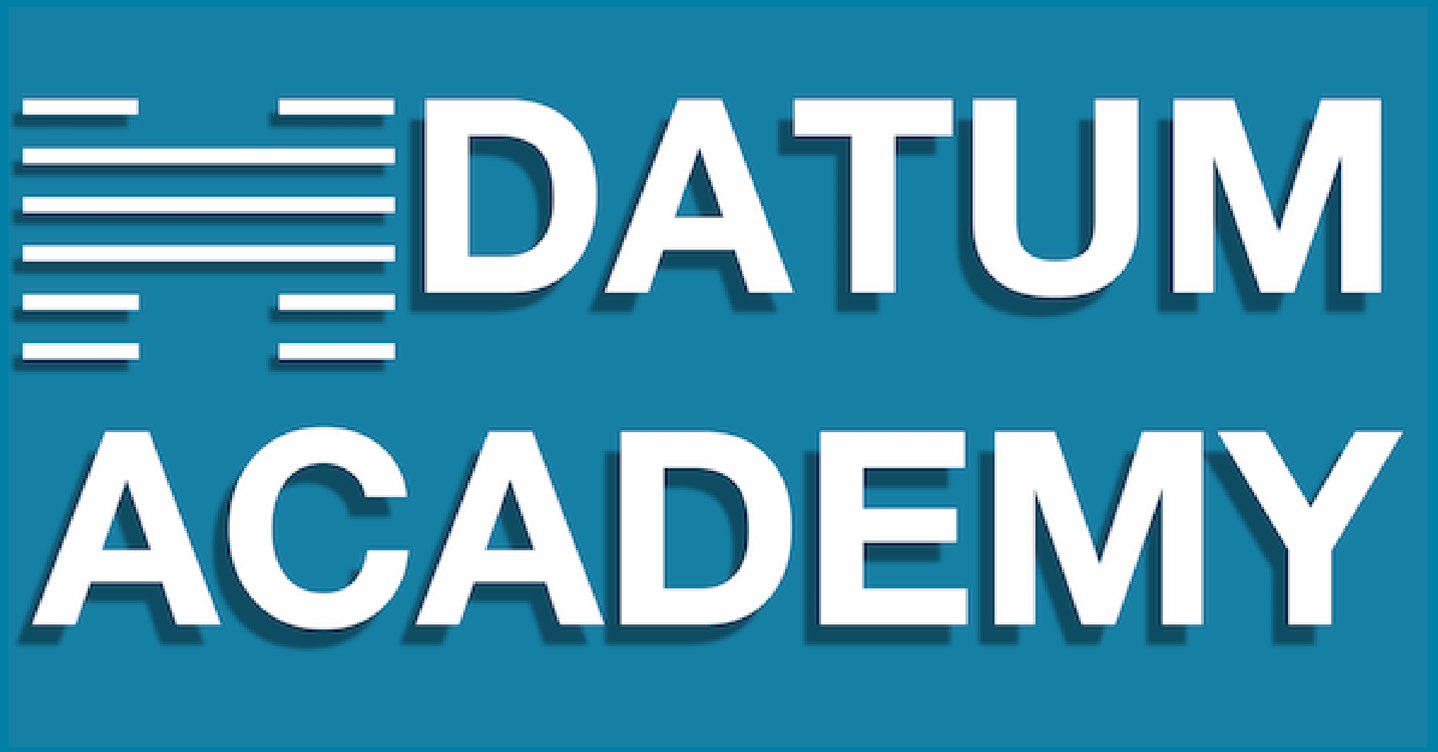

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MBDS course :

« From data bases to big data »

(7 lectures)

Professor Serge Miranda
Dept of Computer Science
University of Nice Sophia Antipolis (member of UCA)
Director of MBDS Master degree
(www.mbds-fr.org)

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Membre de UNIVERSITÉ CÔTE D'AZUR

Introduction to ODMG

(lecture 5)

