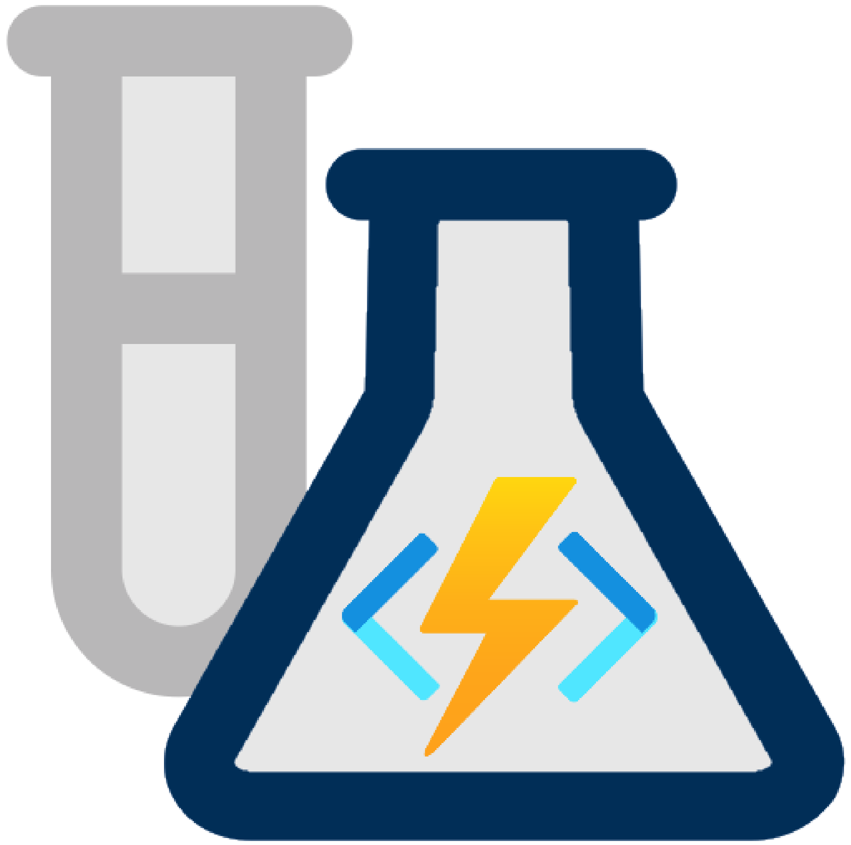
*#PitchOnline presents:*

# The art of Azure Functions (unit) testing and monitoring!



Massimo Bonanni

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Coding

## The art of Azure Functions (unit) testing and monitoring!

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Fabio Mannis

Francesco Del Re

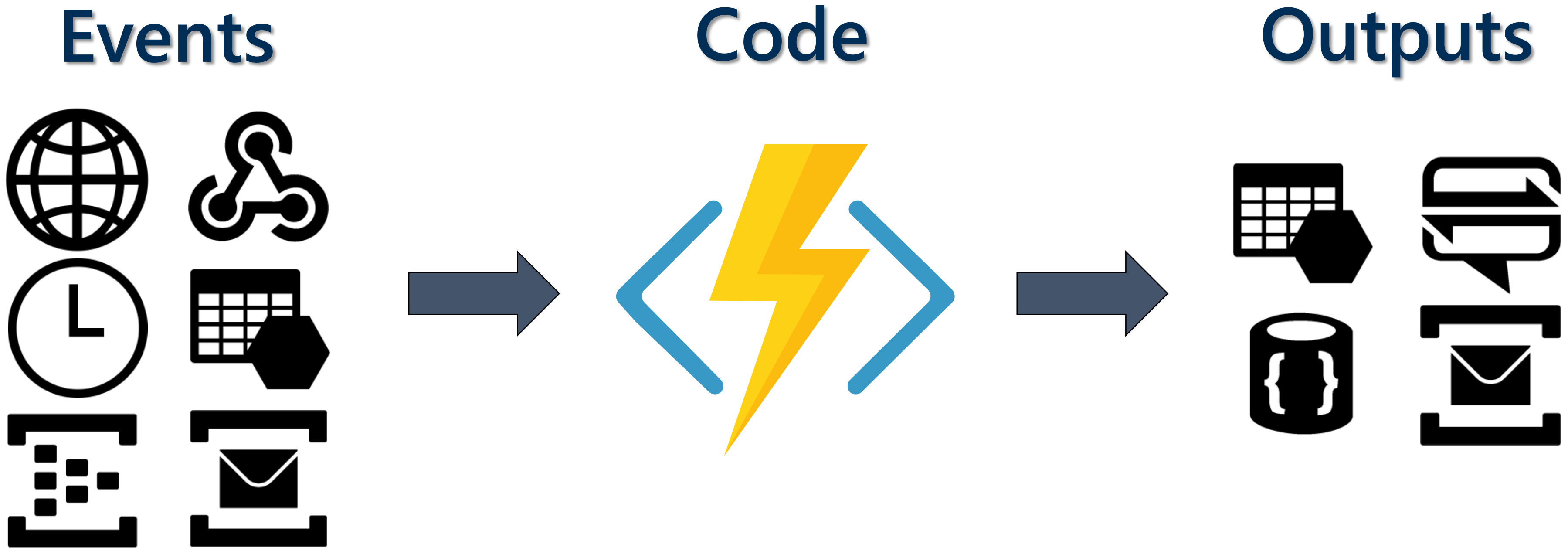
Matteo Riccardi

Valerio Benedetti

## The issue....

If you want to use Azure Functions as components of your Enterprise solutions, you must test and monitor them!!!

## What are Azure Functions



React to timers, HTTP, or events from your favorite Azure services, with more on the way

Author functions in C#, F#, Node.JS, Java, Powershell, and more

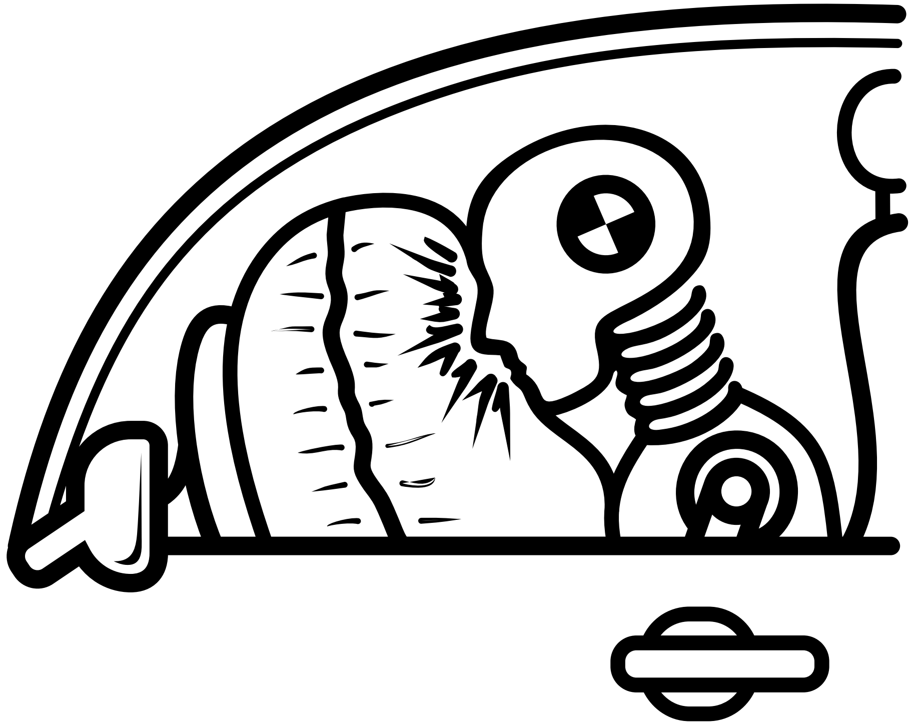
Send results to an ever-growing collection of services

## What is a Unit Test

In a unit test you invoke a piece of your code with a set of parameters and you checks the correctness its behavior.

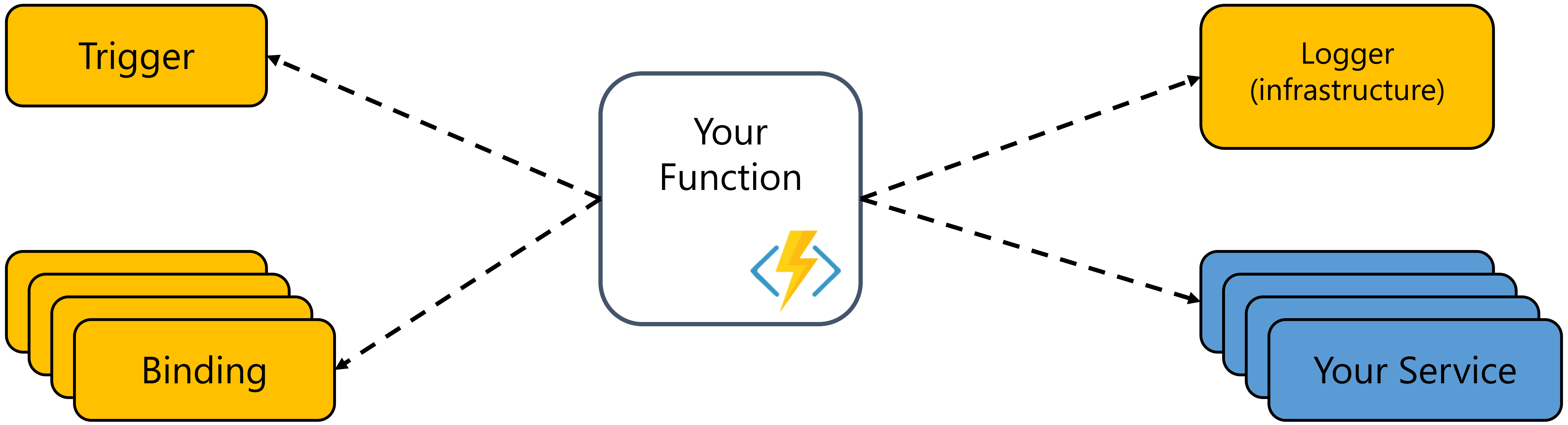
In a unit test you must substitute all your external reference with a mock or stub.

