



Microsoft Ignite The Tour



BRK30167

The art of Azure Functions (unit) testing and monitoring



Massimo Bonanni

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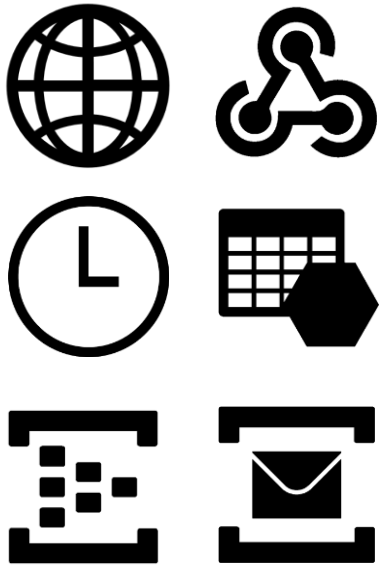
The issue....

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



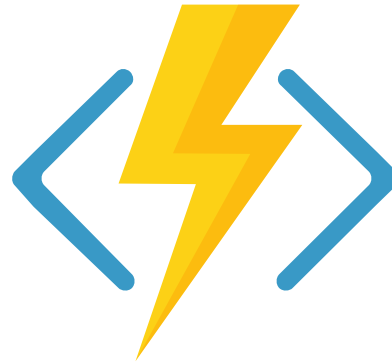
What are Azure Functions

Events



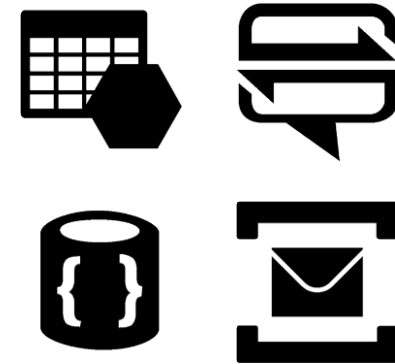
React to timers, HTTP, or events from your favorite Azure services, with more on the way

Code



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

Outputs



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 check the correctness of its behavior.

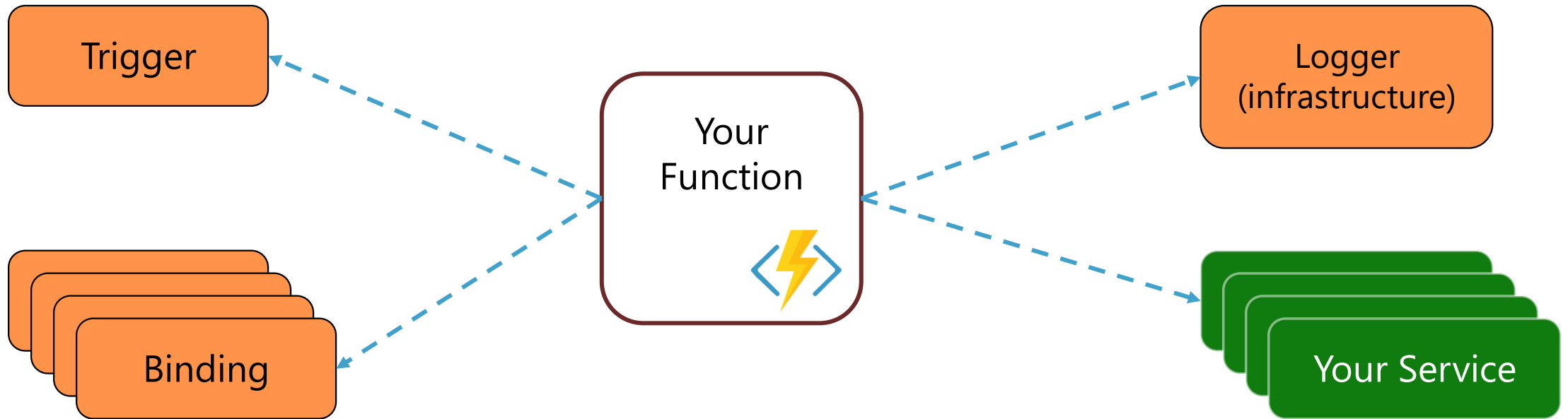
In a **unit test** you must substitute all your external reference with a **mock** or **stub**.

***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")]
    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)
        {
            return new OkObjectResult(calculatorResult.Result);
        }

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

    [ Private Methods ]
}
```

Azure Function ... trigger!!

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

    [FunctionName(FunctionNames.MortgageCalculatorFunction + "STATIC")]
    public static async Task<IActionResult> Run(
        [HttpTrigger(AuthorizationLevel.Function, "get", Route = null)] HttpRequest req,
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        ILogger log)
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        var calculatorResult =
            await mortgageCalculator.CalculateMontlyRateAsync(loan, interest, nPaym

        [ Create the response ]

        if (calculatorResult.Succeed)
        {
            return new OkObjectResult(calculatorResult.Result);
        }
    }
}
```

Trigger

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

Azure Function ... bindings!!

