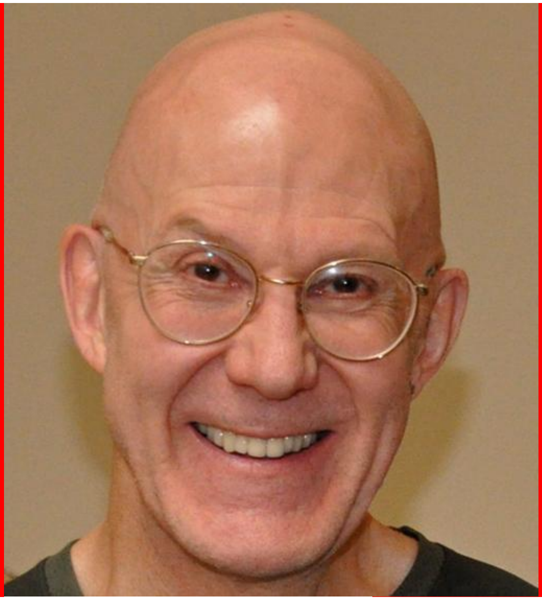

Using the PL/SQL Hierarchical Performance Profiler

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Overview

- You can can get information like this:
  - List of subprograms and SQL statements that were executed during the run, ordered by the elapsed time
  - For a particular subprogram, the time spent in itself and the time spent in each of the subprograms it calls
  - For a particular subprogram, the list of subprograms that call it ordered by the total time for those calls
- This information guides you efficiently to the code whose optimization will have the greatest effect

Agenda

- Hierarchical *vs* statement-oriented profiling
- The Hprof Operating model
- What information is delivered?
- Some case studies; looking at the reports
- Use plshprof canned HTML reports or roll your own
- Summary: the *method*

Hierarchical *vs* statement-oriented profiling

- **DBMS_Profiler** watches statements
  - How many times was each statement executed?
    For each, how much time was spent on those executions?
- Doesn’t know about the subprograms within a package…
  - … let alone inner subprograms (arbitrarily deeply nested) within those
- Has no notion of “self time” vs “total time”
  - Both the time for the statement *p()* and the the time for all the statements that *p()* executes show up.
    You have to puzzle it out.

Hierarchical *vs* statement-oriented profiling

- **DBMS_Hprof** watches as control moves into and back from subprograms
  - Records each transition – *i.e.* the explicit call history
  - Notes the time spent between each transition
- No end of interesting reports can be derived from this raw data
  - Allows computing *both* a function's self-time *and* a function's total (a.k.a. subtree) time
- Such reports cannot be derived from bald per-statement times 'cos the overall context is never recorded

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The Hprof Operating model

- DBA nominates a directory on the database machine’s filesystem and gives the developer’s o/s user read/write access to it
- DBA maps the o/s directory to a directory object and grants the developer’s Oracle user read/write access to it

-
  ```
  begin
    DBMS_Hprof.Start_Profiling('DIR', 'My_Run_1.trc');
    My_Proc();
    DBMS_Hprof.Stop_Profiling();
  end;
  ```
- Format the raw data for human browsing *(plshprof)*
- No installation or configuration.
  No need to “instrument” your code.

