
Acumatica
The Cloud ERP

# Performance Optimization

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# Agenda

## Intro

- Optimization as an Equilibrium
- Detecting the Bottleneck

## Optimization of Reading Data

- Data View Select Delegates
- Implicit Joins and Subselects
- Reading Huge Amounts of Data

## Optimization of Data Processing

- Reusing and Recycling
- Redesigning of Heavy Processing
- Saving Data

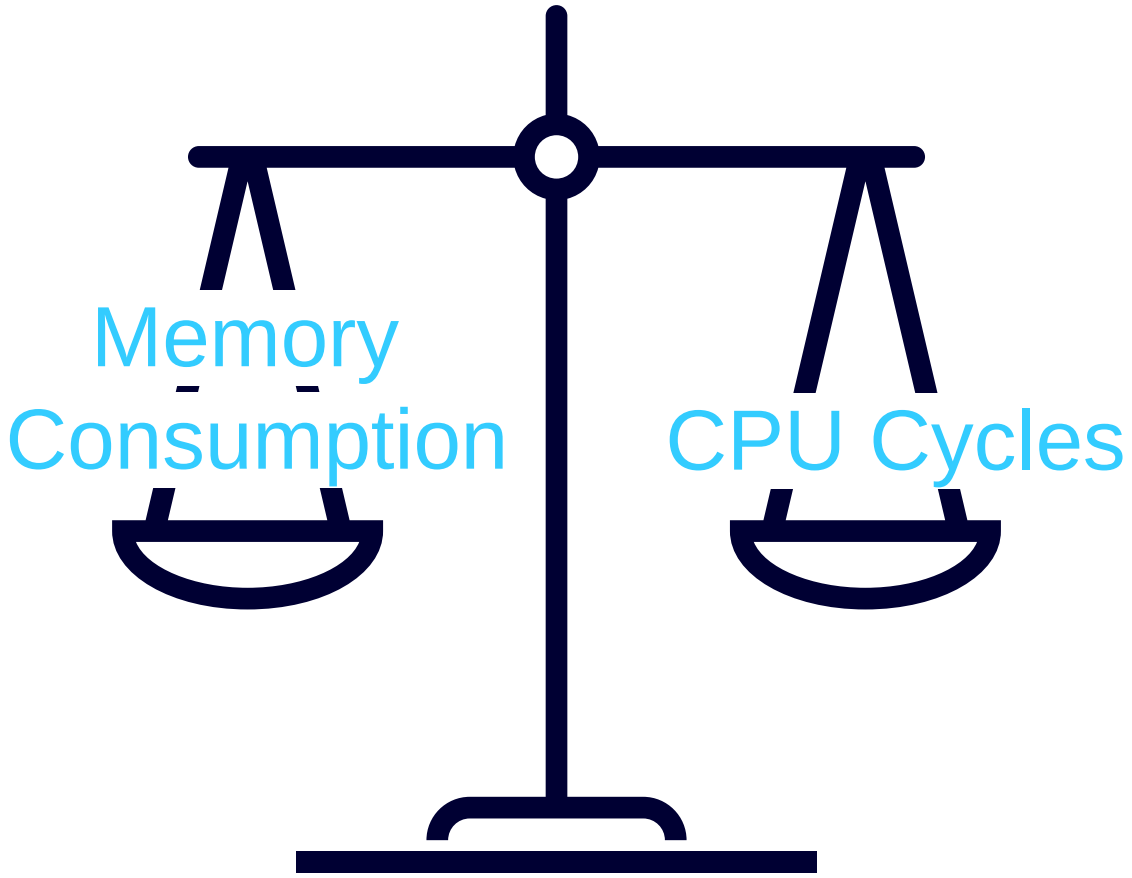
## Summary

# Intro: Optimization as an Equilibrium

*Premature optimization is the root of all evil.*

Donald Knuth

# Equilibrium



# Equilibrium

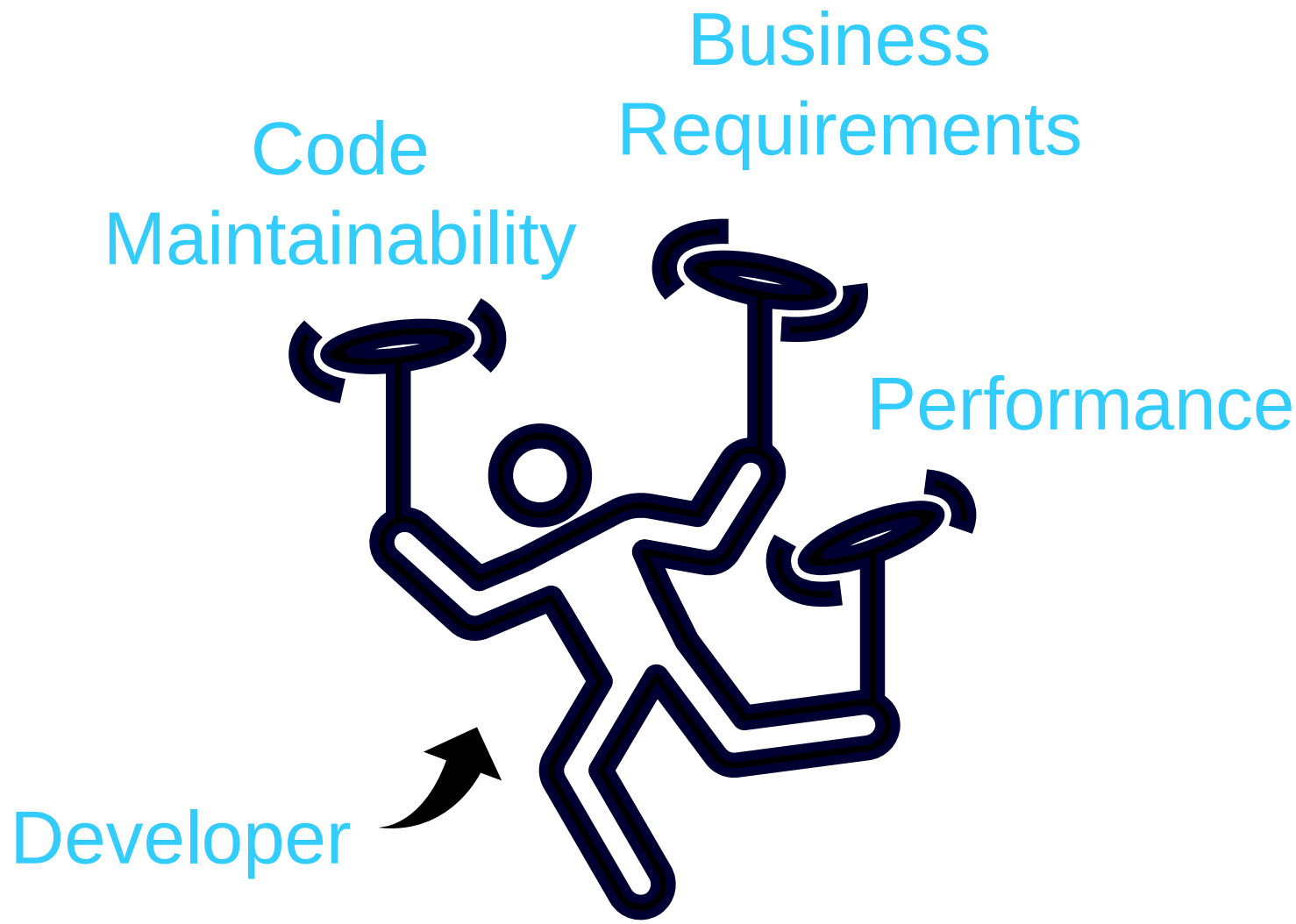
# How Optimization Affects Maintainability

