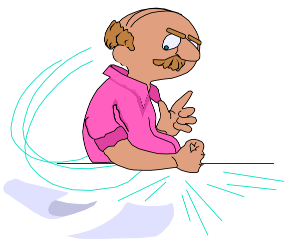
1

Introduction to Data Management

Lecture #24

~~SQL~~ *NoSQL*



Instructor: Mike Carey

mjcarey@ics.uci.edu

1

It's time for the season finale of...

Friday Nights With Databases...

Brought to you by…

2

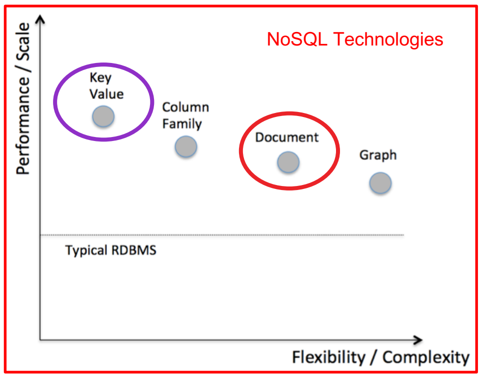
Announcements

- Homework info:
  - HW #8 (NoSQL) is the ***last one***!
  - Due Thursday (at 5 PM), with ***NoLateDay* (!)**
  - Warning: *LOAD* can be (path) finicky...
- Endterm exam info:
  - Non-cumulative and **in class next Friday** (as usual)
- NoSQL lecture plans:
  - Today: **NoSQL & Big Data** (*a la* AsterixDB)
    - Refer to the ***Using SQL++*** Primer and other docs on the Apache AsterixDB site
  - Read ***SQL++ For SQL Users*** from Couchbase, by **Don Chamberlin** (the Father of SQL!)
    - **Lots** of useful info for moving from SQL to SQL++!