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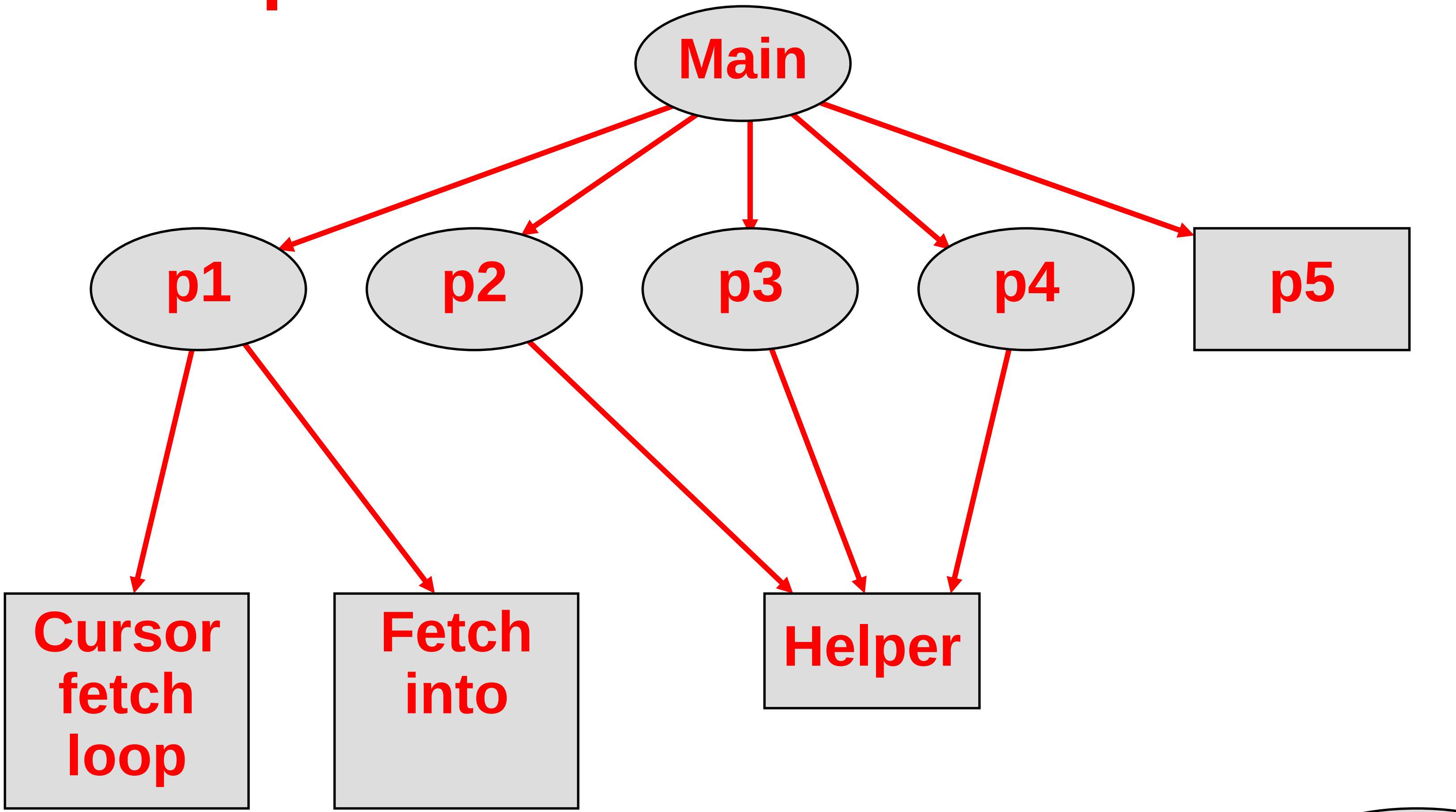
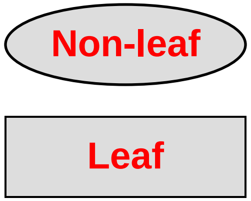
How are subprograms identified?

- Namespace (PL/SQL or SQL)
- Owner
- Unit Name
- Path to subprogram from top of unit
- Source code line number (to distinguish overloads)
- System-generated names
  - __pkg_init
  - __static_sql_exec_line*NNN*
  - __sql_fetch_line*NNN*
  - __dyn_sql_exec_line*NNN*
  - __plsql_vm
  - __anonymous_block