Mock is for the software what a dummy is for a car crash test (you don’t test a car with a human being inside…I Hope!!)

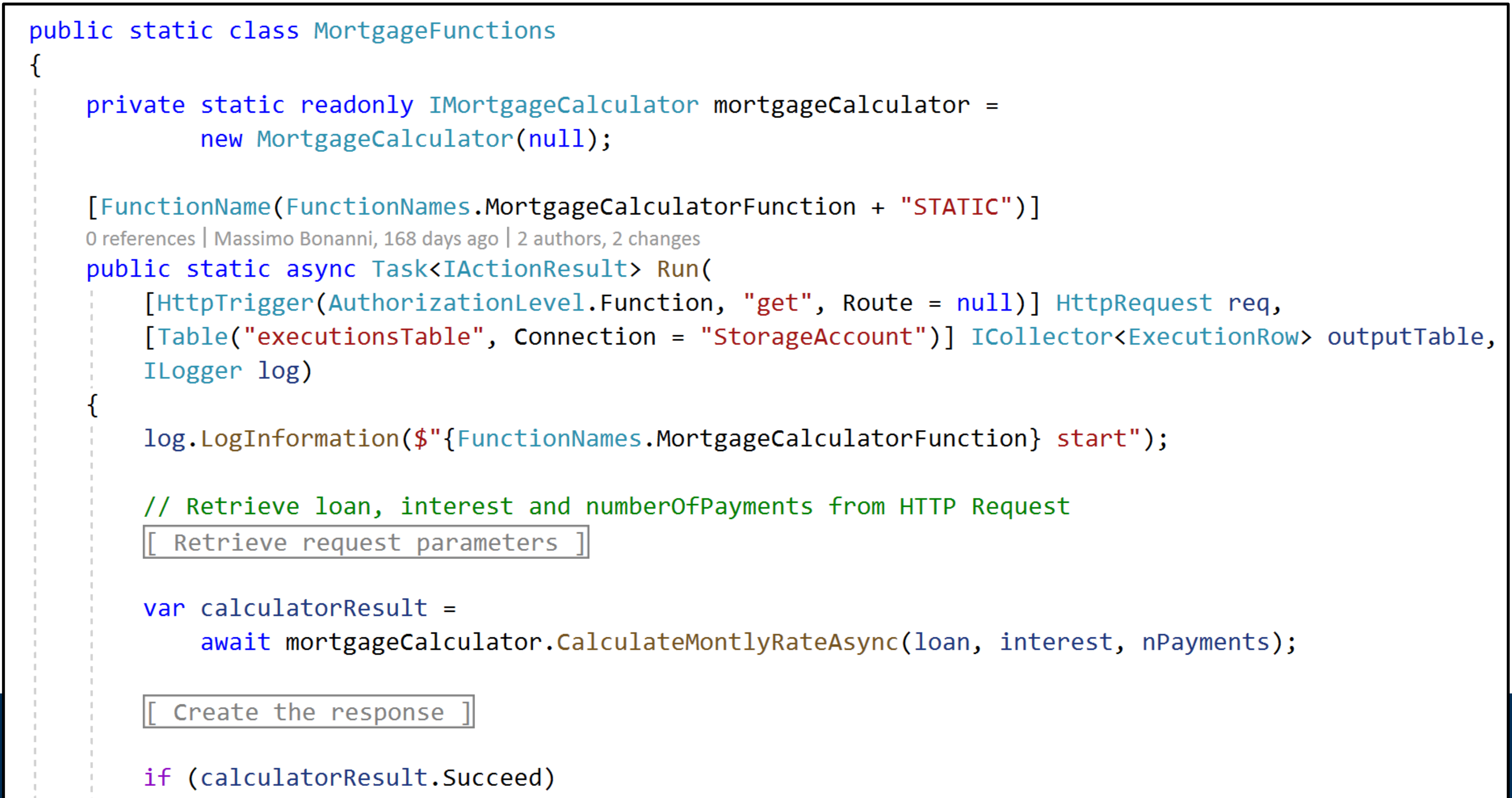


## Azure Functions Dependencies

You **should implement** your Azure Functions to allow you to use mock/stub for all external reference!



# Azure Function … untestable!!



```
public static class MortgageFunctions
{
    private static readonly IMortgageCalculator mortgageCalculator =
            new MortgageCalculator(null);

    [FunctionName(FunctionNames.MortgageCalculatorFunction + "STATIC")]
    0 references | Massimo Bonanni, 168 days ago | 2 authors, 2 changes
    public static async Task<IActionResult> Run(
        [HttpTrigger(AuthorizationLevel.Function, "get", Route = null)] HttpRequest req,
        [Table("executionsTable", Connection = "StorageAccount")] ICollector<ExecutionRow> outputTable,
        ILogger log)
    {
        log.LogInformation($"{FunctionNames.MortgageCalculatorFunction} start");

        // Retrieve loan, interest and numberOfPayments from HTTP Request
        [ Retrieve request parameters ]

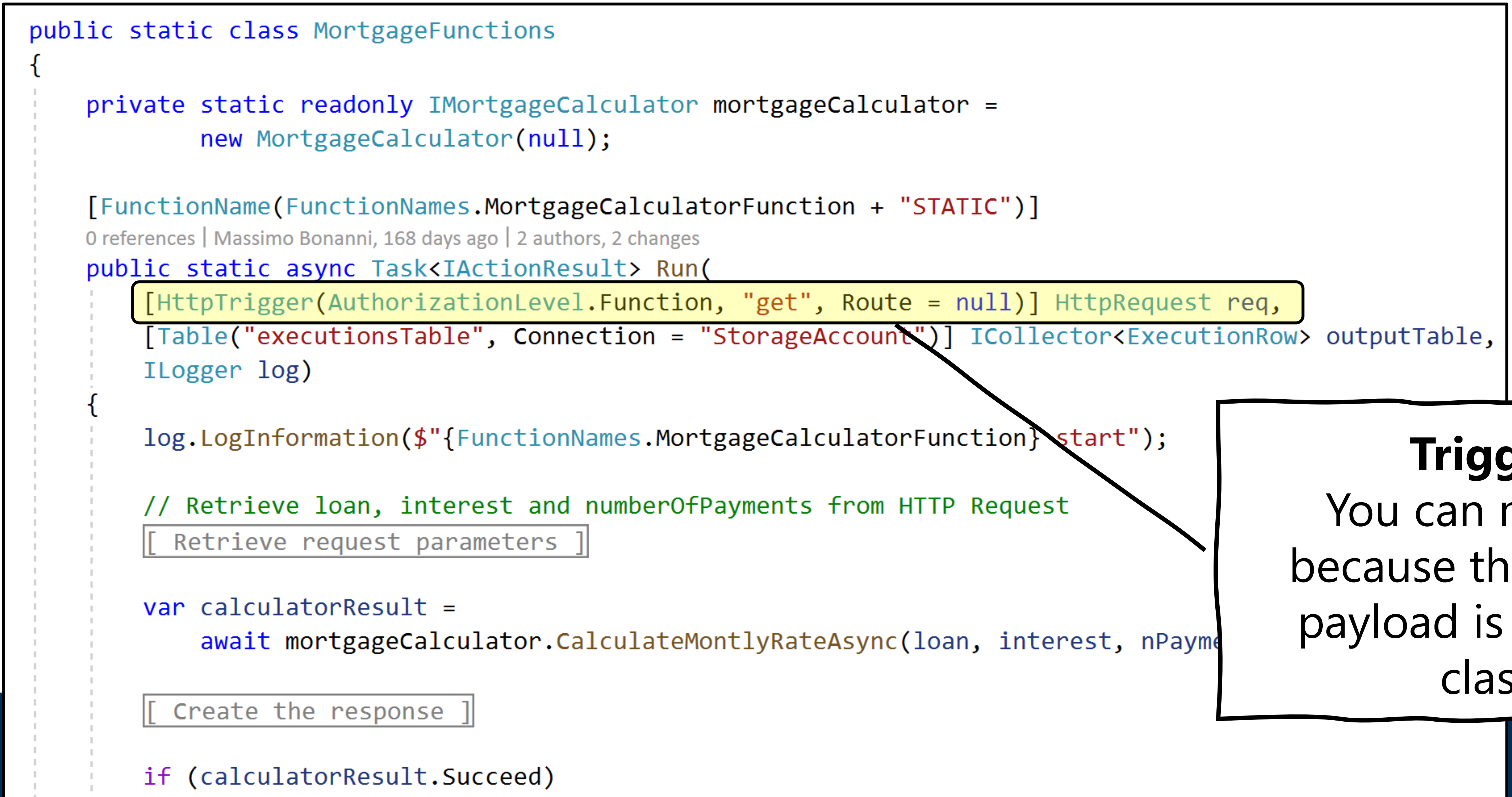
        var calculatorResult =
            await mortgageCalculator.CalculateMontlyRateAsync(loan, interest, nPayments);

        [ Create the response ]

        if (calculatorResult.Succeed)
```