- Obscure code
- Hard to catch bugs
- “Leaking” abstraction layers

- “Hello World!”
  - Assembly version

```
1  ;-----------------------------------------------------------------------
2  ; Writes "Hello, World" to the console using only system calls.
3  ; To assemble and run:
4  ;
5  ;     nasm -f elf hello.asm & ld -m elf_i386 hello.o -o hello
6  ;-----------------------------------------------------------------------
7
8            global    _start
9
10           section   .text
11 _start:   mov       eax, 4                ; system call number for writ
12           mov       ebx, 1                ; file handle 1 is stdout
13           mov       ecx, message          ; address of string to output
14           mov       edx, 13               ; number of bytes
15           int 80h                         ; request an interrupt on lib
16 exit:     mov       eax, 1                ; syscam call number for exit
17           mov       ebx, 0                ; return 0 status on exit - '
18           int 80h                         ; request an interrupt on lib
19
20           section   .data
21 message:  db        "Hello, World", 0Ah      ; note the newline at the en
22
```

# Equilibrium



# Know Your Enemy

DB SLOWNESS

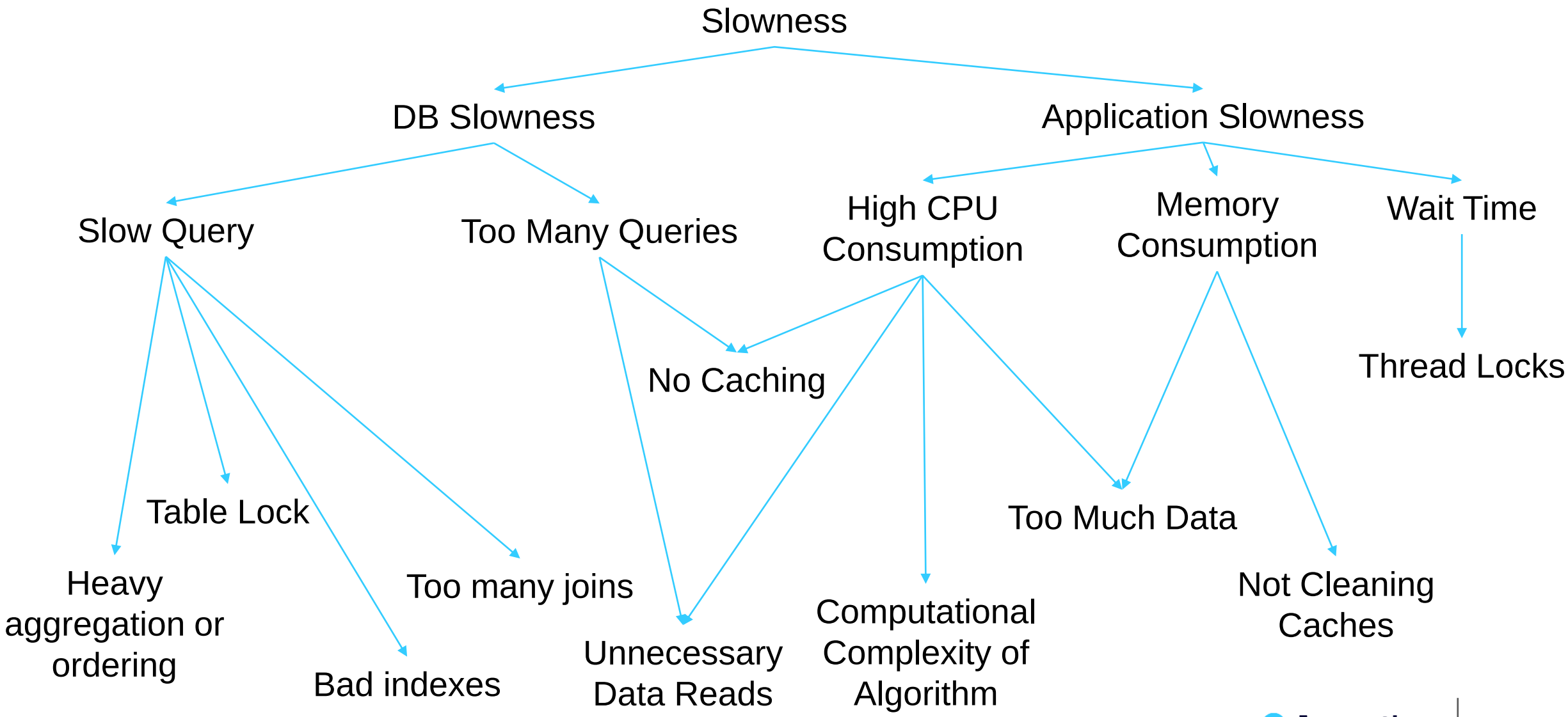
WRONG EXPECTATIONS

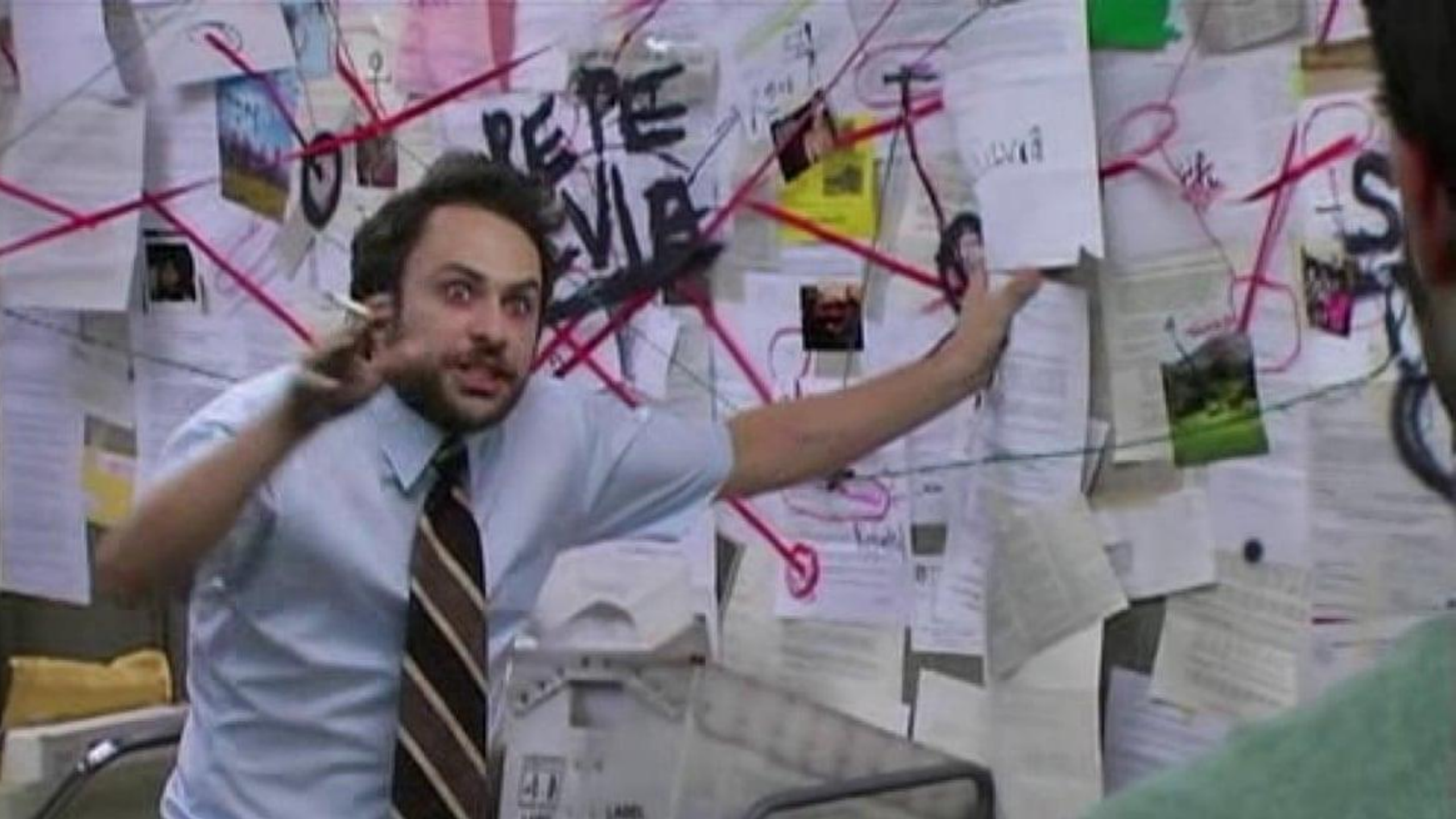
APPLICATION SLOWNESS

# Know Your Enemy

| | DB Slowness | Application Slowness |
|---|---|---|
| Data Read Slowness |  | |
| Data Processing Slowness | | |