Example 0





- This is the dynamic call graph of a particular execution of *Main*

Information derived from the raw trace

No.of calls

Some_Subprogram

Subtree time = Self time + Callees time

Information derived – *continued…*

“function” time

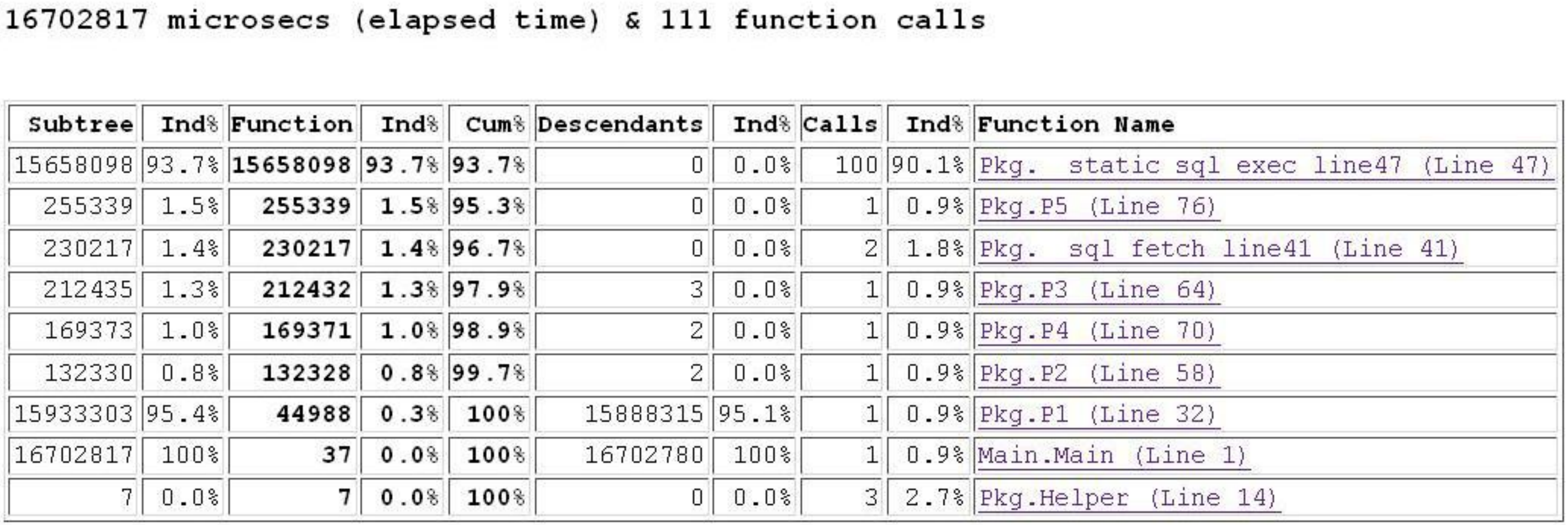
“descendants” time

Subtree time	Self time	Callees time	No.of calls	Name
15.658098	**15.**658098	**0.**000000	**100**	**Static SQL Exec**
0.255339	**0.**255339	**0.**000000	**1**	**P5**
0.230217	**0.**230217	**0.**000000	**2**	**SQL Fetch**
…	…	…	…	…
15.933303	**0.**044988	**15.**888315	**1**	**P1**
16.702817	**0.**000037	**16.**702780	**1**	**Main**
0.000007	**0.**000007	**0.**000000	**3**	**Helper**

sort by descending self time

total
16.702817

Sort by descending self time



16702817 microsecs (elapsed time) & 111 function calls

Subtree	Ind%	Function	Ind%	Cum%	Descendants	Ind%	Calls	Ind%	Function Name
15658098	93.7%	15658098	93.7%	93.7%	0	0.0%	100	90.1%	Pkg. static sql exec line47 (Line 47)
255339	1.5%	255339	1.5%	95.3%	0	0.0%	1	0.9%	Pkg.P5 (Line 76)
230217	1.4%	230217	1.4%	96.7%	0	0.0%	2	1.8%	Pkg. sql fetch line41 (Line 41)
212435	1.3%	212432	1.3%	97.9%	3	0.0%	1	0.9%	Pkg.P3 (Line 64)
169373	1.0%	169371	1.0%	98.9%	2	0.0%	1	0.9%	Pkg.P4 (Line 70)
132330	0.8%	132328	0.8%	99.7%	2	0.0%	1	0.9%	Pkg.P2 (Line 58)
15933303	95.4%	44988	0.3%	100%	15888315	95.1%	1	0.9%	Pkg.P1 (Line 32)
16702817	100%	37	0.0%	100%	16702780	100%	1	0.9%	Main.Main (Line 1)
7	0.0%	7	0.0%	100%	0	0.0%	3	2.7%	Pkg.Helper (Line 14)

The Heisenberg effect

```
 Caption constant varchar2(35) :=  'Elapsed time '||
    $if $$Profiling $then   '(profiling ON)'
    $else                   '(profiling OFF)'
    $end;
  t0 constant integer not null :=
                                DBMS_Utility.Get_Time();
  t integer not null := 0;
begin
  $if $$Profiling $then
    DBMS_Hprof.Start_Profiling('PLSHPROF', 'Run_1.trc');
  $end
  Main();
  $if $$Profiling $then
    DBMS_Hprof.Stop_Profiling();
  $end
  t := DBMS_Utility.Get_Time() - t0;
  DBMS_Output.Put_Line(Caption||Lpad(t, 5));
end;
```

The Heisenberg effect

	seconds
Self-reported* (profiling OFF)	**16.66**
Self-reported (profiling ON)	**16.79**
Hprof-reported	**16.67**

* The self-reported times were done using *DBMS_Utility.Get_Time()*

The Heisenberg effect…

But it’s not always as nice as this!

