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LINQ to SQL: Taking the Boredom out of Querying

Introduction

LINQ = Language INtegrated Query

= new features that was added to C#3, VB9 and .NET Framework 3.5 for querying databases and local collections

Brings static type safety to database queries

Simple and composable

A universal querying language that can work across SQL, XML, local collections and third-party APIs such as SharePoint

Proliferation of Querying APIs

SQL

```
select * from customer where FirstName = 'Jim'
```

XPath

```
customers/customer[FirstName='Jim']
```

C# 2.0

```
Array.Find (customers, delegate (Customer c) { return c.FirstName == "Jim"; } )
```

CAML

```
<Query>
  <Where>
    <Eq>
      <FieldRef Name="FirstName"/>
      <Value Type="Text">Jim</Value>
    </Eq>
  </Where>
</Query>
```

What's wrong with SQL?

- Lack of static type checking in embedded SQL queries

  ```
  new SqlCommand ("select * from Customer where Name=@p0");
  ```

- Awkward to dynamically compose queries
- Plumbing code in parameterization & marshalling data
- Difficulty in working with hierarchical data
- Has not been redesigned in decades

Pagination


```
SELECT TOP 20 UPPER(Customer.Name)
FROM Customer
WHERE (NOT (EXISTS (
    SELECT NULL
    FROM (
        SELECT TOP 40 ID
        FROM Customer c1
        WHERE c1.Name LIKE 'A%'
        ORDER BY c1.Name
        ) AS c2
    WHERE Customer.ID = c2.ID
    ))) AND (Customer.Name LIKE 'A%')
ORDER BY Customer.Name
```

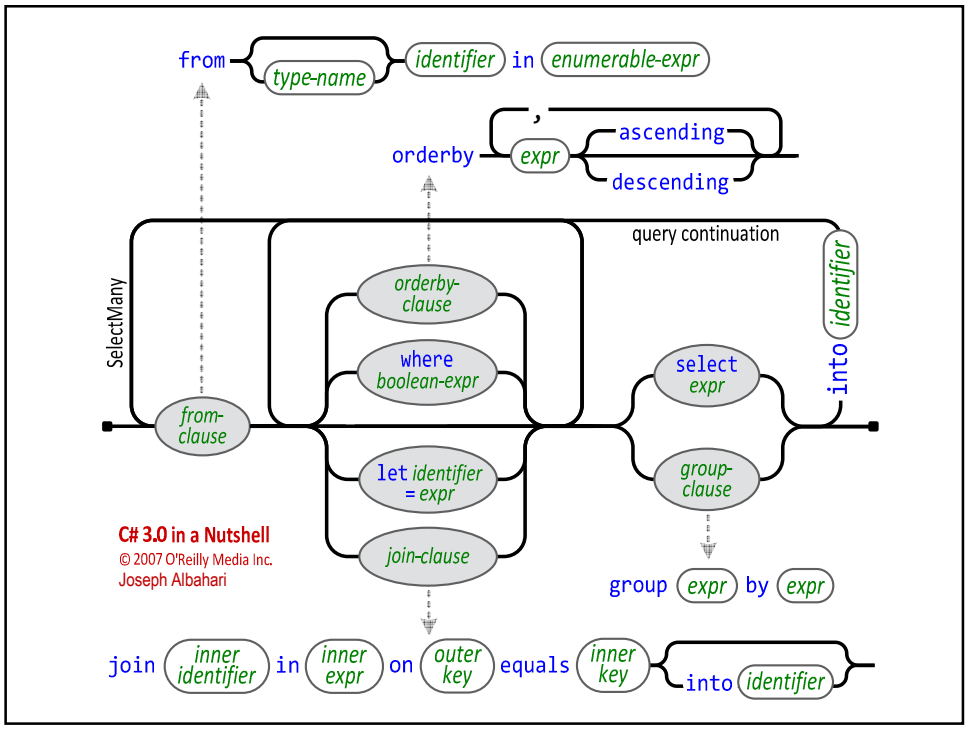
How does LINQ do better?

```
var query =
  from c in db.Customers
  where c.Name.StartsWith ("A")
  orderby c.Name
  select c.Name.ToUpper();

var thirdPage = query.Skip(40).Take(20);
```

- Simplicity
- Static type safety
- Composability (thanks to *deferred execution*)

Query syntax is syntactic sugar.



