Polyspace Hands-on Workshop

Case Study

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目标

- Understanding Polyspace workflow
- Learn how to use Polyspace
  - Checking MISRA C rules violations
  - Checking defects and runtime errors

内容

- Polyspace Overview
  - Category of Static analysis
  - Use case of Polyspace products
- Polyspace Hands-on workshop
  - Description of the logic
  - Exercise 1 / 2 / 3 / 4 (Review MISRA, Defect, Code Metrics, Runtime Error)
  - Conclusion
- Q&A

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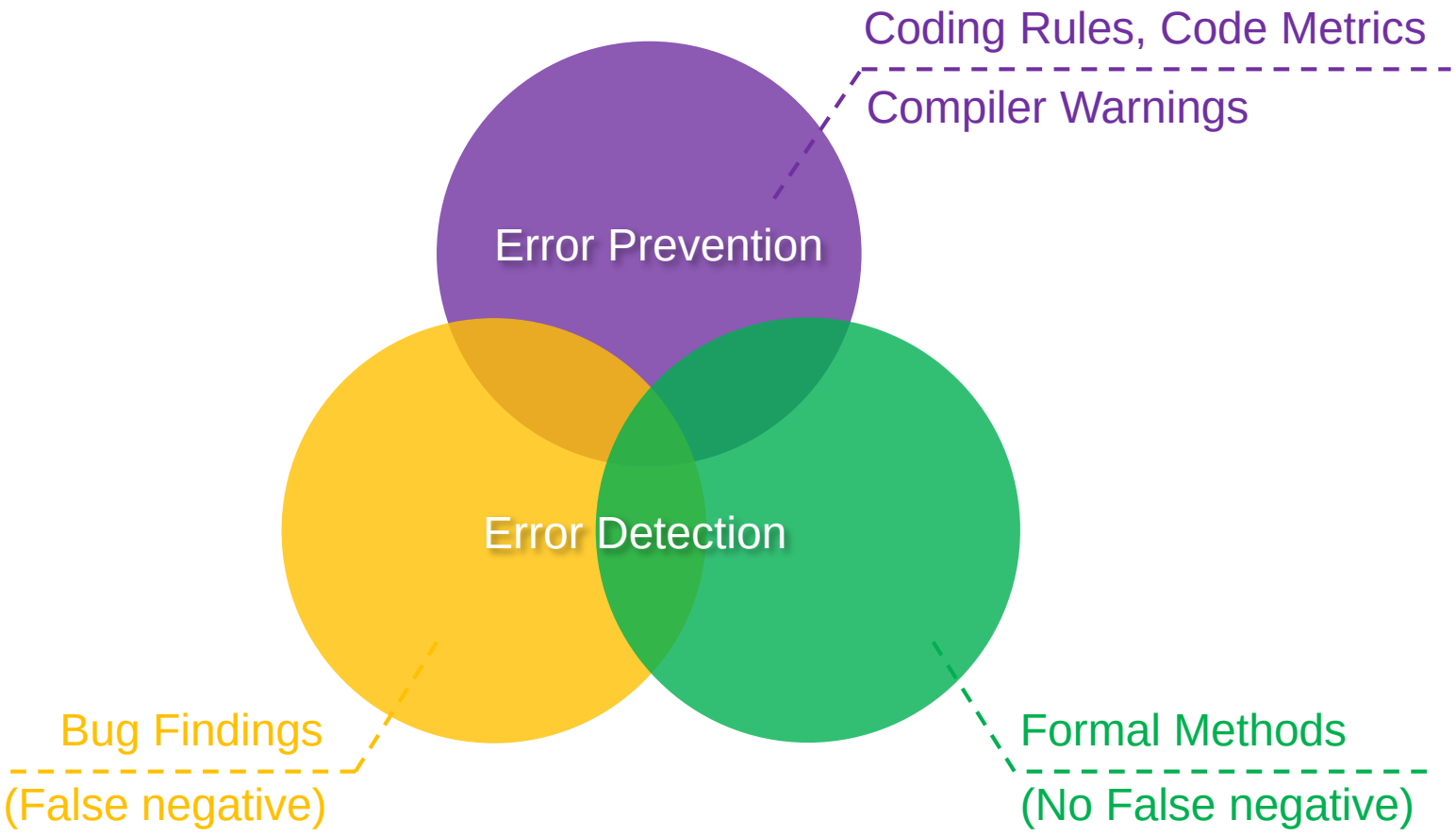
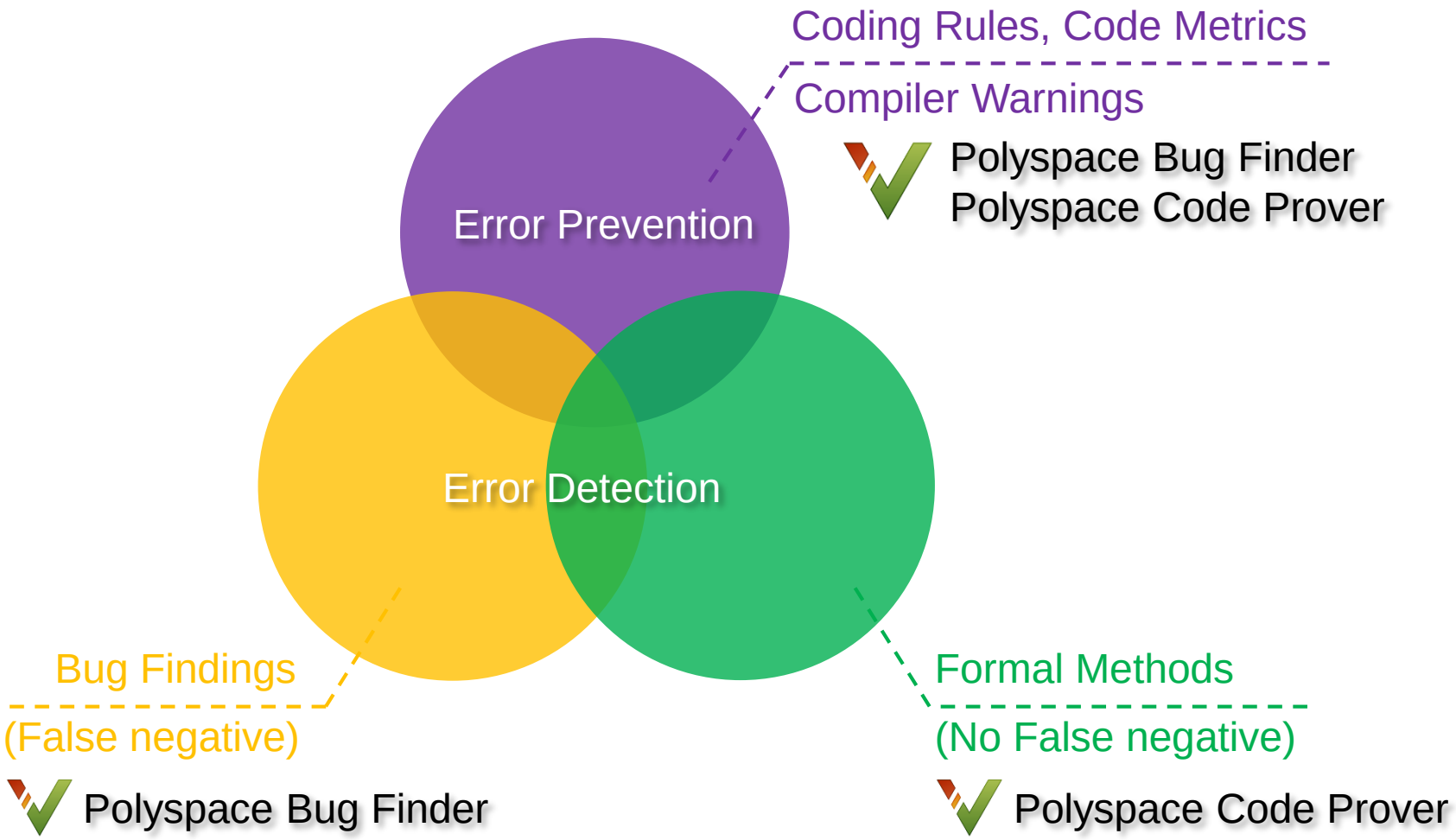
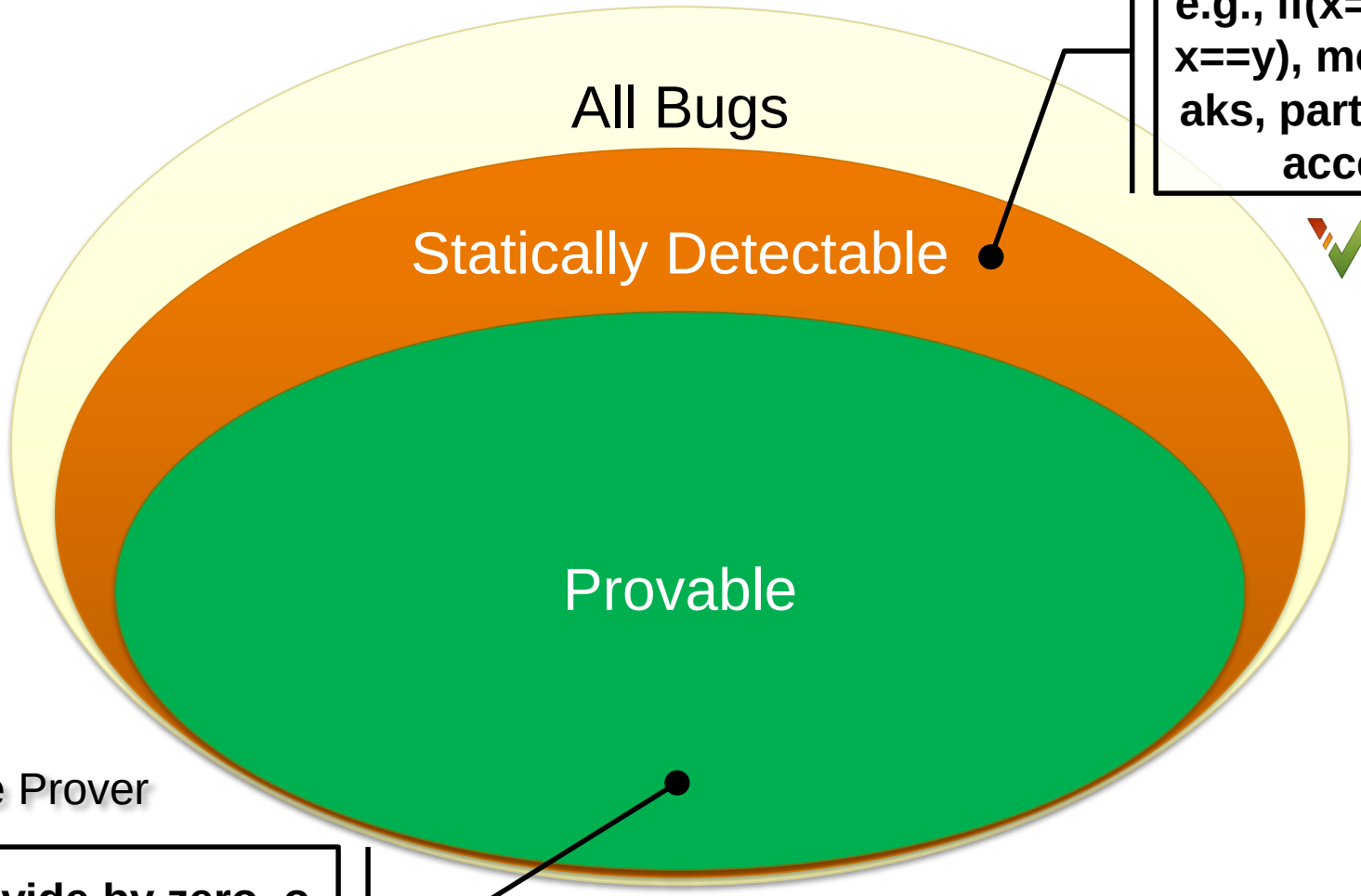
静态分析功能分类