Information derived – *continued…*

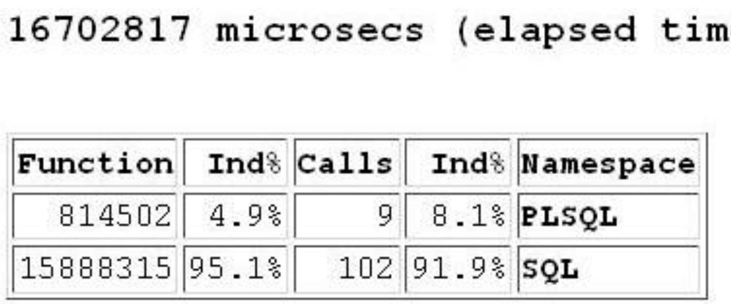
- Order by
  - Self time
  - Subtree time
  - No.of calls
  - Callees time
  - Alphabetically by name

Information derived – *continued…*

- Rollup by PL/SQL vs SQL (a.k.a. “namespace”)
  - Order by self time
  - Order by no.of calls
  - Order by namespace

- Rollup by PL/SQL Unit (a.k.a. “module”)
  - Order by self time
  - Order by no.of calls
  - Order by name

Sort by elapsed time in namespace



```
16702817 microsecs (elapsed time) & 111 function calls
```

Function	Ind%	Calls	Ind%	Namespace
814502	4.9%	9	8.1%	**PLSQL**
15888315	95.1%	102	91.9%	**SQL**

- Say no more!

  This one isn’t a PL/SQL performance exercise.