Professor Serge Miranda

Departement of Computer Science
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Director of MBDS Master (www.mbds-fr.org)

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French version of this course since 2015

DATUM ACADEMY

- « BD*2 : Des Bases de Données à Big Data »
sur la plateforme de Mooc FUN (www.fun-mooc.org) :

trailer du cours à
http://www.canal-u.tv/video/universite_de_nice_sophia_antipolis/mooc_bd_2_des_bases_de_donnees_a_big_data_le_trailer.15548

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ODMG consortium

- Created in 1991 by Rick Cattell (SUN, Javasoft) as sub group of OMG (Object Management Group) with :
  - 02 Tech., Object Design, Ontos, Versant,
  - **ORIENT, OBJECTIVITY/DB , CACHE (Intersystems)**
- OMG : UML, CORBA, …
- More than 50 companies in 2000
  (Lucent, Lockheed, CA, Microsoft, Baan, ...)
- Bancilhon's Manifesto on Data Base of the future (1st Manifesto)
- **GOALS :**
  - Promoting OO (Object-Oriented) DBMS beyond FUD, before …SQL3 !
  - Creating an Object standard for application portability

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ODMG History

- 1st meeting at SUN with Rick Catell in Sept 91 and 5 revisions in 10 years (one for SQL3)

- ODMG 1.0 (1993) : 5 Editors
  - ODL, OQL, C++ Interface, Smalltalk
- ODMG 2.0 (1996) : 10 Editors
  (Poet, Lucent, Windward, American Man, Barry)
  - Java interface (Java Binding), Meta Model, OIF
- **ODMG 3.0 (2000)** *<Morgan Kaufmann book by Rick Cattell cf pdf>*
  - Java interface enrichment
  - Integration with OMG and X3H2 (SQL3)

  - *In 2001 the ODMG group disbanded; then JAVA DATA OBJECT SPECIFICATION..then in 2006 revival by OMG with ODBT WG*

  - **www.odbms.org/odmg-standard**

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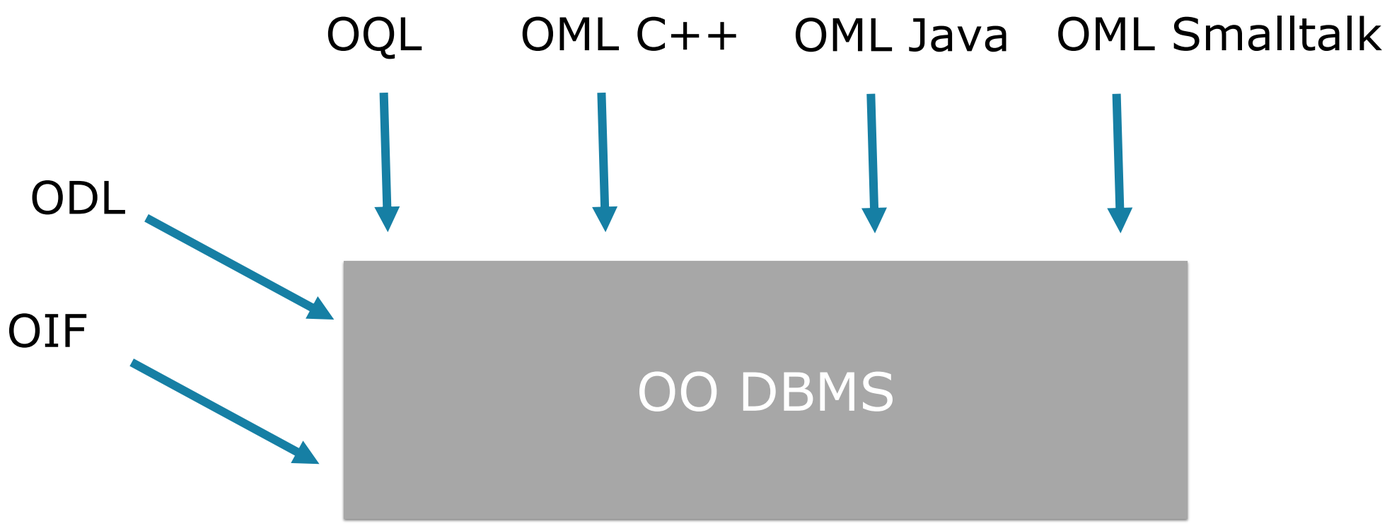
ODMG 3.0 components