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

    [FunctionName(FunctionNames.MortgageCalculatorFunction + "STATIC")]
    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, nPaym

        [ Create the response ]

        if (calculatorResult.Succeed)
        {
            return new OkObjectResult(calculatorResult.Result);
        }
    }
}
```

Binding

You can mock it because
the binding payload is an
interface

Azure Function ... logger!!

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

    [FunctionName(FunctionNames.MortgageCalculatorFunction + "STATIC")]
    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, nP);

        [ Create the response ]

        if (calculatorResult.Succeed)
        {
            return new OkObjectResult(calculatorResult.Result);
        }
    }
}
```

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

Azure Function ... your service!!

```
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  
    [Table("executionsTable", Connection = "StorageAccount")] ICollector<Execut  
    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)  
{  
    return new OkObjectResult(calculatorResult.Result);  
}
```

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

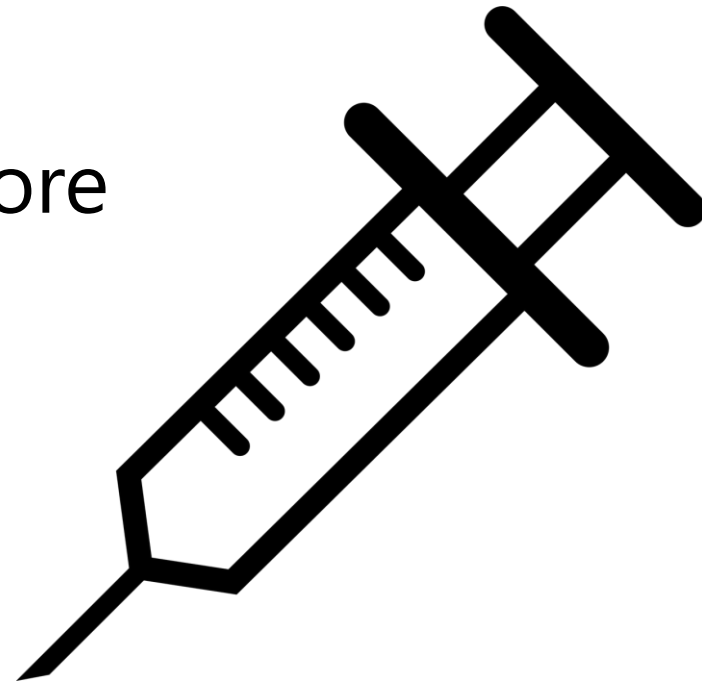
Make your Azure Function testable!!!

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)] HttpRequest request,
        [Table("executionsTable", Connection = "StorageAccount")] ICollection<Execution> executions,
        ILogger log)
    {
        log.LogInformation($"[{FunctionNames.MortgageCalculatorFunction}] started");

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

        var calculatorResult =
            await this.mortgageCalculator.CalculateMontlyRateAsync(loan, i
```

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!!

Azure Function ... how to use mock!!

```
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)] 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 this.mortgageCal

        [ Create the response ]

        if (calculatorResult.Succes
        {
            return new OkObjectRes
        }