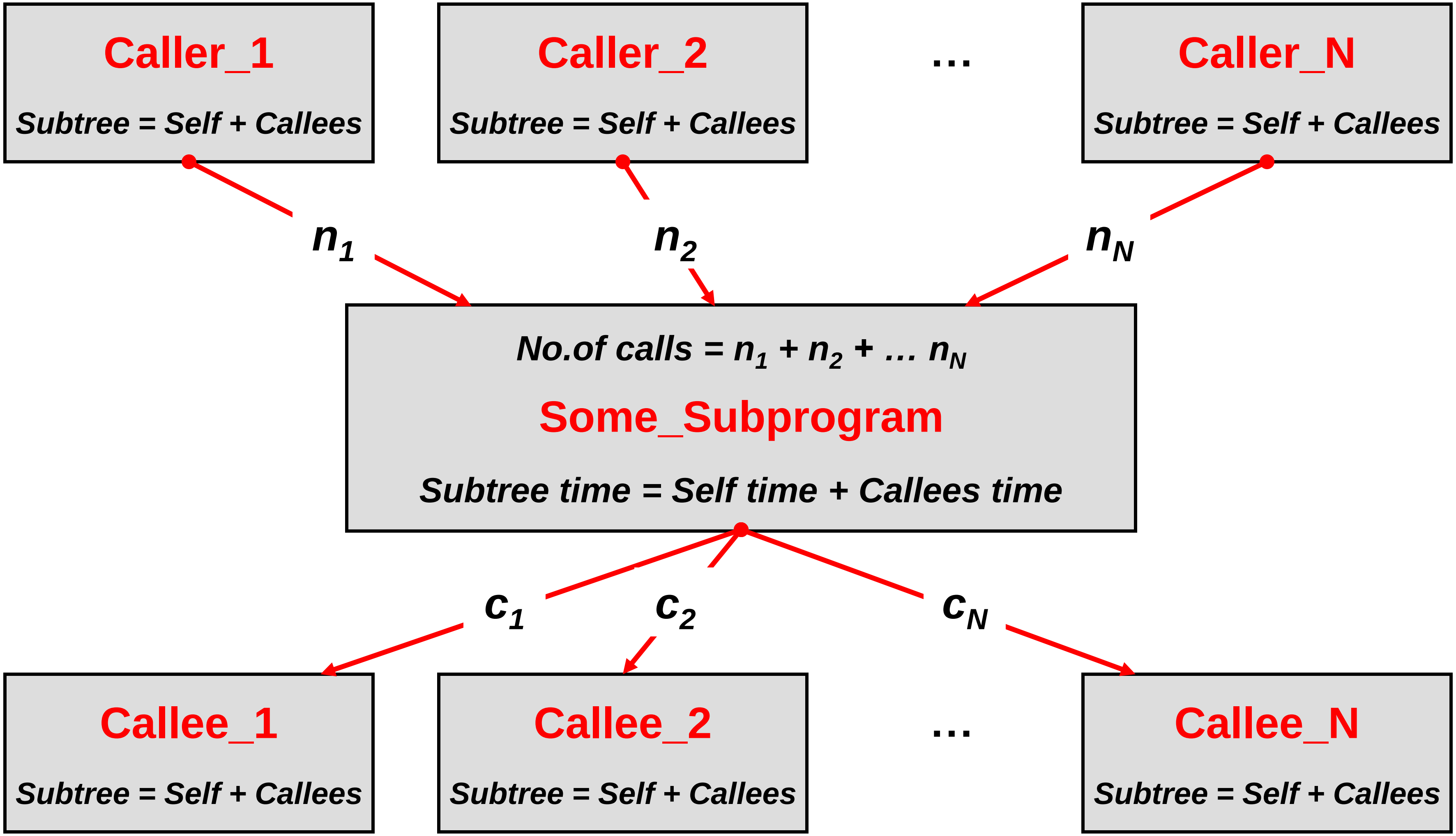
Information derived – *continued…*

No.of calls

Some_Subprogram

Subtree time = Self time + Callees time

Information derived – *continued…*



Caller_1

Subtree = Self + Callees

Caller_2

Subtree = Self + Callees

…

Caller_N

Subtree = Self + Callees

n_1 n_2 n_N

No.of calls = $n_1 + n_2 + \dots n_N$

Some_Subprogram

Subtree time = Self time + Callees time

c_1 c_2 c_N

Callee_1

Subtree = Self + Callees

Callee_2

Subtree = Self + Callees

…

Callee_N

Subtree = Self + Callees

Information derived – *continued…*

- For each caller, we see:
  - How many times it calls *Some_Subprogram*
  - That portion of *Some_Subprogram*’s time consumption for which that caller is responsible
  - The sum of these, over the callers, is equal to the figures noted for *Some_Subprogram* itself
- Each caller might not call *Some_Subprogram* in each call to it
- For each child, we see:
  - How many times it was called by *Some_Subprogram*