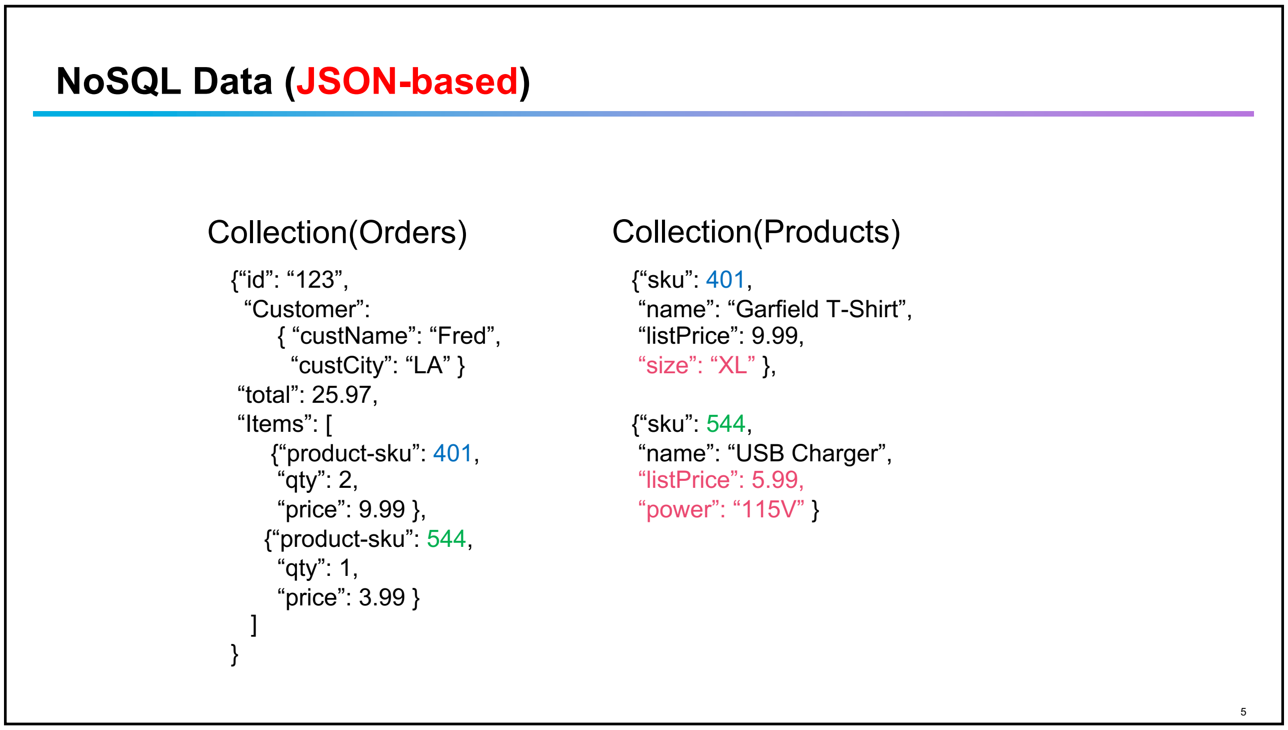
3

What is a NoSQL DB – why "not SQL"?

- ***Not*** from the DB world
  - Distributed systems folks
  - Also various startup companies
- From caches → persistent K/V use cases
  - Apps needed massive scale-out
  - OLTP (vs. parallel query DB) apps
  - Simple, low-latency API – get/put by key
  - Need a key K, but want ***no schema*** for V
  - Record-level atomicity, replica consistency varies
- In the context of this talk, NoSQL does **not** mean
  - Hadoop (or SQL on Hadoop)
  - Graph databases or graph analytics platforms



4



NoSQL Data (JSON-based)

Collection(Orders)

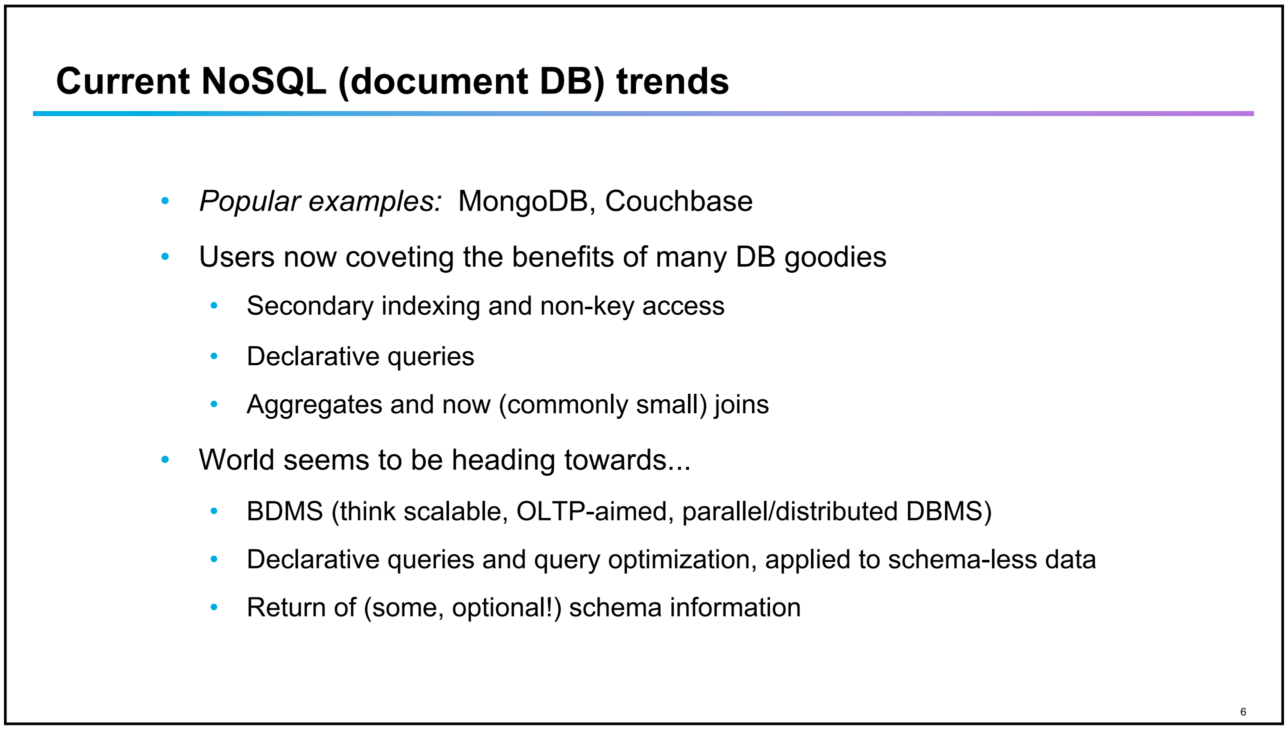
```
{“id”: “123”,
  “Customer”:
       { “custName”: “Fred”,
         “custCity”: “LA” }
 “total”: 25.97,
 “Items”: [
      {“product-sku”: 401,
        “qty”: 2,
        “price”: 9.99 },
     {“product-sku”: 544,
        “qty”: 1,
        “price”: 3.99 }
   ]
}
```

