C# Expression Trees

In the real world

Spencer Schneidenbach

Aviron

spencer@avironlabs.com

Have you ever...

- Queried a table with a LINQ expression?

```
from product in db.Products
where product.Price < 2.55
select new {
    product.Name,
    product.Price
}
```

Have you ever...

- Rendered a field in an ASP.NET Core app like this?

```
@Html.EditorFor(e => e.FirstName)
```

Have you ever...

- Selected one or more members from an object?

```
ForMember(x => x.Name)
```

If you’ve ever done any of those

- Then you’ve used expression trees

```
ForMember(x => x.Name)
```

So what are expression trees anyways?

Let’s talk lambdas first

Lambda expressions

```
Func<string, string> toUpper = str => str.ToUpper();

var result = toUpper(“spencer");
```

Lambda expressions

```
Func<string, string> toUpper = str => str.ToUpper();

var result = toUpper(“spencer");        //SPENCER
```

Lambda expressions

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();

var result = toUpper("spencer");
```

Lambda expressions

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();

var result = toUpper("spencer");    //does not compile
```

What the heck?

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();

var result = toUpper("spencer");
```

```
Func<string, string> toUpper = str => str.ToUpper();

var result = toUpper("spencer");
```

Key difference

- Lambdas do the thing
- Expressions describe the lambda that does the thing

Homoiconicity

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();

var result = toUpper("spencer");
```

```
Func<string, string> toUpper = str => str.ToUpper();

var result = toUpper("spencer");
```

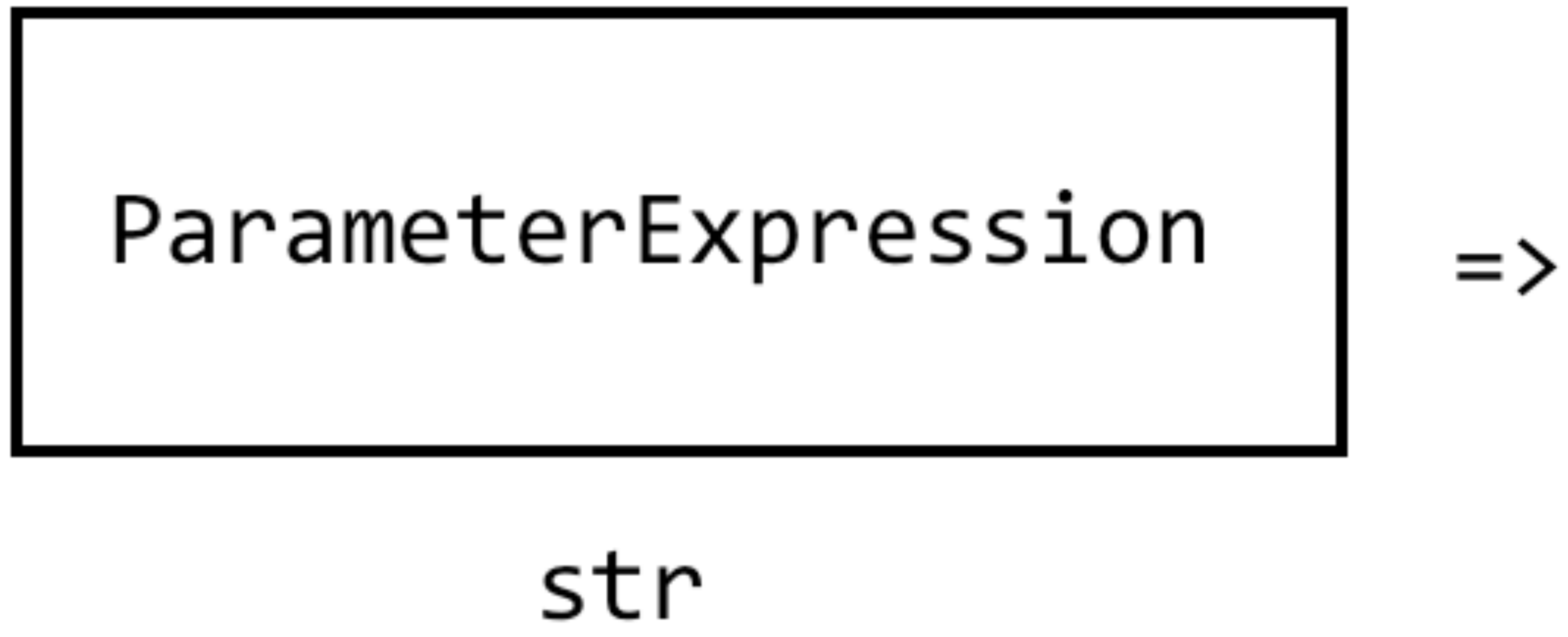
So what can we do with expressions?