  - Its time consumption when called from *Some_Subprogram*
- Each child may be called by other subprograms

Information derived – *continued…*

Subtree time	Self time	Callees time	No.of calls	Name
42.448067	1.577936	40.870131	421	Some_Subprogram

35.240135	1.215322	34.024813	323	Caller_1
6.917576	0.337475	6.580101	91	Caller_2
…	…	…	…	…
0.290356	0.025139	0.265217	7	Caller_N

28.908427	28.908427	0.000000	8712	Callee_1
7.266276	7.266276	0.000000	6495	Callee_2
…	…	…	…	…
4.695428	4.695428	0.000000	1435	Callee_N

Live exploration of available report

- Order by
  - Self time
  - Subtree time
  - No.of calls
  - Alphabetically by name
- Navigating up to a caller and down to a callee
  - Start with Callee_3 (has the biggest self time)
  - Navigate to *Some_Subprogram*
  - Look at all of *Some_Subprogram*’s callers and callees
- ⌘ – 0

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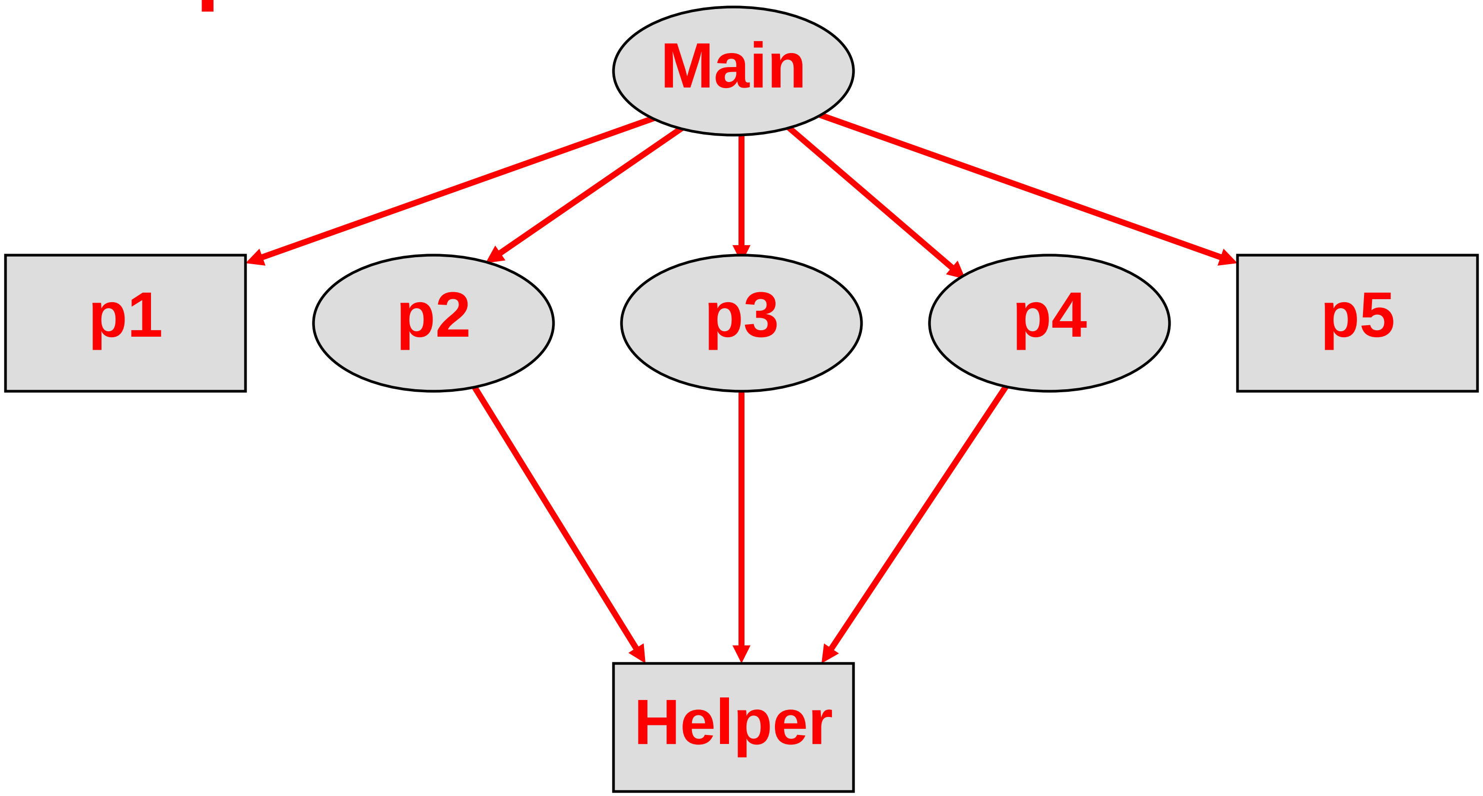
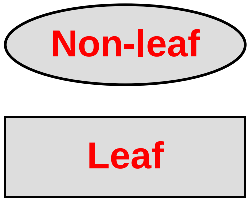
Example 1