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ODMG 3.0 components

- Object data model derived from OMG
- Specification language
  - ODL : Object Definition Lnaguage
  - OIF (object Interchange Format) : import/export
- Object Query Language : OQL (SQL like)
- OML (with links)
  - C++, SMALLTALK et JAVA

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« Object-value » paradigm

DATUM ACADEMY

- **OBJECT CLASS ?**
  - OID for object (and PK for Class)
  - « VALUE » for SET of OBJECTS (extension)
  - ATTRIBUTES
  - METHODS
  - Bi-directional pointers among classes (REF, INVERSE)
- Manipulation : NAVIGATION between classes with POINTERS
- Inheritance

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« Object-value » paradigm

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OMG Extension

- Standardized object model by OMG *(« Everything is OBJECT »)*
- Object data model supported by IDL (Interface Definition Language))
- Object-oriented DBs require TIPS extensions

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ODMG and RICE properties

R * Multiple Inheritance (C++)

I * OID

C * STRUCTURE

* COLLECTIONS :

SET, BAG, LIST, ARRAY, Dictionary

* Bidirectional pointers . REF & INVERSE

E * « Types » with methods

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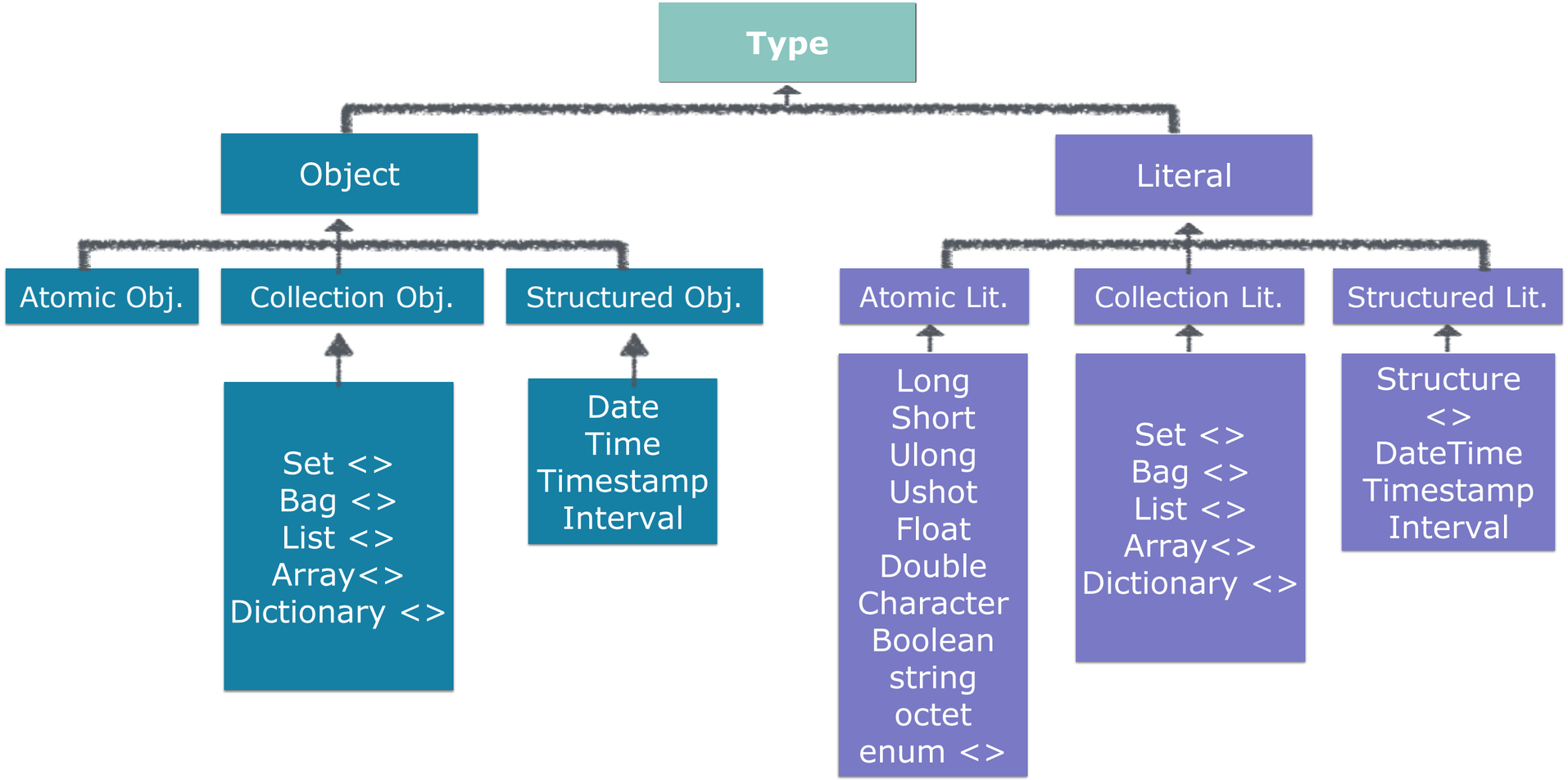
TYPE Hierarchy



