than some kind of global.

```
Create or replace view v_generic_lov as
select id_nr, display_tx
from table( cast(f_getLov_nt
      (GV_pkg.f_getCurTable,
       GV_pkg.f_getPK(GV_pkg.f_getCurTable),
       GV_pkg.f_getDSP(GV_pkg.f_getCurTable),
       GV_pkg.f_getSORT(GV_pkg.f_getCurTable))
            as lov_nt)
          )
```

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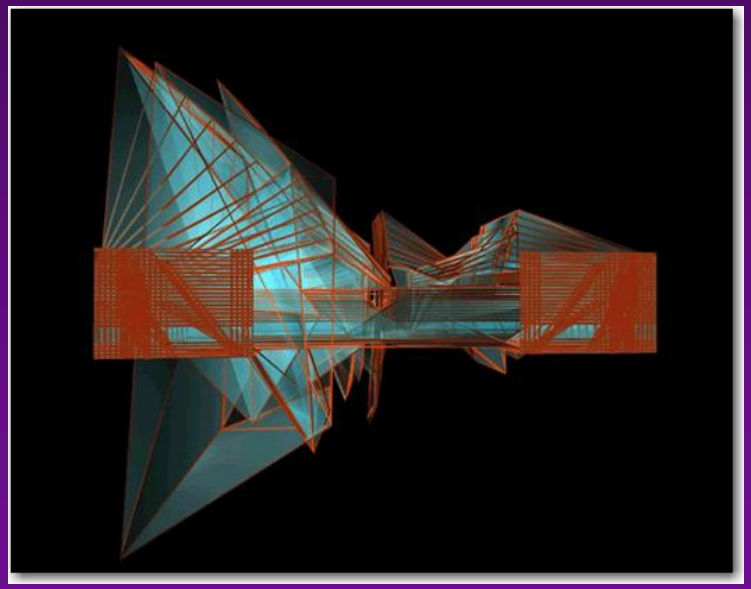
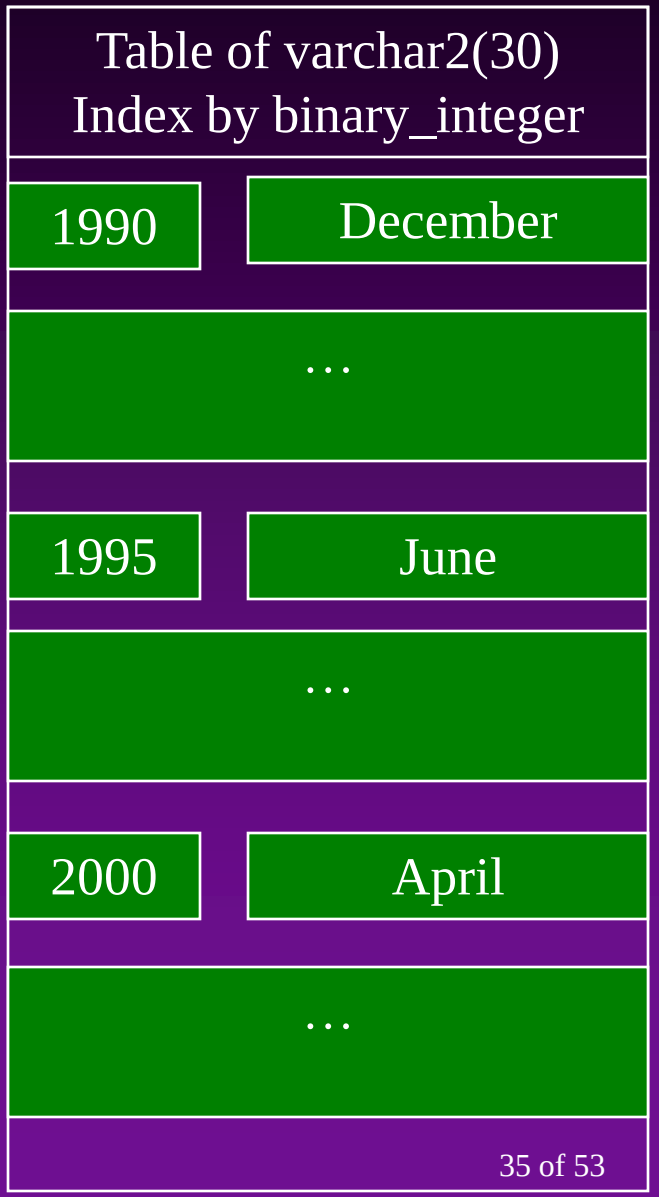
Optimizing Database Processing