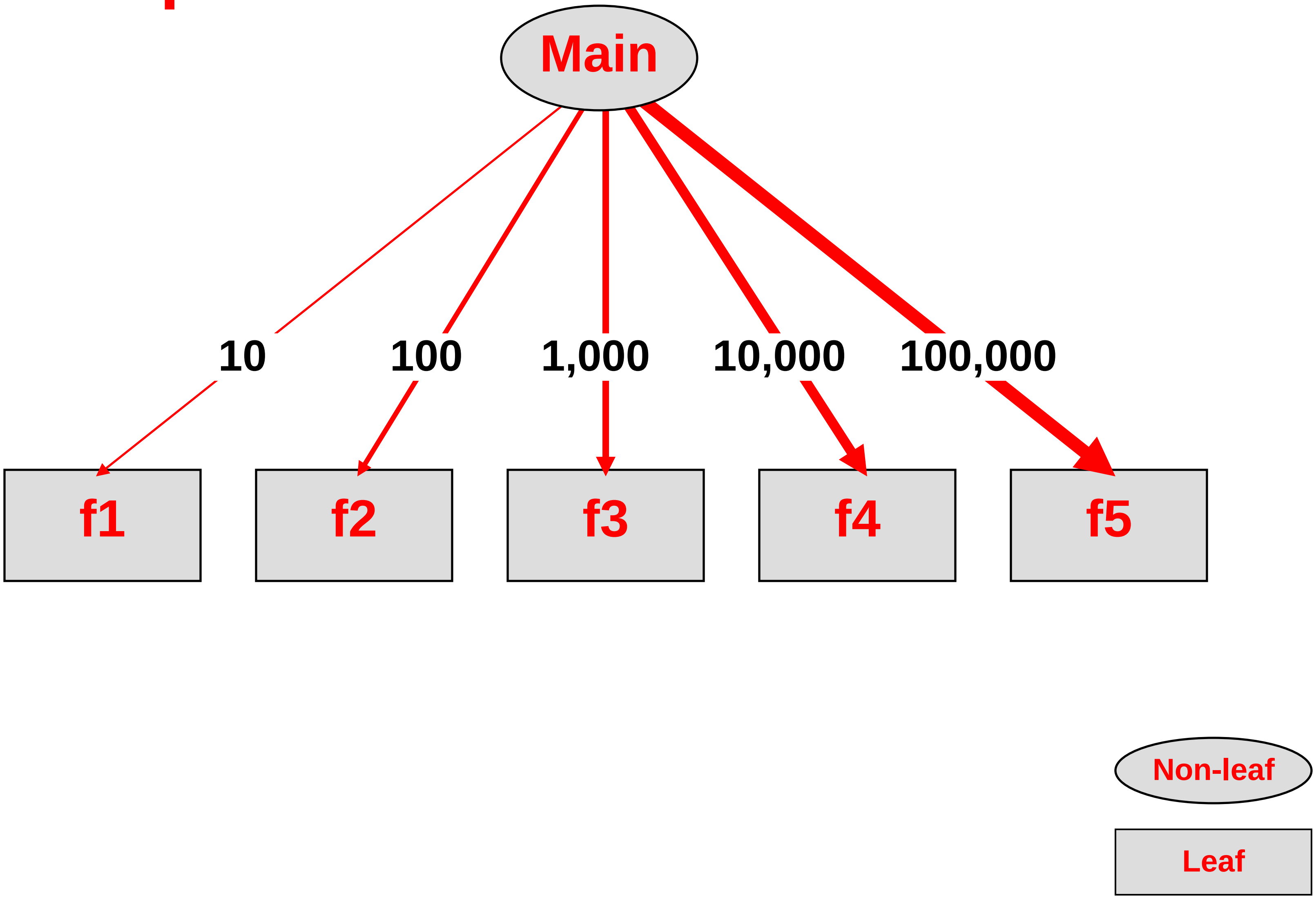
Live exploration of available reports

- Order by
  - Self time

- There’s an obvious culprit!
- Fix it
- Do another Hprof run
- Look at the new report
- Look at the *difference* report

- ⌘ – 1 ⌘ – 2 ⌘ – 3

Example 2



Live exploration of available reports

- Order by
  - Self time

- ⌘ – 4 ⌘ – 5 ⌘ – 6

Live exploration of available reports

- Order by
  - Self time

- Both *f5* and *Main* have a very big self time
- Together, these dominate
- But *Main* does no “real work”
- And, looking at *f5*, it’s very lightweight
- But Main calls *f5* 100,000 times!
- All the time is going on the mechanics of calling
- The fix is to inline *f5* into *Main*

- ⌘ – 4 ⌘ – 5 ⌘ – 6

The Heisenberg effect – Example 2

	seconds
Self-reported* (profiling OFF)	0.06
Self-reported (profiling ON)	2.46
Hprof-reported	0.50

No.of calls = 111,112

Self-reported* (profiling OFF)	0.02
Self-reported (profiling ON)	0.33
Hprof-reported	0.06