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« ODMG Meta model *(model on model)*

- Fundamentals
  - Object model description
- Meta Objects
  - Modules, Operations, Exceptions, values,
  - Properties (relationship & Attributes),
  - TypeDefinitions, Interfaces, Classes, Collections,
  - Specifiers, Operands

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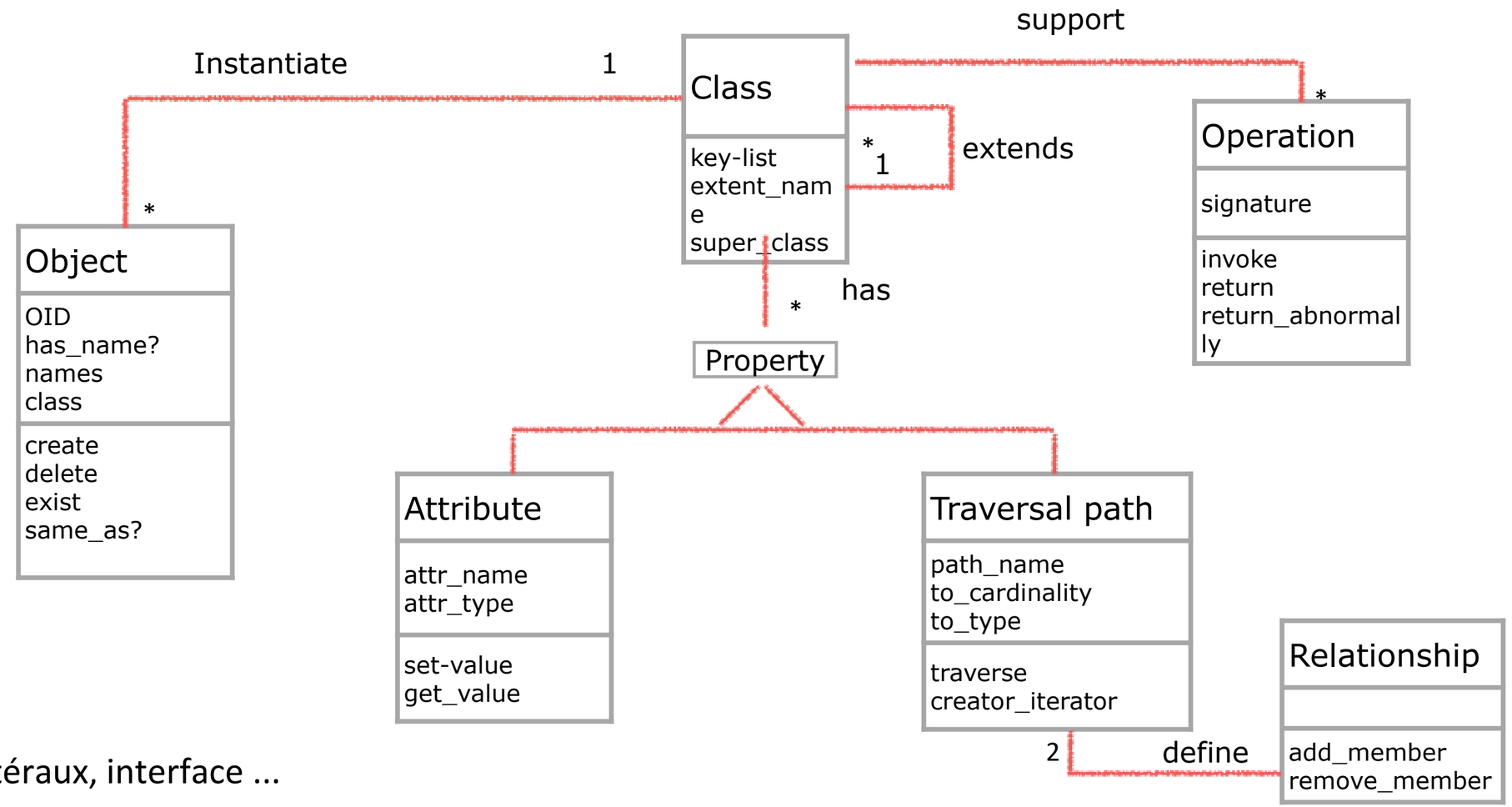
ODMG meta-model