Coding

## Azure Function … trigger!!



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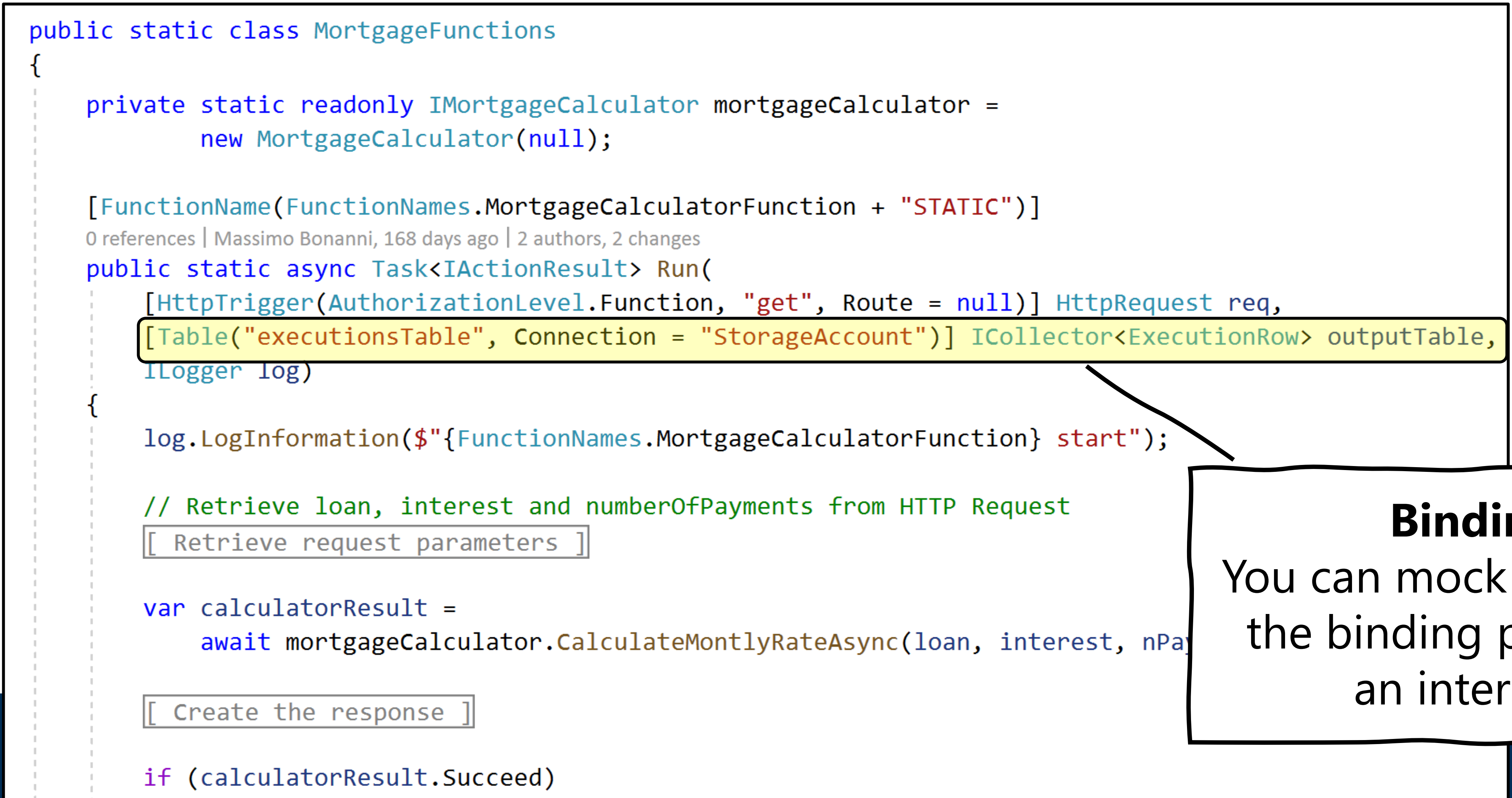
        [ Create the response ]

        if (calculatorResult.Succeed)
```

**Trigger**

You can mock it because the trigger payload is a POCO class

## Azure Function … bindings!!



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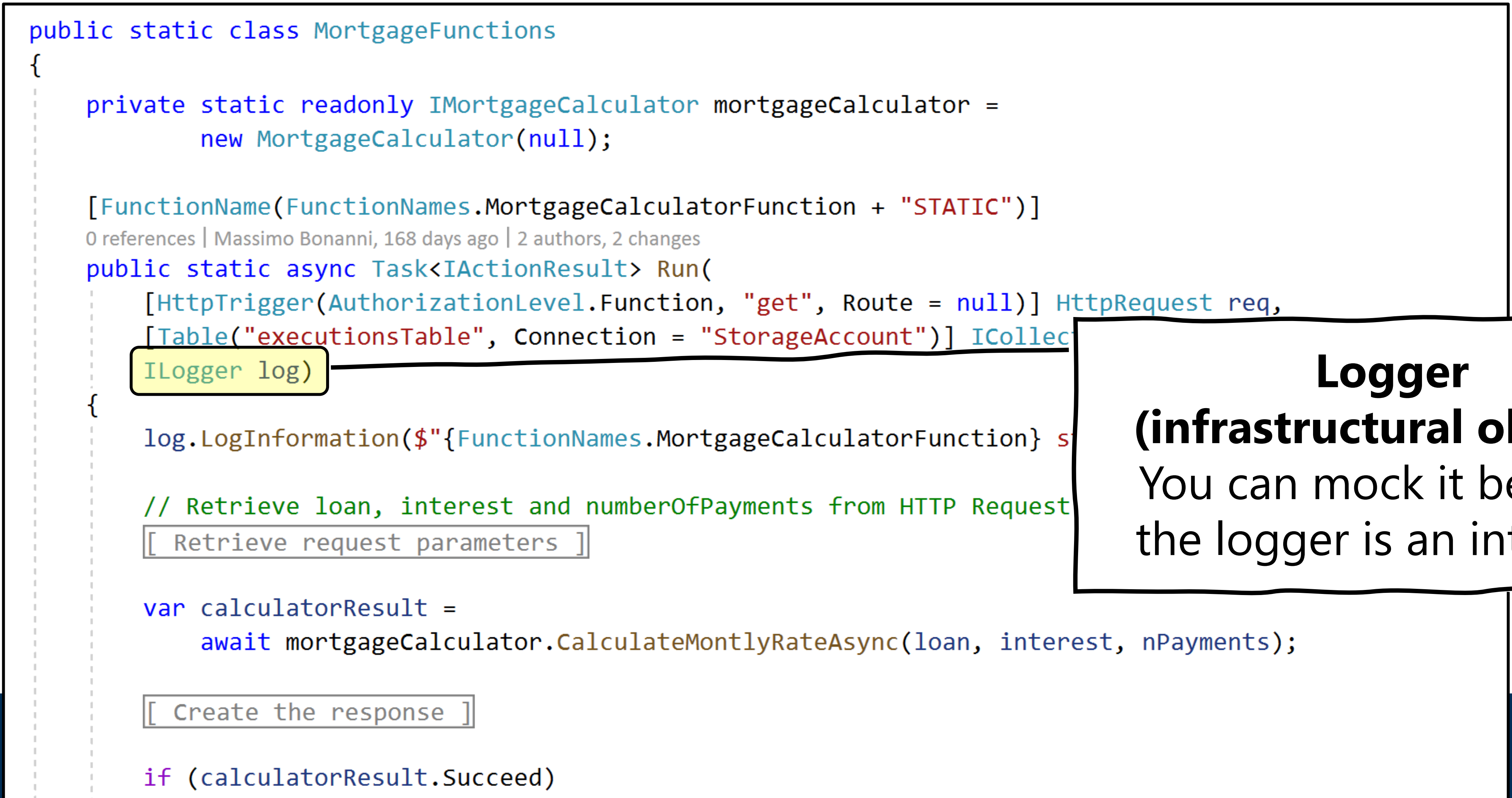
        var calculatorResult =
            await mortgageCalculator.CalculateMontlyRateAsync(loan, interest, nPa

        [ Create the response ]

        if (calculatorResult.Succeed)
```

**Binding**
You can mock it because the binding payload is an interface

## Azure Function … logger!!



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    {
        log.LogInformation($"{FunctionNames.MortgageCalculatorFunction} s