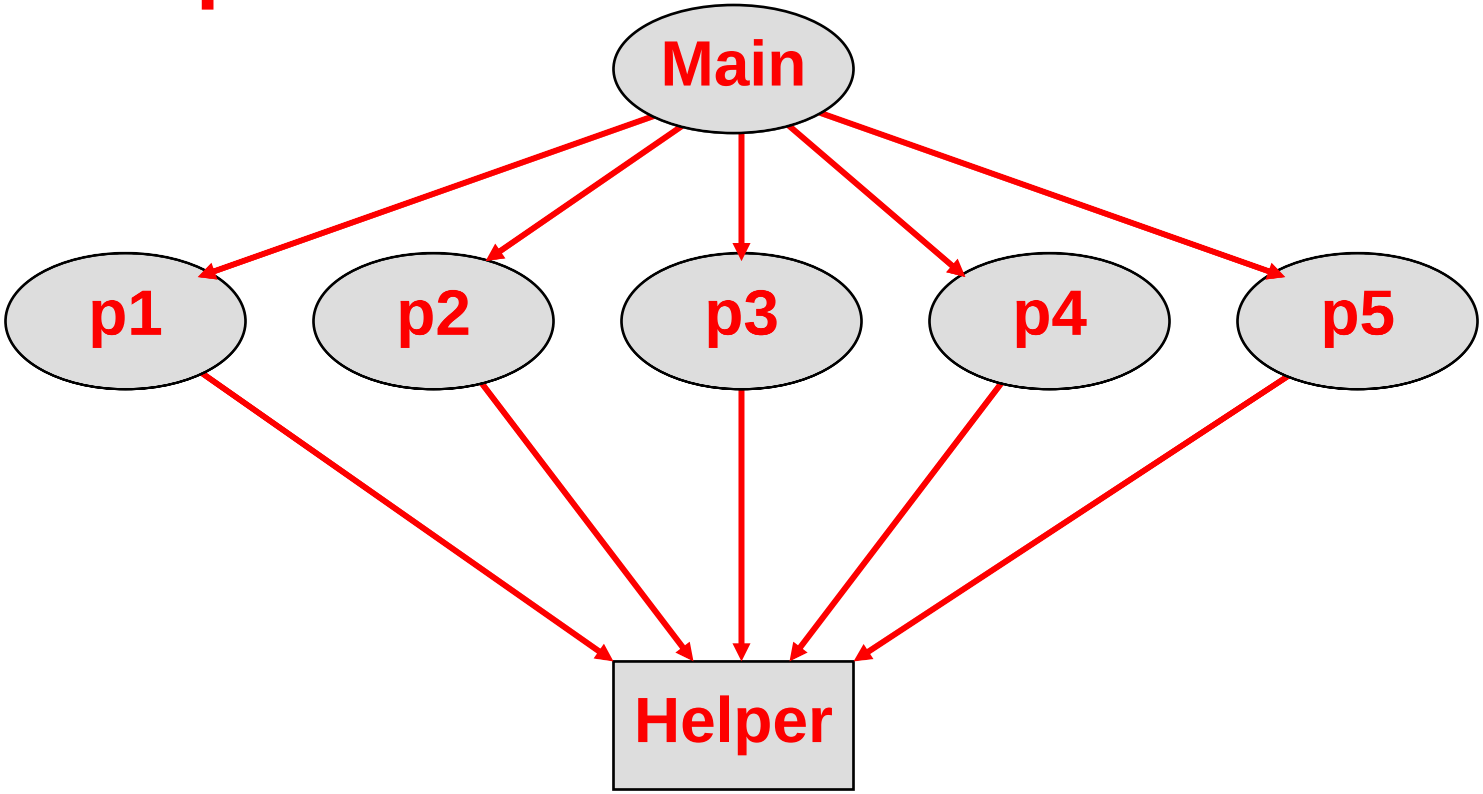
No.of calls =   11,112

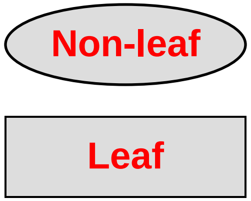
The Heisenberg effect – Example 0

	seconds
Self-reported* (profiling OFF)	16.66
Self-reported (profiling ON)	16.79
Hprof-reported	16.67

No.of calls = 112

Example 3





Live exploration of available reports

- Order by
  - Self time

- There’s something fishy with *Helper*

- ⌘ – 7 ⌘ – 8 ⌘ – 9

Live exploration of available reports

- Order by
  - Self time

- There’s something fishy with *Helper*
- Its self time when called from *p3* is hugely bigger than when called from elsewhere
- Ah…

  p3 called it with an actual requesting self-tracing!

- ⌘ – 7 ⌘ – 8 ⌘ – 9

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Use plshprof canned HTML reports or roll your own

- Run the script rdbms/admin/dbmshptab.sql

-
  ```
  Unique_Run_ID := DBMS_Hprof.Analyze(
    Location          The_Directory,
    Filename          The_Filename,
    Summary_Mode      Full_Analysis,
    ...               ,
    Run_Comment       The_Run_Comment);
  ```
- Tables are populated with data sufficent to let you write reports with the same information content as the supplied ones
- You could use APEX

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- **Summary: the *method***

Summary: the *method*

```
if
    the SQL time dominates the PL/SQL time
then
    Stop obsessing about your PL/SQL performance
    and fix the SQL;
elsif
    …
```

Summary: the *method*

```
elsif
    one PL/SQL subprogram, p1, has a dominant self time
then
    Fix the implementation of p1;
elsif
    …
```

- If you can’t spot the problem in p1 just by reading the code and thinking about it (e.g. binary search using index-by-varchar2 table vs pre-9.2 linear scan)…
- Then this is where you might want statement-level profiling

Summary: the *method*

```
elsif

     (one PL/SQL subprogram that ought to be quick, p2,
     has a very big self time)
     and
     (p2's caller has a surprisingly big self time)

then

     Check how many times the caller calls p2;
     if
       p2 is called a huge number of times
     then
       Inline p2 into its caller;
     end if;

elsif

     …
```

Summary: the *method*

```
elsif
      (one PL/SQL subprogram that ought to be quick, p3,
      has a very big self time)
      and
      (p3 is called by many callers)
       and
      (p3's self time depends hugely on who calls it)
then
      Check for the explanation;
      if
        p3 is called in self-tracing mode from just one caller
      then
        Rewrite the call so's not to ask for self-tracing;
      end if;
elsif …
```

Summary: the *method*

```
else
    Sort the report by subtree time;

    (Mentally) prune away the quick subtrees;

    Focus attention on the slowest subtree and understand its purpose;

    Understand the design and consider alternative designs that implement the same purpose;

    Tell your manager that this one is going to be hard;
end if;
```

Finally…

For more information…

- The PL/SQL hierarchical performance profiler
  is documented
  in the

  Oracle Database
  Advanced Application Developer’s Guide

Q&A