- **Read them**
- Create them
- Use them

Lambda expressions

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();
```

```
str => str.ToUpper()
str => str.ToUpper()
```

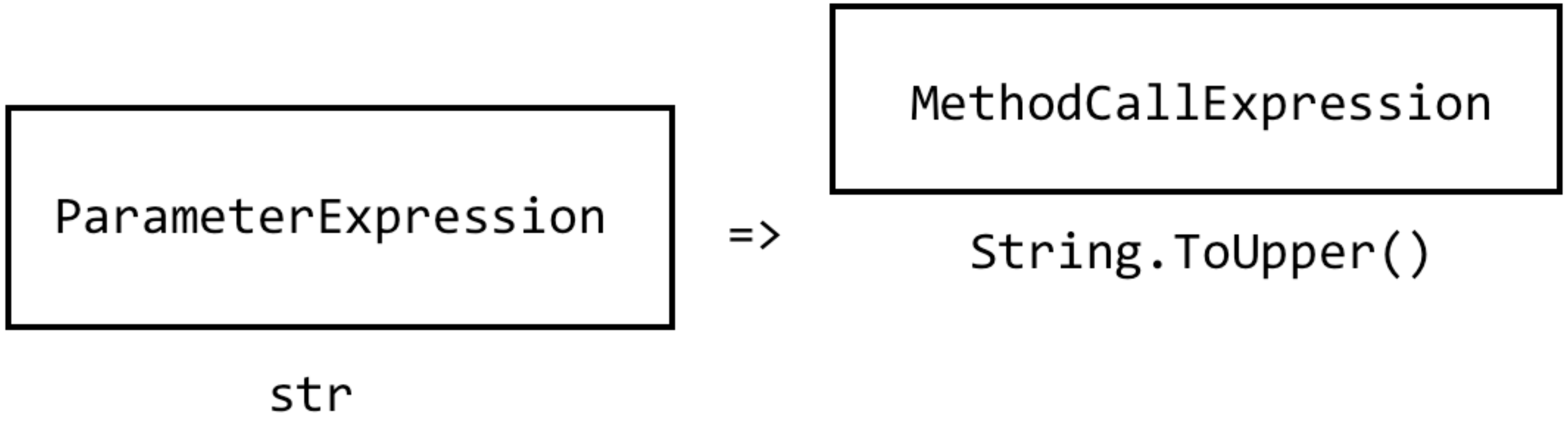


ParameterExpression

=>

str

```
str => str.ToUpper()
```



ParameterExpression

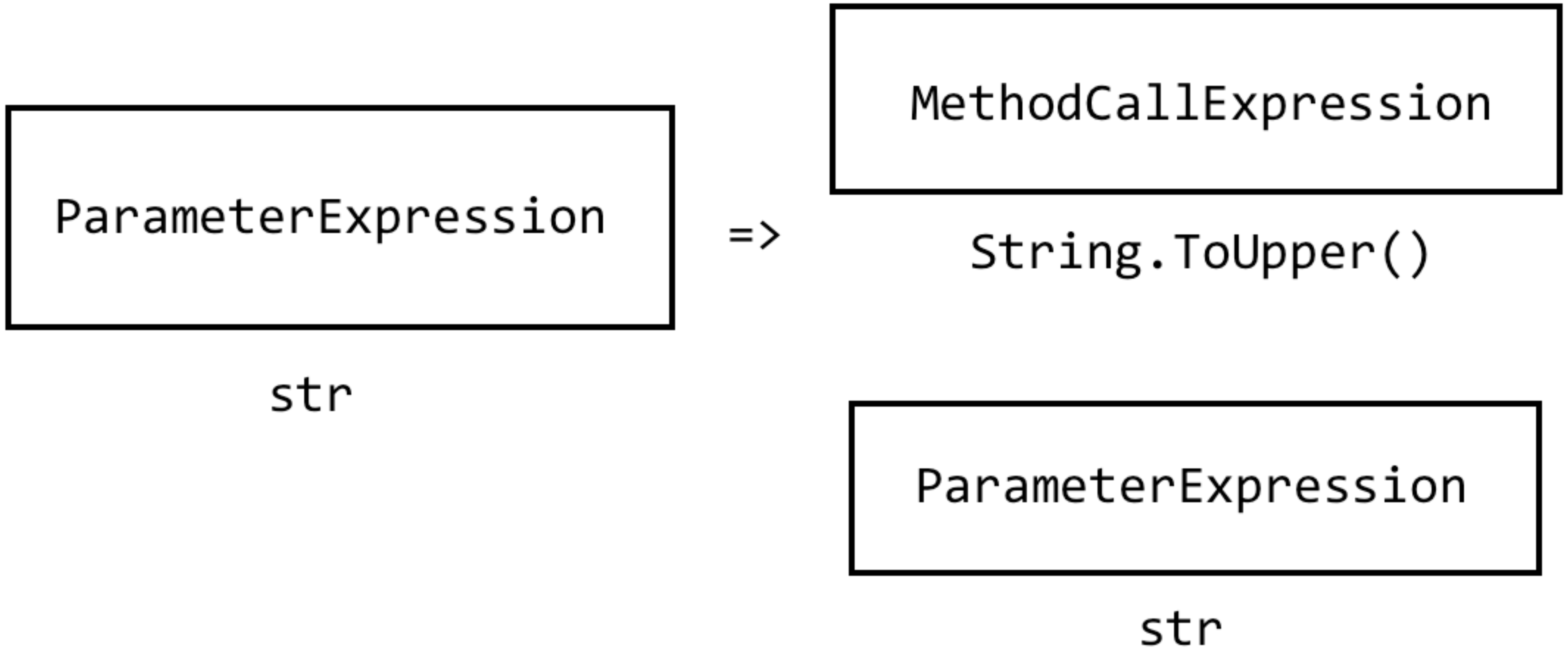
str

=>

MethodCallExpression

String.ToUpper()

str => str.ToUpper()



ParameterExpression

str

=>

MethodCallExpression

String.ToUpper()

ParameterExpression

str

So what can we do with expressions?

- Read them
- **Create them**
- Use them

Lambda expressions

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();
```