+ Type, littéraux, interface ...

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OQL (F.Bancilhon, Dasfaa 1995)

- **OQL : SQL- like interactive ad-hoc queries**
  - query optimization
  - Data independence
  - Embedded queries
  - TIPS support
  - data enrichment operators

- *Navigation and... « Surf » ☺*

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OQL

DATUM ACADEMY

1. Single-valued *expression* in SELECT/WHERE clauses

- *EXPRESSION* : X1.X2.X3…Xi with XI attribute or pointer
- Such single-valued expression could be used to replace an attribute in a SQL SELECT/ WHERE clause

2. Dependent Multivalued Collection in FROM clause

- COLLECTION embedding in FROM clause

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OQL query format

- **Select** [<type résultat>] (<**expression**> [, <expression>] ...)

  From

  x in <**collection**>

  [, y in <collection>]...

  Where <**expression**>

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OQL by example

- Object schema:
  - Either in ODL (IDL extension),
  - Or C++/Smalltalk/Java

  - With LINKS:
    - REF : persistent C++ pointer
    - INVERSE : pointer for referential integrity

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ODL example

C++ binding

```
CLASS employee  {
        E# INT,
        Name  STRING,
        Adress ADDRESS <other class>
        //methods...}
```


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ODL example

CLASS pilot : employee {
NumberFH # INT,
salary FLOAT,
SET REF <flight> insures INVERSE is-insured-by
//methods...}

CLASS flight {
F# STRING,…
REF <pilot> is-insured-by INVERSE insures,
REF <plane> uses INVERSE is-used-in,.
DC...}

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ODL example (cont.)