# Know Your Enemy





# Steps to Identify the Root of the Slowness

Step 1: Expectations (+ License, Hardware)

Step 2: Request Profiler to Categorize the Slowness

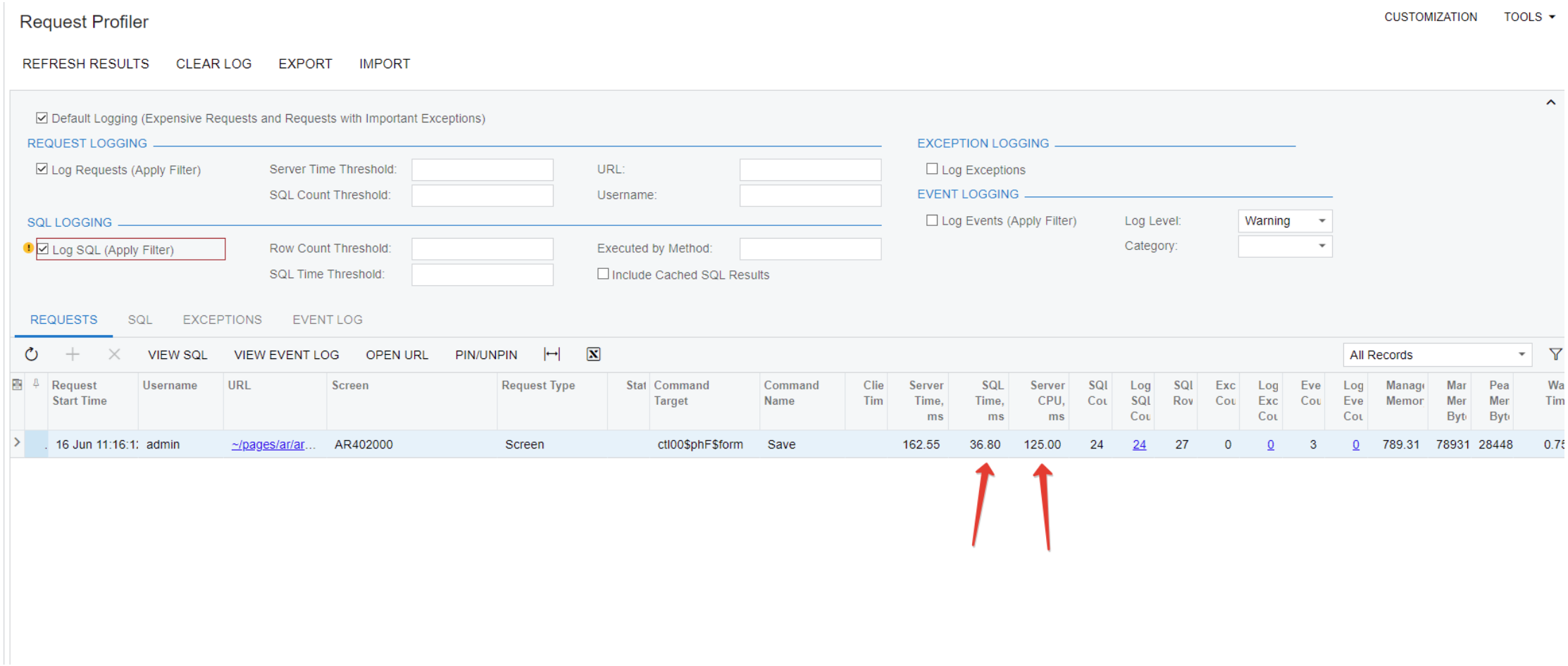
Step 3: Additional Measurements or Tests to detect the bottleneck