Coding Rules, Code Metrics
Compiler Warnings
Error Prevention
Error Detection
Bug Findings
(False negative)
Formal Methods
(No False negative)

Polyspace产品对应



理解差异



e.g., if(x=y) vs. if(x==y), memory leaks, partial array access

Polyspace Bug Finder

Polyspace Code Prover

e.g., divide by zero, overflow, illegal pointer dereferences

功能对比

Bug Finder

Nothing Found

Probable Bug

vs.

Code Prover

Orange - Vulnerability

Green - Reliable

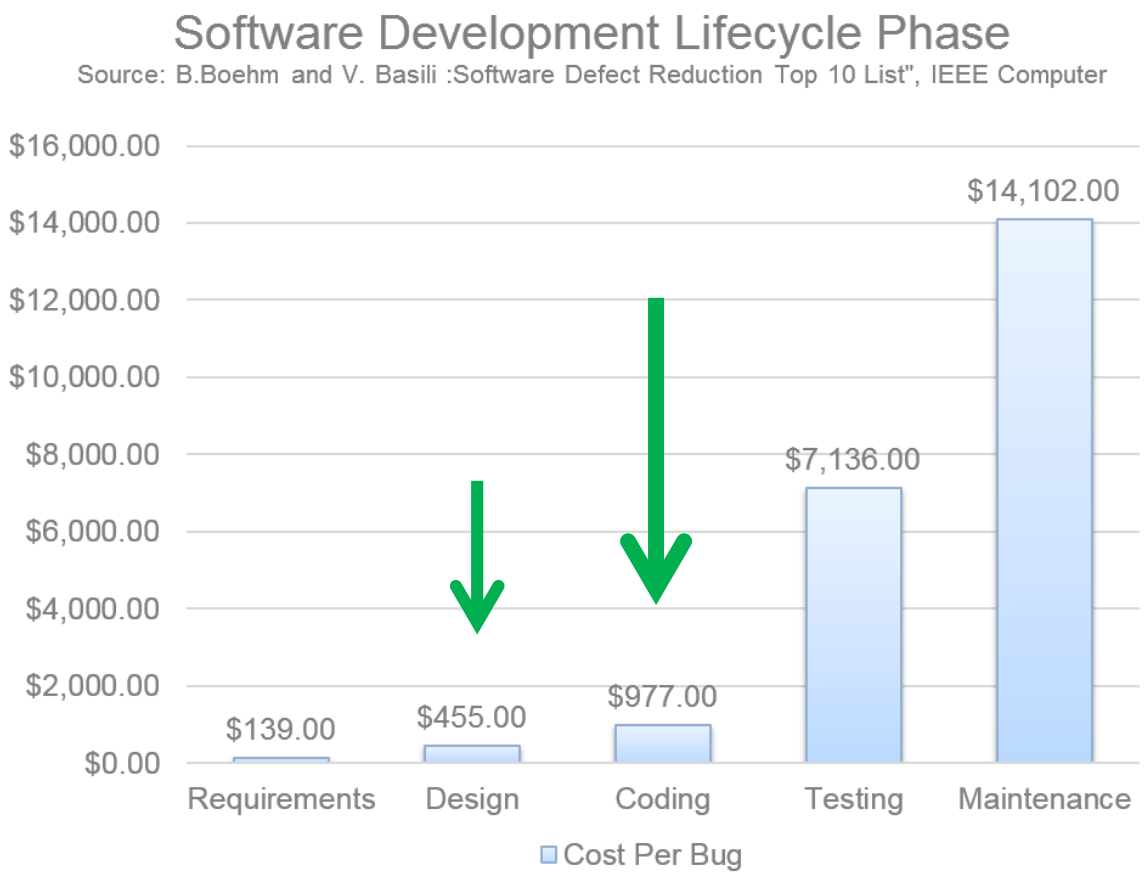
Grey – Unreachable / Dead

Red - Faulty

Purple - coding rule violations

早期验证

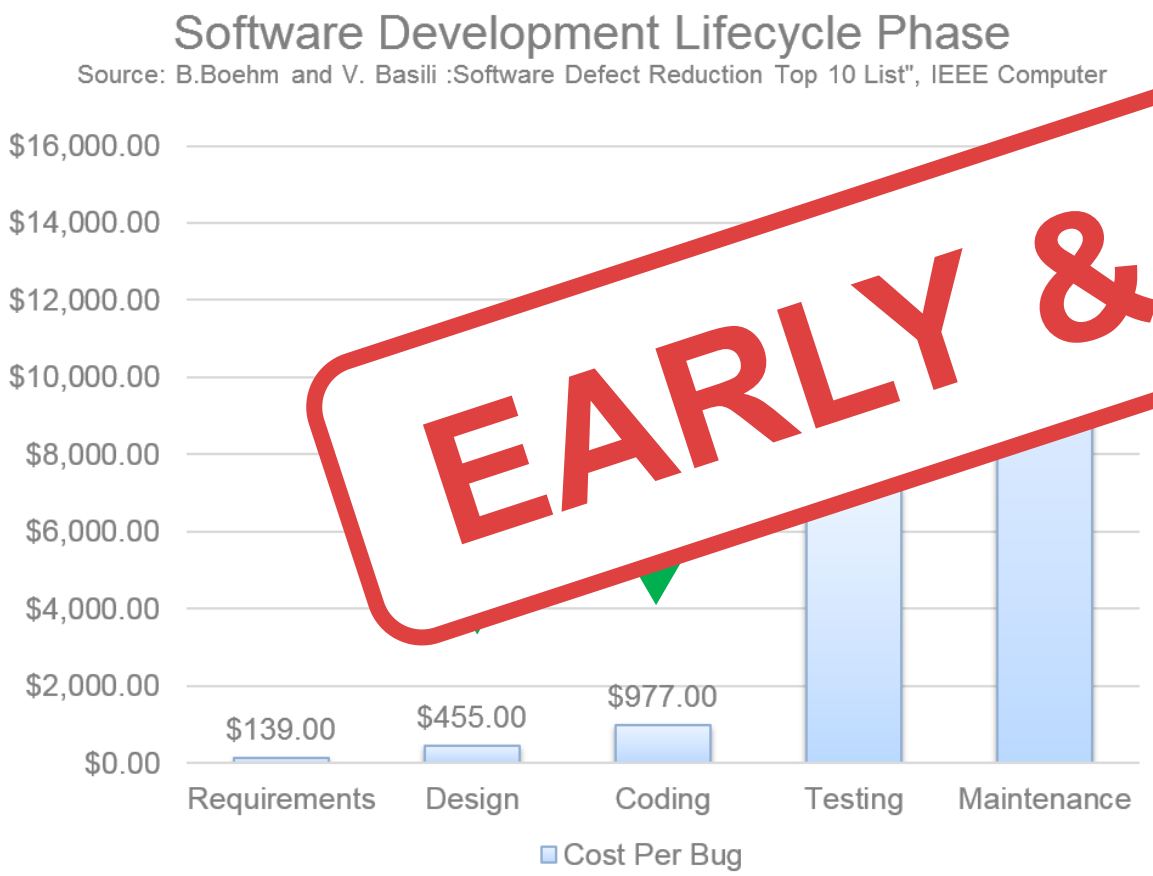
Use Verification tools early in the lifecycle:



- Developers and testers
  - Prior to functional tests
- Project managers
  - Check progress of a project
- External quality assessor
  - Audit supplier’s code
- Model-Based Design
  - On generated code

早期验证

Use Verification tools early in the lifecycle:



EARLY & OFTEN!

