

用SQL访问树结构

- 为了检查效率和性能，分别用不同模型解决如下两个问题：
- 法国将军Dominique Vandamme指挥哪些部队，以缩排方式或简单列表的方式显示他们。注意，所有的commander字段都构建了索引（简称Vandamme查询）
- Scottish Highlanders的每个团各属于哪个部队（自底向上的查询）。在部队的名称（description字段）上没有索引，唯一的方法是在description字段中查找“Highland”字符串，在没有任何全文索引的情况下，这个问题简称highland问题
 - 注：层次结构Corp-division-brigade-regiment
 - Oracle



自顶向下查询：Vandamme查询

- 邻接模式

- connect by *<a column of the current row> = prior <a column of the previous row>*,
- connect by *<a column of the previous row> = prior <a column of the current row>*

```
select lpad(description, length(description) + level) description,  
       commander  
from adjacency_model  
connect by parent_id = prior id  
start with commander = 'Général de Division Dominique Vandamme'
```



邻接模式

DESCRIPTION	COMMANDER
-----	-----
III Corps	Général de Division Dominique Vandamme
8th Infantry Division	Général de Division Baron Etienne-Nicolas Lefol
2nd Brigade	Général de Brigade Baron Corsin
37th Rgmt de Ligne	Colonel Cornebise
1st Brigade	Général de Brigade Billard (d.15th)
23rd Rgmt de Ligne	Colonel Baron Vernier
15th Rgmt Léger	Colonel Brice
...	
10th Infantry Division	Général de Division Baron Pierre-Joseph Habert
2nd Brigade	Général de Brigade Baron Dupeyroux
70th Rgmt de Ligne	Colonel Baron Maury
22nd Rgmt de Ligne	Colonel Fantin des Odoards
2nd (Swiss) Infantry Rgmt	Colonel Stoffel
1st Brigade	Général de Brigade Baron Gengoult
88th Rgmt de Ligne	Colonel Baillon
34th Rgmt de Ligne	Colonel Mouton
Division Artillery	
18/2nd Foot Artillery	Captain Guérin

40 rows selected.



邻接模式:递归实现

- STEP 1: define starting point

```
select 1 level,  
       id,  
       description,  
       commander  
from adjacency_model  
where commander = 'Général de Division Dominique Vandamme'
```

- STEP 2: define how each child row relates to its parent row

```
select parent.level + 1,  
       child.id,  
       child.description,  
       child.comander  
from recursive_query parent, adjacency_model child  
where parent.id = child.parent_id
```



邻接模式:递归实现

```
with recursive_query(level, id, description, commander)
as (select 1 level,
      id,
      description,
      commander
  from adjacency_model
 where commander = 'Général de Division Dominique Vandamme'
 union all
 select parent.level + 1,
        child.id,
        child.description,
        child.commander
  from recursive_query parent,
       adjacency_model child
 where parent.id = child.parent_id)
select char(concat(repeat(' ', level), description), 60) description,
       commander
  from recursive_query
```



邻接模式:递归实现

```
with recursive_query(level, id, rank, description, commander)
as (select 1,
      id,
      cast(1 as double),
      description,
      commander
 from adjacency_model
 where commander = 'Général de Division Dominique Vandamme'
 union all
 select parent.level + 1,
        child.id,
        parent.rank + ranking.sn / power(100.0, parent.level),
        child.description,
        child.commander
 from recursive_query parent,
      (select id,
       row_number( ) over (partition by parent_id
                          order by description) sn
       from adjacency_model) ranking,
      adjacency_model child
 where parent.id =child.parent_id
       and child.id = ranking.id)
 select char(concat(repeat(' ', level), description), 60) description,
        commander
 from recursive_query
 order by rank
```



邻接模式:递归实现

DESCRIPTION	COMMANDER
-----	-----
III Corps	Général de Division Dominique Vandamme
10th Infantry Division	Général de Division Baron Pierre-Joseph Habert
1st Brigade	Général de Brigade Baron Gengoult
34th Rgmt de Ligne	Colonel Mouton
88th Rgmt de Ligne	Colonel Baillon
2nd Brigade	Général de Brigade Baron Dupeyroux
22nd Rgmt de Ligne	Colonel Fantin des Odoards
2nd (Swiss) Infantry Rgmt	Colonel Stoffel
70th Rgmt de Ligne	Colonel Baron Maury
Division Artillery	
18/2nd Foot Artillery	Captain Guérin
11th Infantry Division	Général de Division Baron Pierre Berthézène
...	
23rd Rgmt de Ligne	Colonel Baron Vernier
2nd Brigade	Général de Brigade Baron Corsin
37th Rgmt de Ligne	Colonel Cornebise
Division Artillery	
7/6th Foot Artillery	Captain Chauveau
Reserve Artillery	Général de Division Baron Jérôme Doguereau
1/2nd Foot Artillery	Captain Vollée
2/2nd Rgmt du Génie	



那MySQL呢?