Step 4: Fix

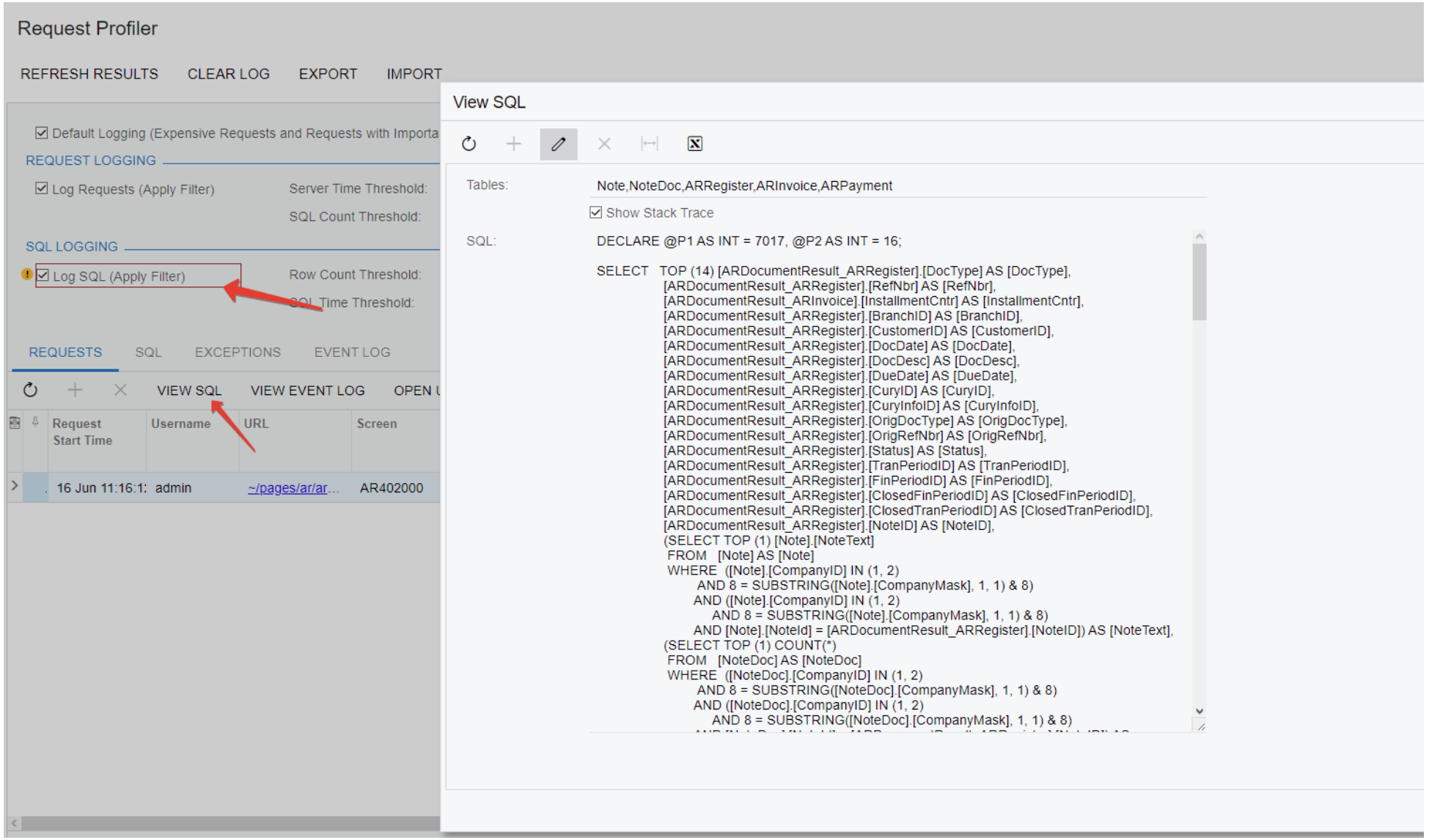
Step 5: Test

# Demo: Profiling Tools

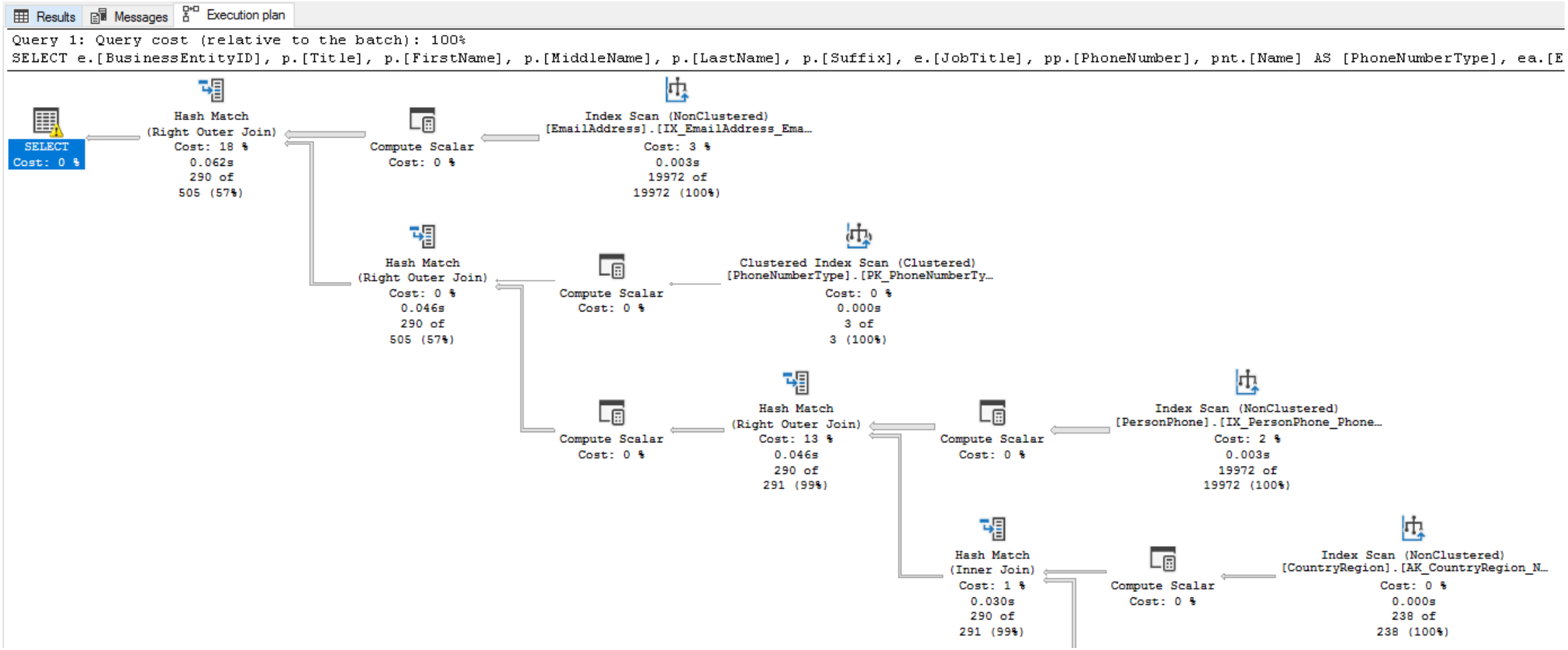
# Request Profiler



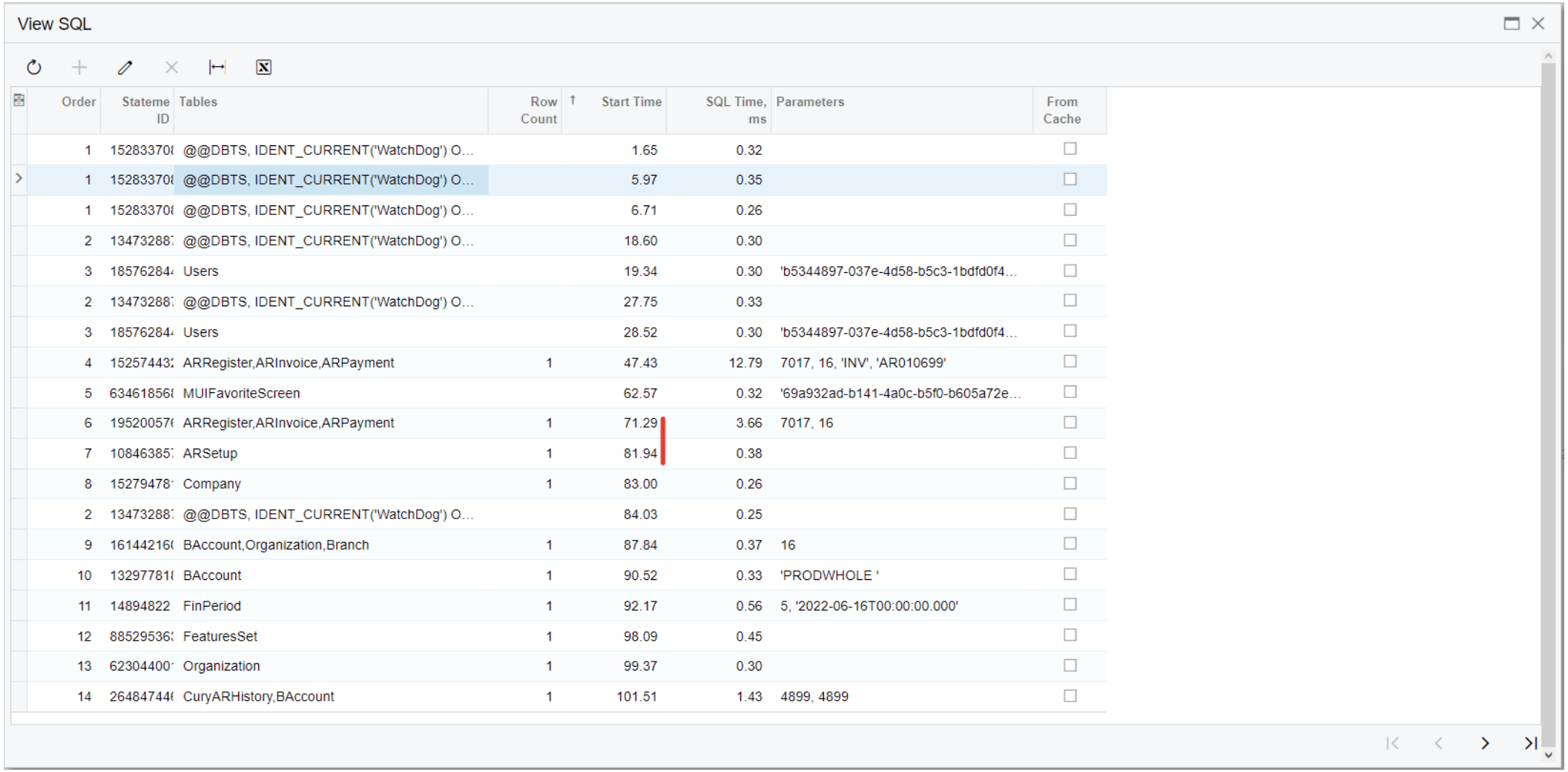
# SQL Time


Request Profiler
REFRESH RESULTS
CLEAR LOG
EXPORT
IMPORT
Default Logging (Expensive Requests and Requests with Importa
REQUEST LOGGING
Log Requests (Apply Filter)
Server Time Threshold:
SQL Count Threshold:
SQL LOGGING
Log SQL (Apply Filter)
Row Count Threshold:
SQL Time Threshold:
REQUESTS
SQL
EXCEPTIONS
EVENT LOG
VIEW SQL
VIEW EVENT LOG
Request Start Time
Username
URL
Screen
16 Jun 11:16:1:
admin
~/pages/ar/ar...
AR402000
View SQL
Tables:
Note,NoteDoc,ARRegister,ARInvoice,ARPayment
Show Stack Trace
SQL:
DECLARE @P1 AS INT = 7017, @P2 AS INT = 16;
SELECT TOP (14) [ARDocumentResult_ARRegister].[DocType] AS [DocType],
[ARDocumentResult_ARRegister].[RefNbr] AS [RefNbr],
[ARDocumentResult_ARInvoice].[InstallmentCntr] AS [InstallmentCntr],
[ARDocumentResult_ARRegister].[BranchID] AS [BranchID],
[ARDocumentResult_ARRegister].[CustomerID] AS [CustomerID],
[ARDocumentResult_ARRegister].[DocDate] AS [DocDate],
[ARDocumentResult_ARRegister].[DocDesc] AS [DocDesc],