Collection(Products)

```
{“sku”: 401,
 “name”: “Garfield T-Shirt”,
 “listPrice”: 9.99,
 “size”: “XL” },

{“sku”: 544,
 “name”: “USB Charger”,
 “listPrice”: 5.99,
 “power”: “115V” }
```

5

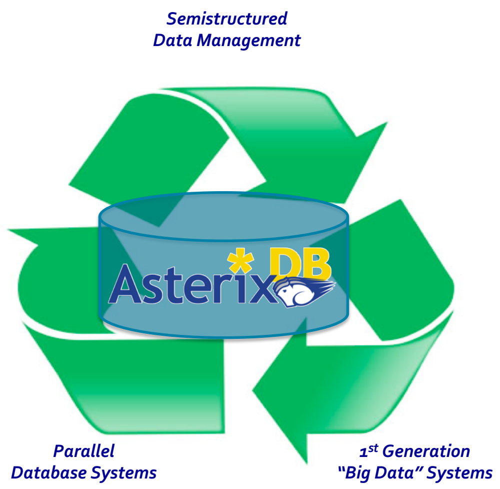


Current NoSQL (document DB) trends

- *Popular examples:* MongoDB, Couchbase
- Users now coveting the benefits of many DB goodies
  - Secondary indexing and non-key access
  - Declarative queries
  - Aggregates and now (commonly small) joins
- World seems to be heading towards...
  - BDMS (think scalable, OLTP-aimed, parallel/distributed DBMS)
  - Declarative queries and query optimization, applied to schema-less data
  - Return of (some, optional!) schema information

6

Towards a Big Data Management System (BDMS)

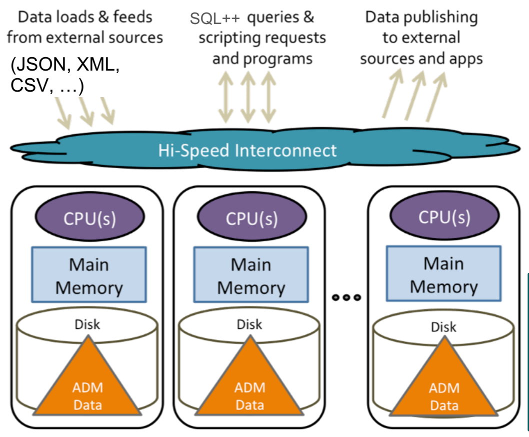

Semistructured Data Management
AsterixDB
Parallel Database Systems
1st Generation "Big Data" Systems

BDMS Desiderata:

- Able to **manage** data
- **Flexible** data model
- Full **query** capability
- Continuous data **ingestion**
- Efficient and robust **parallel** runtime
- Cost **proportional** to task at hand
- Support "**Big Data** data types"
  - •
  - •
  - •

7

Apache AsterixDB (from UCI+UCR)


Data loads & feeds from external sources
(JSON, XML, CSV, …)
SQL++ queries & scripting requests and programs
Data publishing to external sources and apps
Hi-Speed Interconnect
CPU(s)
Main Memory
Disk
ADM Data
CPU(s)
Main Memory
Disk
ADM Data
CPU(s)
Main Memory
Disk
ADM Data

ASTERIX Goal: To *ingest, digest, persist, index, manage, query, analyze*, and *publish* massive quantities of semistructured information…

http://asterixdb.apache.org/

AsterixDB™

8

Data Model: JSON (JavaScript Object Notation)