Lambda expressions

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();
```

Useful, but mainly for libraries to use them or to construct your own

Expression API

ParameterExpression

- Represents a parameter to a function

```
Expression.Parameter(typeof(string));
Expression.Parameter(typeof(string), "myStr"); //with a name
```

ConstantExpression

- Represents a declared value (e.g. 1, “str”, etc)

```
Expression.Constant("spencer");
```

MethodCallExpression

- Represents a call to a method

```
var prm = Expression.Parameter(typeof(string));
var toUpper = typeof(string).GetMethod("ToUpper", Type.EmptyTypes);

Expression.Call(prm, toUpper);
```

Let’s build this guy!

```
Expression<Func<string, string>> toUpper = str => str.ToUpper();
```

str => str.ToUpper()

```
var prm = Expression.Parameter(typeof(string), "str");
var toUpper = typeof(string).GetMethod("ToUpper", Type.EmptyTypes);

var body = Expression.Call(prm, toUpper);

var lambda = Expression.Lambda(body, prm);
```

So what can we do with expressions?

- Read them
- Create them
- **Use them**

Your favorite libraries

- Entity Framework/EF Core
- AutoMapper

Entity Framework

- Translates LINQ expressions to SQL

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

```
SELECT * FROM Products
WHERE Name = 'eggs'
ORDER BY Price DESC
```

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

?

```
SELECT * FROM Products
WHERE Name = 'eggs'
ORDER BY Price DESC
```

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

db.Products is an `IQueryable`

Enumerable

```
IEnumerable<T>.Where(Func<T, bool> predicate)
```

Queryable

```
IQueryable<T>.Where(Expression<Func<T, bool>> predicate)
```

Queryable

```
Queryable<T>.Where(Expression<Func<T, bool>> predicate)
```

This one can be interpreted at runtime!

ExpressionVisitor

Used to read and operate on expressions

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

Entity Framework

```
.Where(p => p.Name == "eggs")
```

```
WHERE Name = 'eggs'
```

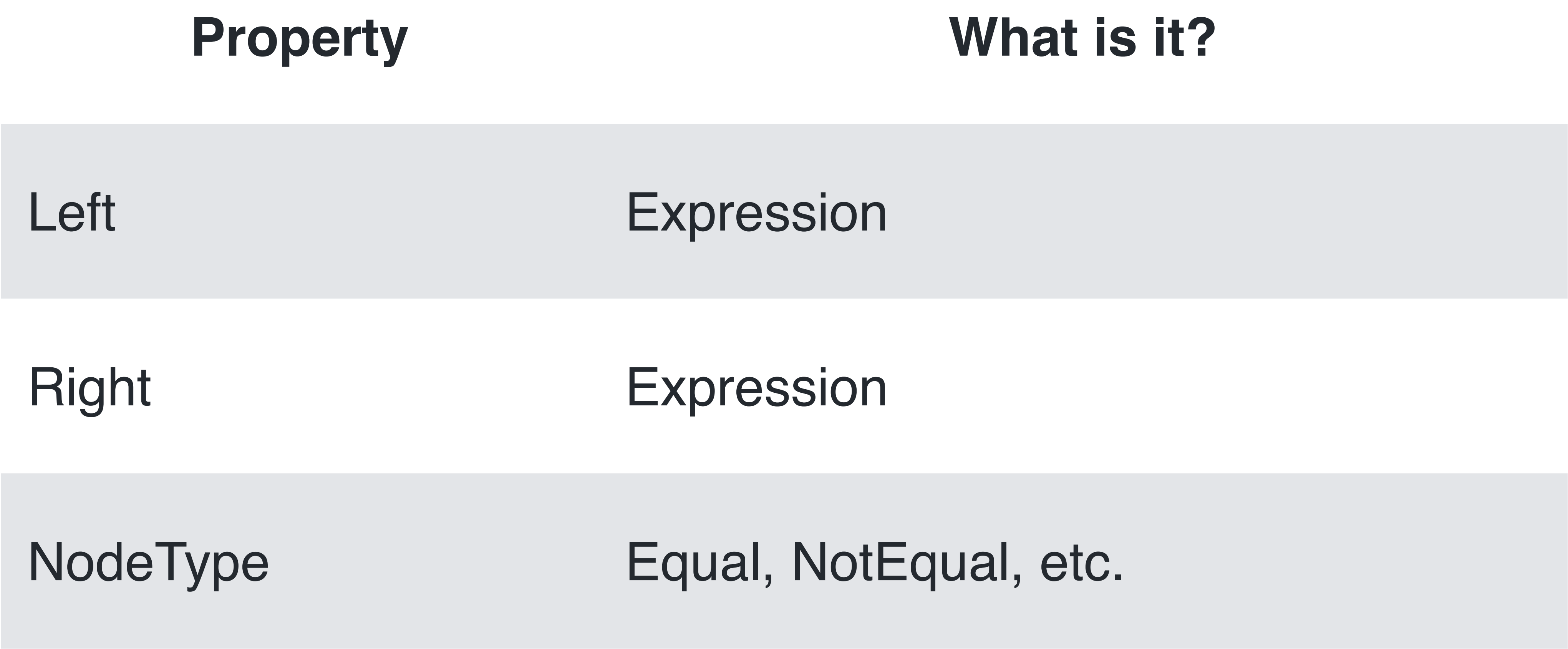
Entity Framework