Associative Arrays (1)

- An associative array is a collection of elements that uses arbitrary numbers and strings for subscript values
  - PL/SQL only
  - Still useful



Associative Arrays (2)

- Definition:

```
declare
   type NestedTable is
      table of ElementType
            index by Varchar2([N]);
...
 type NestedTable is
      table of ElementType
            index by binary_integer;
```

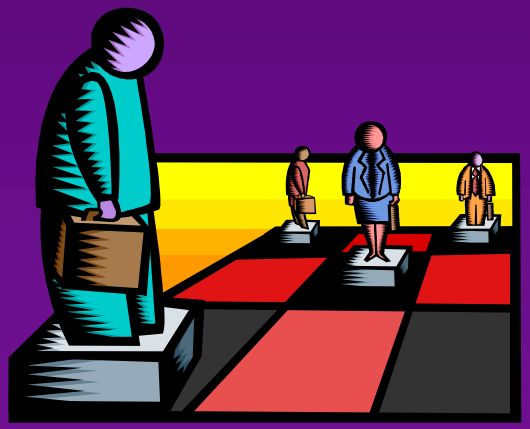
Associative Arrays - Example 1

```
declare
  type dept_rty is record
      (deptNo number, extra_tx VARCHAR2(2000));
  type dept_aa is table of dept_rty
      index by binary_integer;
  v_dept_aa dept_aa;
begin
  for r_d in (select deptno from dept)  loop
    v_dept_aa(r_d.deptno).deptNo:=r_d.deptno;
  end loop;

  for r_emp in (select ename, deptno from emp) loop
    v_dept_aa(r_emp.deptNo).extra_tx:=
        v_dept_aa(r_emp.deptNo).extra_tx||
              ' '||r_emp.eName;
  end loop;
end;
```

More About Associative Arrays

- Index by VARCHAR2 instead of by BINARY_INTEGER
  - Cannot be used in a FOR-loop
  - Allow creation of simple composite keys with direct access to the row in memory



Associative Arrays - Example 2a

- Prepare memory structure

```
declare
  type list_aa is table of VARCHAR2(2000)
       index by VARCHAR2(256);
  v_list_aa list_aa;
  cursor c_emp is
  select ename, deptno,to_char(hiredate,'q') q_nr
  from emp;
  v_key_tx VARCHAR2(256);
begin
  for r_d in (select deptno from dept order by 1) loop
    v_list_aa(r_d.deptno||'|1'):=
      'Q1 Dept#' ||r_d.deptno||':';
    v_list_aa(r_d.deptno||'|2'):=
      'Q2 Dept#' ||r_d.deptno||':';
    ...
end loop;
```

Associative Arrays - Example 2b

- Process data and present results

```
  ...
 for r_emp in c_emp loop
   v_list_aa(r_emp.deptno||'|'||r_emp.q_nr):=
      list_aa(r_emp.deptno||'|'||r_emp.q_nr)||
      ' '||r_emp.ename;
 end loop;

 v_key_tx:=v_list_aa.first;
 loop
   DBMS_OUTPUT.put_line
     (v_list_aa(v_key_tx));
   v_key_tx:=v_list_aa.next(v_key_tx);
   exit when v_key_tx is null;
 end loop;
end;
```

Bulk Operations

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Bulk operations

- Operations on SETs
  - BULK loading into the memory
  - BULK processing

BULK COLLECT (1)

- BULK COLLECT clause
  - The idea:
    - Fetch a group of rows all at once to the collection
    - Control a number of fetched rows (LIMIT)
  - Risks:
    - Does not raise NO_DATA_FOUND
    - Could run out of memory

BULK COLLECT (2)

- Syntax:

```
select …
bulk collect into Collection
 from Table;


update …
returning … bulk collect into
Collection;


fetch Cursor
bulk collect into Collection;
```

BULK COLLECT example

```
declare
   type emp_nt is table of emp%rowtype;
   v_emp_nt emp_nt;

   cursor c_emp is select * from emp;
begin
   open c_emp;
   loop
      fetch c_emp
      bulk collect into v_emp_nt limit 100;
      p_proccess_row (v_emp_nt);
      exit when c_emp%NOTFOUND;
   end loop;
   close c_emp;
end;
```