Customers

```
{
  "custid":"C37",
  "name":"T. Hanks",
  "address":{
    "street":"120 Harbor Blvd.",
    "city":"Boston, MA",
    "zipcode":"02115"
  },
  "rating":750
}

{
  "custid":"C47",
  "name":"S. Lauren",
  "address":{
    "street":"17 Rue d'Antibes",
    "city":"Cannes, France"
  },
  "rating":625
}
```

Orders

```
{
  "orderno":1004,
  "custid":"C35",
  "order_date":"2017-07-10",
  "ship_date":"2017-07-15",
  "items":[
    {
      "itemno":680,
      "qty":6,
      "price":9.99
    },
    {
      "itemno":195,
      "qty":4,
      "price":35.00
    }
  ]
}
```

…

```
{
  "orderno":1008,
  "custid":"C13",
  "order_date":"2017-10-13",
  "items":[
    {
      "itemno":460,
      "qty":20,
      "price":99.99
    }
  ]
}
```

Data from *D. Chamberlin. SQL++ for SQL Users: A Tutorial*

9

Data

Customers

```
{
  "custid":"C37",
  "name":"T. Hanks",
  "address":{
    "street":"120 Harbor Blvd.",
    "city":"Boston, MA",
    "zipcode":"02115"
  },
  "rating":750
}

{
  "custid":"C47",
  "name":"S. Lauren",
  "address":{
    "street":"17 Rue d'Antibes",
    "city":"Cannes, France"
  },
  "rating":625
}
```

Orders

```
{
  "orderno":1004,
  "custid":"C35",
  "order_date":"2017-07-10",
  "ship_date":"2017-07-15",
  "items":[
    {
      "itemno":680,
      "qty":6,
      "price":9.99
    },
    {
      "itemno":195,
      "qty":4,
      "price":35.00
    }
  ]
}
```

…

```
{
  "orderno":1008,
  "custid":"C13",
  "order_date":"2017-10-13",
  "items":[
    {
      "itemno":460,
      "qty":20,
      "price":99.99
    }
  ]
}
```

Data from *D. Chamberlin. SQL++ for SQL Users: A Tutorial*

10

Data (Relational version)

Customers

```
{
  "custid":"C37",
  "name":"T. Hanks",
  "address_street":"120 Harbor Blvd.",
  "address_city":"Boston, MA",
  "address_zipcode":"02115"
  "rating":750
}
{
  "custid":"C47",
  "name":"S. Lauren",
  "address_street":"17 Rue d'Antibes",
  "address_city":"Cannes, France"
  "address_zipcode":null
  "rating":625
}
```

Orders

```
{
  "orderno":1004,
  "custid":"C35",
  "order_date":"2017-07-10",
  "ship_date":"2017-07-15"
}
{
  "orderno":1008,
  "custid":"C13",
  "order_date":"2017-10-13",
  "ship_date":null
}
```

```
CREATE TABLE Lineitems (
  orderno INTEGER,
  itemno INTEGER,
  quantity INTEGER NOT NULL,
  price DECIMAL(8,2) NOT NULL,
  PRIMARY KEY (orderno, itemno),
  FOREIGN KEY (orderno) REFERENCES Orders(orderno)
)
```

Lineitems

```
{
  "orderno":1004,
  "itemno":680,
  "qty":6,
  "price":9.99
}
{
  "orderno":1004,
  "itemno":195,
  "qty":4,
  "price":35.00
}
{
  "orderno":1008,
  "itemno":460,
  "qty":20,
  "price":99.99
}
```

11

Data (Relational version)

Customers

```
{
  "custid":"C37",
  "name":"T. Hanks",
  "address_street":"120 Harbor Blvd.",
  "address_city":"Boston, MA",
  "address_zipcode":"02115"
  "rating":750
}
{
  "custid":"C47",
  "name":"S. Lauren",
  "address_street":"17 Rue d'Antibes",
  "address_city":"Cannes, France"
  "address_zipcode":null
  "rating":625
}
```