- 嗯.....
- 两个方法
 - 手动union
 - 在一个查询中多次连接
 - 前提都是已知深度（自己眼睛看）

```
create view v1
as
select id, description, commander
  from adjacency_model
 where commander = 'Général de Division Dominique Vandamme'
```

```
create view v2
as
select id, description, commander
  from adjacency_model
 where id =(select id from v1)
```

```
create view v3
as
select id, description, commander
  from adjacency_model
 where id =(select id from v2)
```

```
select description, commander from v1
union
select description, commander from v2
union
select description, commander from v3
```




物化路径模型

- 查询编写不困难
- 计算由路径导出的层次不方便
- 假设mp_depth()函数返回当前节点深度

```
select lpad(a.description, length(a.description)
      + mp_depth(...)) description,
       a.commander
from materialized_path_model a,
     materialized_path_model b
where a.materialized_path like b.materialized_path || '%'
     and b.commander = 'Général de Division Dominique Vandamme')
order by a.materialized_path
```

length((materialized_path) -
length(replace(materialized_path, '.', '')))



嵌套集合模型

- 很简单，某节点的后代的left_num和right_num都会在该节点的left_num和right_num范围内

```
select a.description,  
       a.commander  
from nested_sets_model a,  
     nested_sets_model b  
where a.left_num between b.left_num and b.right_num  
     and b.commander = 'Général de Division Dominique  
Vandamme'
```



嵌套集合模型

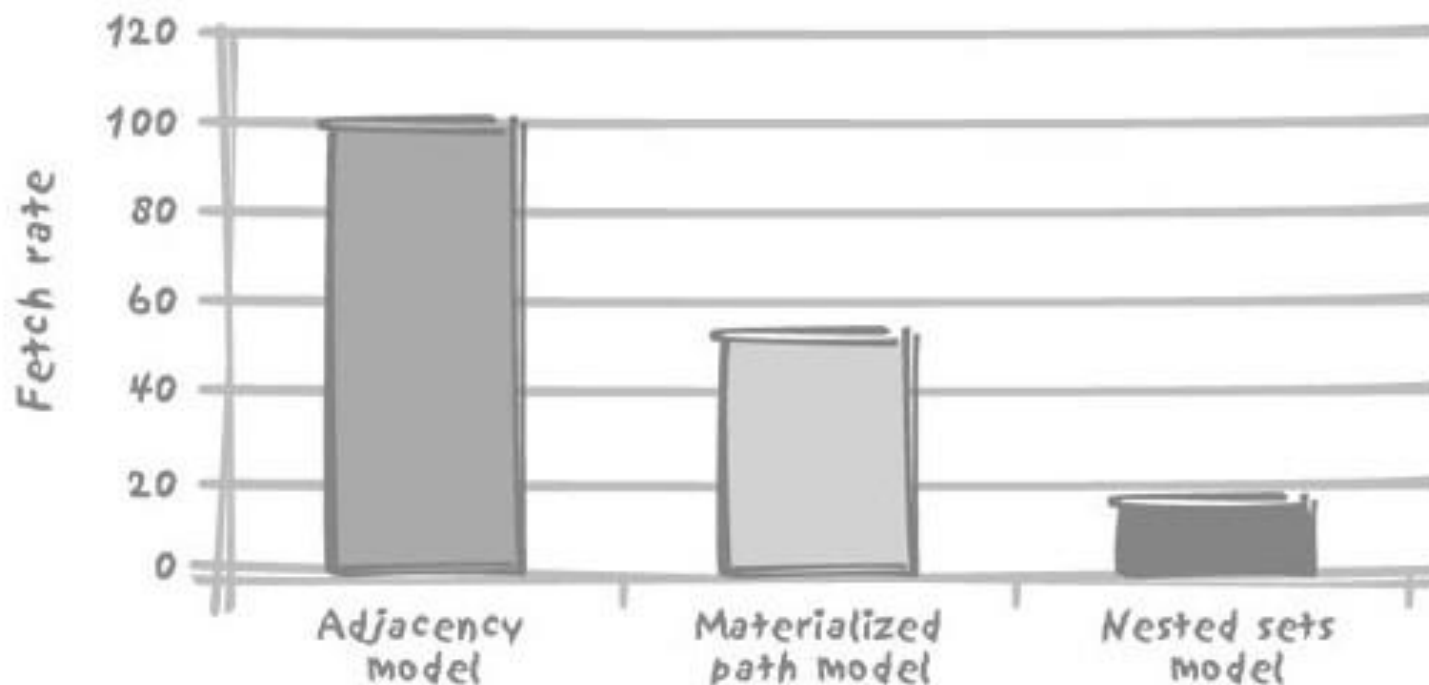
- 缩排怎么办.....

```
select lpad(description, length(description) + depth) description,  
       commander  
from (select count(c.left_num) depth,  
            a.description,  
            a.commander,  
            a.left_num  
from nested_sets_model a,  
     nested_sets_model b,  
     nested_sets_model c  
where a.left_num between c.left_num and c.right_num  
     and c.left_num between b.left_num and b.right_num  
     and b.commander = 'Général de Division Dominique Vandamme'  
group by a.description,  
         a.commander,  
         a.left_num)  
order by left_num
```