Compiler Translation

```
var query = db.Customers
  .Where   (c => c.Name.StartsWith ("A"))
  .OrderBy (c => c.Name)
  .Select  (c => c.Name.ToUpper());

var thirdPage = query.Skip (40).Take (20);
```

The db variable is a window into an object relational mapper.

Creating a DataContext

```
db = new MyDB ("connection string");

var query = db.Customers
  .Where   (c => c.Name.StartsWith ("A"))
  .OrderBy (c => c.Name)
  .Select  (c => c.Name.ToUpper());

var thirdPage = query
  .Skip (40)
  .Take (20);
```

Typed DataContext

```
public class MyDB : DataContext
{
   public Table<Customer> Customers
   {
      get { return GetTable<Customer>(); }
   }
}

[Table]
public class Customer
{
   [Column(IsPrimaryKey=true)]
   public int ID;

   [Column]
   public string Name;

   [Association (OtherKey="CustomerID")]
   public EntitySet<Purchase> Purchases = new EntitySet<Purchase>();
}
```

Object Relational Mappers allow Associations

```
[Table]
public class Purchase
{
    [Column(IsPrimaryKey=true)]
    public int ID;

    [Column]
    public int CustomerID;

    [Column]
    public string Description;

    [Column]
    public decimal Price;

    EntityRef<Customer> custRef;

    [Association (Storage="custRef",ThisKey="CustomerID",IsForeignKey=true)]
    public Customer Customer
    {
       get { return custRef.Entity; } set { custRef.Entity = value; }
    }
}
```

Querying through Associations

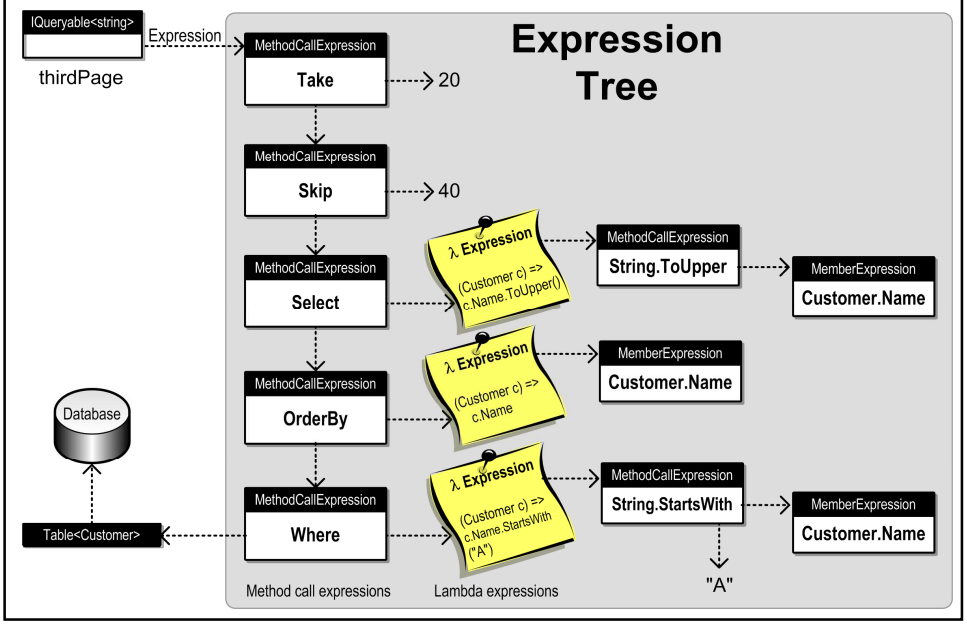
```
from c in db.Customers
where c.Purchases.Count() >= 2
select new
{
    c.Name,
    TotalSpend = c.Purchases.Sum (p => p.Price)
}
```

Previous Query, in One Step

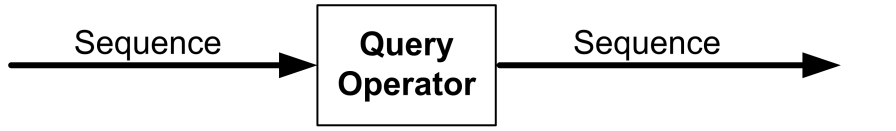
```
var thirdPage = db.Customers
  .Where   (c => c.Name.StartsWith ("A"))
  .OrderBy (c => c.Name)
  .Select  (c => c.Name.ToUpper())
  .Skip    (40)
  .Take    (20);
```

thirdPage evaluates to an *expression tree*.