        return new BadRequestObjec

    }

    [ Private Methods ]
}
```

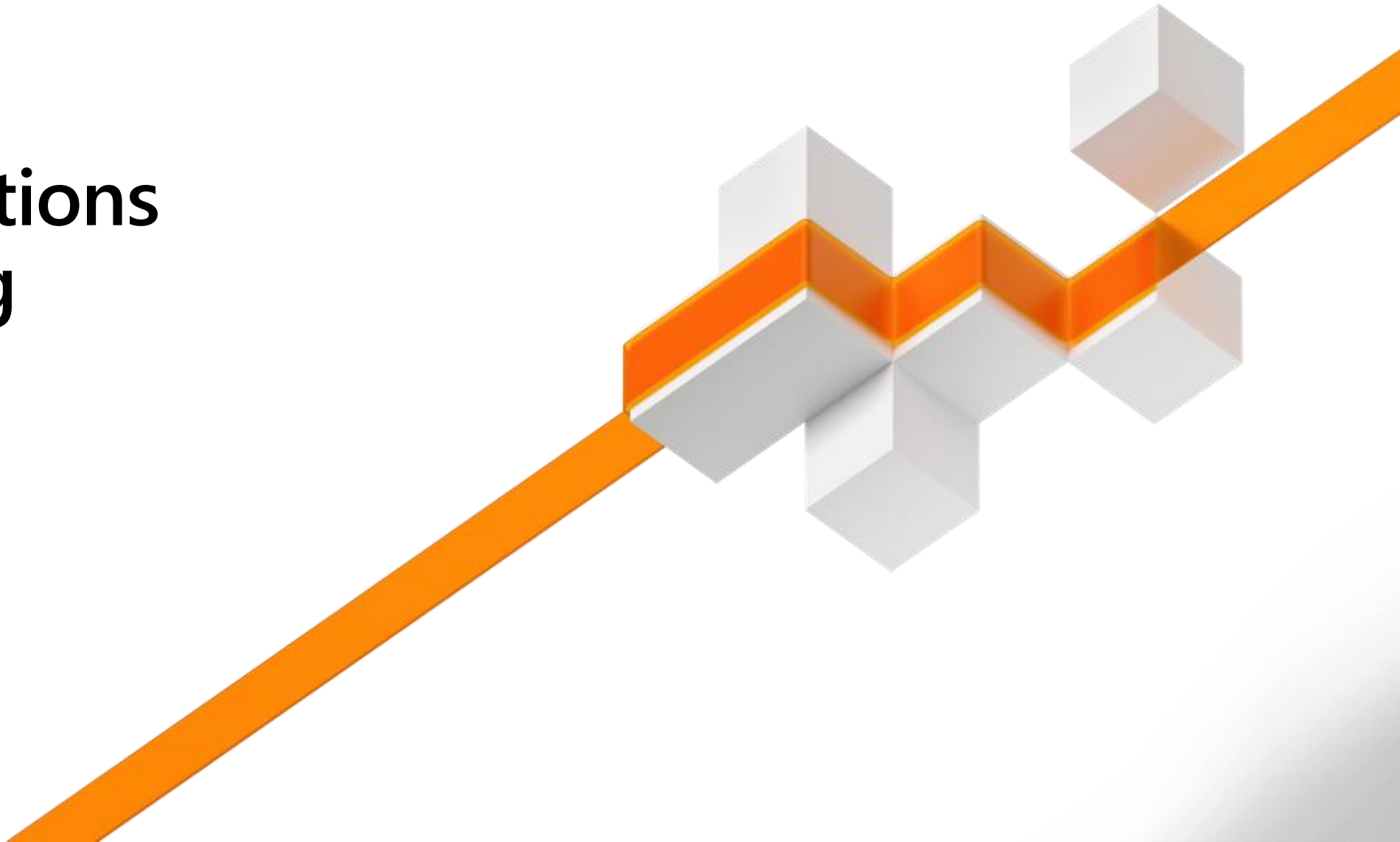
Mock
Create a mock to use in the test!!

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

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

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.

Home > AzureFunctionMonitorDemo-rg > AzureFunctionMonitor - TimerTriggerFunction

AzureFunctionMonitor - TimerTriggerFunction

Function Apps

"AzureFunctionMonitor" ✖

Visual Studio Enterprise

Function Apps

AzureFunctionMonitor

Functions (Read Only)

TimerTriggerFunction

Integrate

Manage

Monitor

Proxies (Read Only)

Slots

Refresh Live app metrics

Application Insights Instance AzureFunctionMonitorAppInsight

Success count in last 30 days 44

Error count in last 30 days 3

Query returned 20 items

Troubleshoot your app

Run in Application Insights

Diagnose and solve problems

DATE (UTC)	SUCCESS	RESULT CODE	DURATION (MS)	OPERATION ID
2019-12-18 20:01:59.995	✓	0	1.8035	8d1d6c053598024eb328527b2519753
2019-12-18 20:00:00.001	✓	0	2.0628	94fb458b85829340bd9602d8061a0c6