CLASS plane : {
p# INT,
pname STRING,
…
SET REF flight is-used-in INVERSE uses
…}

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Note : NAVIGATION and implicit joins

DATUM ACADEMY

- Navigation among classes (« DB *joins* ») are done EXCLUSIVELY by chasing pointers explicitly PRE-defined in the schema
  - generally performed in the FROM clause except if there are single-valued (and then could be in a WHERE expression)

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OQL query example

- *Q1: What are the flight numbers ensured by a pilot whose name is SERGE?*

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OQL example

- *Q1: What are the flight numbers ensured by a pilot whose name is SERGE?*

```
SELECT f.f#
FROM
        f IN flight      <IN collection>

        pl IN f.is-insured-by

WHERE pl.Name  = 'Serge' ;
```


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OQL Example

- *Q1: What are the flight numbers ensured by a pilot whose name is SERGE?*

```
Select f.f.#
from f IN flight
where f.is-insured-by.name='Serge';
```

- <**Note : Single-valued expression :** X1.X2.X3>

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OQL example (cont')

- Q2 : *What are the names of planes driven by a pilot from NICE ?*

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OQL example (cont')

- Q2 : *What are the names of planes driven by a pilot from NICE ?*

```
SELECT  p.pname
FROM    p in plane <in COLLECTION>
        f in p.is-used-by <in COLLECTION>
        pl in f.is-insured-by
WHERE   pl.adr = ' Nice ' ;
```


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Exemple OQL

- Q2 : *What are the names of planes driven by a pilot from NICE ?*

```
SELECT  p.pname
FROM    p in plane <in COLLECTION>
        f in p.is-used-in<in COLLECTION>
WHERE   f.is-insured-by.adr = 'Nice'
```


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DATUM ACADEMY

Following EXERCICE with solution next week ☺

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Exercices

- *Q3 : What are the names of pilots from NICE who insure flights from Nice with a plane located in Nice ?*

- *Q4 : What are the names of pilots who live in a city where an Airbus ('A300') is located ?*

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Answers

DATUM ACADEMY

- Q3 : *What are the names of pilots from NICE who insure flights from Nice with a plane located in Nice ?*

```
SELECT      pl.Name
From    pl in PILOT
        f in pl.insure
        p in f.use
Where   pl.adr = 'Nice' and p.loc = 'Nice' and f.DC= 'Nice';
```

or

Where pl.adr= 'Nice' and f.use.loc= 'Nice ' and f.DC = 'Nice' (replacing p in f.use)

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Answers

DATUM ACADEMY

- Q4: *What are the names of pilots who live in a city where an Airbus ('A300') is located ?*

1. Impossible query with the existing schema (no ad hoc queries)
2. First : creation of pointers between PLANE and PILOT : LIVE pointer ans its reverse IS-LOCATED-IN
3. Then

```
SELECT    pl.Name
From      pl in PILOT
          p in pl.LIVE <collection>
Where     p.pname = 'A300' ;
```


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OQL

- Quantifier possible within FROM
  - universal (for all x in collection: predicate)
    - Example : « for all p in plane : a.cap<350 »
  - existence (exists x in collection..)
- GROUP BY allowed

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Example with universal quantifier

- Q5 : *What are the names of the pilots who are driving **ALL** the A300 located in Nice ?*

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Universal quantifier

- Q5 : *What are the names of the pilots who are driving **ALL** the A300 located in Nice ?*

```
Select pl.Name
From   pl in pilot
       f in pl.insure
       For all p in f.use : p.pname = 'A300 ' and p.loc = 'Nice';
```


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GROUP BY example

```
Select      f
from        f in flight
group by    (early : f.DT<9am, late : f.AT>6pm)
```

< 2 partitions for flights>

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OQL summary

- Join EXCLUSIVELY expressed by pointer chasing (within an expression in WHERE clause if single-valued or within a collection of FROM clause if multi-valued)

- Complex language (with difficult implementation)

- note : *SQL improvement with ODMG 2.0*

"from c IN class1" is replaced by "from class1 c"

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THESAURUS EXAMPLE

DATUM ACADEMY

ODL

```
INTERFACE document
(extent documents key doc#) : persistent
{attribute integer  doc#,
  attribute string title ;
  attribute string editor ;
  attribute date Publidate);
```


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Thesaurus example (cont’)