- sters
  - ctional tests
- Project managers
  - Check progress of a project
- External quality assessor
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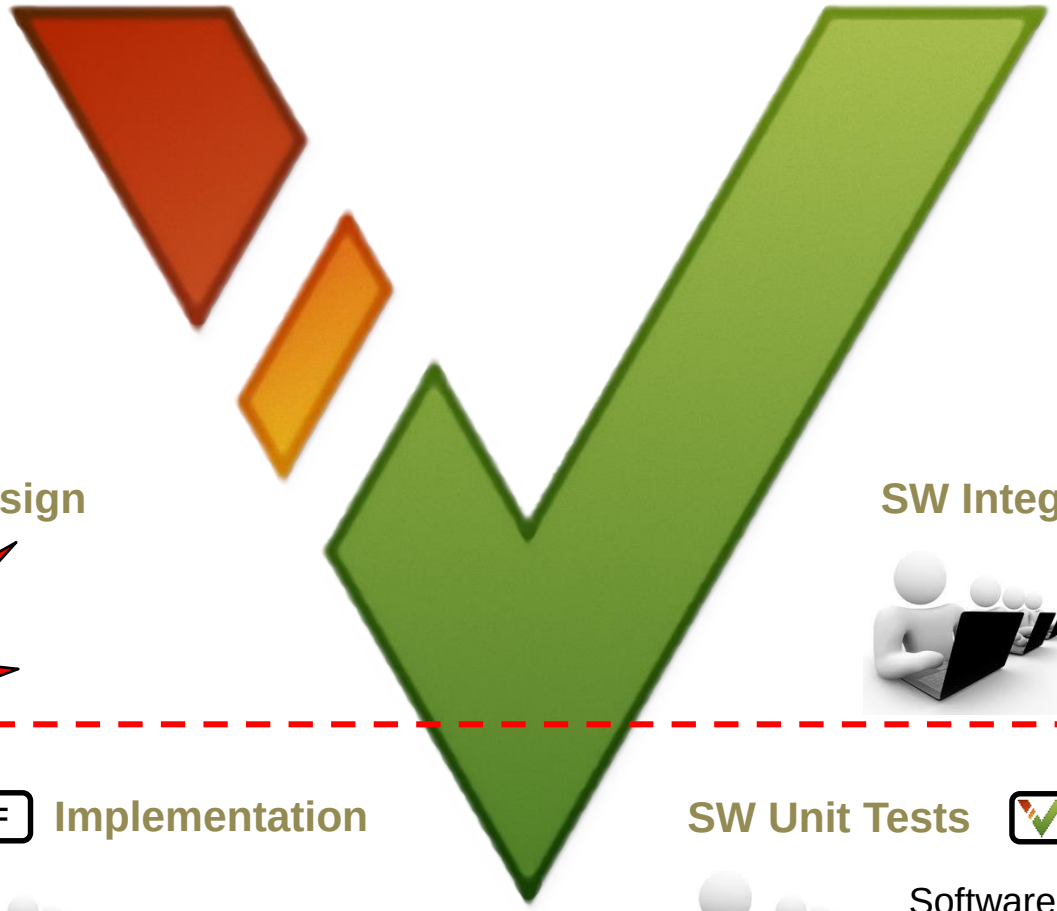
- Model-Based Design
  - On generated code