        // Retrieve loan, interest and numberOfPayments from HTTP Request
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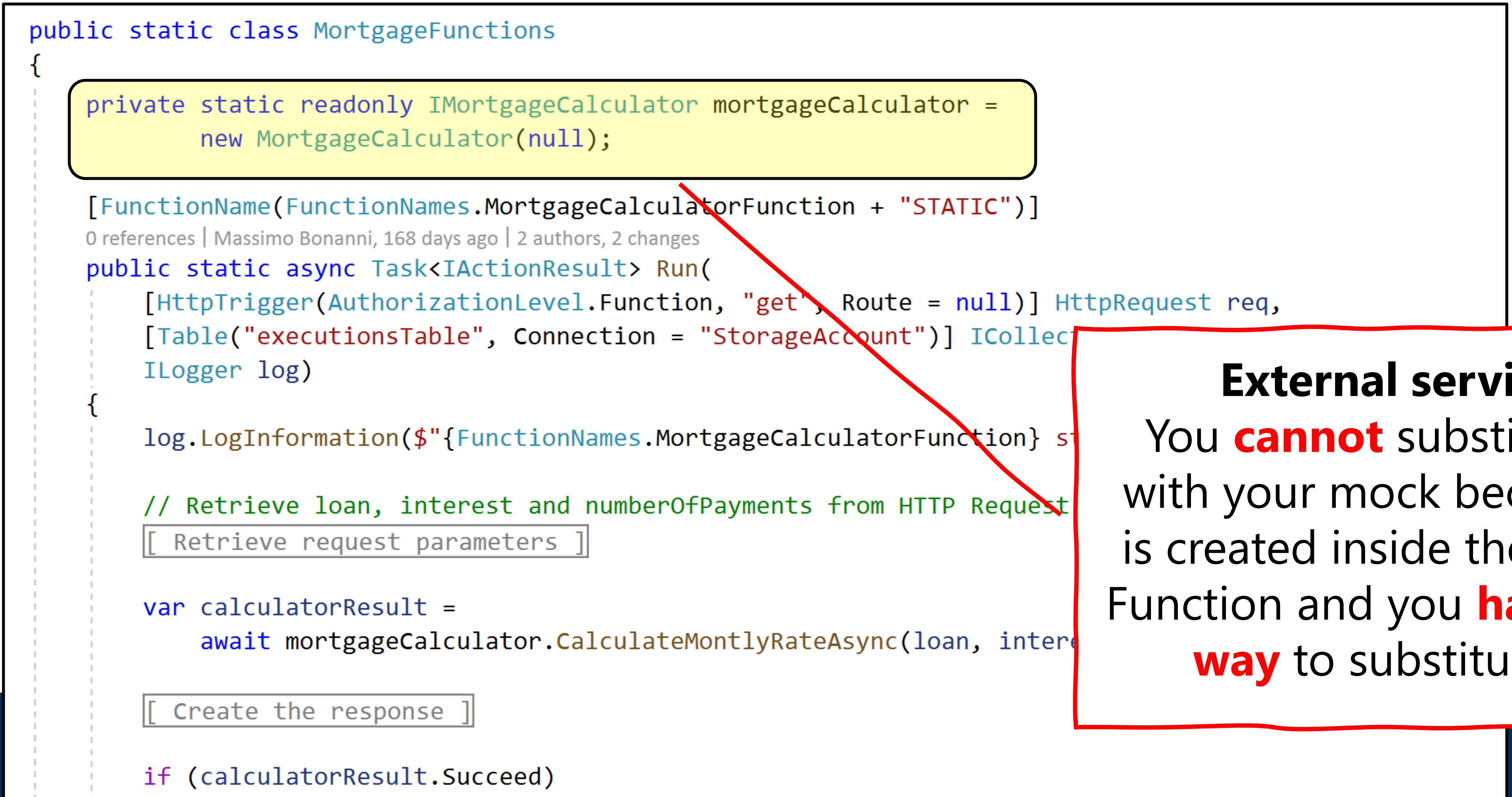
        var calculatorResult =
            await mortgageCalculator.CalculateMontlyRateAsync(loan, interest, nPayments);

        [ Create the response ]

        if (calculatorResult.Succeed)
```

**Logger**
**(infrastructural objects)**
You can mock it because the logger is an interface

# Azure Function … your service!!



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    {
        log.LogInformation($"{FunctionNames.MortgageCalculatorFunction} st

        // Retrieve loan, interest and numberOfPayments from HTTP Request
        [ Retrieve request parameters ]

        var calculatorResult =
            await mortgageCalculator.CalculateMontlyRateAsync(loan, intere

        [ Create the response ]

        if (calculatorResult.Succeed)
```

**External service**

You **cannot** substitute it with your mock because it is created inside the Azure Function and you **haven't a way** to substitute it

## Make your Azure Function testable!!!

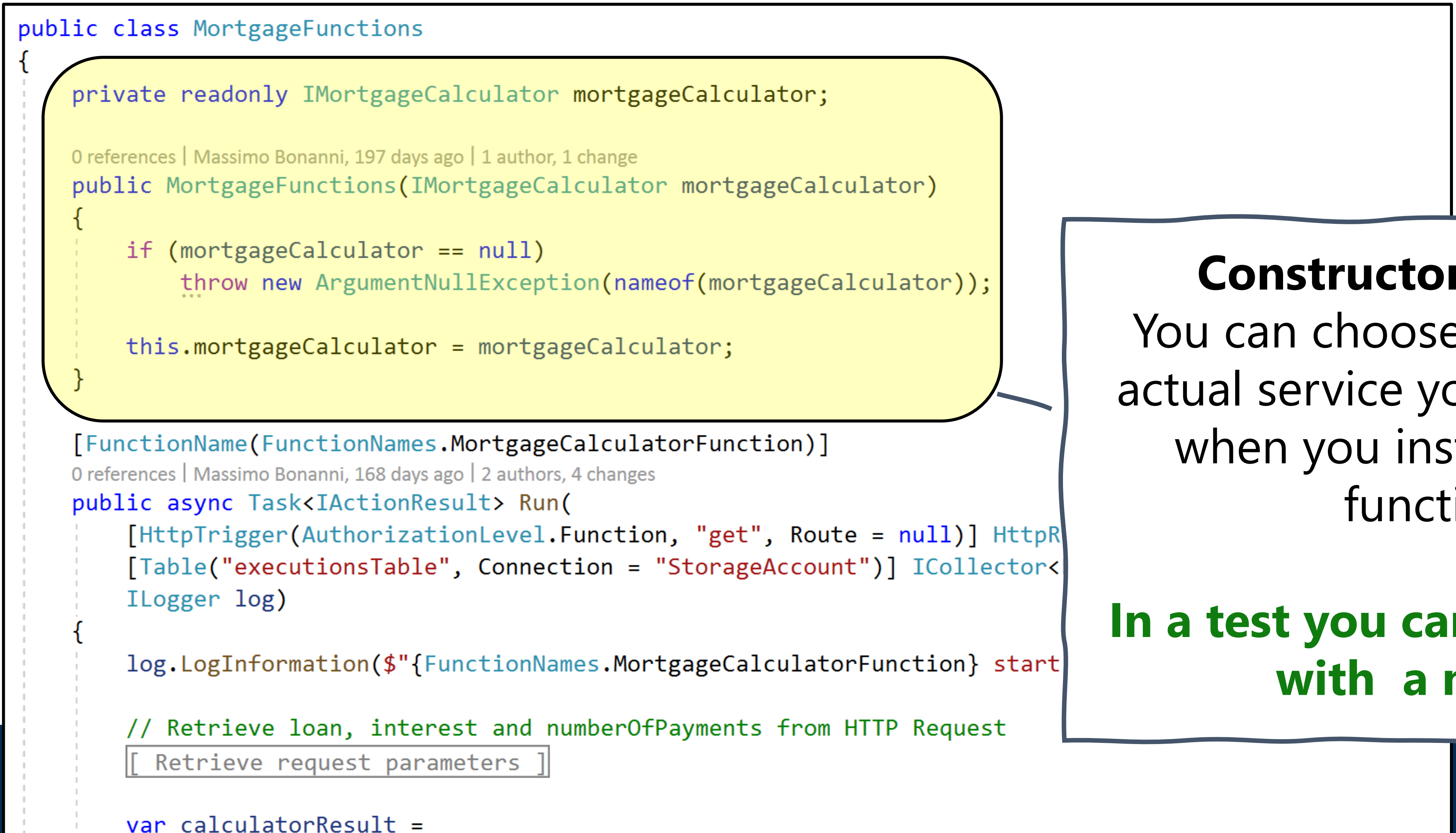
The solution of your problem is: **Dependency Injection** !!

Azure Functions Runtime is based on .NET Core.

Azure Functions support the same ASP.NET Core Dependency Injection!!!

Using Dependency Injection you provide a way to substitute your Services with a mock!