- **relationship** LIST<author>
  is-written-by INVERSE wrote;

- **relationship** SET <key-word>
  includes INVERSE is-in;

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Thesaurus example (cont')

- INTERFACE THESAURUS
  - Relationship FATHERof <thesaurus> inverse SONof
  - Relationship CLOSE…
  - Relationship SYNONYMY…

- INTERFACE author : person (extent authors)
  - relationship LIST<document> wrote
  - INVERSE is-written-by

- INTERFACE person…

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Thesaurus example

C++ binding

```
CLASS document
{ integer  doc#,
  string title;
  string editor ;
  date    publidate;
  integer nb_pages;
}
```


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Thesaurus example

list Ref <author> is-written-by
inverse wrote;
set Ref <keyword>include
inverse is-in;

CLASS author : person
List Ref<document>wrote
inverse is-written-by;

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Thesaurus example

DATUM ACADEMY

<thesaurus ; C++ binding >

CLASS person,…

CLASS keyword
{ string ident } ;
Set Ref <document> is-in
inverse include ;

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Thesaurus example

List REF<keyword>is-synonymous-to
inverse is-synonymous-to;
Set REF< keyword>is-father-of
inverse is-son-of;
Set REF<keyword>is-son-of
inverse is-father-of;
Set REF<keyword>is-close-to
inverse is-close-to;

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Thesaurus example (OQL)

Documents referred by « software »?

```
Select D
 from
      D in documents
      K in D. include
 Where K.ident = « software »;
```


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Thesaurus example (OQL)

- *Documents concerning « software » whose title starts with « concepts »?*

```
Select d
From
        k in keywords
       ?…
```


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SOLUTION NEXT WEEK

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Thesaurus (OQL)

Documents concerning « software » whose title starts with « concepts »?

```
Select d
      From
            k in keywords
            c in k.is-close-to
            s in k.is-synonymous-of
            f in k.is-son-of
            d in set (k.is-in, c. is-in, s. is-in, f.is-in)
      Where k.ident = 'software" and d.title = Concepts%;
```


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Thesaurus example (with Poet)

```
import COM.POET.odmg.*;
import COM.POET.odmg.collection.*;

class Document {
    int num_doc;
    String titre;
    String editeur;
    java.util.Date date_de_publication;
    int nb_pages;
    ListOfObject est_ecrit_par; // liste des auteurs
    SetOfObject contient;       // ensemble des mots clés
```

```
 public Document(int num_doc, String titre, String editeur,
                    java.util.Date date_de_publication, int
nb_pages){
        this.num_doc = num_doc;
        this.titre = titre;
        this.editeur = editeur;
        this.date_de_publication = date_de_publication;
        this.nb_pages = nb_pages;
    }

    public void ajouteAuteur(Auteur auteur){
        est_ecrit_par.add(auteur);
    }

    public void ajouteMotCle(MotCle motCle){
        contient.add(motCle);
    }
}
```


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Thesaurus example(Poet DBMS)

```
import COM.POET.odmg.*;
import COM.POET.odmg.collection.*;

class MotCle{
    String ident;
    SetOfObject est_dans;              // liste des documents qui
contiennt ce mot clé
    ListOfObject est_synonyme_de; // liste des synonymes de
ce mot clé
    SetOfObject est_pere_de;         // ensemble des mots clé
père
    SetOfObject est_fils_de;          // ensemble des mots clé
fils
    SetOfObject est_voisin_de;       // ensemble des mots clé
voisin
```

```
public MotCle(String ident){
        this.ident = ident;
   }
   public void ajouteSynonyme(MotCle synonyme){
        est_synonyme_de.add(synonyme);
   }
   public void ajouteVoisin(MotCle voisin){
        est_voisin_de.add(voisin);
   }
   public void ajoutePere(MotCle pere){
        est_pere_de.add(pere);
   }
   public void ajouteFils(MotCle fils){
        est_fils_de.add(fils);
   }
   public void ajouteDocument(Document document){
        est_dans.add(document);
   }
}
```