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FORALL (1)

- FORALL command
  - The idea:
    - Apply the same action for all elements in the collection.
    - Have only one context switch between SQL and PL/SQL
  - Risks:
    - Special care is required if only some actions from the set succeeded

FORALL (2)

- Syntax:

```
forall Index in lower..upper
 update … set … where id = Collection(i)
...
forall Index in lower..upper
 execute immediate '…'
using Collection(i);
```

FORALL (3)

- Restrictions:
  - Only a single command can be executed.
  - Must reference at least one collection inside the loop
  - All subscripts between lower and upper limits must exist.
  - Cannot work with associative array INDEX BY VARCHAR2
  - Cannot use the same collection in SET and WHERE
  - Cannot refer to the individual column on the object/record (only the whole object)

FORALL Example

```
declare
    type number_nt is table of NUMBER;
    v_deptNo_nt number_nt:=number_nt(10,20);
begin
    forall i in v_deptNo_nt.first()
                                ..v_deptNo_nt.last()
      update emp
        set sal=sal+10
      where deptNo=v_deptNo_nt(i);
end;
```

Conclusions

- The #1 critical success factor for any web development is effective utilization of the database.
- PL/SQL is not irrelevant (and it continues to improve).
- Code that needs to access the database is faster if it is placed in the database.
- Database independence is irrelevant
  - UI technology independence is more important.
- Just because everyone is moving logic to the middle tier, does not make it a smart idea.

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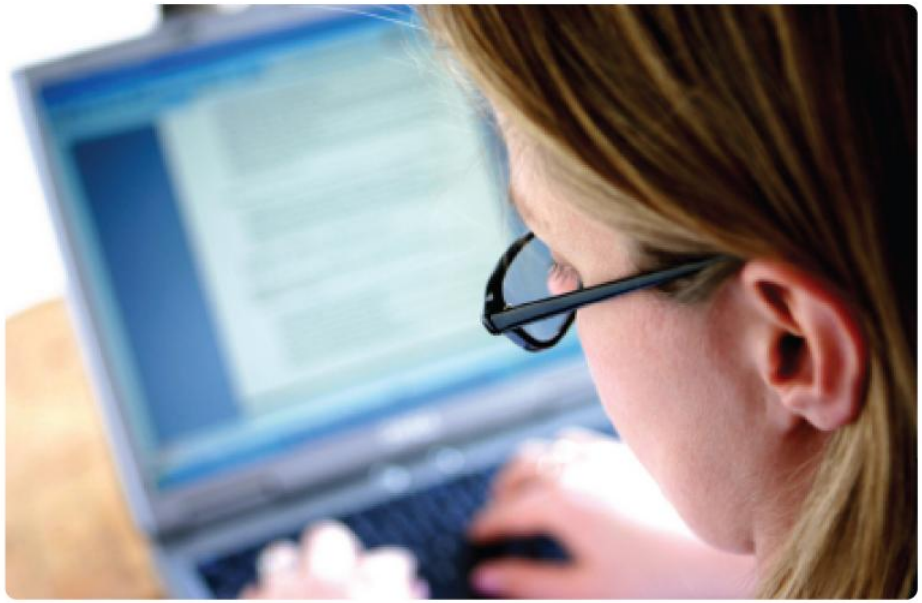

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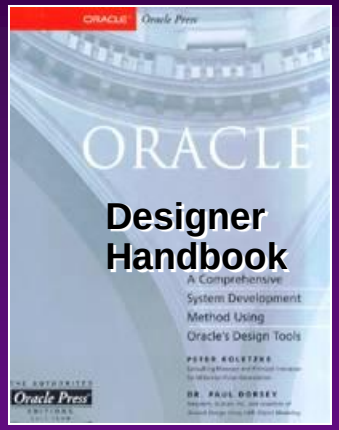

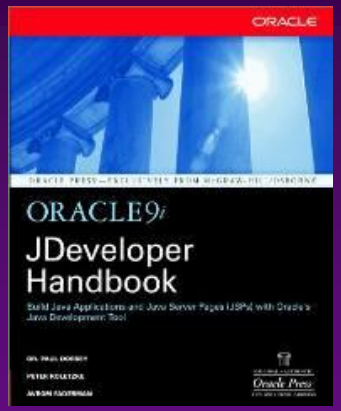

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