[ARDocumentResult_ARRegister].[DueDate] AS [DueDate],
[ARDocumentResult_ARRegister].[CuryID] AS [CuryID],
[ARDocumentResult_ARRegister].[CuryInfoID] AS [CuryInfoID],
[ARDocumentResult_ARRegister].[OrigDocType] AS [OrigDocType],
[ARDocumentResult_ARRegister].[OrigRefNbr] AS [OrigRefNbr],
[ARDocumentResult_ARRegister].[Status] AS [Status],
[ARDocumentResult_ARRegister].[TranPeriodID] AS [TranPeriodID],
[ARDocumentResult_ARRegister].[FinPeriodID] AS [FinPeriodID],
[ARDocumentResult_ARRegister].[ClosedFinPeriodID] AS [ClosedFinPeriodID],
[ARDocumentResult_ARRegister].[ClosedTranPeriodID] AS [ClosedTranPeriodID],
[ARDocumentResult_ARRegister].[NoteID] AS [NoteID],
(SELECT TOP (1) [Note].[NoteText]
FROM [Note] AS [Note]
WHERE ([Note].[CompanyID] IN (1, 2)
AND 8 = SUBSTRING([Note].[CompanyMask], 1, 1) & 8)
AND ([Note].[CompanyID] IN (1, 2)
AND 8 = SUBSTRING([Note].[CompanyMask], 1, 1) & 8)
AND [Note].[NoteId] = [ARDocumentResult_ARRegister].[NoteID]) AS [NoteText],
(SELECT TOP (1) COUNT(*)
FROM [NoteDoc] AS [NoteDoc]
WHERE ([NoteDoc].[CompanyID] IN (1, 2)
AND 8 = SUBSTRING([NoteDoc].[CompanyMask], 1, 1) & 8)
AND ([NoteDoc].[CompanyID] IN (1, 2)
AND 8 = SUBSTRING([NoteDoc].[CompanyMask], 1, 1) & 8)