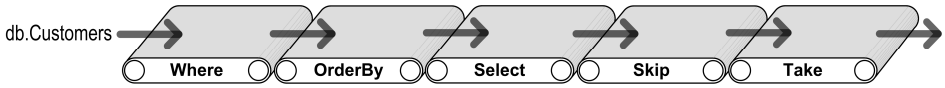
LINQ to SQL Queries are Expression Trees



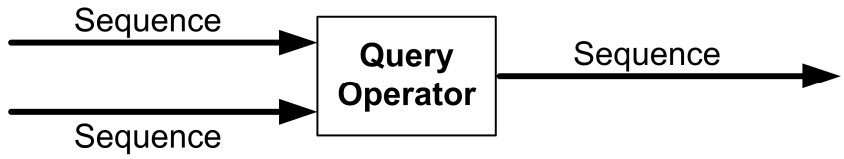
Sequence→Sequence Query Operators




```
var thirdPage = db.Customers
  .Where   (c => c.Name.StartsWith ("A"))
  .OrderBy (c => c.Name)
  .Select  (c => c.Name)
  .Skip    (40)
  .Take    (20);
```

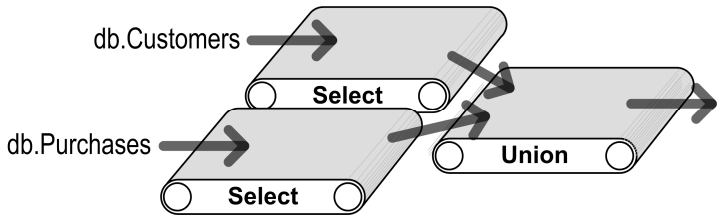


Set Operators

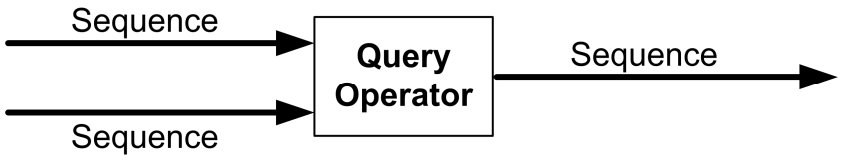


Concat, Union, Intersect, Except

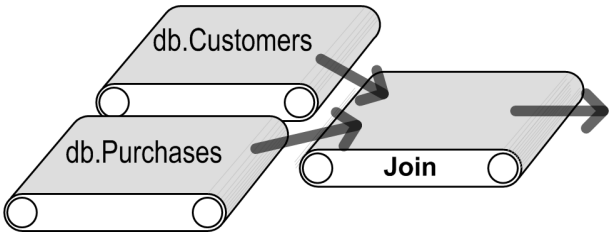
```
db.Customers.Select (c => c.Name)
.Union (
db.Purchases.Select (p => p.Description))
```