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Thesaurus example with POET (OQL)

DATUM ACADEMY

➢// document whose author is Serge Miranda

```
SELECT d
FROM
      k IN MocleExtent,
      c IN m.est_voisin_de,
      s IN m.est_synonyme_de,
      f IN m.est_fils_de,
      d IN SET(m.est_dans, c.est_dans, s.est_dans, f.est_dans),
      aut IN d.est_ecrit_par
WHERE  m.ident = 'software' AND aut.nom = 'Miranda'
      AND aut.prenom='Serge';
```

eMBDS

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Extra slides

OIF

- Specification language for
  - Importing
  - Exporting

➔ Exchanging data between different DBMS

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OIF Exemple

Prenons par exemple la définition ODL :

```
Interface Person {
        attribute string Name;
        relationship Employer
                inverse Company : : Employees ;
        relationship Property
                inverse Company : :Owner ;
} ;
Interface Company {
        relationship set<Person> Employees
                inverse Person : : Employer ;
        relationship Person Owner
                inverse Person : :Property ;
} ;
```

Dans le fichier OIF les objets seront créés ainsi :

Personne1 Person{Name «Julio»}
Personne2 Person{«Pedro»}
Entreprise1 Company {Employees {Personne1,Personne2}}

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OIF (commands)

- For exporting objects :
  odbdump <database name>

- For importing objects from several OIF files:
  odbload <database name> <file 1>…<file n>

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Transaction management

- Object Transaction created by Factory
  - begin() to open a transaction ;
  - commit() to validate transaction update ;
  - abort() to undo transaction updates;
  - checkpoint() = commit() + begin(), without releasing locks
  - join() to get transaction into thread ;
  - leave() to discard transaction from thread ;
  - To embed transactions
  - Concurrency control at object grain level;

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Locking

- Implicit locking (object graph traversal) or Explicit locking (LOCK or TRY_LOCK in object interface) with level-3 SQL isolation level and ACID transactions

- Interface TransactionFactory
  - Transaction…
  - Transaction…..
- LOCK
  - Read
  - Write
  - Upgrade (before Read or Write to avoid livelock)

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Other 2D Example with POET Dbms

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2D Example

```
//classe qui représente un point
import COM.POET.odmg.*;
import COM.POET.odmg.collection.*;

class Point2D{
    int x;
    int y;
    Point2D(){
    }
    Point2D(int pi_x, int pi_y){
            x = pi_x;
            y = pi_y;
    }
    void move(int pi_x, int pi_y){
            x = pi_x;
            y = pi_y;
    }
    void moveRelative(int pi_x, int pi_y){
            x += pi_x;
            y += pi_y;
    }
}
```


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2D Example

```
// Classe qui représente un polygone 2D
import COM.POET.odmg.*;
import COM.POET.odmg.collection.*;
class Polygone2D {
    SetOfObject points; //les points du polygone
    public Polygone2D() { //Constructeur
                points = new SetOfObject();
    }
    public void ajoutePoint(Point2D pr_point){ //rajouter un Point2D
                points.add(pr_point);
    }
    public int nombreDeCote() throws PolygoneException {
                if (points.size() > 2)
                    return points.size();
                else
                    throw new PolygoneException("Ce n'est pas un polygone");
    }
}
```


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2D Example (OQL)

```
//combien d'hexagone existent-ils dans notre base
SELECT COUNT(*)
FROM Polygone2DExtent h
WHERE h.nombreDeCote = 6

//tous les points qui forment des octagones
SELECT p
FROM
        pol IN Polygone2DExtent,
        p IN pol.points
WHERE pol.nombreDeCote = 8

//tous les point qui sont dans des cercles d'un rayon superieure à 10
SELECT p
FROM (SELECT c FROM Cercle2DExtent c WHERE c.rayon > 10) AS x,
     Point2DExtent p
WHERE
        x.contient(p)
```


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CERTIFICATION
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