使用角色

Legend

- BF — Bug Finder
- CP — Code Prover



Specification

SW Acceptance tests CP BF

Quality Assurance Engineers

Design

SW Integration tests BF CP

Software Architects/Engineers and/or Quality Engineers

Your job of today

BF **Implementation**

Software Engineers

SW Unit Tests CP

Software Engineers and/ or Quality engineers

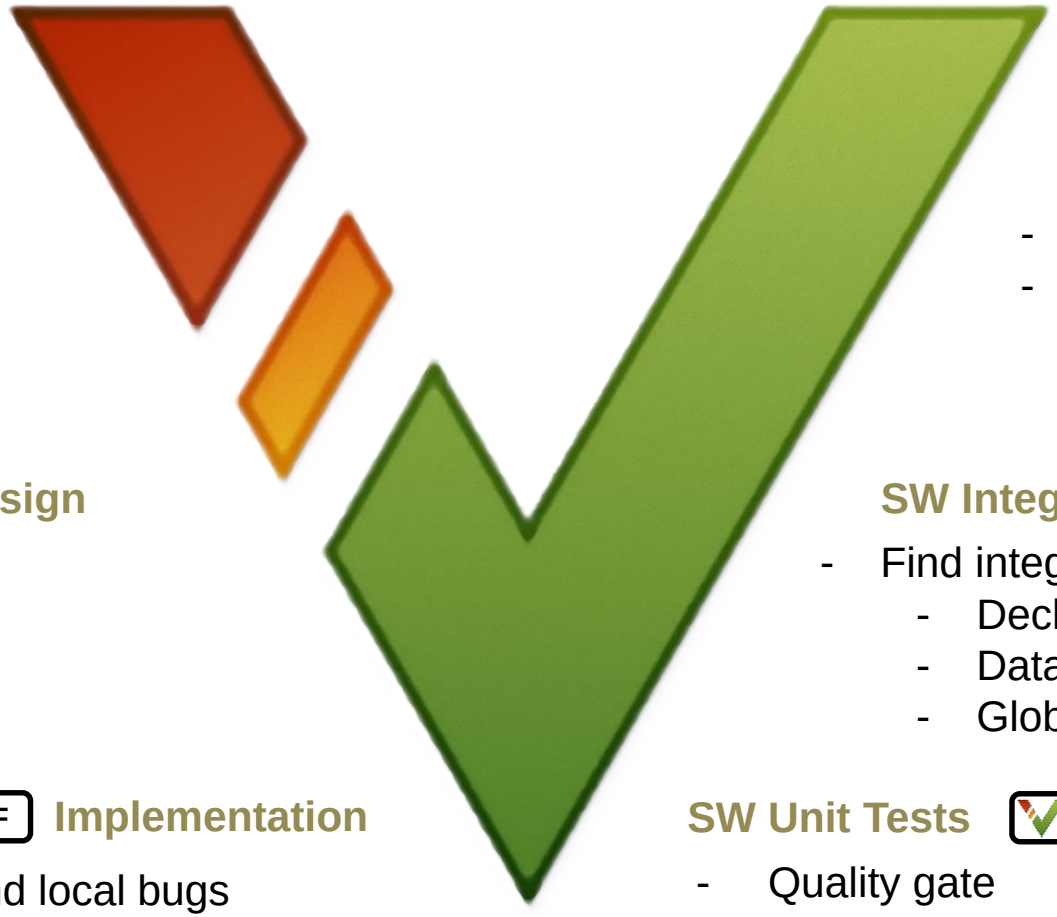
Exercise 1/2/3/4

参考流程

Legend

BF Bug Finder

CP Code Prover



Specification

SW Acceptance tests CP BF

- Measure SW quality
- Quality report generation

Design

SW Integration tests BF CP

- Find integration bugs
  - Declaration mismatches
  - Data race on shared variables
  - Global variables usage

BF **Implementation**

- Find local bugs
- Find MISRA violations
- Find “untestable” functions
- Perform Code Reviews

SW Unit Tests CP

- Quality gate
  - Find runtime errors / unused code
  - Prove absence of runtime errors on modules
  - Justify MISRA violations

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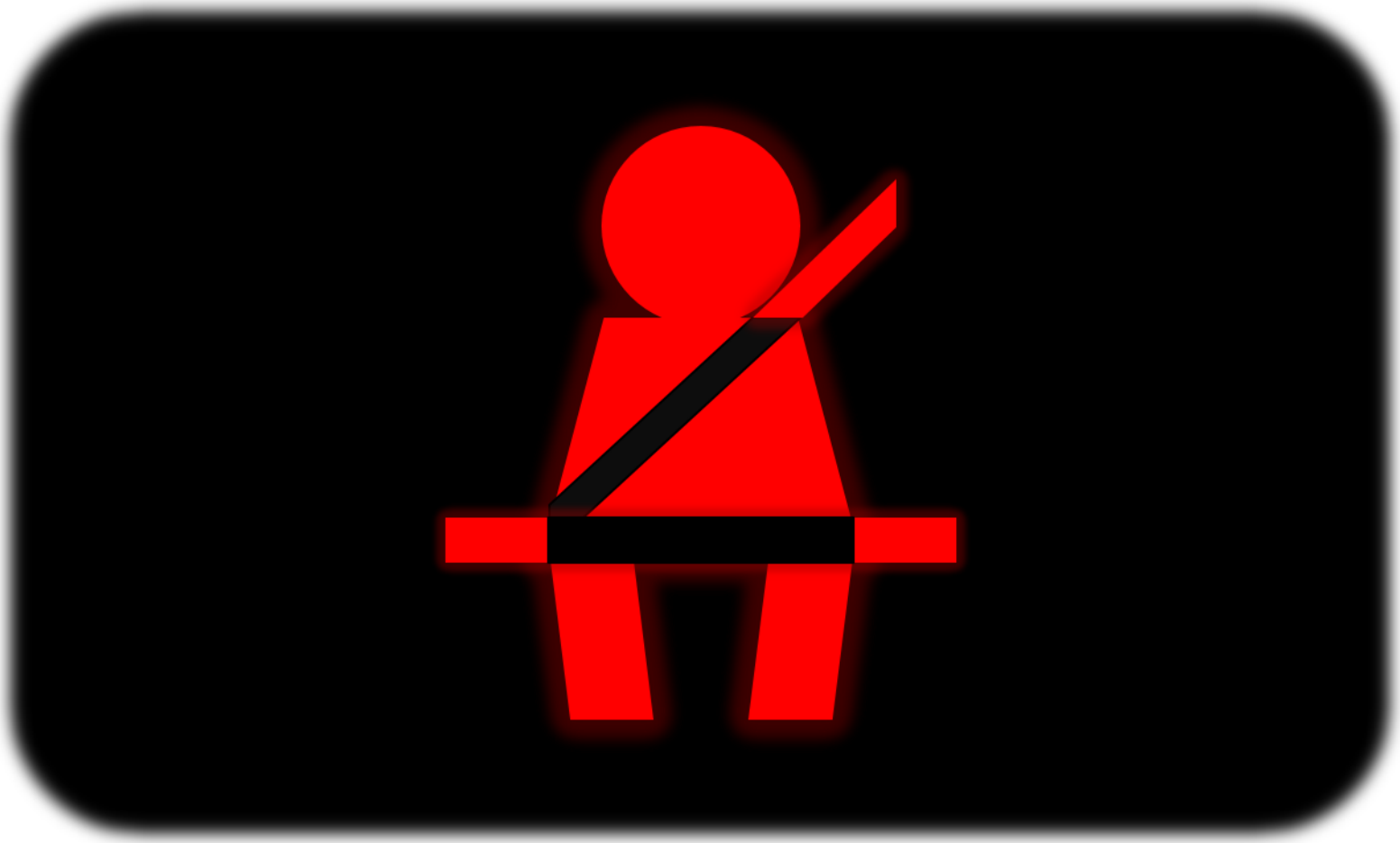
案例 - 安全带提示功能

