Pattern Matching

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Pattern Matching in C#

First introduced in C# 7.0

Improved with each new version of C# to get more patterns

Expect newer versions of **C#** to **introduce additional patterns**

What Is **Pattern Matching**?

A way to write code that determines what an object is

Is the type a specific sub-class?

```
order is ProcessedOrder
```

Does it contain any specific values?

```
order is ProcessedOrder { IsReadyForShipment: true }
```

Does a value conform to a given range?

```
order is CancelledOrder { Total: <100 }
```

Before Pattern Matching

Before Pattern Matching

```
if(order.GetType() == typeof(ProcessedOrder))
{




}
```

Before Pattern Matching

```
if(order.GetType() == typeof(ProcessedOrder))
{
    var processedOrder = order as ProcessedOrder;
    if(processedOrder.IsReadyForShipment)
    {
    }
}
```

Pattern Matching

```
if(order is ProcessedOrder { IsReadyForShipment: true })
{
}
```

Pattern matching **can make** the **code easier** to **read** and **understand**

Pattern Matching: **Type Pattern**

Pattern Matching: **Type Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{

}
```

Pattern Matching: **Type Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{

}
```

Checks if the **ShippingProvider** is **set to an instance** that **matches the type** on the right hand side

Pattern Matching: **Type Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
```

```
if(order.ShippingProvider.GetType() == typeof(SwedishPostalServiceShippingProvider))
{
      var provider = order.ShippingProvider as SwedishPostalServiceShippingProvider;
}
```

The **goal is** to make this **easier** by using **pattern matching**

Pattern Matching: **Type Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{




}
```

Pattern Matching: **Type Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{
    var provider = order.ShippingProvider as SwedishPostalServiceShippingProvider;

    if(provider.DeliverNextDay)
    {

    }
}
```

Pattern Matching

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
```

Pattern Matching

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
```

Define the **pattern(s)** on the **right hand side** of the **is operator**

Patterns can be **easy** and **complex**!

Pattern Matching: **Declaration Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider            )
{

}
```

Pattern Matching: **Declaration Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider provider)
{

}
```

Capture the shipping **provider** as the **matched type** and make it **available** in the **if-statement**

Pattern Matching: **Declaration Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider provider)
{
    var nextDayDelivery = provider.DeliverNextDay;
}
```

Property that **only exist** on the **SwedishPostalServiceShippingProvider**

A combination of patterns can produce a very complex yet readable evaluation

Patterns

Type pattern

Declaration pattern

Constant pattern

Relational pattern

Logical pattern

Property pattern

Positional pattern

Var pattern

Discard pattern

Parenthesized pattern

How to Use **Patterns** in C#

How to Use **Patterns** in C#

```
// Using the is operator
if(GetOrder() is ProcessedOrder) {}
```

How to Use **Patterns** in C#

```
// Using the is operator
if(GetOrder() is ProcessedOrder) {}

// Using a switch statement
switch(GetOrder())
{
    case ProcessedOrder order: break;
}
```

How to Use **Patterns** in C#

```
// Using the is operator
if(GetOrder() is ProcessedOrder) {}

// Using a switch statement
switch(GetOrder())
{
    case ProcessedOrder order when order.Total > 100: break;
}
```

How to Use **Patterns** in C#

```
// Using the is operator
if(GetOrder() is ProcessedOrder) {}

// Using a switch statement
switch(GetOrder())
{
    case ProcessedOrder order when order.Total > 100: break;
}

// Using a switch expression
var result = GetOrder() switch {
    ProcessedOrder => ""
}
```

How to Use **Patterns** in C#

```csharp
// Using the is operator
if(GetOrder() is ProcessedOrder) {}

// Using a switch statement
switch(GetOrder())
{
    case ProcessedOrder order when order.Total > 100: break;
}

// Using a switch expression
var result = GetOrder() switch {
    ProcessedOrder => ""
}
```

You will often combine more than one pattern

Pattern Matching: **Property Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{

}
```

Pattern Matching: **Property Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider { FreightCost: >100 })
{

}
```

Pattern Matching: **Property Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider { FreightCost: >100 })
{

}
```

This property pattern is a **nested** (recursive) **pattern**

Pattern Matching: **Property Pattern**

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider { FreightCost: >100 })
{

}
```

This is a **relational pattern**

Pattern matching is powerful!

Use it wisely.