# DB Query Optimization

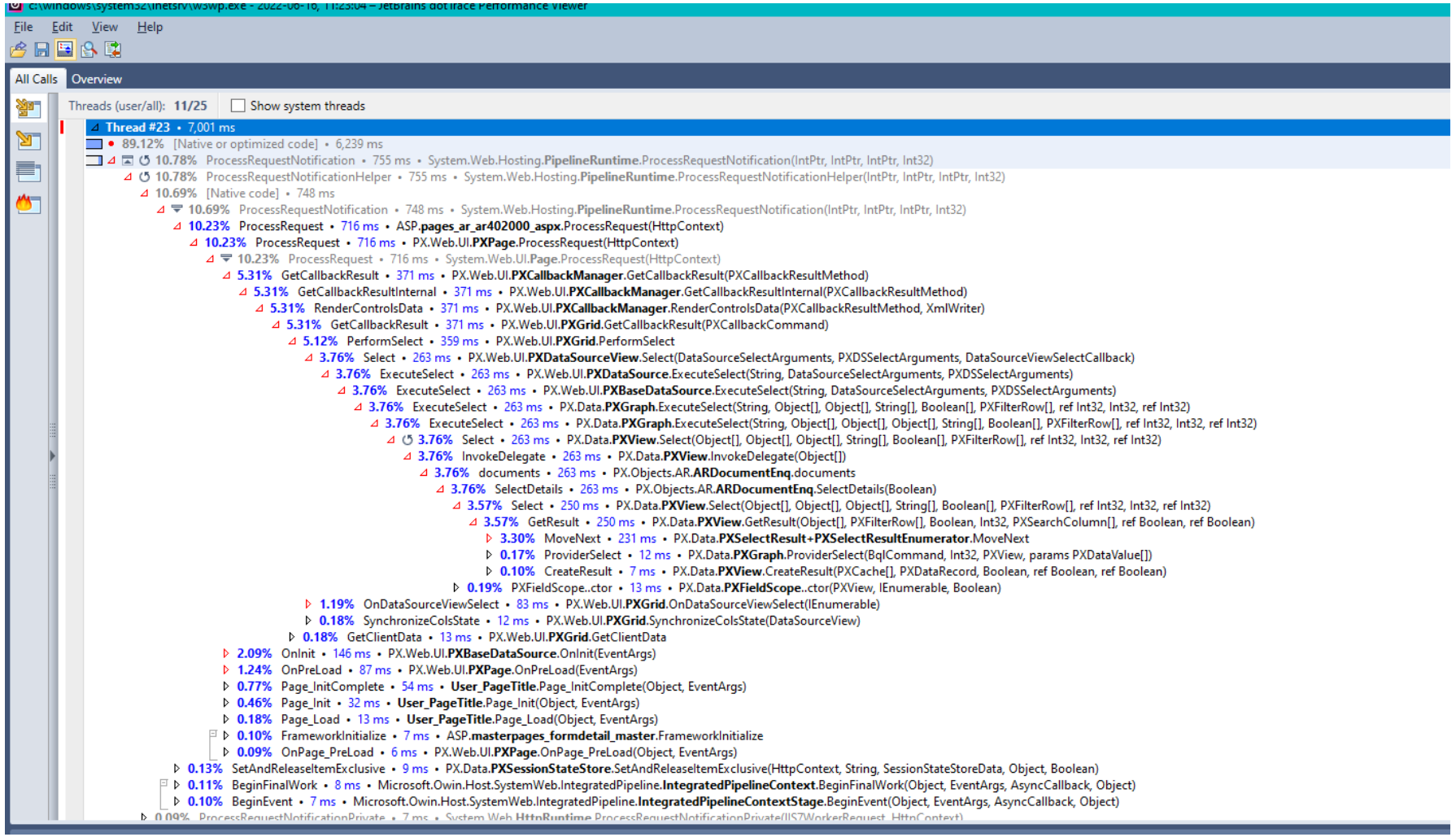


# Application Time



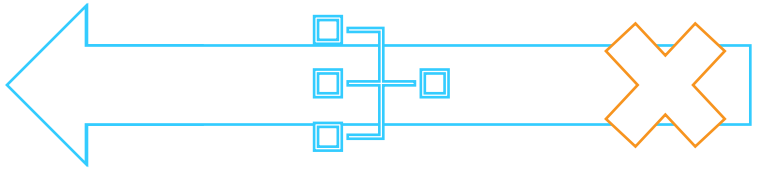

| Order | Stateme ID | Tables | Row Count | Start Time | SQL Time, ms | Parameters | From Cache |
|---|---|---|---|---|---|---|---|
| 1 | 15283370 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 1.65 | 0.32 | | |
| 1 | 15283370 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 5.97 | 0.35 | | |
| 1 | 15283370 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 6.71 | 0.26 | | |
| 2 | 13473288 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 18.60 | 0.30 | | |
| 3 | 18576284 | Users | | 19.34 | 0.30 | 'b5344897-037e-4d58-b5c3-1bdfd0f4… | |
| 2 | 13473288 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 27.75 | 0.33 | | |
| 3 | 18576284 | Users | | 28.52 | 0.30 | 'b5344897-037e-4d58-b5c3-1bdfd0f4… | |
| 4 | 15257443 | ARRegister,ARInvoice,ARPayment | 1 | 47.43 | 12.79 | 7017, 16, 'INV', 'AR010699' | |
| 5 | 63461856 | MUIFavoriteScreen | | 62.57 | 0.32 | '69a932ad-b141-4a0c-b5f0-b605a72e… | |
| 6 | 19520057 | ARRegister,ARInvoice,ARPayment | 1 | 71.29 | 3.66 | 7017, 16 | |
| 7 | 10846385 | ARSetup | 1 | 81.94 | 0.38 | | |
| 8 | 15279478 | Company | 1 | 83.00 | 0.26 | | |
| 2 | 13473288 | @@DBTS, IDENT_CURRENT('WatchDog') O… | | 84.03 | 0.25 | | |
| 9 | 16144216 | BAccount,Organization,Branch | 1 | 87.84 | 0.37 | 16 | |
| 10 | 13297781 | BAccount | 1 | 90.52 | 0.33 | 'PRODWHOLE ' | |
| 11 | 14894822 | FinPeriod | 1 | 92.17 | 0.56 | 5, '2022-06-16T00:00:00.000' | |
| 12 | 88529536 | FeaturesSet | 1 | 98.09 | 0.45 | | |
| 13 | 62304400 | Organization | 1 | 99.37 | 0.30 | | |
| 14 | 26484744 | CuryARHistory,BAccount | 1 | 101.51 | 1.43 | 4899, 4899 | |

# JetBrains DotTrace

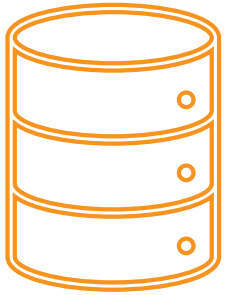


# Data View Select Delegates

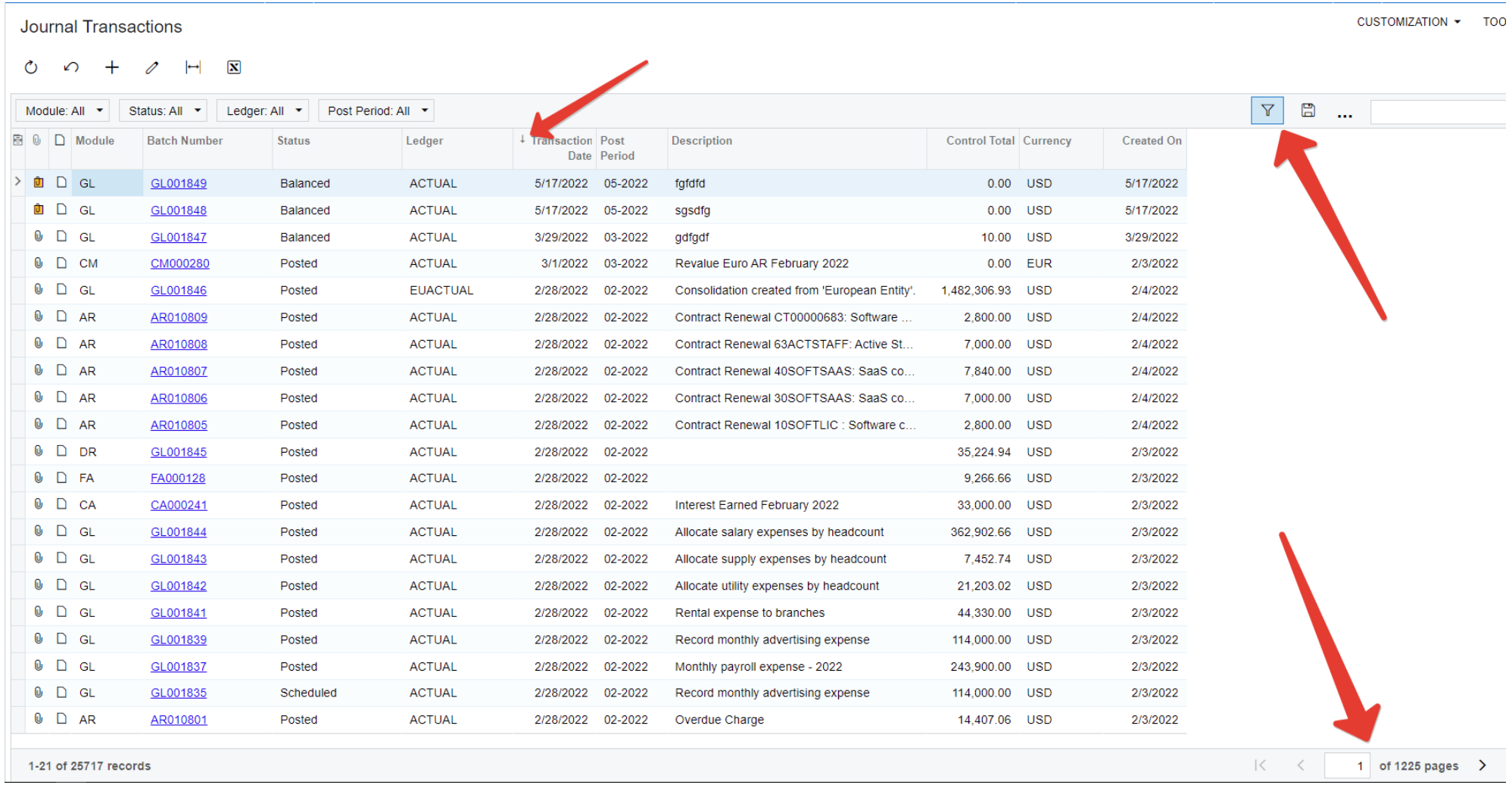
# Data View Delegates



Data View Delegate



# UI Pagination, Ordering and Filtering




| Module | Batch Number | Status | Ledger | Transaction Date | Post Period | Description | Control Total | Currency | Created On |
|---|---|---|---|---|---|---|---|---|---|
| GL | GL001849 | Balanced | ACTUAL | 5/17/2022 | 05-2022 | fgfdfd | 0.00 | USD | 5/17/2022 |
| GL | GL001848 | Balanced | ACTUAL | 5/17/2022 | 05-2022 | sgsdfg | 0.00 | USD | 5/17/2022 |
| GL | GL001847 | Balanced | ACTUAL | 3/29/2022 | 03-2022 | gdfgdf | 10.00 | USD | 3/29/2022 |
| CM | CM000280 | Posted | ACTUAL | 3/1/2022 | 03-2022 | Revalue Euro AR February 2022 | 0.00 | EUR | 2/3/2022 |
| GL | GL001846 | Posted | EUACTUAL | 2/28/2022 | 02-2022 | Consolidation created from 'European Entity'. | 1,482,306.93 | USD | 2/4/2022 |
| AR | AR010809 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Contract Renewal CT00000683: Software ... | 2,800.00 | USD | 2/4/2022 |
| AR | AR010808 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Contract Renewal 63ACTSTAFF: Active St... | 7,000.00 | USD | 2/4/2022 |
| AR | AR010807 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Contract Renewal 40SOFTSAAS: SaaS co... | 7,840.00 | USD | 2/4/2022 |
| AR | AR010806 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Contract Renewal 30SOFTSAAS: SaaS co... | 7,000.00 | USD | 2/4/2022 |
| AR | AR010805 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Contract Renewal 10SOFTLIC : Software c... | 2,800.00 | USD | 2/4/2022 |
| DR | GL001845 | Posted | ACTUAL | 2/28/2022 | 02-2022 | | 35,224.94 | USD | 2/3/2022 |
| FA | FA000128 | Posted | ACTUAL | 2/28/2022 | 02-2022 | | 9,266.66 | USD | 2/3/2022 |
| CA | CA000241 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Interest Earned February 2022 | 33,000.00 | USD | 2/3/2022 |
| GL | GL001844 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Allocate salary expenses by headcount | 362,902.66 | USD | 2/3/2022 |
| GL | GL001843 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Allocate supply expenses by headcount | 7,452.74 | USD | 2/3/2022 |
| GL | GL001842 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Allocate utility expenses by headcount | 21,203.02 | USD | 2/3/2022 |
| GL | GL001841 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Rental expense to branches | 44,330.00 | USD | 2/3/2022 |
| GL | GL001839 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Record monthly advertising expense | 114,000.00 | USD | 2/3/2022 |
| GL | GL001837 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Monthly payroll expense - 2022 | 243,900.00 | USD | 2/3/2022 |
| GL | GL001835 | Scheduled | ACTUAL | 2/28/2022 | 02-2022 | Record monthly advertising expense | 114,000.00 | USD | 2/3/2022 |
| AR | AR010801 | Posted | ACTUAL | 2/28/2022 | 02-2022 | Overdue Charge | 14,407.06 | USD | 2/3/2022 |