Orders

```
{
  "orderno":1004,
  "custid":"C35",
  "order_date":"2017-07-10",
  "ship_date":"2017-07-15"
}
{
  "orderno":1008,
  "custid":"C13",
  "order_date":"2017-10-13",
  "ship_date":null
}
```

```
CREATE TABLE Lineitems (
  orderno INTEGER,
  itemno INTEGER,
  quantity INTEGER NOT NULL,
  price DECIMAL(8,2) NOT NULL,
  PRIMARY KEY (orderno, itemno),
  FOREIGN KEY (orderno) REFERENCES Orders(orderno)
)
```

Lineitems

```
{
  "orderno":1004,
  "itemno":680,
  "qty":6,
  "price":9.99,
  "currency":"USD"
}
{
  "orderno":1004,
  "itemno":195,
  "qty":4,
  "price":35.00,
  "currency":"USD"
}
{
  "orderno":1008,
  "itemno":460,
  "qty":20,
  "price":99.99,
  "currency":"EUR"
}
```

12

Sloppy Data

Customers

```
{
  "custid":"C37",
  "name":"T. Hanks",
  "address":{
    "street":"120 Harbor Blvd.",
    "city":"Boston, MA",
    "zipcode":"02115"
  },
  "rating":750
}

{
  "custid":"C47",
  "name":"S. Lauren",
  "address":{
    "street":"17 Rue d'Antibes",
    "city":"Cannes, France"
  },
  "rating":"625"
}
```

Orders

```
{
  "orderno":1004,
  "custid":"C35",
  "order_date":"2017-07-10",
  "ship_date":"2017-07-15",
  "items":[
    {
      "itemno":680,
      "qty":6,
      "price":9.99
    },
    {
      "itemno":195,
      "qty":4,
      "price":"if you have to ask ..."
    }
  ]
}
```

…

```
{
  "orderno":1008,
  "custid":"C13",
  "order_date":"2017-10-13",
  "items":{
    "itemno":460,
    "qty":20,
    "price":99.99
  }
}
```

13

SQL++: Just like SQL ...

```
SELECT name
FROM customers
WHERE rating > 650;
```

```
[
  {
    "name": "M. Streep"
  },
  {
    "name": "T. Hanks"
  },
  {
    "name": "T. Cruise"
  }
]
```

14

Just like SQL ...

```
SELECT name
FROM customers
WHERE rating > 650;


SELECT c.name, o.order_date
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.custid = "C41";
```

```
[
  {
    "name": "R. Duvall",
    "order_date": "2017-09-02"
  },
  {
    "name": "R. Duvall",
    "order_date": "2017-04-29"
  }
]
```

15

Just like SQL ...

```
SELECT name
FROM customers
WHERE rating > 650;


SELECT c.name, o.order_date
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.custid = "C41";
```

```
SELECT c.name, o.order_date
FROM customers AS c LEFT OUTER JOIN orders AS o
  ON c.custid = o.custid
WHERE c.custid = "C41";
```

16

Just like SQL ...

```
SELECT name
FROM customers
WHERE rating > 650;


SELECT c.name, o.order_date
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.custid = "C41";


SELECT order_date, count(*) AS cnt
FROM orders
GROUP BY order_date
HAVING count(*) > 0
ORDER BY order_date DESC
LIMIT 3;
```

```
[
  {
    "cnt": 1,
    "order_date": "2017-10-13"
  },
  {
    "cnt": 1,
    "order_date": "2017-09-13"
  },
  {
    "cnt": 1,
    "order_date": "2017-09-02"
  }
]
```

17

… almost!

```
SELECT name, order_date
FROM customers, orders
WHERE customers.custid = orders.custid
  AND rating > 650;
```

```
Cannot resolve ambiguous alias reference for
identifier rating (in line 4, at column 7)
```

18

… almost!

```
SELECT name, order_date
FROM customers, orders
WHERE customers.custid = orders.custid
  AND rating > 650;


SELECT c.name, o.order_date
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;
```

```
[
  {
    "name": "T. Hanks",
    "order_date": "2017-08-30"
  },
  {
    "name": "T. Cruise",
    "order_date": "2017-05-01"
  },
  {
    "name": "T. Cruise",
    "order_date": "2017-10-13"
  },
  {
    "name": "T. Cruise",
    "order_date": "2017-09-13"
  }
]
```