Introducing the **Switch Expression**

A combination of switch and expression bodied member

Always returns a value

Creating a **Switch Expression**

Creating a **Switch Expression**

```
decimal freightCost
```

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch {}
```

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch {}
```

```
switch (order.ShippingProvider)
{
}
```

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{

};
```

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{

};
```

Add all your patterns here

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider => 50m
};
```

What to return when there is a match

Creating a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider => 50m
};
```

All expressions must return types that are compatible with each other

Multiple Patterns in a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider { NextDay: true } => 100m,
    SwedishPostalServiceShippingProvider => 50m,
    ShippingProvider => 200m
};
```

Multiple Patterns in a **Switch Expression**

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider { NextDay: true } => 100m,
    SwedishPostalServiceShippingProvider => 50m,
    ShippingProvider => 200m
};
```

Recursive pattern

Match all possible **cases** or add a **default case**

Discard Pattern

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider { NextDay: true } => 100m,
    SwedishPostalServiceShippingProvider => 50m,
    _ => 200m
};
```

Discard Pattern

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider { NextDay: true } => 100m,
    SwedishPostalServiceShippingProvider => 50m,
    _ => 200m
};
```

Discard Pattern

```
decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider { NextDay: true } => 100m,
    SwedishPostalServiceShippingProvider => 50m,
    _ => 200m
};
```

Discard pattern will match
everything else including null

No Match and No Default Case

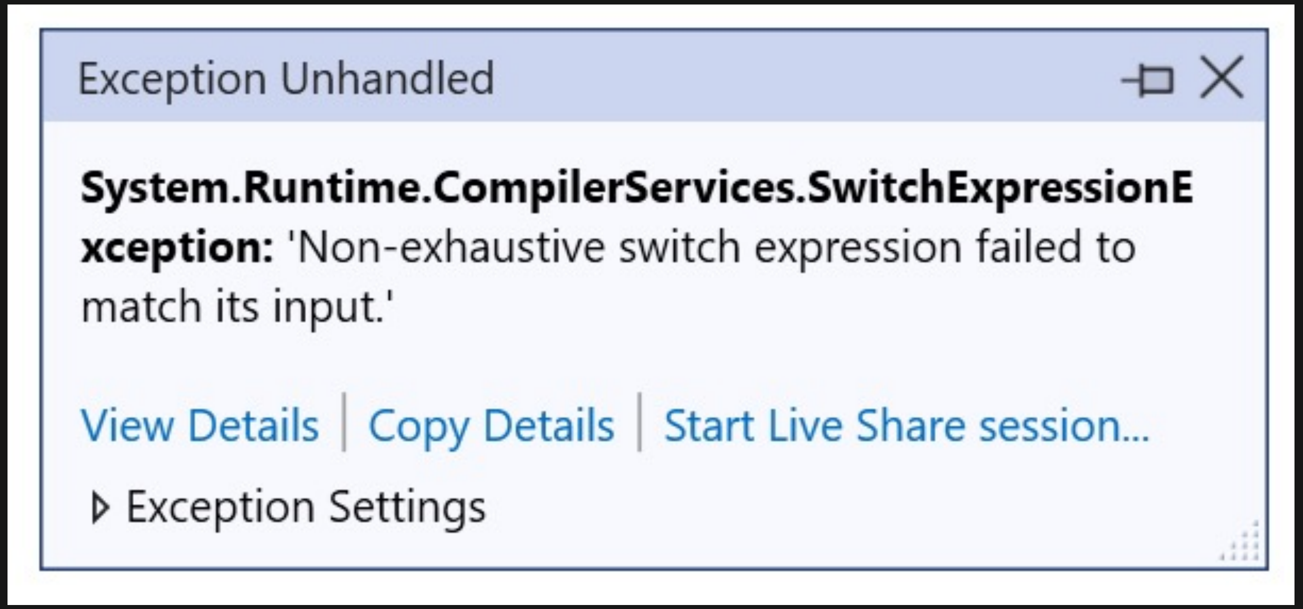
```
order.ShippingProvider = null;

decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider => 50m
};
```

No Match and No Default Case

```
order.ShippingProvider = null;

decimal freightCost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider => 50m
};
```



Exception Unhandled

System.Runtime.CompilerServices.SwitchExpressionException: 'Non-exhaustive switch expression failed to match its input.'