```
.Where(p => p.Name == "eggs")
```

This is what is known as a binary expression

BinaryExpression

Represents an operation with a left side, right side, and an operator



Property	What is it?
Left	Expression
Right	Expression
NodeType	Equal, NotEqual, etc.

ExpressionVisitor

Reads each part of the expression and does *something* based on what it's reading

p.Name == "Eggs"

Part of expression	SQL
p.Name	[t0].[Name]
==	=
"eggs"	‘eggs'

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

?

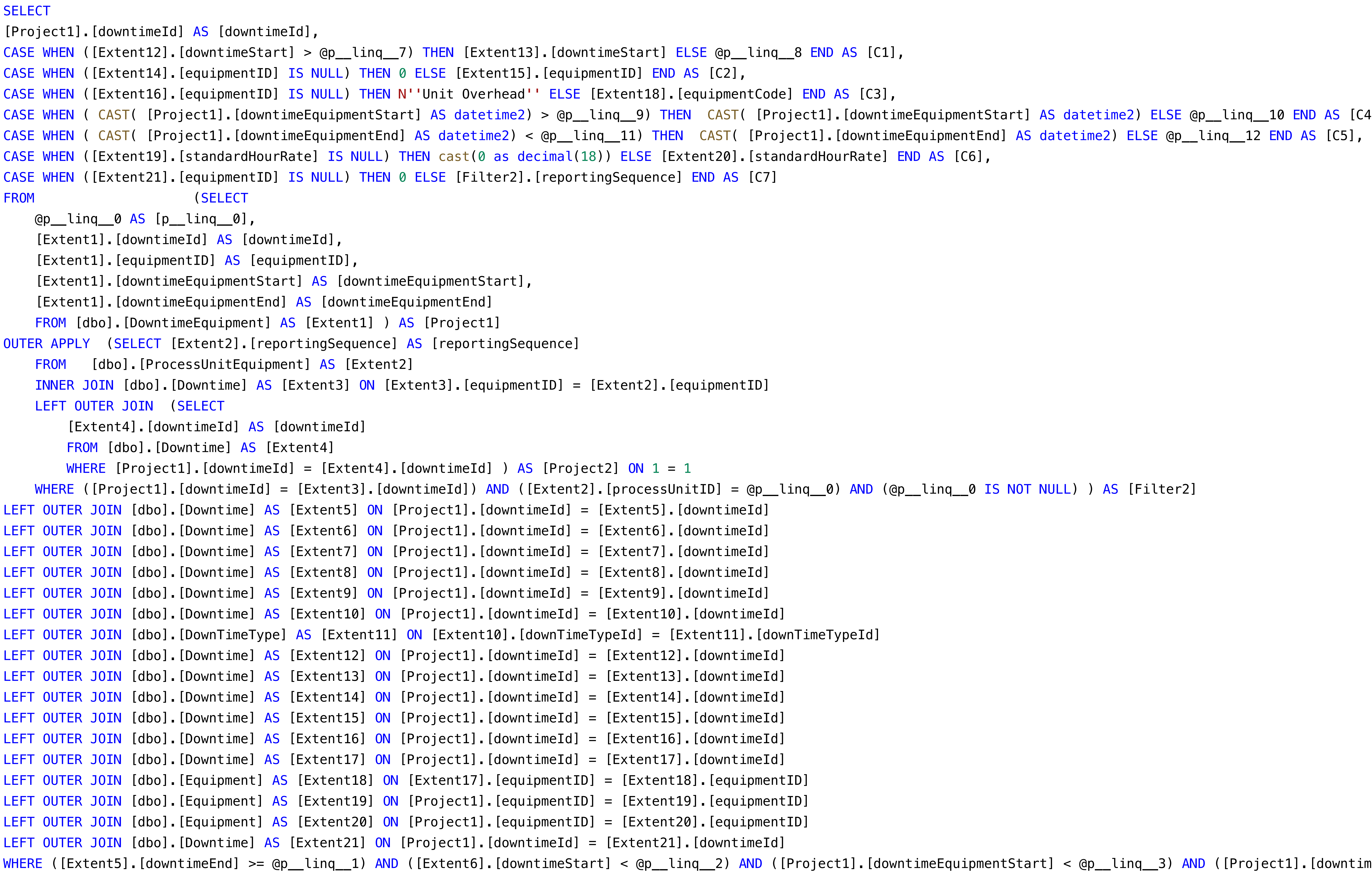
```
SELECT * FROM Products
WHERE Name = 'eggs'
ORDER BY Price DESC
```

Entity Framework