# Azure Function … testable!!



```
public class MortgageFunctions
{
    private readonly IMortgageCalculator mortgageCalculator;

    0 references | Massimo Bonanni, 197 days ago | 1 author, 1 change
    public MortgageFunctions(IMortgageCalculator mortgageCalculator)
    {
        if (mortgageCalculator == null)
            throw new ArgumentNullException(nameof(mortgageCalculator));

        this.mortgageCalculator = mortgageCalculator;
    }

    [FunctionName(FunctionNames.MortgageCalculatorFunction)]
    0 references | Massimo Bonanni, 168 days ago | 2 authors, 4 changes
    public async Task<IActionResult> Run(
        [HttpTrigger(AuthorizationLevel.Function, "get", Route = null)] HttpR
        [Table("executionsTable", Connection = "StorageAccount")] ICollector<
        ILogger log)
    {
        log.LogInformation($"{FunctionNames.MortgageCalculatorFunction} start

        // Retrieve loan, interest and numberOfPayments from HTTP Request
        [ Retrieve request parameters ]

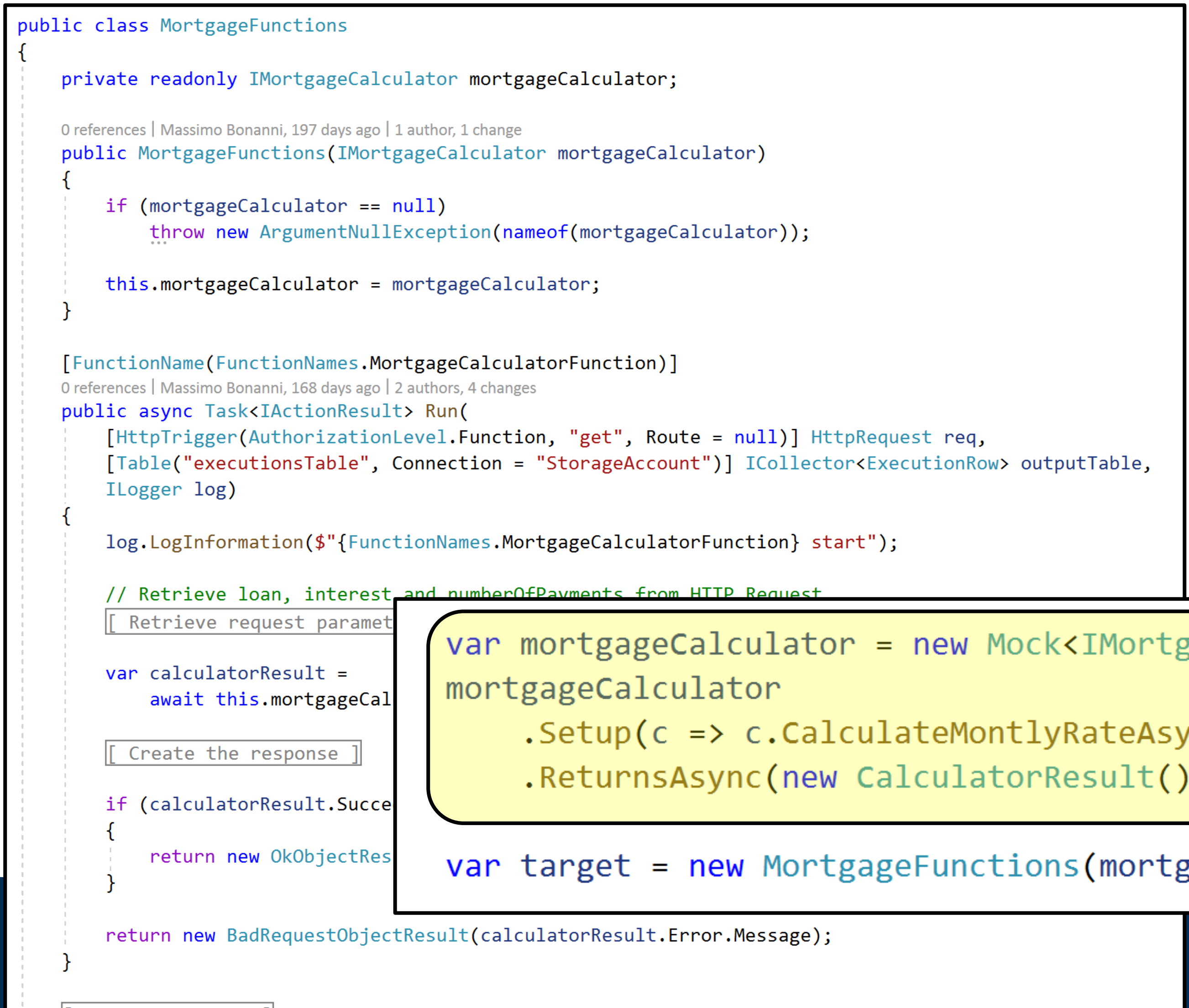
        var calculatorResult =
```

**Constructor Injection**
You can choose what kind of actual service you want to use when you instantiate the function.

**In a test you can substitute it with a mock!!**

Coding

## Azure Function … how to use mock!!



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        if (mortgageCalculator == null)
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        this.mortgageCalculator = mortgageCalculator;
    }

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    public async Task<IActionResult> Run(
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        [Table("executionsTable", Connection = "StorageAccount")] ICollector<ExecutionRow> outputTable,
        ILogger log)
    {
        log.LogInformation($"{FunctionNames.MortgageCalculatorFunction} start");

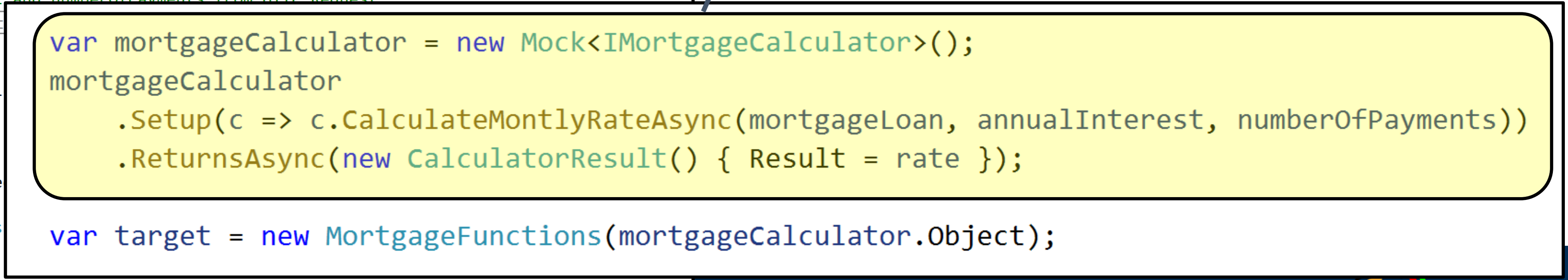
        // Retrieve loan, interest and numberOfPayments from HTTP Request
        [ Retrieve request paramet

        var calculatorResult =
            await this.mortgageCal

        [ Create the response ]

        if (calculatorResult.Succe
        {
            return new OkObjectRes
        }

        return new BadRequestObjectResult(calculatorResult.Error.Message);
    }
```

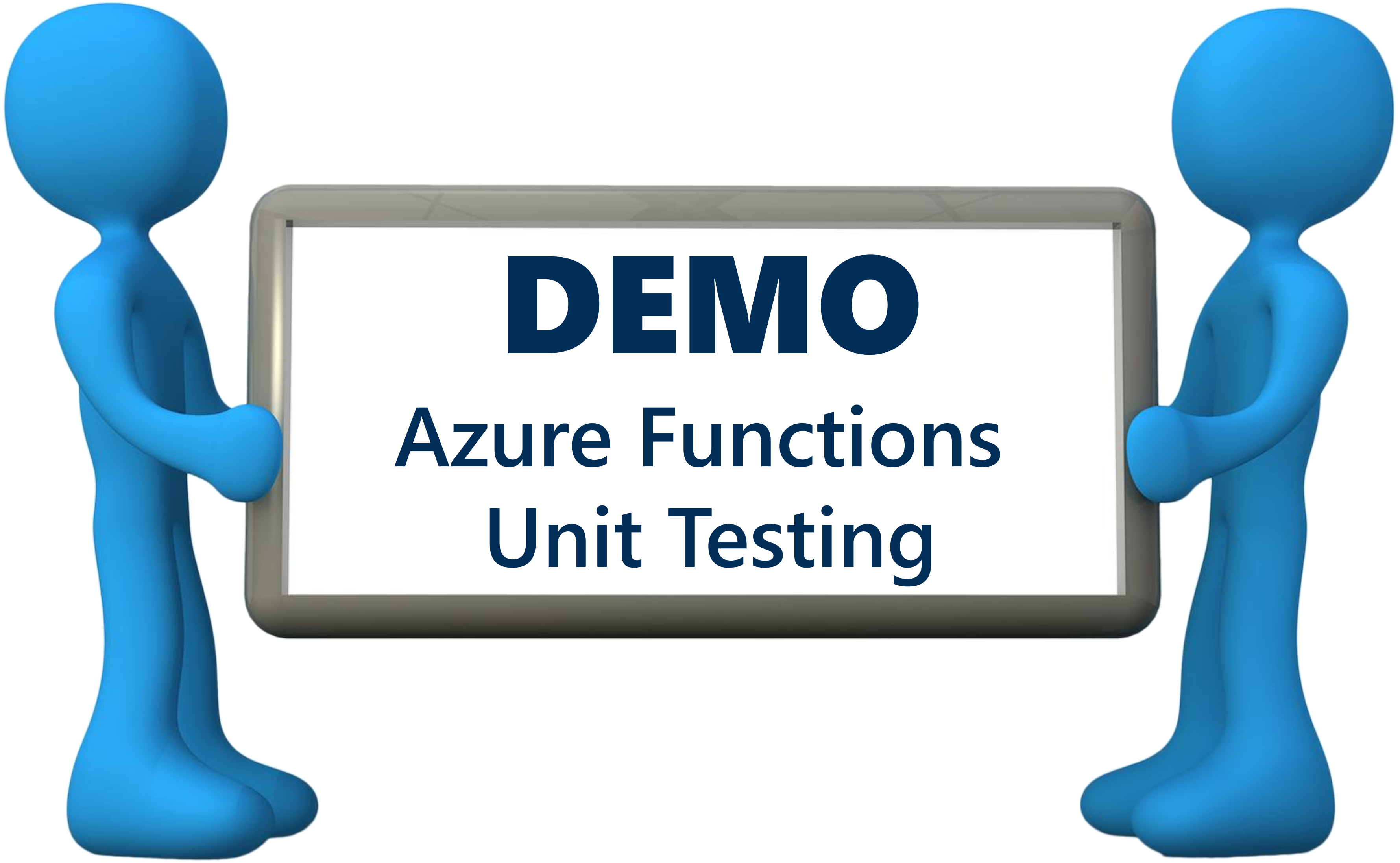