# Data View Select Delegates

```
protected virtual IEnumerable ardocumentlist()
{
    PXSelectBase<BalancedARDocument> cmd =
        new PXSelectJoinGroupBy<BalancedARDocument,
            ...
            OrderBy<Asc<BalancedARDocument.docType, //Set necessary sorting fields: use the key fields
            Asc<BalancedARDocument.refNbr>>>> //Set necessary sorting fields: use the key fields
            (this);

    PXDelegateResult delegResult = new PXDelegateResult
    {
        IsResultFiltered = true,
        IsResultTruncated = true,
        IsResultSorted = true
    }

    foreach (PXResult<BalancedARDocument> res_record in cmd.SelectWithViewContext())
    {
        // add the code to process res_record
        delegResult.Add(res_record);
    }
    return delegResult;
}
```

# Implicit Joins & Subselects

# BQL to SQL

```
PXSelectJoin<
ARInvoice,
InnerJoin<
Customer,
        On<ARInvoice.customerID
        Equal<Customer.bAcco
Where<ARInvoice.lastFinC
        LessEqual<Cu
```

```
SE       FROM
        ON [ARInvoice].[CustomerID]
        = [Customer].[BAccountID]
        voice].[LastFinChargeDate]
```

WRONG!

# BQL to SQL

```
PXSelectJoin<

ARInvoice,

InnerJoin<

Customer,

        On<ARInvoice.customerID,

        Equal<Customer.bAccountID>>>>,

Where<ARInvoice.lastFinChargeDate,

        LessEqual<Current<Filter.date>>>
```

```
(SELECT * FROM [ARInvoice] INNER JOIN
[ARRegister] ON…)
```

```
(SELECT * FROM [Customer] INNER JOIN
[BAccount] ON…

INNER JOIN FSxCustomer …)
```

```
(SELECT MAX(FinChargeDate) FROM
[ARFinChargeTran] WHERE … GROUP
BY…)
```

```
WHERE [ARRegister].[CompanyID]=2

AND [ARRegister].[BranchID] is in (9, 12, 18)
```

# Using JoinSingleTable

PXSelectJoin<ARRegister,

InnerJoin<Customer, On<…>, …>

SELECT * FROM ARRegister

INNER JOIN

(SELECT * FROM [Customer] INNER JOIN [BAccount] ON…) ON …

PXSelectJoin<ARInvoice,

InnerJoinSingleTable<Customer, On<…>, …>

SELECT * FROM ARRegister

INNER JOIN [Customer] ON …

# Avoiding Heavy attributes

Field Attributes:

- PXSelectorAttribute
- PXDBScalarAttribute
- PXNote Attribute

DAC Attributes:

- PXProjection Attribute
- PXTable Attribute on Derived DAC or Cache Extensions

*PRO Tip: Use CacheAttached to remove some heavy attributes that you don't need in a graph*

# Reading Huge Amounts of Data

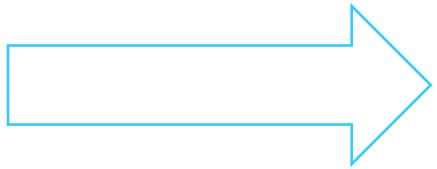
# RowSelecting and FieldSelecting Events

# Restricting Number of Fields

- Using LINQ2Bql
- Using PXFieldScope
- Using Light Versions of DACs

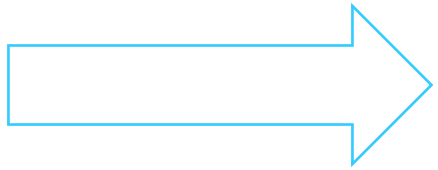
# Linq2Bql

```
PXSelect<ARRegister>.Select(this).
Where(_=>_.DocType="INV");
```



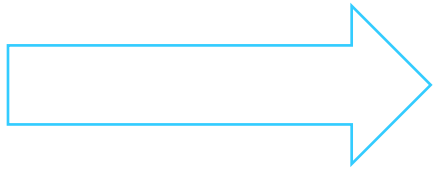
```
SELECT * FROM ARRegister
WHERE DocType = 'INV'
```

```
PXSelect<ARRegister>.Select(this).
FirstOrDefault();
```



```
SELECT TOP(1) * FROM ARRegister
```

```
PXSelect<ARRegister>.Select(this).
Select(_=>_.RefNbr);
```