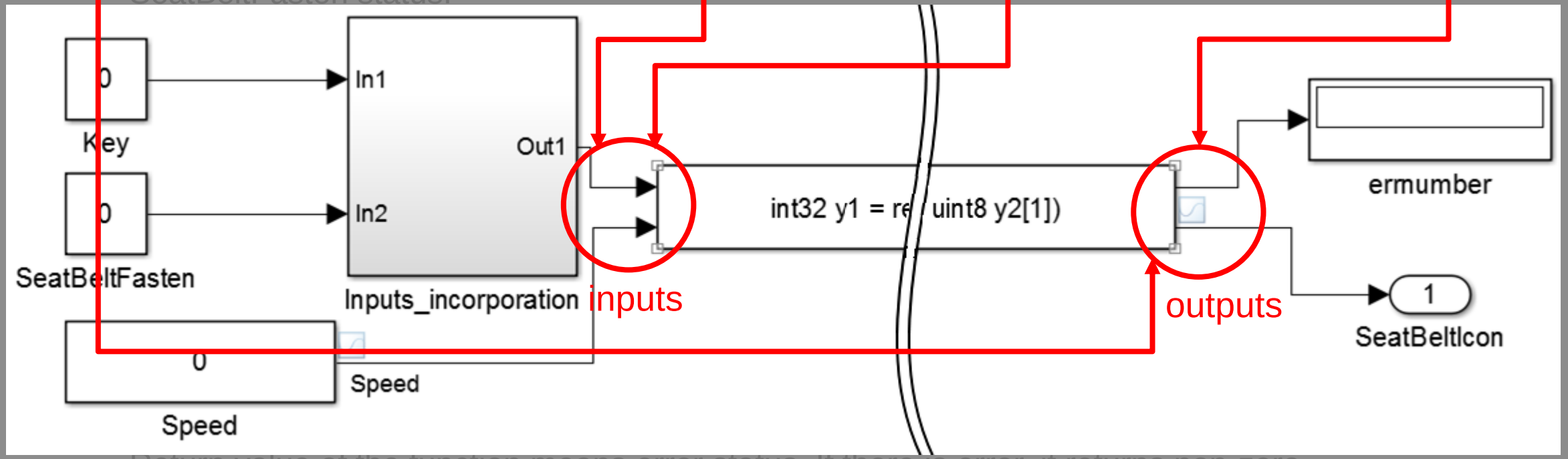


Seatbelt Reminder

安全带提示逻辑 – 软件架构

```
signed int reminder_control (signed short inputs, float *input_Curr_speed, unsigned char * output)
```

- Inputs description
  - First parameter is input to represent Key and SeatBeltFasten. It incorporates Key and SeatBeltFasten status.



  - Return value of the function means error status. If there is error, it returns non-zero.

安全带提示逻辑 – 输入输出

```
signed int reminder_control (signed short inputs, float *input_Curr_speed, unsigned char * output)
```

- Inputs description
  - First parameter is input to represent Key and SeatBeltFasten. It incorporates Key and SeatBeltFasten status.
  - Second parameter is input to represent current Speed. This should be processed by low-pass filter to prevent the signal from splashing in a sudden period.
  - First parameter has information for KEY and SeatBeltFasten status.

Input (First parameter)	**KEY**	**SeatBeltFasten**
0 (00000000 $00000000_{(2)}$)	OFF	Unfastened
256 (00000001 $00000000_{(2)}$)	ON	Unfastened
512 (00000010 $00000000_{(2)}$)	CRANK	Unfastened

Input (First parameter)	**KEY**	**SeatBeltFasten**
0 (00000000 $00000001_{(2)}$)	OFF	Fastened
257 (00000001 $00000001_{(2)}$)	ON	Fastened
513 (00000010 $00000001_{(2)}$)	CRANK	Fastened

- Outputs description
  - Third parameter is output to represent Seatbelt reminder icon.
  - Return value of the function means error status. If there is error, it returns non-zero.

安全带提示逻辑 – 功能描述

- Functional description
  - Sample time : 0.001 s (1000 Hz)
  - It should have low-pass filter to remove noise for the Speed value.
  - At **Key Off**, the **Seatbelt reminder icon** which is showed in the car dashboard must be switched **off**.
  - At **Key On**, the Seatbelt reminder icon status is related to the two inputs Speed and SeatBeltFasten. If the **seat belt is fastened, SeatBeltIcon is always off**. If **the seat belt is unfastened**, we consider **two different cases** (**Low speed** and **High speed**).
  - At **Key Crank**, the **Seatbelt reminder icon** must be switched **on**.

Speed	KEY	SeatBeltFasten	Seatbelt Reminder icon
< 15 km/h (Low speed)	ON	Unfastened	Always ON
>= 15km/h (High speed)	ON	Unfastened	Flickering every ***2 sec***.
-	ON	Fastened	Always OFF
-	CRANK	Unfastened / Fastened	Always ON
-	OFF	Unfastened / Fastened	Always OFF

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Exercises概览

- **Exercise 1 : Create Polyspace project and Run it**
  1. Simulate the logic of the code and understand problems of it
  2. Create Bug Finder project first and Run it

Bug Finder

- **Exercise 2 : Review MISRA violations and defects**
  1. Enable all rules of MISRA C:2012 and most of defects
  2. Review all of them and try to remove most of violations and defects
  3. Run analysis for the modified code repeatedly

Bug Finder

Exercises概览

- **Exercise 3 : Review Code Metrics**

  Bug Finder

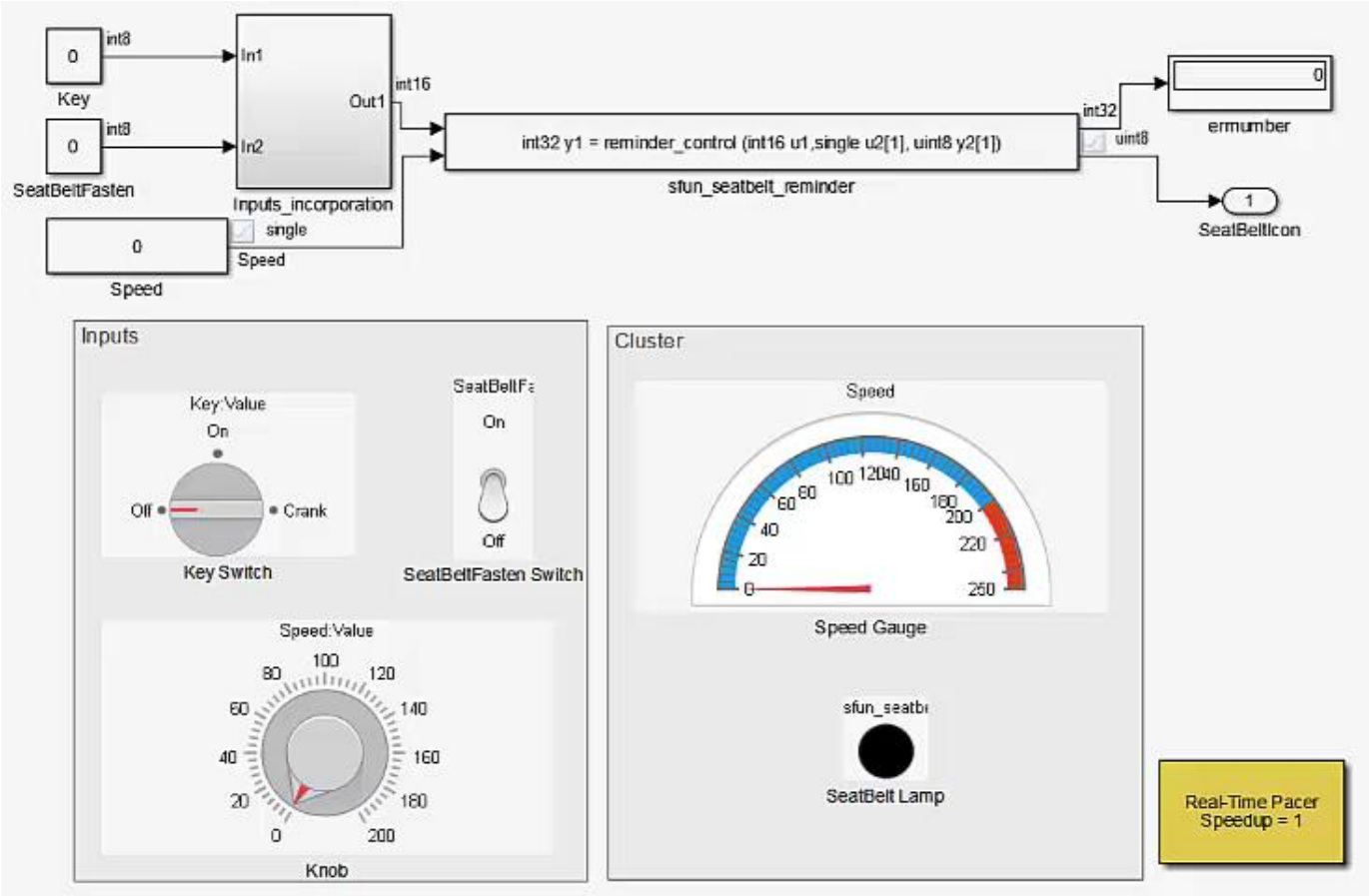
  1. Enable option to calculate Code Metrics
  2. Review the result and modify source code to comply with HIS
  3. Run analysis for the modified code repeatedly