```
var products = db.Products
    .Where(p => p.Name == "eggs")
    .OrderByDescending(p => p.Price);
```

ExpressionVisitor

```
SELECT * FROM Products
WHERE Name = 'eggs'
ORDER BY Price DESC
```



```
SELECT
[Project1].[downtimeId] AS [downtimeId],
CASE WHEN ([Extent12].[downtimeStart] > @p__linq__7) THEN [Extent13].[downtimeStart] ELSE @p__linq__8 END AS [C1],
CASE WHEN ([Extent14].[equipmentID] IS NULL) THEN 0 ELSE [Extent15].[equipmentID] END AS [C2],
CASE WHEN ([Extent16].[equipmentID] IS NULL) THEN N''Unit Overhead'' ELSE [Extent18].[equipmentCode] END AS [C3],
CASE WHEN ( CAST( [Project1].[downtimeEquipmentStart] AS datetime2) > @p__linq__9) THEN  CAST( [Project1].[downtimeEquipmentStart] AS datetime2) ELSE @p__linq__10 END AS [C4
CASE WHEN ( CAST( [Project1].[downtimeEquipmentEnd] AS datetime2) < @p__linq__11) THEN  CAST( [Project1].[downtimeEquipmentEnd] AS datetime2) ELSE @p__linq__12 END AS [C5],
CASE WHEN ([Extent19].[standardHourRate] IS NULL) THEN cast(0 as decimal(18)) ELSE [Extent20].[standardHourRate] END AS [C6],
CASE WHEN ([Extent21].[equipmentID] IS NULL) THEN 0 ELSE [Filter2].[reportingSequence] END AS [C7]
FROM                    (SELECT
    @p__linq__0 AS [p__linq__0],
    [Extent1].[downtimeId] AS [downtimeId],
    [Extent1].[equipmentID] AS [equipmentID],
    [Extent1].[downtimeEquipmentStart] AS [downtimeEquipmentStart],
    [Extent1].[downtimeEquipmentEnd] AS [downtimeEquipmentEnd]
    FROM [dbo].[DowntimeEquipment] AS [Extent1] ) AS [Project1]
OUTER APPLY  (SELECT [Extent2].[reportingSequence] AS [reportingSequence]
    FROM   [dbo].[ProcessUnitEquipment] AS [Extent2]
    INNER JOIN [dbo].[Downtime] AS [Extent3] ON [Extent3].[equipmentID] = [Extent2].[equipmentID]
    LEFT OUTER JOIN  (SELECT
        [Extent4].[downtimeId] AS [downtimeId]
        FROM [dbo].[Downtime] AS [Extent4]
        WHERE [Project1].[downtimeId] = [Extent4].[downtimeId] ) AS [Project2] ON 1 = 1
    WHERE ([Project1].[downtimeId] = [Extent3].[downtimeId]) AND ([Extent2].[processUnitID] = @p__linq__0) AND (@p__linq__0 IS NOT NULL) ) AS [Filter2]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent5] ON [Project1].[downtimeId] = [Extent5].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent6] ON [Project1].[downtimeId] = [Extent6].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent7] ON [Project1].[downtimeId] = [Extent7].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent8] ON [Project1].[downtimeId] = [Extent8].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent9] ON [Project1].[downtimeId] = [Extent9].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent10] ON [Project1].[downtimeId] = [Extent10].[downtimeId]
LEFT OUTER JOIN [dbo].[DownTimeType] AS [Extent11] ON [Extent10].[downTimeTypeId] = [Extent11].[downTimeTypeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent12] ON [Project1].[downtimeId] = [Extent12].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent13] ON [Project1].[downtimeId] = [Extent13].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent14] ON [Project1].[downtimeId] = [Extent14].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent15] ON [Project1].[downtimeId] = [Extent15].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent16] ON [Project1].[downtimeId] = [Extent16].[downtimeId]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent17] ON [Project1].[downtimeId] = [Extent17].[downtimeId]
LEFT OUTER JOIN [dbo].[Equipment] AS [Extent18] ON [Extent17].[equipmentID] = [Extent18].[equipmentID]
LEFT OUTER JOIN [dbo].[Equipment] AS [Extent19] ON [Project1].[equipmentID] = [Extent19].[equipmentID]
LEFT OUTER JOIN [dbo].[Equipment] AS [Extent20] ON [Project1].[equipmentID] = [Extent20].[equipmentID]
LEFT OUTER JOIN [dbo].[Downtime] AS [Extent21] ON [Project1].[downtimeId] = [Extent21].[downtimeId]
WHERE ([Extent5].[downtimeEnd] >= @p__linq__1) AND ([Extent6].[downtimeStart] < @p__linq__2) AND ([Project1].[downtimeEquipmentStart] < @p__linq__3) AND ([Project1].[downtim
```

ExpressionVisitor

Used to read and operate on expressions
...or even modify them... kind of