19

… almost!

```
SELECT name, order_date
FROM customers, orders
WHERE customers.custid = orders.custid
  AND rating > 650;


SELECT c.name, o.order_date
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;


SELECT *
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;
```

```
[
  {
    "c": {
      "address": {
        "city": "Boston, MA",
        "street": "120 Harbor Blvd.",
        "zipcode": "02115"
      },
      "custid": "C37",
      "name": "T. Hanks",
      "rating": 750
    },
    "o": {
      "custid": "C37",
      "items": [
        {
          "itemno": 460,
          "price": 99.98,
          "qty": 2
        }
   ...
```

20

SELECT VALUE: Added "VALUE"

```
SELECT VALUE name
FROM customers
WHERE rating > 650;
```

```
[
  "M. Streep",
  "T. Hanks",
  "T. Cruise"
]
```

Added "VALUE"

```
SELECT VALUE name
FROM customers
WHERE rating > 650;

SELECT VALUE {
  "CustomerName":c.name,
  "OrderDate":o.order_date
}
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;
```

```
[
  {
    "CustomerName": "T. Hanks",
    "OrderDate": "2017-08-30"
  },
  {
    "CustomerName": "T. Cruise",
    "OrderDate": "2017-09-13"
  },
  {
    "CustomerName": "T. Cruise",
    "OrderDate": "2017-05-01"
  },
  {
    "CustomerName": "T. Cruise",
    "OrderDate": "2017-10-13"
  }
]
```

Added "VALUE"

```
SELECT VALUE name
FROM customers
WHERE rating > 650;

SELECT VALUE {
  "CustomerName":c.name,
  "OrderDate":o.order_date
}
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;
```

```
SELECT c.name AS CustomerName,
       o.order_date AS OrderDate
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;
```

23

Added "VALUE"

```
SELECT VALUE name
FROM customers
WHERE rating > 650;

SELECT VALUE {
  "CustomerName":c.name,
  "OrderDate":o.order_date
}
FROM customers AS c, orders AS o
WHERE c.custid = o.custid
  AND c.rating > 650;

SELECT VALUE {
  "CustomerName":c.name,
  "Orders":(SELECT VALUE o.orderno FROM orders AS o
            WHERE o.custid = c.custid)
}
FROM customers AS c
WHERE c.custid = "C41";
```

```
[
  {
    "Orders": [
      1006,
      1001
    ],
    "CustomerName": "R. Duvall"
  }
]
```

24

Quiz

Which query retrieves the names of the customers that have the highest rating?

A
```
SELECT name
FROM customers
WHERE rating =
  (SELECT MAX(rating) FROM customers);
```

B
```
SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2);
```

C
```
SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT MAX(c2.rating) FROM customers AS c2);
```

D
```
SELECT VALUE c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2)[0];
```

25

SQL Pitfalls and the value of VALUE

```
SELECT name
FROM customers
WHERE rating =
  (SELECT MAX(rating) FROM customers);
```

```
Type mismatch: expected value of type multiset or
array, but got the value of type object (in line 4, at
column 28)
```

26

SQL Pitfalls and the value of VALUE

```
SELECT name
FROM customers AS c
WHERE rating =
  (SELECT MAX(rating) FROM c);
```

```
Type mismatch: expected value of type multiset or
array, but got the value of type object (in line 4, at
column 28)
```

27

SQL Pitfalls and the value of VALUE

```
SELECT name
FROM customers
WHERE rating =
  (SELECT MAX(rating) FROM customers);

SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT MAX(c2.rating) FROM customers AS c2);
```

```
[ ]
```

28

SQL Pitfalls and the value of VALUE

```
SELECT name                                           [ ]
FROM customers
WHERE rating =
  (SELECT MAX(rating) FROM customers);

SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT MAX(c2.rating) FROM customers AS c2);

SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2);
```

29

SQL Pitfalls and the value of VALUE

```
SELECT name                                           [
FROM customers                                          "T. Cruise",
WHERE rating =                                          "T. Hanks"
  (SELECT MAX(rating) FROM customers);                ]

SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT MAX(c2.rating) FROM customers AS c2);

SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2);

SELECT VALUE c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2)[0];
```

30

Quiz

Which query retrieves the names of the customers that have the highest rating?