The Join Operator

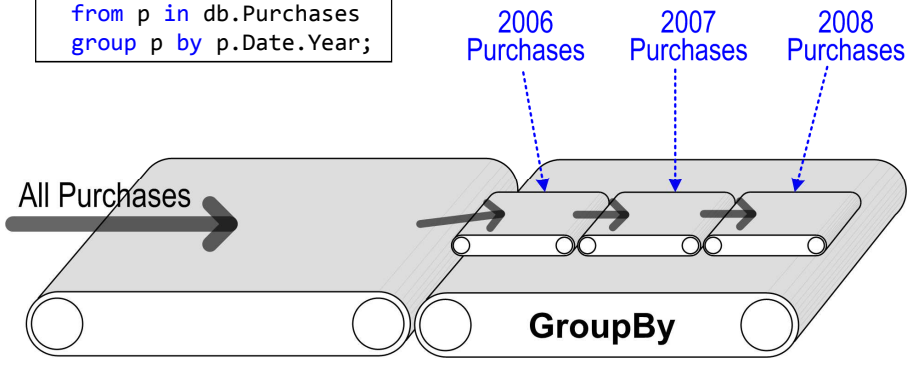


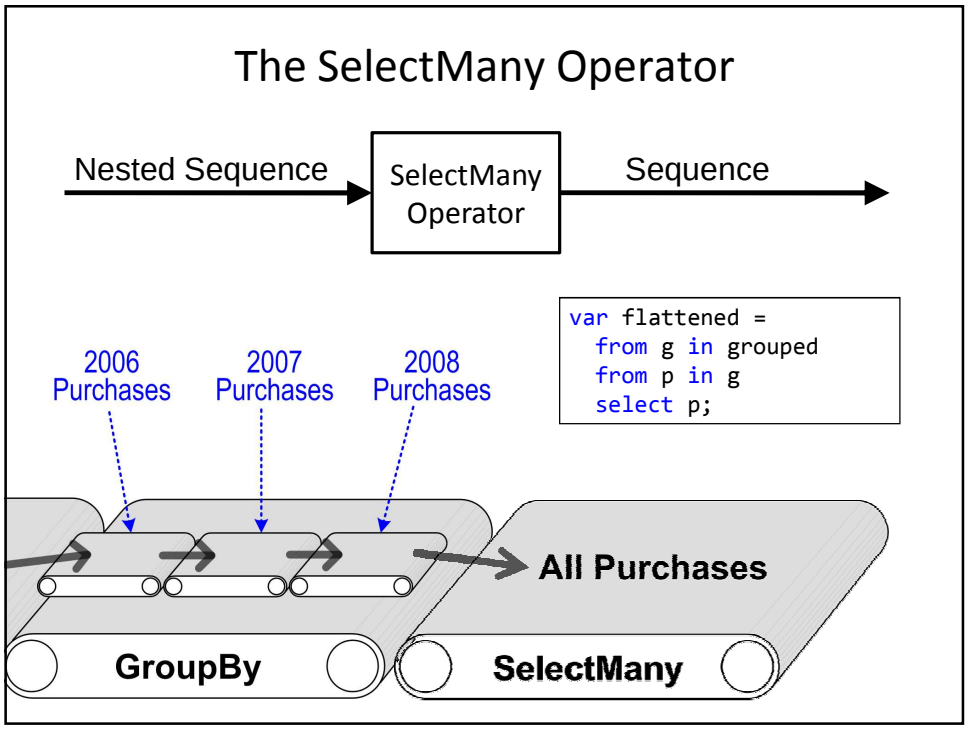

```
from c in db.Customers
join p in db.Purchases on c.ID equals p.CustomerID
```

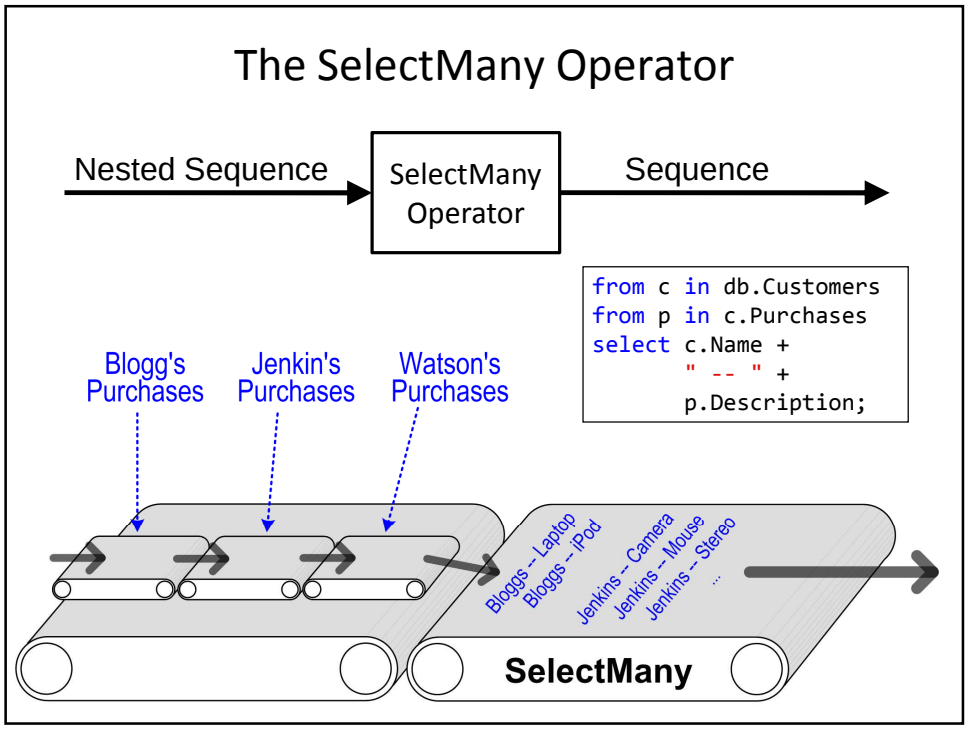


The Group Operator


```
var grouped =
  from p in db.Purchases
  group p by p.Date.Year;
```