```
public class ToUpperVisitor : ExpressionVisitor
{
    public override Expression Visit(Expression node)
    {
        if (node.NodeType == ExpressionType.Parameter)
        {
            return base.Visit(node);
        }

        if (node.Type == typeof(string))
        {
            var toUpper = typeof(string).GetMethod("ToUpper", Type.EmptyTypes);
            var methodCallExpression = Expression.Call(node, toUpper);
            return methodCallExpression;
        }
        return base.Visit(node);
    }
}
```

```
public class ToUpperVisitor : ExpressionVisitor
{
    public override Expression Visit(Expression node)
    {
        if (node.NodeType == ExpressionType.Parameter)
        {
            return base.Visit(node);
        }

        if (node.Type == typeof(string))
        {
            var toUpper = typeof(string).GetMethod("ToUpper", Type.EmptyTypes);
            var methodCallExpression = Expression.Call(node, toUpper);
            return methodCallExpression;
        }
        return base.Visit(node);
    }
}
```

```
Expression<Func<string, string>> spencyString =
    s => s + " belongs to Spencer";

var toUpperVisitor = new ToUpperVisitor();
var expressed = toUpperVisitor.VisitAndConvert(spencyString, null);

Console.WriteLine(expressed.Compile().DynamicInvoke("the cheese"));

//output: THE CHEESE BELONGS TO SPENCER
```

My Real World

SQL Model Mapper

- Needed to map one entity to another
- Stored procs vs. code

SQL Model Mapper

- SalesForce Customer -> Quickbooks Customer

```
public class SalesForceCustomer
{
    public string CustomerName { get; set; }
    public DateTime? CreateDate { get; set; }
}

public class QuickbooksCustomer
{
    public string Name { get; set; }
    public DateTime? OpenDate { get; set; }
}
```

```
INSERT QuickbooksCustomers (Name, OpenDate)
SELECT CustomerName, CreateDate
FROM SalesForceCustomers
```

```sql
INSERT QuickbooksCustomers (Name, OpenDate)
SELECT CustomerName, CreateDate
FROM SalesForceCustomers
```

Now do this for 100’s of objects and 1,000’s of properties, and never make a mistake

```
public class SfCustomerToQbCustomer
{
    public SfCustomerToQbCustomer()
    {
        SourceField(sfc => sfc.CustomerName)
            .IsEqualTo(qbc => qbc.Name.Trim());
        SourceField(sfc => sfc.CreateDate)
            .IsEqualTo(qbc => qbc.OpenDate ?? DateTime.Now);
    }
}
```

Tasks

- Write an expression visitor
- Handle any type of expression we want to translate

```
qbc => qbc.Name.Trim()
qbc => qbc.Name.Trim()
```

```
LTRIM(RTRIM(Name))
```

```
qbc => qbc.CreateDate ?? DateTime.Now
qbc => qbc.CreateDate ?? DateTime.Now
```

```
ISNULL(CreateDate, GETDATE())
```

```sql
INSERT QuickbooksCustomers (Name, OpenDate)
SELECT LTRIM(RTRIM(CustomerName)), ISNULL(CreateDate, GETDATE())
FROM SalesForceCustomers
```

Benefits

- Predictable
- Gave developers a natural way to express mappings
- Saved 1,000’s of hours of developer time

Very simple example

https://dotnetfiddle.net/PUij3K

Order by...`string`?

```
api/Customers?orderBy=name
```

```
db.Customers.OrderBy(c => c.Name)
db.Customers.OrderBy("Name")    //doesn't exist
```

```
public async Task<IActionResult> GetCustomers(string orderBy){
    var customersQuery = _context.Customers;
    switch (orderBy)
    {
        case "Name":
            customersQuery = customersQuery.OrderBy(c => c.Name);
            break;
        case "Age":
            customersQuery = customersQuery.OrderBy(c => c.Age);
            break;
        case "Address":
            customersQuery = customersQuery.OrderBy(c => c.Address);
            break;
        case "Id":
            customersQuery = customersQuery.OrderBy(c => c.Id);
            break;
        default:
            break;
    }

    return Ok(customers);
}
```

Solution: cook an expression!