```
var mortgageCalculator = new Mock<IMortgageCalculator>();
mortgageCalculator
    .Setup(c => c.CalculateMontlyRateAsync(mortgageLoan, annualInterest, numberOfPayments))
    .ReturnsAsync(new CalculatorResult() { Result = rate });

var target = new MortgageFunctions(mortgageCalculator.Object);
```

**Mock**

Create a mock to use in the test!!



# DEMO

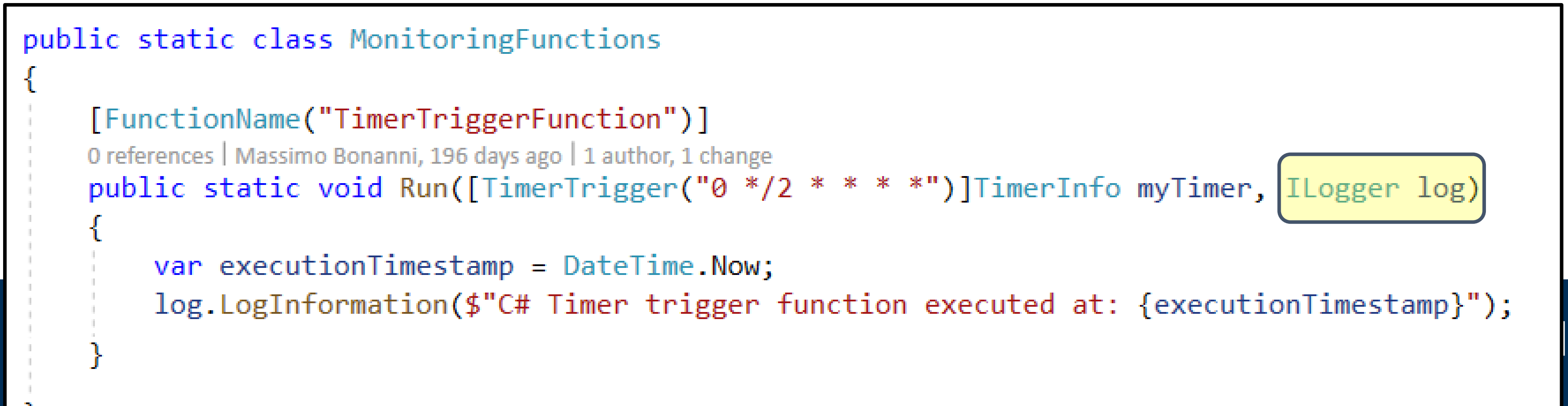
Azure Functions
Unit Testing

## Monitoring Azure Functions

Once you deploy your Azure Functions on Azure, you need to monitor them to check when something goes wrong.

The signature of an Azure Function Run method provides the instance of **ILogger** that you can use to log information about your code.

Using **ILogger**, you can collect information from your code execution to monitor and triage errors and exceptions.

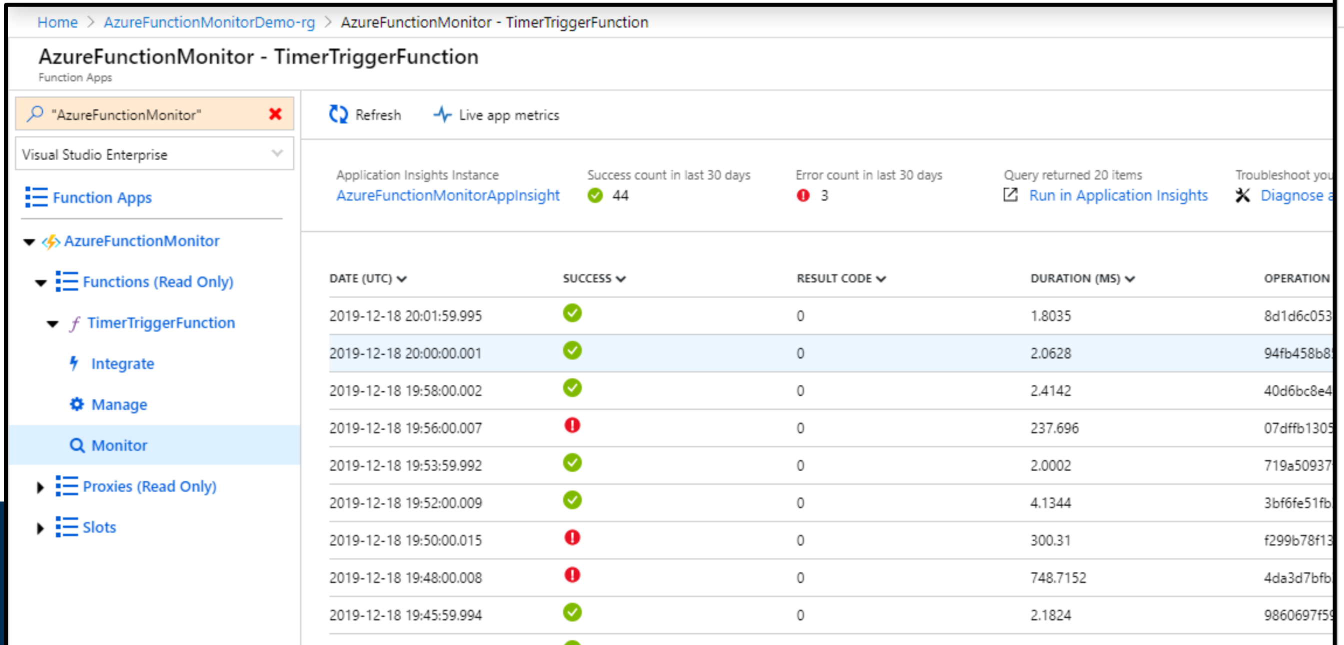