The SelectMany Operator
Nested Sequence
SelectMany Operator
Sequence
var flattened =
from g in grouped
from p in g
select p;
2006 Purchases
2007 Purchases
2008 Purchases
All Purchases
GroupBy
SelectMany


The SelectMany Operator
Nested Sequence
SelectMany Operator
Sequence
from c in db.Customers
from p in c.Purchases
select c.Name +
" -- " +
p.Description;
Blogg's Purchases
Jenkin's Purchases
Watson's Purchases
Bloggs -- Laptop
Bloggs -- iPod
Jenkins -- Camera
Jenkins -- Mouse
Jenkins -- Stereo
...
SelectMany

Element/Quantifiers/Aggregation Operations

Element Operators
First, Single

```
db.Customers.First (c => c.ID == 123);
```

Quantifiers
All, Any, Contains

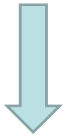
```
bool anyInDebt =
  db.Customers.Any (c => c.Balance < 0);
```

Aggregation Operators
Aggregate, Average, Count, Sum, Max, Min

```
decimal totalBalance =
  db.Customers.Sum (c => c.Balance);
```

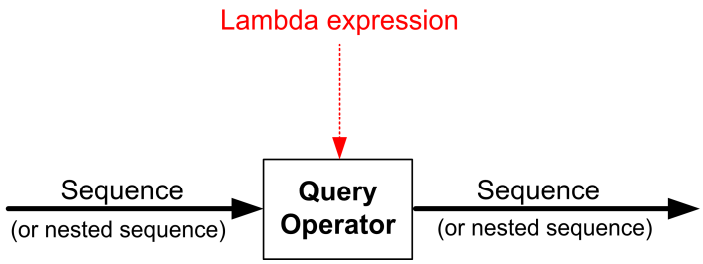
Lambda Expressions

```
from c in db.Customers
where c.Name.StartsWith ("a")
select c
```



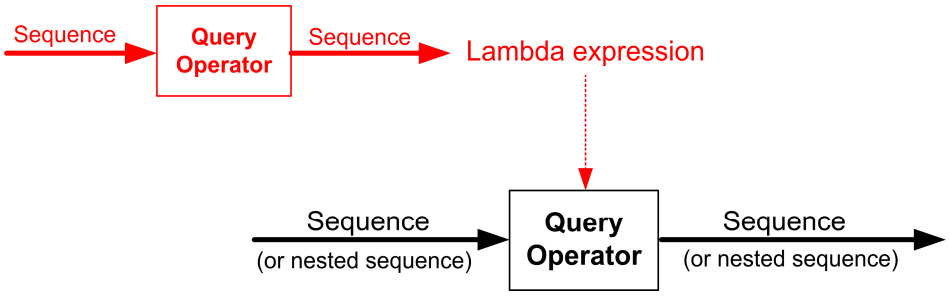
```
db.Customers.Where (c => c.Name.StartsWith ("a"))
```

Lambda Expressions



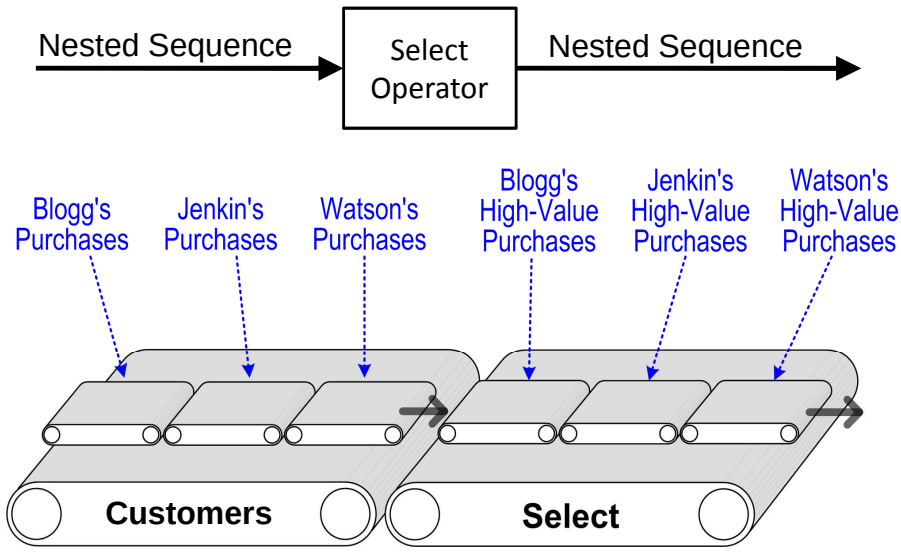

```
db.Customers.Where (c => c.Name.StartsWith ("a"))
```