```
db.Customers.OrderBy(c => c.Name)
```

Goals

- Cook our expression
- Apply it to our `IQueryable`

```
IQueryable<T> OrderByPropertyOrField<T>(
    this IQueryable<T> queryable,
    string propertyOrFieldName,
    bool ascending
)
```

```
IQueryable<T> OrderByPropertyOrField<T>(
    this IQueryable<T> queryable,
    string propertyOrFieldName,
    bool ascending
)
{
    var elementType = typeof (T);
    var parameter = Expression.Parameter(elementType);
    var prop = Expression.PropertyOrField(parameter, propertyOrFieldName);
    var selector = Expression.Lambda(prop, parameter);
```

```
Queryable.OrderBy<TSource, TKey>(
    IQueryable<TSource>,
    Expression<Func<TSource, TKey>>
)
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
var selector = Expression.Lambda(prop, parameter);

var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
var orderByExpression = Expression.Call(
    typeof (Queryable),     //the type whose function we want to call
    orderByMethodName,      //the name of the method
    new[] {elementType, prop.Type},    //the generic type signature
    queryable.Expression,   //parameter
    selector);              //parameter
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
var selector = Expression.Lambda(prop, parameter);

var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
var orderByExpression = Expression.Call(
    typeof (Queryable),     //the type whose function we want to call
    orderByMethodName,      //the name of the method
    new[] {elementType, prop.Type},    //the generic type signature
    queryable.Expression,   //parameter
    selector);              //parameter
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
    var selector = Expression.Lambda(prop, parameter);

    var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
    var orderByExpression = Expression.Call(
        typeof (Queryable),     //the type whose function we want to call
        orderByMethodName,      //the name of the method
        new[] {elementType, prop.Type},    //the generic type signature
        queryable.Expression,   //parameter
        selector);              //parameter
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
var selector = Expression.Lambda(prop, parameter);

var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
var orderByExpression = Expression.Call(
    typeof (Queryable),     //the type whose function we want to call
    orderByMethodName,      //the name of the method
    new[] {elementType, prop.Type},    //the generic type signature
    queryable.Expression,   //parameter
    selector);              //parameter
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
    var selector = Expression.Lambda(prop, parameter);

    var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
    var orderByExpression = Expression.Call(
        typeof (Queryable),     //the type whose function we want to call
        orderByMethodName,      //the name of the method
        new[] {elementType, prop.Type},    //the generic type signature
        queryable.Expression,   //parameter
        selector);              //parameter
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
var selector = Expression.Lambda(prop, parameter);

var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
var orderByExpression = Expression.Call(
    typeof (Queryable),       //the type whose function we want to call
    orderByMethodName,        //the name of the method
    new[] {elementType, prop.Type},    //the generic type signature
    queryable.Expression,     //parameter
    selector);                //parameter
```

```
Queryable.OrderBy<TSource, TKey>(
    IQueryable<TSource>,
    Expression<Func<TSource, TKey>>
)
```

```
Queryable.OrderBy<TSource, TKey>(IQueryable<TSource>, Expression<Func<TSource, TKey>>)
```

```
    var selector = Expression.Lambda(prop, parameter);

    var orderByMethodName = ascending ? "OrderBy" : "OrderByDescending";
    var orderByExpression = Expression.Call(
        typeof (Queryable),     //the type whose function we want to call
        orderByMethodName,      //the name of the method
        new[] {elementType, prop.Type},    //the generic type signature
        queryable.Expression,   //parameter
        selector);              //parameter
```

https://dotnetfiddle.net/5PlilF

Rules engine?

Define structure

```
public class Rule
{
    public string PropertyName { get; set; }
    public Operation Operation { get; set; }
    public object Value { get; set; }
}

public enum Operation
{
    GreaterThan,
    LessThan,
    Equal
}
```

Employee search criteria

```
new Rule {
    PropertyName = "Name",
    Operation = Operation.Equal,
    Value = "gary"
},
new Rule {
    PropertyName = "HireDate",
    Operation = Operation.GreaterThan,
    Value = new DateTime(2016, 1, 1)
}
```

Cook an expression

```
var parameter = Expression.Parameter(typeof(Employee));
BinaryExpression binaryExpression = null;

foreach (var rule in rules)
{
    var prop = Expression.Property(parameter, rule.PropertyName);
    var value = Expression.Constant(rule.Value);
    var newBinary = Expression.MakeBinary(rule.Operation, prop, value);

    binaryExpression =
        binaryExpression == null
        ? newBinary
        : Expression.MakeBinary(AndAlso, binaryExpression, newBinary);
}
```

Cook an expression

```
var parameter = Expression.Parameter(typeof(Employee));
BinaryExpression binaryExpression = null;

foreach (var rule in rules)
{
    var prop = Expression.Property(parameter, rule.PropertyName);
    var value = Expression.Constant(rule.Value);
    var newBinary = Expression.MakeBinary(rule.Operation, prop, value);

    binaryExpression =
        binaryExpression == null
        ? newBinary
        : Expression.MakeBinary(AndAlso, binaryExpression, newBinary);
}
```

Cook an expression

```
var parameter = Expression.Parameter(typeof(Employee));
BinaryExpression binaryExpression = null;

foreach (var rule in rules)
{
    var prop = Expression.Property(parameter, rule.PropertyName);
    var value = Expression.Constant(rule.Value);
    var newBinary = Expression.MakeBinary(rule.Operation, prop, value);

    binaryExpression =
        binaryExpression == null
        ? newBinary
        : Expression.MakeBinary(AndAlso, binaryExpression, newBinary);
}
```

Cook an expression