2019-12-18 19:58:00.002	✓	0	2.4142	40d6bc8e49d6c84093c7bbe88e2211c4
2019-12-18 19:56:00.007	✗	0	237.696	07dff1305bd5e4ea3426ed7b2a88a3d
2019-12-18 19:53:59.992	✓	0	2.0002	719a50937f8b8242bdf4664226322dd0
2019-12-18 19:52:00.009	✓	0	4.1344	3bf6fe51fb360540b20640e8f161a8e1
2019-12-18 19:50:00.015	✗	0	300.31	f299b78f1338b3418837990e8e884717
2019-12-18 19:48:00.008	✗	0	748.7152	4da3d7bf3a28042b7cc35a9345f40fa
2019-12-18 19:45:59.994	✓	0	2.1824	9860697f594d9e4a91ec250b5a1a7184
2019-12-18 19:43:59.999	✓	0	2.3494	d015a5473ecb534f8e423ee3a8c7b194
2019-12-18 19:42:00.000	✓	0	3.7738	02b6caabbcb5154d85e1fe4984e1d880
2019-12-18 19:40:00.001	✓	0	2.0733	76506ff922677e4280b21a3f27aa7679
2019-12-18 19:38:00.006	✓	0	2.9773	1092778a6f0e5e4ca57b4552c88d8720

Invocation Details

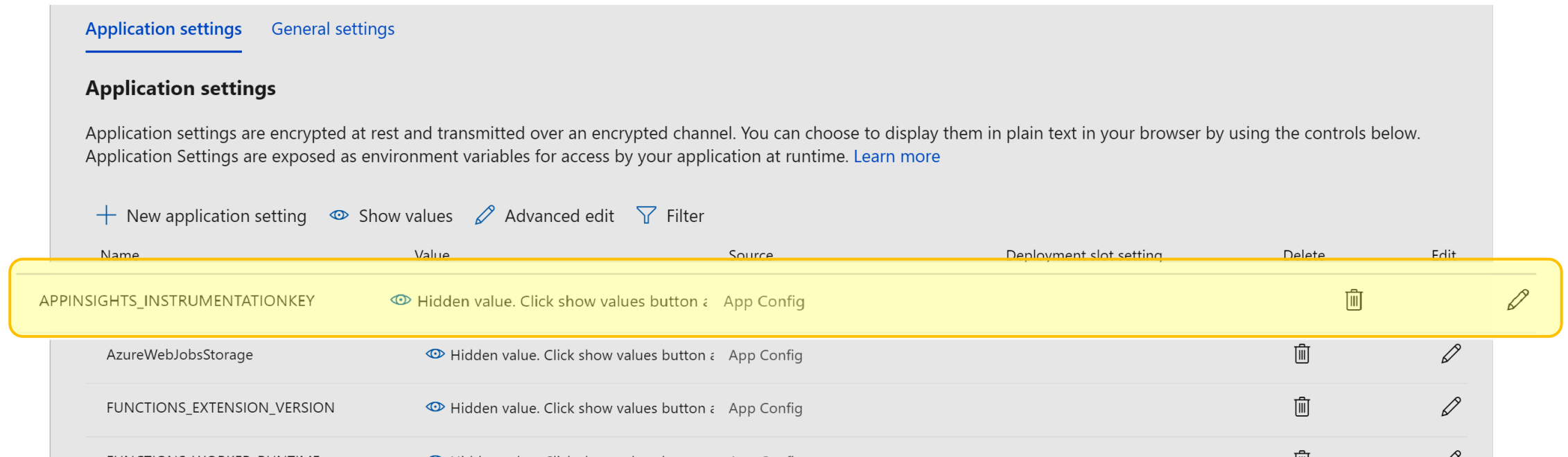
Run in Application Insights

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 >	App Config		🗑	✎
AzureWebJobsStorage	👁 Hidden value. Click show values button >	App Config		🗑	✎
FUNCTIONS_EXTENSION_VERSION	👁 Hidden value. Click show values button >	App Config		🗑	✎
FUNCTIONS_WORKER_RUNTIME	👁 Hidden value. Click show values button >	App Config		🗑	✎

Custom Metric