Subqueries

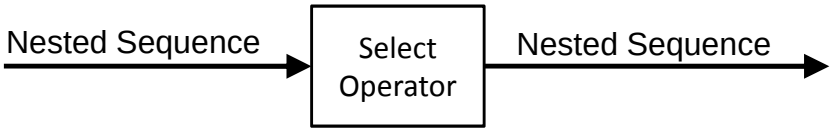



```
db.Customers.Where (c => c.Purchases.Any (p => p.Price > 1000))
```

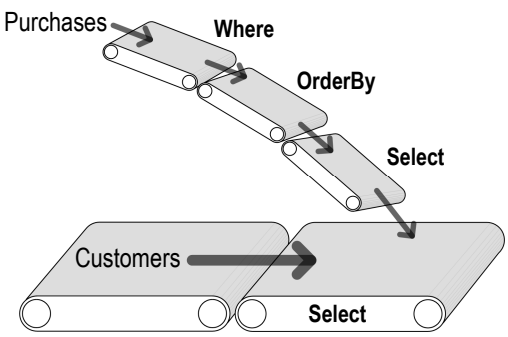
Projecting Subsequences



Subqueries - Select




```
from c in db.Customers
select new
{
   c.Name,
   HighValuePurchases =
      from p in c.Purchases
      where p.Price > 1000
      orderby p.Date
      select new { p.Description, p.Price }
}
```




```
from c in db.Customers
select new
{
   c.Name,
   Purchases =
      from p in db.Purchases
      where p.Price > 1000 && p.CustomerID == c.ID
      orderby p.Date
      select new { p.Description, p.Price }
}
```

Sample Queries

Preloaded in LINQPad:

www.linqpad.net

Collateral Damage

- Losses in translation
  - certain kinds of SQL query hard to achieve
    - workaround = table-value functions
  - locking and optimization hints impossible
- C# expressions with no SQL translation
- Limits in expression composability
  - workaround: www.albahari.com/nutshell/extras.html
- Mistaking local for interpreted queries
- Leaks in abstraction
  - local & LINQ to SQL queries may need to be formulated differently for maximum efficiency
- Performance cost
  - Conversion time
    - workaround = compiled queries & metamodel sharing
  - Non-optimal SQL
    - workaround = use SQL or SPs for those cases
- Updates that don't involve retrieving data first

Verdict

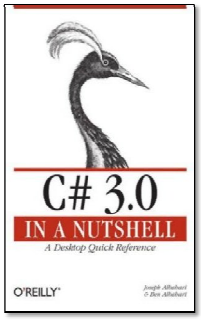
- LINQ to SQL has more than halved the middle tier development time, in my own experience
- A LINQ to SQL middle tier is smaller, tidier and safer
- Mix and match where necessary: sometimes old-fashioned SQL is best
- The technology has further promise
  - Provider independence
  - LINQ to Entities
  - Third party Object Relational Mappers

Resources

MS LINQ Forum:
http://tinyurl.com/4y93ta

PredicateBuilder & LINQKit:
www.albahari.com/nutshell/extras.html

LINQPad:
www.linqpad.net



C# 3.0 in a Nutshell

- C# 3.0 Language
- CLR
- Core .NET Framework
- LINQ to Objects
- LINQ to SQL
- LINQ to XML

C# 3.0
Pocket Reference

- C# 3.0 Language
- LINQ: distilled summary

LINQ
Pocket Reference

- Learn LINQ in 170 pages
- LINQ to Objects
- LINQ to SQL
- LINQ to XML

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