```
public static class MonitoringFunctions
{
    [FunctionName("TimerTriggerFunction")]
    0 references | Massimo Bonanni, 196 days ago | 1 author, 1 change
    public static void Run([TimerTrigger("0 */2 * * * *")]TimerInfo myTimer, ILogger log)
    {
        var executionTimestamp = DateTime.Now;
        log.LogInformation($"C# Timer trigger function executed at: {executionTimestamp}");
    }
```

## Azure Functions Monitor

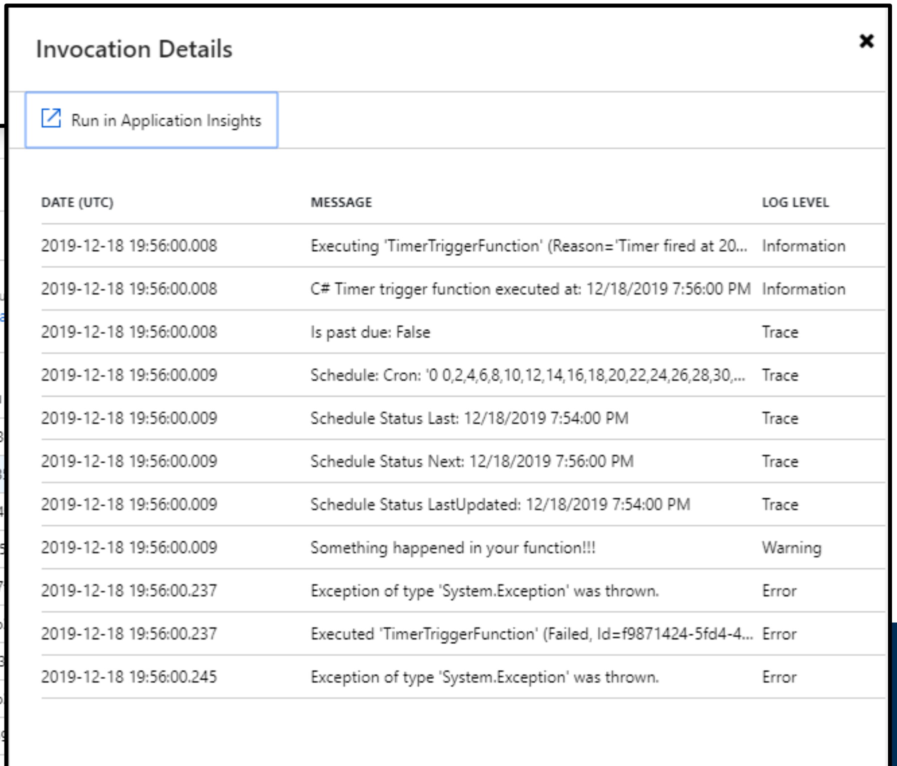
Azure Functions provide out-of-the-box monitor feature.

For each Function, you can have info about every function execution.



Application Insights Instance: AzureFunctionMonitorAppInsight
Success count in last 30 days: ✓ 44
Error count in last 30 days: ● 3
Query returned 20 items: Run in Application Insights
Troubleshoot you: Diagnose a

| DATE (UTC) | SUCCESS | RESULT CODE | DURATION (MS) | OPERATION |
|---|---|---|---|---|
| 2019-12-18 20:01:59.995 | ✓ | 0 | 1.8035 | 8d1d6c053 |
| 2019-12-18 20:00:00.001 | ✓ | 0 | 2.0628 | 94fb458b8 |
| 2019-12-18 19:58:00.002 | ✓ | 0 | 2.4142 | 40d6bc8e4 |
| 2019-12-18 19:56:00.007 | ● | 0 | 237.696 | 07dffb1305 |
| 2019-12-18 19:53:59.992 | ✓ | 0 | 2.0002 | 719a50937 |
| 2019-12-18 19:52:00.009 | ✓ | 0 | 4.1344 | 3bf6fe51fb |
| 2019-12-18 19:50:00.015 | ● | 0 | 300.31 | f299b78f13 |
| 2019-12-18 19:48:00.008 | ● | 0 | 748.7152 | 4da3d7bfb |
| 2019-12-18 19:45:59.994 | ✓ | 0 | 2.1824 | 9860697f5 |

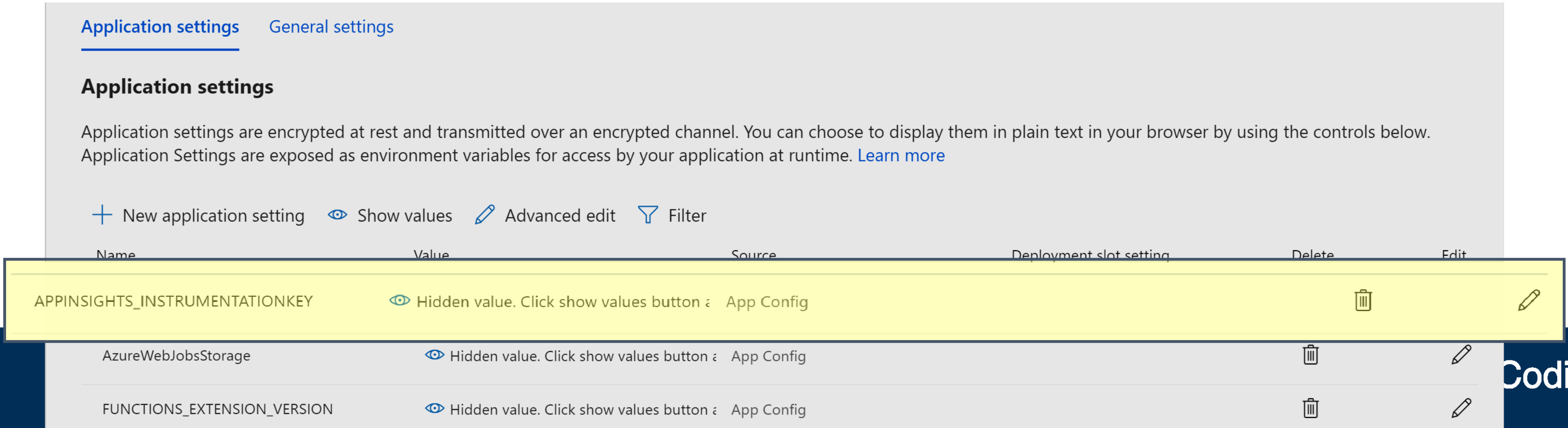


| DATE (UTC) | MESSAGE | LOG LEVEL |
|---|---|---|
| 2019-12-18 19:56:00.008 | Executing 'TimerTriggerFunction' (Reason='Timer fired at 20... | Information |
| 2019-12-18 19:56:00.008 | C# Timer trigger function executed at: 12/18/2019 7:56:00 PM | Information |
| 2019-12-18 19:56:00.008 | Is past due: False | Trace |
| 2019-12-18 19:56:00.009 | Schedule: Cron: '0 0,2,4,6,8,10,12,14,16,18,20,22,24,26,28,30,... | Trace |
| 2019-12-18 19:56:00.009 | Schedule Status Last: 12/18/2019 7:54:00 PM | Trace |
| 2019-12-18 19:56:00.009 | Schedule Status Next: 12/18/2019 7:56:00 PM | Trace |
| 2019-12-18 19:56:00.009 | Schedule Status LastUpdated: 12/18/2019 7:54:00 PM | Trace |
| 2019-12-18 19:56:00.009 | Something happened in your function!!! | Warning |
| 2019-12-18 19:56:00.237 | Exception of type 'System.Exception' was thrown. | Error |
| 2019-12-18 19:56:00.237 | Executed 'TimerTriggerFunction' (Failed, Id=f9871424-5fd4-4... | Error |
| 2019-12-18 19:56:00.245 | Exception of type 'System.Exception' was thrown. | Error |

## Azure Functions and Application Insight

The Azure Functions platform offers built-in integration with Azure Application Insights.

Put the **Application Insights instrumentation key** in the function app settings.



Application settings | General settings

**Application settings**

Application settings are encrypted at rest and transmitted over an encrypted channel. You can choose to display them in plain text in your browser by using the controls below. Application Settings are exposed as environment variables for access by your application at runtime. Learn more

+ New application setting | Show values | Advanced edit | Filter

| Name | Value | Source | Deployment slot setting | Delete | Edit |
|---|---|---|---|---|---|
| APPINSIGHTS_INSTRUMENTATIONKEY | Hidden value. Click show values button a | App Config | | | |
| AzureWebJobsStorage | Hidden value. Click show values button a | App Config | | | |
| FUNCTIONS_EXTENSION_VERSION | Hidden value. Click show values button a | App Config | | | |

## Configure monitoring

Logging is configured in **`host.json`** file.

Logger default level

Logger level for all the functions in Function App

Logger level for a specific function in Function App

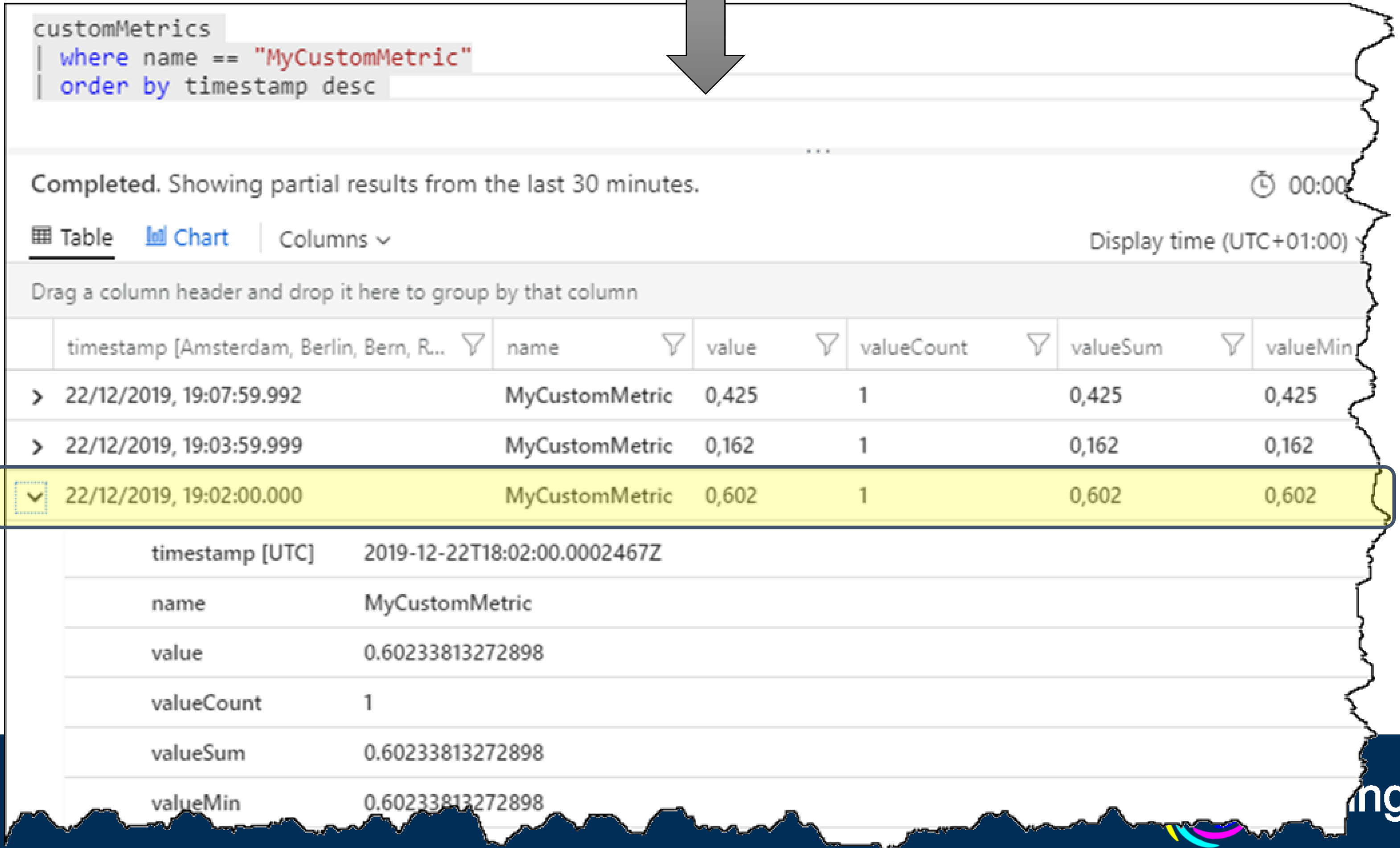
Logger category for .NET runtime components invoked by the host

```json
{
  "version": "2.0",
  "logging": {
    "fileLoggingMode": "always",
    "logLevel": {
      "default": "Trace",
      "Function": "Trace",
      "Function.TimerTriggerFunction": "Information",
      "Microsoft": "Information",
      "Host.Results": "Information",
      "Host.Aggregator": "Error"
    }
  }
}
```

# Custom Metrics

Azure Function SDK provides you extension methods to log custom metrics.