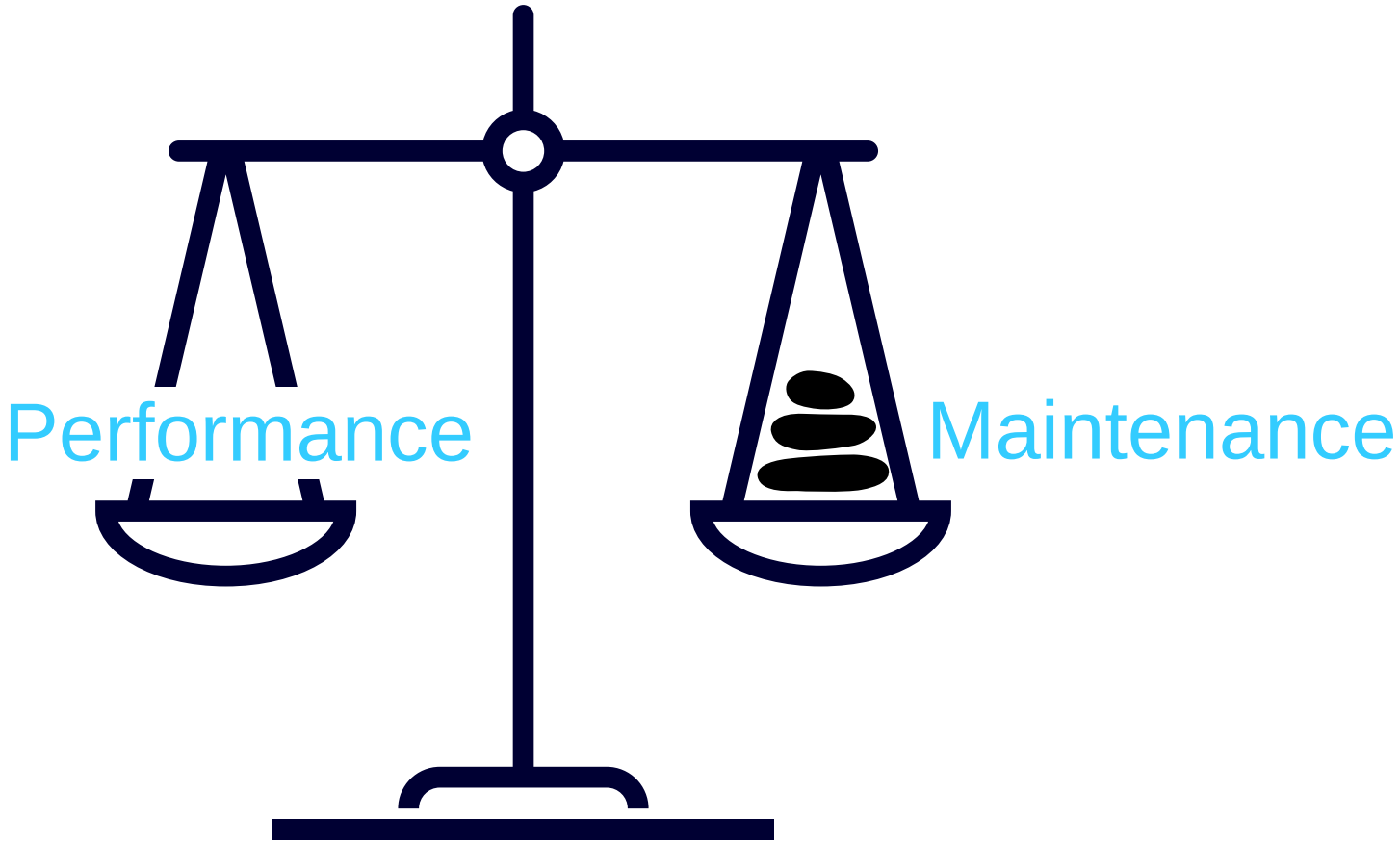


```
SELECT RefNbr FROM ARRegister
```

# Using PXFieldScope

```
using (new PXFieldScope(_ARInvoice.View,
typeof(ARInvoice.docType), typeof(ARInvoice.refNbr), typeof(ARInvoice.docDate)…))
{
        foreach (ARInvoice ardoc in _ARInvoice.Select(cust.BAccountID))
        {
                …
        }
}
```

# Using Light Versions of DACs



# Using Light Versions of DACs

```
namespace PX.Objects.AR

public class Customer : Baccount

{
        Field1
        Field2
        …
        Field238
}
```

```
namespace PX.Objects.AR.Light

public class Customer : IBqlTable

{
        Field1
        Field2
        Field3
}
```

# Optimization of Data Processing: Reusing and Recycling

# Reusing and Recycling

```
private static void ProcessDoc(List<Document> list)
{
        foreach(var doc in list)
        {
                var processingGraph = PXGraph.CreateInstance<ProcessingGraph>();
                var newDoc = new ResultDocument();
                newDoc.Field1 = doc.Field1;
                newDoc.Field2 = doc.Field2;
                ...
                processingGraph.Document.Insert(newDoc);
                processingGraph.Save.Press()
        }
}
```

# Reusing and Recycling

```
private static void ProcessDoc(List<Document> list)
{
        var processingGraph = PXGraph.CreateInstance<ProcessingGraph>();
        foreach(var doc in list)
        {
                processingGraph.Clear();
                var newDoc = new ResultDocument();
                newDoc.Field1 = doc.Field1;
                newDoc.Field2 = doc.Field2;
                ...
                processingGraph.Document.Insert(newDoc);
                processingGraph.Save.Press()
        }
}
```

# Reusing and Recycling

```
private static void ProcessDoc(List<Document> list)
{
        var processingGraph = PXGraph.CreateInstance<ProcessingGraph>();
        foreach(var doc in list)
        {
                processingGraph.Clear();
                var newDoc = new ResultDocument();
                newDoc.Field1 = doc.Field1;
                newDoc.Field2 = doc.Field2;
                ...
                processingGraph.Document.Insert(newDoc);

                foreach(var doc in doc.Details)
                {
                        //insert document lines
                }
                processingGraph.Save.Press()
        }
}
```

# Reusing and Recycling

```
private static void ProcessDoc(List<Document> list)
{
        var processingGraph = PXGraph.CreateInstance<ProcessingGraph>();
        foreach(var doc in list)
        {
                processingGraph.Clear();
                var newDoc = new ResultDocument();
                newDoc.Field1 = doc.Field1;
                newDoc.Field2 = doc.Field2;
                ...
                processingGraph.Document.Insert(newDoc);

                foreach(var doc in doc.Details)
                {
                        //insert document lines
                        processingGraph.Save.Press() // do for every 1000
                }
        }
}
```

# Optimization of Data Processing: Redesign of Heavy Processing

# Redesign of Heavy Processing

Examples of a Heavy Process:

- Data recalculation – aggregating historical data – e.g. account balances
- Data recalculation – quadratic complexity – e.g. discounts

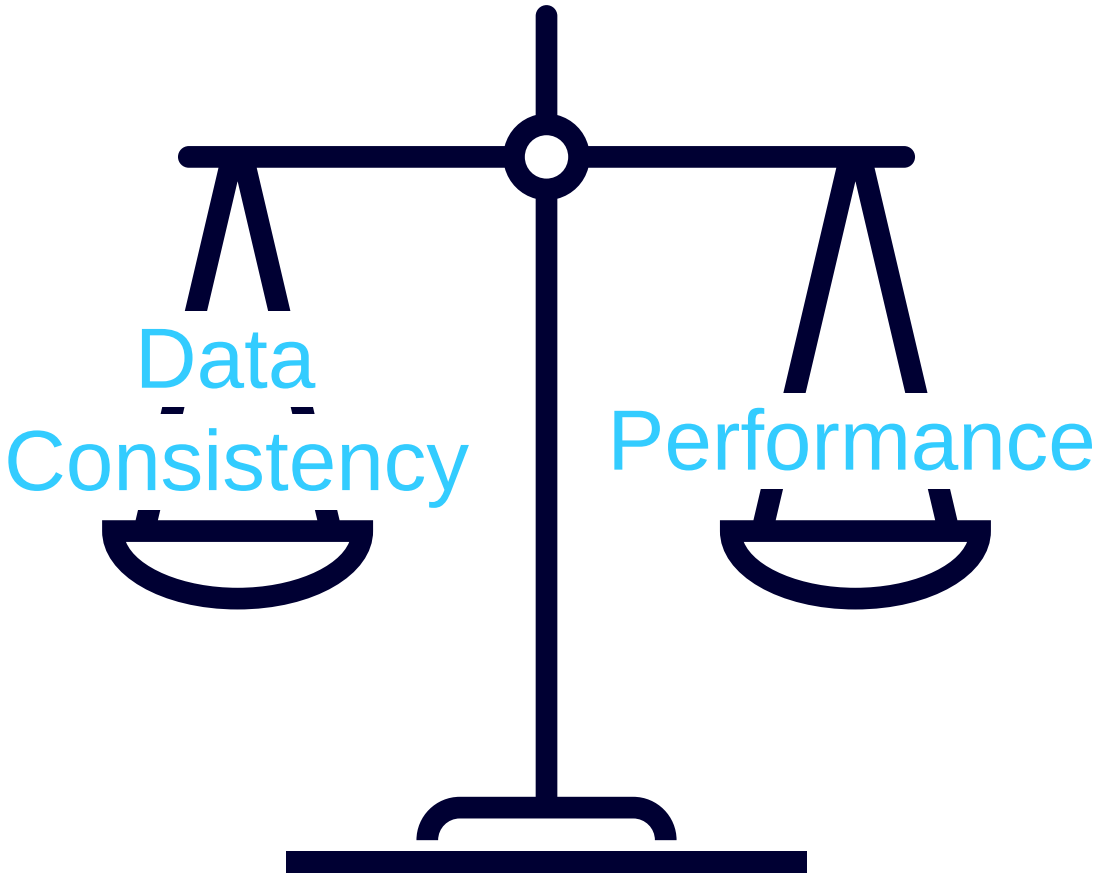
# Redesign of Heavy Processing

# Optimization of Data Processing: Saving Data

# Big Transaction Scopes

- Consume all available memory of SQL Server
- Lock a lot of tables and prevent parallel processes

# Big Transaction Scopes



# Summary

# Optimization

1. Do not optimize what you don’t need to optimize
2. Identify the areas that you need to optimize using available tools
3. Understand why the slowness appears and fix the reason
   - Use Best Practices for Data reading and Data Processing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# Thank You!

www.acumatica.com/developers