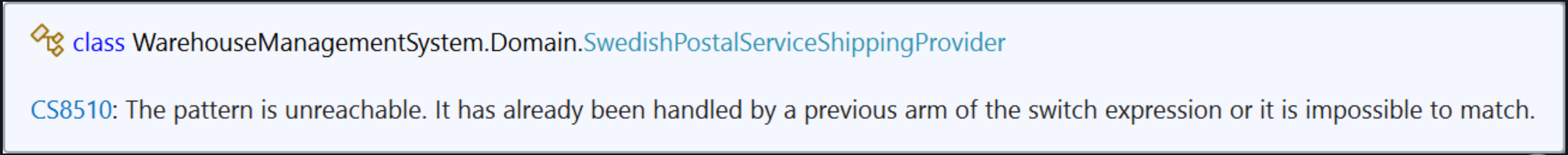
Order of Patterns

The order matters!

Most granular patterns at the top of the switch expression

Unreachable Pattern

```
decimal freightCost = order.ShippingProvider switch
{
    _ => 100m,
    SwedishPostalServiceShippingProvider => 50m
};
```



class WarehouseManagementSystem.Domain.SwedishPostalServiceShippingProvider

CS8510: The pattern is unreachable. It has already been handled by a previous arm of the switch expression or it is impossible to match.

There are still many patterns to explore!

Pattern Matching: **Type Pattern**

```
ShippingProvider provider = order switch
{



};
```

Pattern Matching: **Type Pattern**

```
ShippingProvider provider = order switch
{
    PriorityOrder    => new GlobalExpressShippingProvider(),
    LowPriortyOrder => new BoatShippingProvider(),
    _                => new()
};
```

Pattern Matching: **Type Pattern**

```
object instance = GetInstance();
```

Pattern Matching: **Type Pattern**

```
object instance = GetInstance();

var result = instance switch
{




};
```

Pattern Matching: **Type Pattern**

```
object instance = GetInstance();

var result = instance switch
{
    string     => "This is a string",
    int        => "This is an integer",
    null       => "This is null",
    _          => "This is everything else that is not null",
};
```

Pattern Matching with Generics

```
decimal CalculateFor<T>(T instance) where T : ShippingProvider
{







}
```

Pattern Matching with Generics

```
decimal CalculateFor<T>(T instance) where T : ShippingProvider
{
    return instance switch
    {
        SwedishPostalServiceShippingProvider => 100m,




    };
}
```

Pattern Matching with Generics

```
decimal CalculateFor<T>(T instance) where T : ShippingProvider
{
    return instance switch
    {
        SwedishPostalServiceShippingProvider => 100m,
        string     => 0m,
        int        => 0m,
        null       => 0m,
        _          => 0m,
    };
}
```

The generic constraint is ignored and this is valid

The compiler will let you know if the pattern is not applicable to the given type

Powerful and **Useful** Pattern

What sub-class is the type?
Is the order cancelled or shipped?

Is the instance set to a value?
Checked during runtime!

Capture in a local variable as the actual type!
Used together with the declaration pattern

Pattern Matching: **Positional Pattern**

Pattern Matching: **Positional Pattern**

```
if(order is (100, true)) { ... }
```

Pattern Matching: **Positional Pattern**

```
if(order is (100, true)) { ... }
```

Pattern Matching: **Positional Pattern**

```
if(order is (100, true)) { ... }
```

↑

Can contain **any patterns**
These are constant patterns

Positional Pattern with Deconstruct

```
if(order is (100, true)) { ... }

public void Deconstruct(out decimal total, out bool ready)
{ ... }
```

Positional Pattern with Deconstruct

total ready

```
if(order is (100, true)) { ... }

public void Deconstruct(out decimal total, out bool ready)
{ ... }
```

Do you have to provide constants for all deconstructed values?

No!

Positional Pattern with a **Discard**

Discard the value and allow **any value**

```
if(order is (_, true)) { ... }

public void Deconstruct(out decimal total, out bool ready)
{ ... }
```

Positional Pattern with a **Discard**

What is this?

↓

```
if(order is (_, true)) { ... }

public void Deconstruct(out decimal total, out bool ready)
{ ... }
```

Positional Pattern with a **Discard**

```
if(order is (_, ready: true)) { ... }

public void Deconstruct(out decimal total, out bool ready)
{ ... }
```

Can you use the property pattern instead?