比较各模型下的Vandamme模型

- 返回40条记录，循环执行每个查询5000次，比较每秒返回的记录数



自底向上访问：Highland查询

- 在description字段中查找 “Highland” 字符串
- 必然导致完整的表扫描
- 不同模型下Highland查询的差异



邻接模式

- Connect by相当容易实现

```
select lpad(description, length(description) + level) description,  
       commander  
from adjacency_model  
connect by id = prior parent_id  
start with description like '%Highland%'
```



DESCRIPTION	COMMANDER
2/73rd (Highland) Rgmt of Foot	Lt-Colonel William George Harris
5th British Brigade	Major-General Sir Colin Halkett
3rd Anglo-German Division	Lt-General Count Charles von Alten
I Corps	Prince William of Orange
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington
1/71st (Highland) Rgmt of Foot	Lt-Colonel Thomas Reynell
British Light Brigade	Major-General Frederick Adam
2nd Anglo-German Division	Lt-General Sir Henry Clinton
II Corps	Lieutenant-General Lord Rowland Hill
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington
1/79th (Highland) Rgmt of Foot	Lt-Colonel Neil Douglas
8th British Brigade	Lt-General Sir James Kempt
5th Anglo-German Division	Lt-General Sir Thomas Picton (d.18th)
General Reserve	Duke of Wellington
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington
1/42nd (Highland) Rgmt of Foot	Colonel Sir Robert Macara (d.16th)
9th British Brigade	Major-General Sir Denis Pack
5th Anglo-German Division	Lt-General Sir Thomas Picton (d.18th)
General Reserve	Duke of Wellington
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington
1/92nd (Highland) Rgmt of Foot	Lt-Colonel John Cameron
9th British Brigade	Major-General Sir Denis Pack
5th Anglo-German Division	Lt-General Sir Thomas Picton (d.18th)
General Reserve	Duke of Wellington
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington

25 rows selected.



物化路径模型

- 仅找出适当的记录并缩排显示算容易

```
select lpad(a.description, length(a.description)
          + mp_depth(b.materialized_path)
          - mp_depth(a.materialized_path)) description,
       a.commander
from materialized_path_model a,
     materialized_path_model b
where b.materialized_path like a.materialized_path || '%'
     and b.description like '%Highland%')
```

- 重复记录的问题
- 顺序的问题



物化路径模型

```
select description, commander
from (select distinct lpad(a.description, length(a.description)
    + mp_depth(b.materialized_path)
    - mp_depth(a.materialized_path)) description,
    a.commander,
    a.materialized_path
from materialized_path_model a,
    materialized_path_model b
where b.materialized_path like a.materialized_path || '%'
    and b.description like '%Highland%')
order by materialized_path desc
```



much nicer and more compact result

DESCRIPTION	COMMANDER
1/92nd (Highland) Rgmt of Foot	Lt-Colonel John Cameron
1/42nd (Highland) Rgmt of Foot	Colonel Sir Robert Macara (d.16th)
9th British Brigade	Major-General Sir Denis Pack
1/79th (Highland) Rgmt of Foot	Lt-Colonel Neil Douglas
8th British Brigade	Lt-General Sir James Kempt
5th Anglo-German Division	Lt-General Sir Thomas Picton (d.18th)
General Reserve	Duke of Wellington
1/71st (Highland) Rgmt of Foot	Lt-Colonel Thomas Reynell
British Light Brigade	Major-General Frederick Adam
2nd Anglo-German Division	Lt-General Sir Henry Clinton
II Corps	Lieutenant-General Lord Rowland Hill
2/73rd (Highland) Rgmt of Foot	Lt-Colonel William George Harris
5th British Brigade	Major-General Sir Colin Halkett
3rd Anglo-German Division	Lt-General Count Charles von Alten
I Corps	Prince William of Orange
The Anglo-Allied Army of 1815	Field Marshal Arthur Wellesley, Duke of Wellington

16 rows selected.