```
var parameter = Expression.Parameter(typeof(Employee));
BinaryExpression binaryExpression = null;

foreach (var rule in rules)
{
    var prop = Expression.Property(parameter, rule.PropertyName);
    var value = Expression.Constant(rule.Value);
    var newBinary = Expression.MakeBinary(rule.Operation, prop, value);

    binaryExpression =
        binaryExpression == null
        ? newBinary
        : Expression.MakeBinary(AndAlso, binaryExpression, newBinary);
}
```

Cook an expression

```
var parameter = Expression.Parameter(typeof(Employee));
BinaryExpression binaryExpression = null;

foreach (var rule in rules)
{
    var prop = Expression.Property(parameter, rule.PropertyName);
    var value = Expression.Constant(rule.Value);
    var newBinary = Expression.MakeBinary(rule.Operation, prop, value);

    binaryExpression =
        binaryExpression == null
        ? newBinary
        : Expression.MakeBinary(AndAlso, binaryExpression, newBinary);
}
```

Employee search criteria

```
new Rule {
    PropertyName = "Name",
    Operation = Operation.Equal,
    Value = "gary"
},
new Rule {
    PropertyName = "HireDate",
    Operation = Operation.GreaterThan,
    Value = new DateTime(2016, 1, 1)
}
```

```
e => (e.Name == "gary") && (e.HireDate > new DateTime(2016, 1, 1))
```

https://dotnetfiddle.net/iobiuW

Making it more complex

```
e => (e.Name == "gary") && (e.HireDate > new DateTime(2016, 1, 1))
```

Making it more complex

```
e => (e.Name == "gary" || e.Name == "spencer") &&
     (e.HireDate > new DateTime(2015, 1, 1))
```

Making it more complex

```
e => (e.Name == "gary" || e.Name == "spencer") &&
     (e.HireDate > new DateTime(2015, 1, 1))
```

```
public abstract class Rule
{
    public abstract Expression BuildExpression(ParameterExpression parameter);
}
```

```csharp
public class RuleGroup : Rule
{
    public List<Rule> SubRules { get; set; }
    public ExpressionType CombineWith { get; set; }

    public RuleGroup(List<Rule> subRules, ExpressionType combineWith)
    {
        SubRules = subRules;
        CombineWith = combineWith;
    }

    public override Expression BuildExpression(ParameterExpression parameter)
    {
        var expressions = SubRules.Select(rule => rule.BuildExpression(parameter));
        var combined = expressions.Aggregate((left, right) => Expression.MakeBinary(CombineWith, left, right));
        return combined;
    }
}
```

```
public class RulePrimitive : Rule
{
    public string PropertyName { get; set; }
    public ExpressionType Operation { get; set; }
    public object Value { get; set; }

    public RulePrimitive(string propertyName, ExpressionType operation, object value)
    {
        PropertyName = propertyName;
        Operation = operation;
        Value = value;
    }

    public override Expression BuildExpression(ParameterExpression parameter)
    {
        var left = Expression.Property(parameter, PropertyName);
        var right = Expression.Constant(Value);
        return Expression.MakeBinary(Operation, left, right);
    }
}
```

https://dotnetfiddle.net/XuF4ci

Some other things

Expression.Block

Expression.Block

- Used for grouping expressions in a “block”
- Can declare variables for use inside of this block

```
Expression.Variable(typeof(int), "x");
```

```
// Define a variable
var variable = Expression.Variable(typeof(int), "x");

// Create an expression block
var blockExpr = Expression.Block(
    new[] { variable },
    Expression.Assign(variable, Expression.Constant(5)),
    Expression.Add(variable, Expression.Constant(10))
);

// Compile and execute the expression block
var lambda = Expression.Lambda<Func<int>>(blockExpr).Compile();
var result = lambda();

Console.WriteLine("Result: " + result); // Output: Result: 15
```

https://dotnetfiddle.net/LOe2iO

Here Be Dragons

(Problems, limitations, and oddities)

C# compiler == magic

```
Expression<Func<string, string, string>> combineStringsExp =
    (str1, str2) => str1 + str2;
```

```
var str1Param = Expression.Parameter(typeof(string));
var str2Param = Expression.Parameter(typeof(string));

var combineThem = Expression.MakeBinary(ExpressionType.Add, str1Param, str2Param);
var str1Param = Expression.Parameter(typeof(string));
var str2Param = Expression.Parameter(typeof(string));

var combineThem = Expression.MakeBinary(ExpressionType.Add, str1Param, str2Param);
```

EXCEPTION: The binary operator Add is not defined for the types 'System.String' and 'System.String'

```
Expression<Func<string, string, string>> combineStringsExp =
    (str1, str2) => str1 + str2;
```

This uses string.Concat

Conversions need to be done explicitly

Doesn’t support every language feature

Homoiconicity

```
customers.Where(c => c.Address?.ZipCode == "12345")
customers.Where(c => c.Address?.ZipCode == "12345")
```

(Spencer is paraphrasing from memory)

“We’re not going to update the Expression API. We looked at the work that would be required and we’d basically have to stop developing other features for an entire year and focus on that and that alone.”

How to start

- Experiment
- LINQPad
- ~~Not google~~
- ChatGPT
- Intellisense!

Most importantly,
EXPERIMENT!

Thank you!

aironlabs.com

@schneidenbach