That may be even more readable in less complex situatuons

What is deconstructed may be the result of a complex computation

You can use the **positional pattern** to **match tuple** values

Constant Patterns

Numbers
```
{ total: 100.50m }
```

Characters or string literals
```
{ name: "Filip Ekberg" }
```

Enum
```
{ status: OrderStatus.Shipped }
```

Constant fields
```
{ name: DefaultShippingProviderName }
```

Null
```
{ name: null }
```

You **don’t have to** use the **property** pattern **together with** the **type** pattern

An Alternative **Null Check**

An Alternative **Null Check**

```
if(order is { })
{
}
```

An Alternative **Null Check**

Empty property pattern!
This will verify that it is not null

↓

```
if(order is { })
{
}
```

Properties of Properties

```
if(order is { })
{
}
```

Properties of Properties

```
if(order is { ShippingProvider.FreightCost: >100 })
{
}
```

Properties of Properties

```
if(order is { ShippingProvider.FreightCost: >100 })
{
}
```

↑

Will first ensure that ShippingProvider is not null!

```csharp
var cost = order.ShippingProvider switch
{
    SwedishPostalServiceShippingProvider
    { DeliverNextDay: true } provider => provider.Freight + 50m
}
```

Combination of Patterns

Type pattern
Property pattern
Constant pattern
Declaration pattern

Multiple **Property Patterns**

```
if (order is {
        ShippingProvider: SwedishPostalServiceShippingProvider,
        Total: >100
    })
{ }
```

Logical Patterns

Negated not

```
order is not null
```

Conjunctive and

```
order is (total: >50 and <100, _)
```

Disjunctive or

```
order is CancelledOrder or ShippedOrder
```

Negate Any Pattern

```
if(order is not CancelledOrder)     { ... }

if(order is not { Total: <100 })    { ... }
```

Negate Any Pattern

```
if(order is not CancelledOrder)    { ... }

if(order is not { Total: <100 })   { ... }

if(order is not (_, false))        { ... }
```

Don’t negate the Boolean

Negating a Property Pattern

```
if(order is not { ShippingProvider.FreightCost: >100 })
{ ... }
```

Negating a Property Pattern

```
if(order is not { ShippingProvider.FreightCost: >100 })
{ ... }
```

Negating a Property Pattern

```
if(order is not { ShippingProvider.FreightCost: >100 })
{ ... }
```

First evaluates this entire pattern to check null and the property values.

Then negates that!

Relational Pattern

Relational Pattern

```
if(order is { Total: <100 }) { ... }
```

A **constant value** matched against the related **property** or **position**

Define an **Allowed Range** with **Patterns**

```
if(order is { Total: >50 and <=100 }) { ... }
```

How do we **exclude shipped** and **cancelled orders**?

Try to **compare** this to an **approach** that **does not use pattern matching**