- **Exercise 4 : Review Code Prover result**

  Code Prover

  1. Import Bug Finder project into Code Prover and Run it
  2. Run verification with Code Prover
  3. Review all MISRA violations and RTEs
  4. Do anything to make ALL GREEN! (Please don't remove all source code.)

系统需求理解 – 期望行为



Speed	KEY	SeatBeltFasten	Seatbelt Reminder icon
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>= 15km/h (High speed)	ON	Unfastened	Flickering every ***2 sec***.
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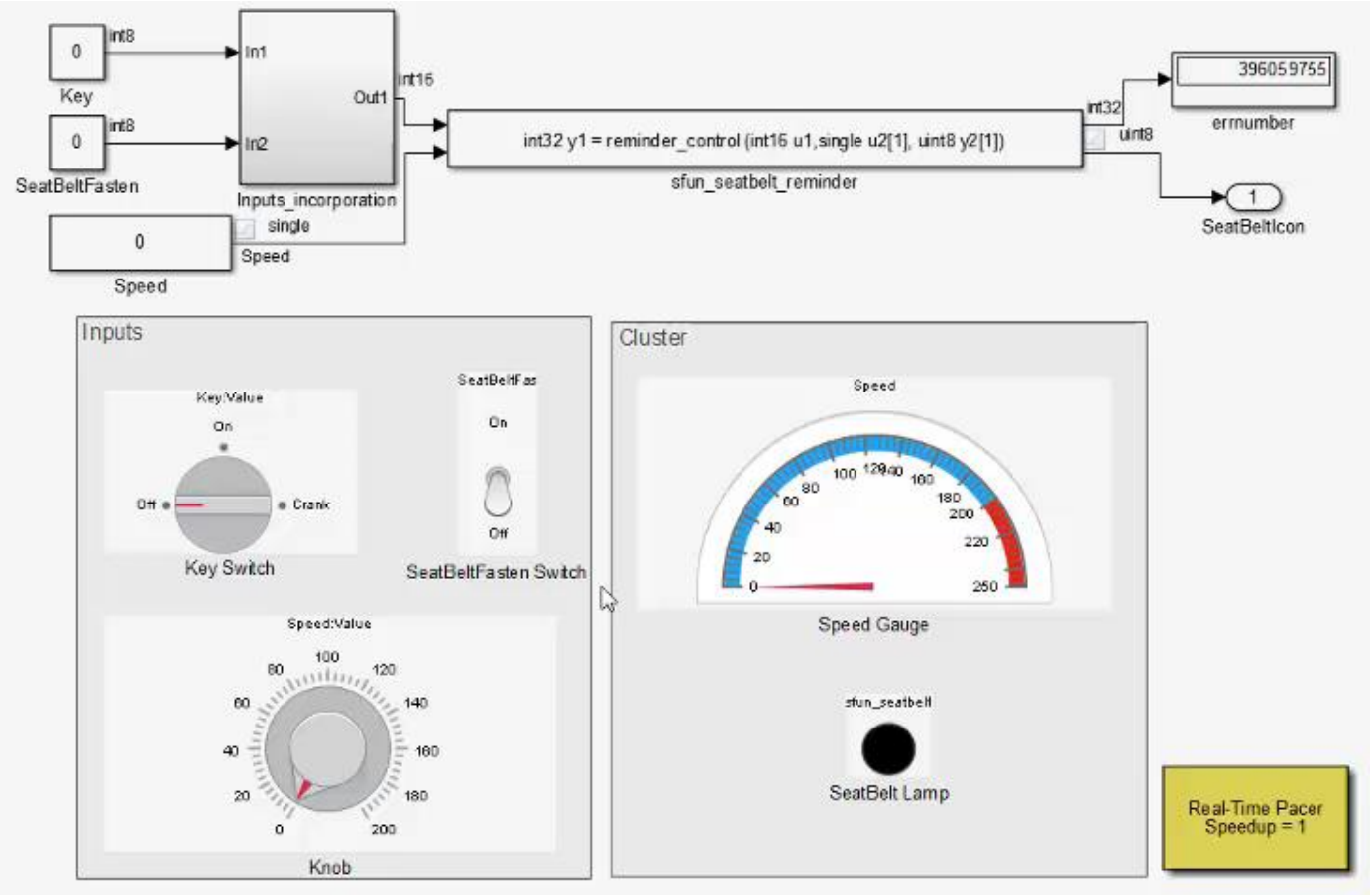
系统需求理解 – 问题发现