```
log.LogMetric("MyCustomMetric", CalculateMyCustomMetric());
```



```
customMetrics
| where name == "MyCustomMetric"
| order by timestamp desc
```

**Completed.** Showing partial results from the last 30 minutes.

Table | Chart | Columns | Display time (UTC+01:00)

Drag a column header and drop it here to group by that column

| timestamp [Amsterdam, Berlin, Bern, R... | name | value | valueCount | valueSum | valueMin |
|---|---|---|---|---|---|
| 22/12/2019, 19:07:59.992 | MyCustomMetric | 0,425 | 1 | 0,425 | 0,425 |
| 22/12/2019, 19:03:59.999 | MyCustomMetric | 0,162 | 1 | 0,162 | 0,162 |
| 22/12/2019, 19:02:00.000 | MyCustomMetric | 0,602 | 1 | 0,602 | 0,602 |

| | |
|---|---|
| timestamp [UTC] | 2019-12-22T18:02:00.0002467Z |
| name | MyCustomMetric |
| value | 0.60233813272898 |
| valueCount | 1 |
| valueSum | 0.60233813272898 |
| valueMin | 0.60233813272898 |

## Pricing

Azure Functions consumption plan is billed based on per-second resource consumption and executions

| METER | PRICE | FREE GRANT (PER MONTH) |
|---|---|---|
| Execution Time* | €0.000014/GB-s | 400,000 GB-s |
| Total Executions* | €0.169 per million executions | 1 million executions |

## Pricing

Azure Functions consumption plan is billed based on per-second **resource consumption** and **executions**

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|---|---|---|
| Execution Time* | €0.000014/GB-s | |
| Total Executions* | €0.169 per million executi | |

If your function use 1GB of memory and its duration is 1 second, you pay €0.000014 each time the function runs.

## Pricing

Azure Functions consumption plan is billed b
**resource consumption** and **executions**

| METER | PRICE | |
|---|---|---|
| Execution Time* | €0.000014/GB-s | 400,000 GB-s |
| Total Executions* | €0.169 per million executions | 1 million executions |

If your function runs 1 million times every month, you pay €0.169 each month.

## Pricing - Example

You have a function:

- It runs every second
- Its duration is 1 second
- It uses 512 MB of memory

## Resource Consumption Billing Calculation

- It runs every second
- Its duration is 1 second
- It uses 512 MB of memory

| | |
|---|---|
| Executions | 2,592,000 |
| Resource Consumption Total | 2,592,000 x 1 sec = 2,592,000 sec |
| Total GB-s | 2,592,000 x 0.5 GB = 1,296,000 GB-s |
| Total billable consumption | 1,296,000 – 400,000 = 896,000 GB-s |
| Total cost | 896,000 x 0.000014€ = **12.54 €** |

## Executions billing calculation

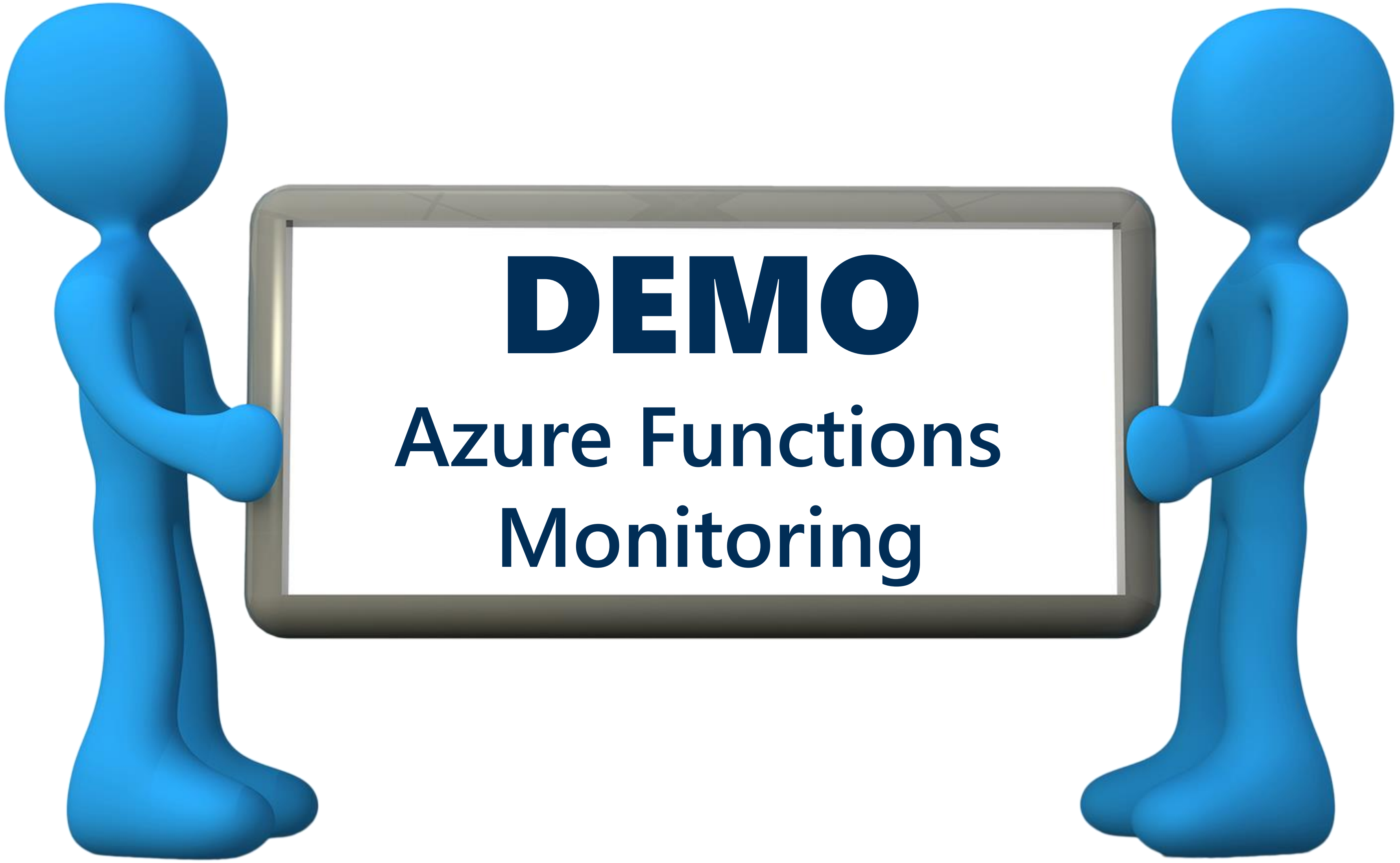
- It runs every second
- Its duration is 1 second
- It uses 512 MB of memory

| | |
|---|---|
| Billable Monthly Executions | 2,592,000 – 1,000,000 = 1,592,000 |
| Total cost | 1.592 x 0.169 € = **0.269 €** |

## Total Monthly Cost

- It runs every second
- Its duration is 1 second
- It uses 512 MB of memory

| | |
|---|---|
| Monthly resource consumption cost | **12.540 €** |
| Monthly executions cost | **0.269 €** |
| **Total monthly cost** | **12.809 €** |



# DEMO

Azure Functions Monitoring

Photo by Aaron Burden on Unsplash

## Takeaway

- Write an Azure Functions is **simple**!
- Testing Azure Functions is **simple**!
- Monitoring Azure Functions is **simple**!
- .... *then* ....

KEEP
CALM
AND
USE
AZURE FUNCTIONS

Mastering
Azure Serverless Computing

A practical guide to build and deploy enterprise-grade serverless applications using Azure Functions

Lorenzo Barbieri and Massimo B

**http://bit.ly/MasteringServerless**

Connect with me on LinkedIn

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## Massimo Bonanni

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Microsoft Certified Azure Data Fundamentals
Microsoft Certified Azure AI Fundamentals
Microsoft Certified Azure Developer Associate
Microsoft Certified Azure Administrator Associate
Microsoft Certified Azure AI Engineer Associate
Microsoft Certified Azure Solutions Architect Expert
Microsoft Certified Azure DevOps Engineer Expert
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## References

- Azure Functions Documentation
  https://docs.microsoft.com/en-US/azure/azure-functions/
- Azure Functions Code Samples
  https://azure.microsoft.com/en-us/resources/samples/?service=functions&sort=0
- Azure Updates
  https://azure.microsoft.com/en-us/roadmap/?category=compute
- Azure Friday – Build Serverless APIs with Azure Functions
  https://azure.microsoft.com/en-us/resources/videos/azure-friday-build-serverless-apis-with-azure-functions/
- GitHub Demo
  https://github.com/massimobonanni/AzureFunctionsSamples

# Coding

*Thank You!*

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