Pattern Matching

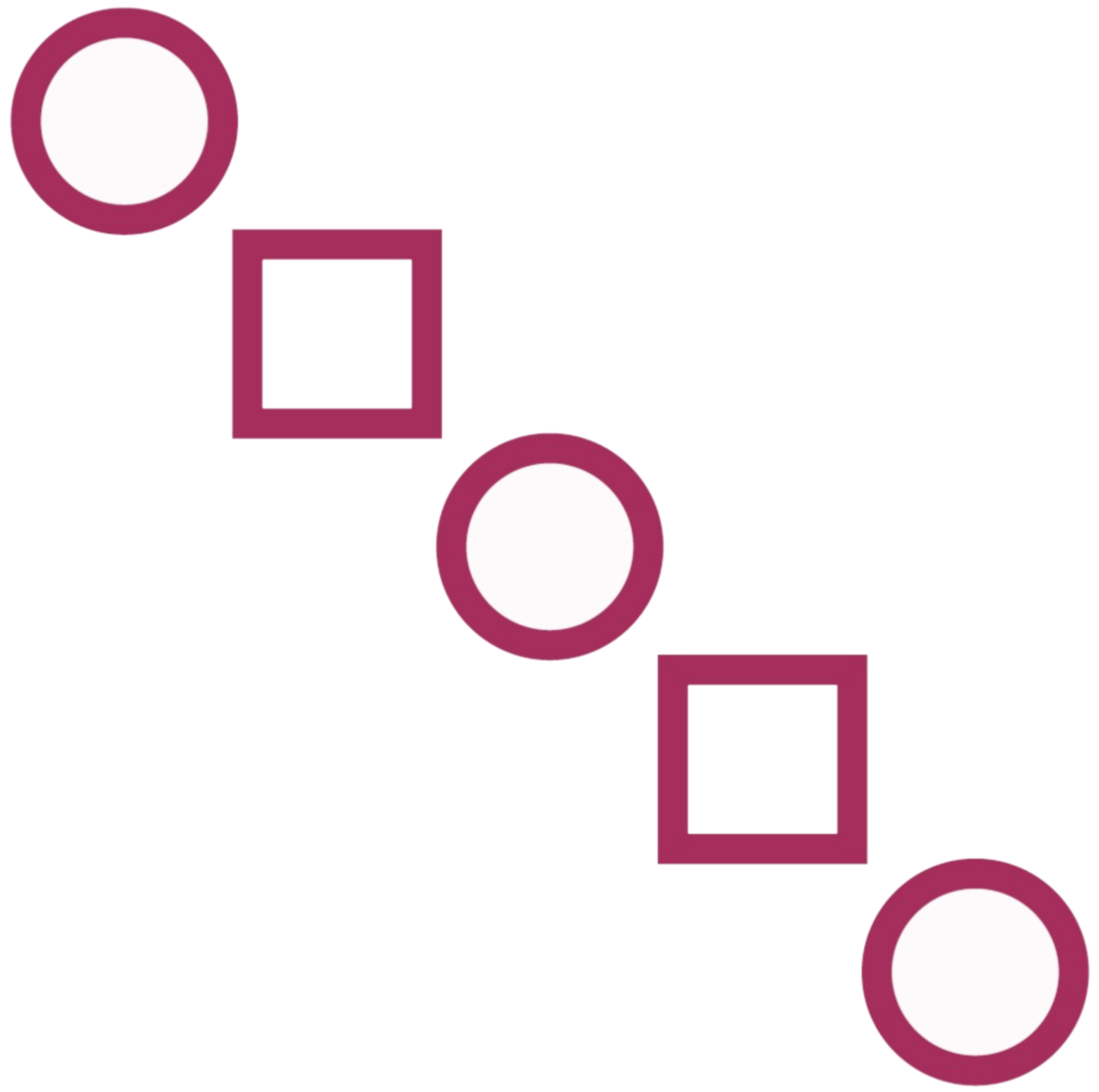
What a type is and what it isn't

How can this be deconstructed?

Does it have a property with a given value?

Which sub-class has been used?

Pattern matching helps to express the intent in **a clear way**



Type

Declaration

Constant

Relational

Logical

Property

Positional

Var

Discard

Parenthesized

Pattern: Type

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider)
{

}
```

Pattern: Declaration

```
if(order.ShippingProvider is SwedishPostalServiceShippingProvider provider)
{

}
```

Capture a local variable as the actual type

Pattern: Constant

```
if(order is { Total: 100 })
{

}

if(provider is { Name: "Swedish Postal Service" })
{

}
```

Pattern: Constant

```
if(order is { Total: 100 })
{

}

if(provider is { Name: "Swedish Postal Service" })
{

}
```

Constants

Pattern: Relational

```
if(order is { Total: >100 })
{

}
```

Pattern: Logical

Pattern: Logical

```
// Negated not
if(order is not CancelledOrder) { }
```

Pattern: Logical

```
// Negated not
if(order is not CancelledOrder) { }

// Disjunctive or
if(order is not (CancelledOrder or ShippedOrder)) { }
```

Pattern: Logical

```
// Negated not
if(order is not CancelledOrder) { }

// Disjunctive or
if(order is not (CancelledOrder or ShippedOrder)) { }

// Conjunctive and
if(order is { Total: >100 and <1000 }) { }
```

Pattern: Negated Not

```
if(order is not null) { }
```

Pattern: Property

```
if(order is { ShippingProvider: SwedishPostalService { FreightCost: 50m } }) { }
```

Pattern: Positional

```
if(order is (>100, true)) { }

if((total, ready) is (>100, true)) { }
```

Pattern: Var

```
var result = GetOrder() switch
{
    var match => ""
};
```

Pattern: Discard

```
var result = GetOrder() switch
{
    (_, true) => "",
    _ => ""
};
```

Case Guards

```
var result = order switch
{
    PriorityOrder when HasAvailability() => "",
    _ => ""
};
```

A **powerful language feature**
that is constantly improved