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. 00:00

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

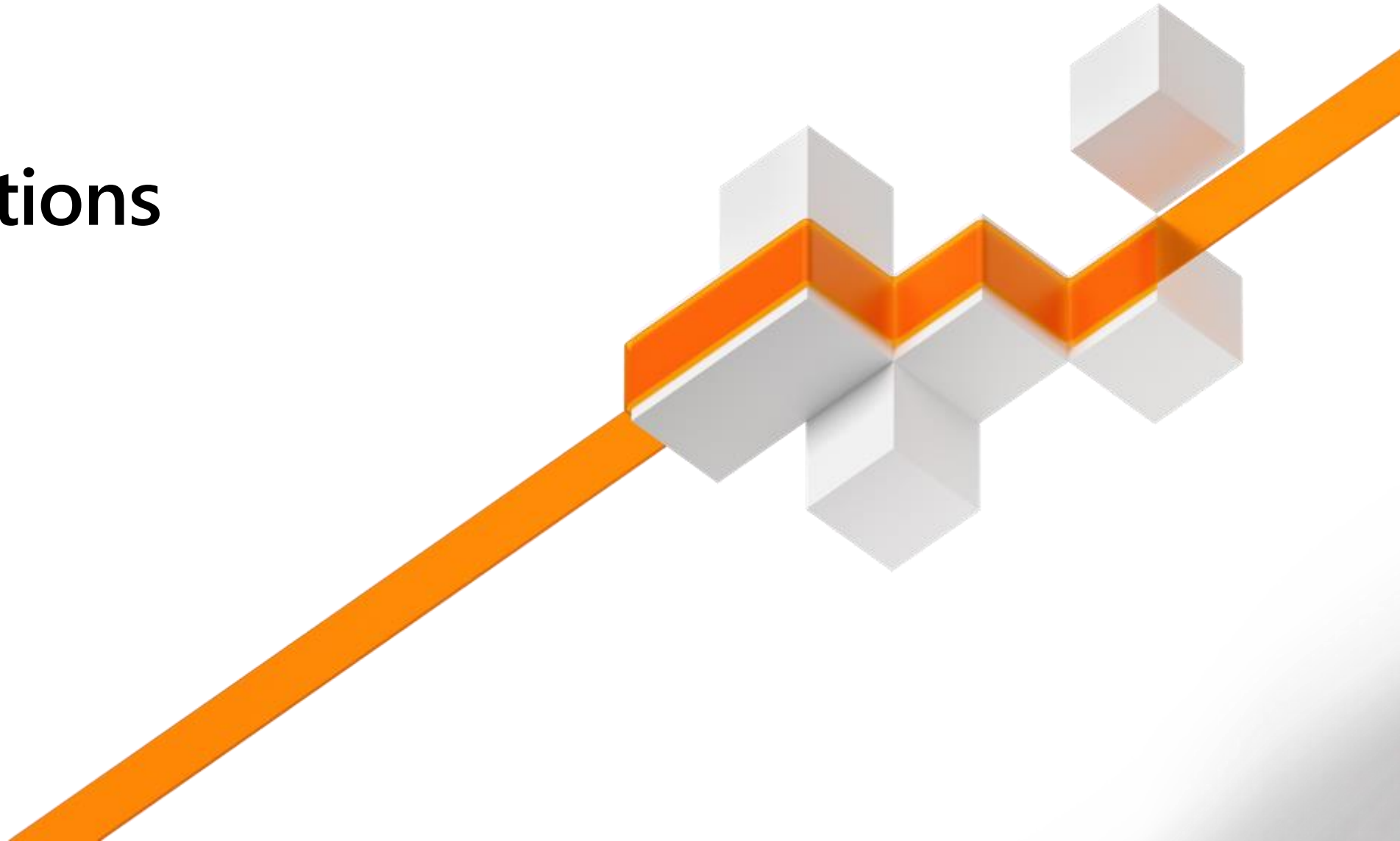
Drag a column header and drop it here to group by that column

	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

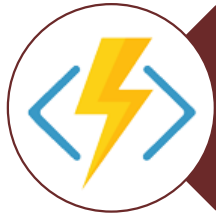
timestamp [UTC]	2019-12-22T18:02:00.0002467Z
name	MyCustomMetric
value	0.60233813272898
valueCount	1
valueSum	0.60233813272898
valueMin	0.60233813272898

DEMO

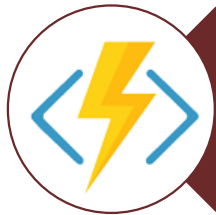
Azure Functions Monitoring



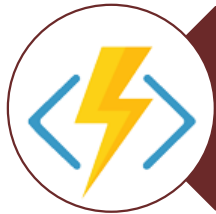
Take away



Write an Azure Functions is **simple**!



Testing Azure Functions is **simple**!



Monitoring Azure Functions is **simple**!



.... then



**KEEP
CALM
AND
USE**

AZURE FUNCTIONS

BRK30167

Thanks for your attention!!!!

Q&A

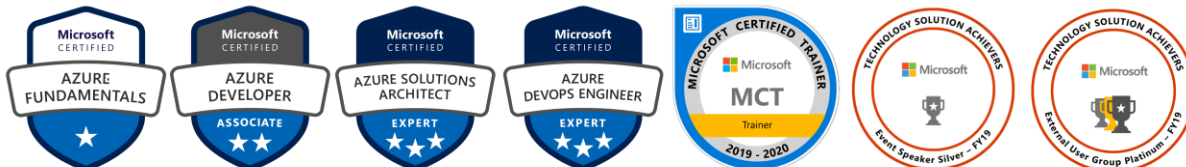
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References



⚡ 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>

⚡ Demo MortgageCalculator – GitHub

<http://bit.ly/TestAZFunc>

⚡ Demo Monitor Azure Functions – GitHub

<http://bit.ly/MonitorAZFunc>