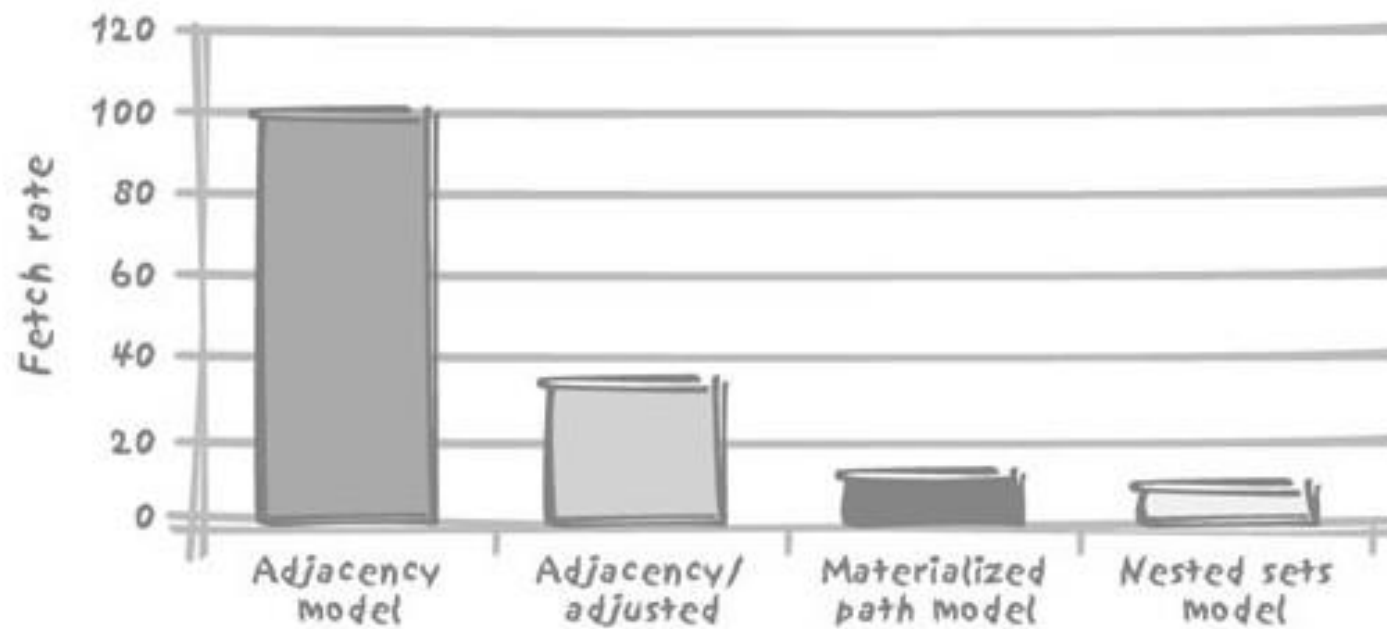
嵌套集合模型

- 动态计算深度依旧是个问题
- 不要显示人造根节点
- 硬编码最大深度（为了缩排显示）

```
select lpad(description, length(description) + 6 - depth) description,  
       commander  
from (select distinct b.description,  
                     b.commander,  
                     b.left_num,  
                     (select count(c.left_num)  
                      from nested_sets_model c  
                      where b.left_num between c.left_num  
                               and c.right_num) depth  
from nested_sets_model a,  
     nested_sets_model b  
where a.description like '%Highland%'  
     and a.left_num between b.left_num and b.right_num  
     and b.left_num > 1)  
order by left_num desc
```



比较各种模型下的Highland查询



一些问题

- 物化路径不该是KEY，即使他们有唯一性
- 物化路径不该暗示任何兄弟节点的排序
- 所选择的编码方式不需要完全中立



思考题

- 课程中的例子使用了oracle，请尝试使用MySQL写成三种模型下的自顶向下和自底向上的两种查询模式的查询（共6个查询）
- 注意，对邻接模型，查询会非常繁琐，你体会一下会提高你的SQL能力，特别是如何进行缩排。



End

下一讲介绍叶节点聚合的树状结构操作，以及多父节点的树状结构