A
```
SELECT name
FROM customers
WHERE rating =
  (SELECT MAX(rating) FROM customers);
```

B
```
SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2);
```

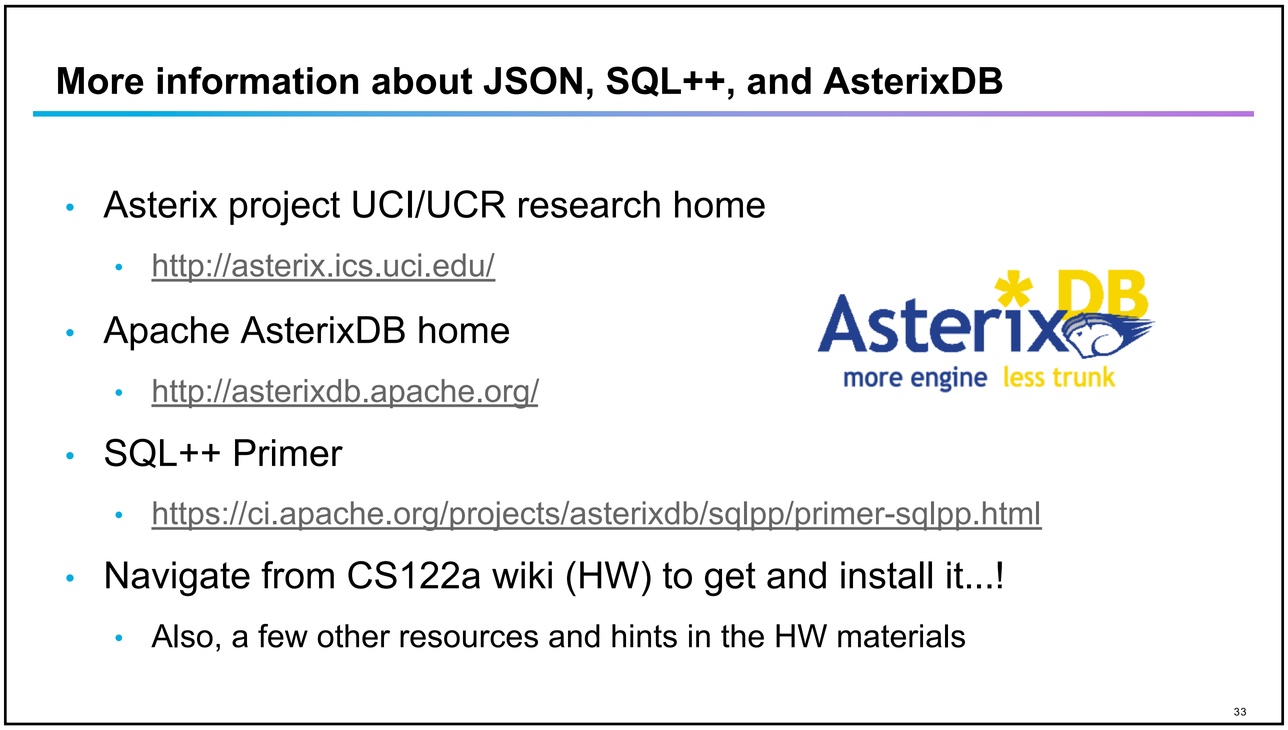
C
```
SELECT c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT MAX(c2.rating) FROM customers AS c2);
```

[✓ D]
```
SELECT VALUE c1.name
FROM customers AS c1
WHERE c1.rating =
   (SELECT VALUE MAX(c2.rating) FROM customers AS c2)[0];
```

31

To be continued....

32



More information about JSON, SQL++, and AsterixDB

- Asterix project UCI/UCR research home
  - http://asterix.ics.uci.edu/
- Apache AsterixDB home
  - http://asterixdb.apache.org/
- SQL++ Primer
  - https://ci.apache.org/projects/asterixdb/sqlpp/primer-sqlpp.html
- Navigate from CS122a wiki (HW) to get and install it...!
  - Also, a few other resources and hints in the HW materials

AsteriX DB more engine less trunk

33