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>= 15km/h (High speed)	ON	Unfastened	Flickering every ***2 sec***.
-	ON	Fastened	Always OFF
-	CRANK	Unfastened / Fastened	Always ON
-	OFF	Unfastened / Fastened	Always OFF

- Errnumber when low speed
- Rapid flash when high speed
- …

代码审查...

```c
signed int reminder_control (signed short inputs, float *input_Curr_speed, unsigned char * output)
{
    int errnumber;
    unsigned char input_SeatBeltFasten, input_KEY;
    static int timer_cnt;
    static unsigned char output_SeatBeltIcon = SB_ICON_OFF;
    signed int gFiltered_speed = 0;

    if (((unsigned short)inputs&0x00FF) == 1) {
        input_SeatBeltFasten = 1;
    } else {
        input_SeatBeltFasten = 0;
    }

    switch ((((unsigned short)inputs&0xFF00)>>8)) {
    case 0:
        input_KEY = 0;
        break;
    case 1:
        input_KEY = 1;
        break;
    case 2:
        input_KEY = 2;
        break;
    }

    errnumber = lowPassFilter_SpeedSignal(&gFiltered_speed, input_Curr_speed);
```

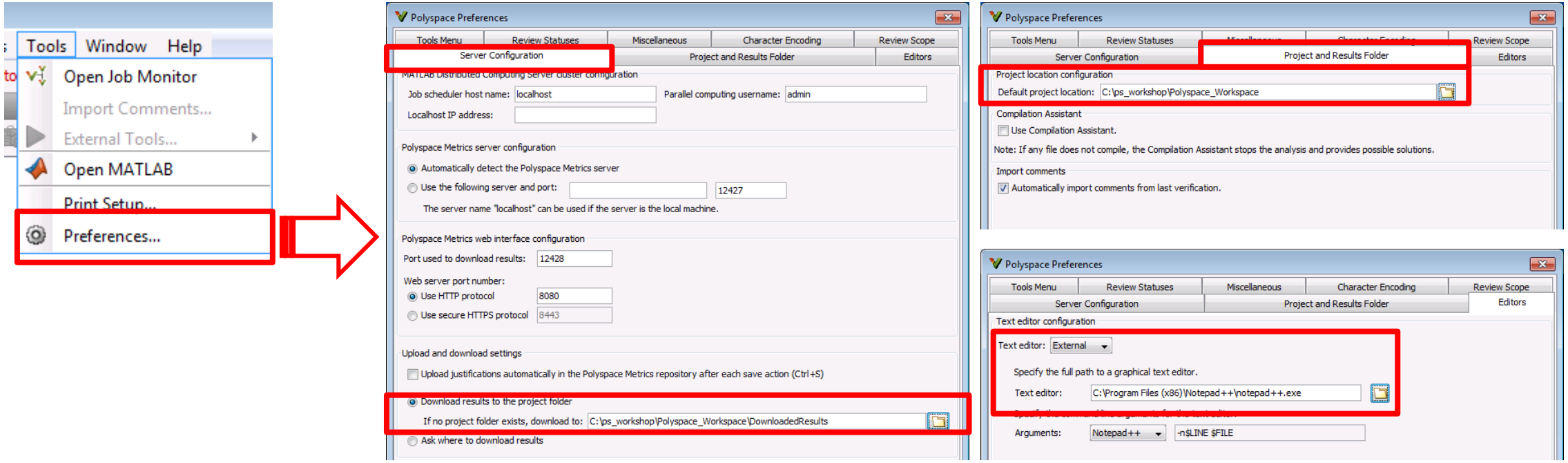
```c
    if (errnumber == 0) {
        if (KEY_OFF == input_KEY) {
            output_SeatBeltIcon = SB_ICON_OFF;
        } else if (KEY_ON == input_KEY) {
            if (SB_UNFASTENED == input_SeatBeltFasten) {
                if (gFiltered_speed < 15) {
                    output_SeatBeltIcon = SB_ICON_ON;
                } else {
                    if (timer_cnt > COUNT_FOR_BLINK)
                    {
                        if (output_SeatBeltIcon == SB_ICON_OFF) {
                            output_SeatBeltIcon = SB_ICON_ON;
                        } else {
                            output_SeatBeltIcon = SB_ICON_OFF;
                        }
                    }
                    timer_cnt++;
                }
            } else {
                output_SeatBeltIcon = SB_ICON_OFF;
            }
        } else {
            output_SeatBeltIcon = SB_ICON_ON;
        }
    }

    *output = output_SeatBeltIcon;

    return errnumber;
}
```

Exercise 1

Create project and Run it

- Create project manually
- Create project by using Configuration template

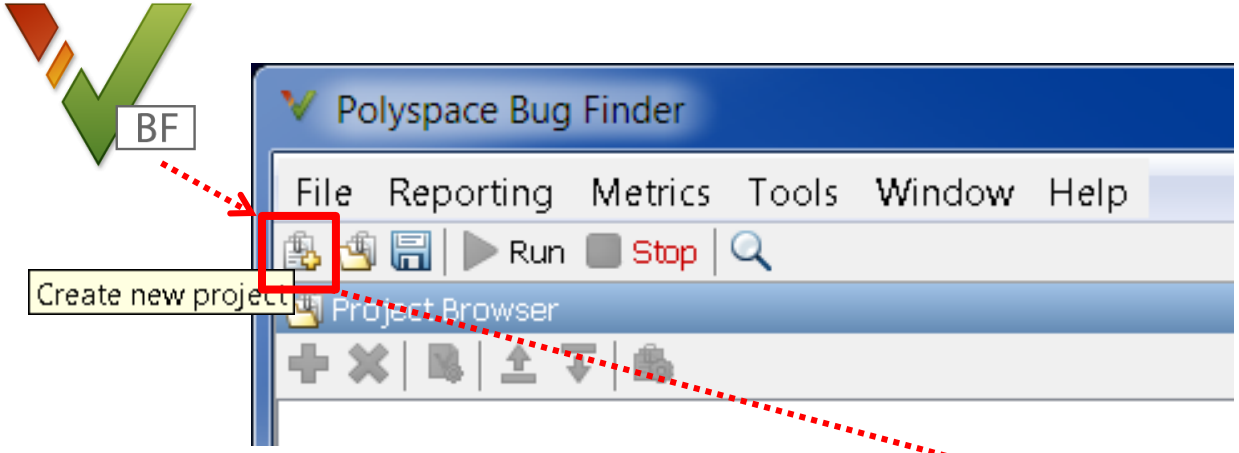
项目配置

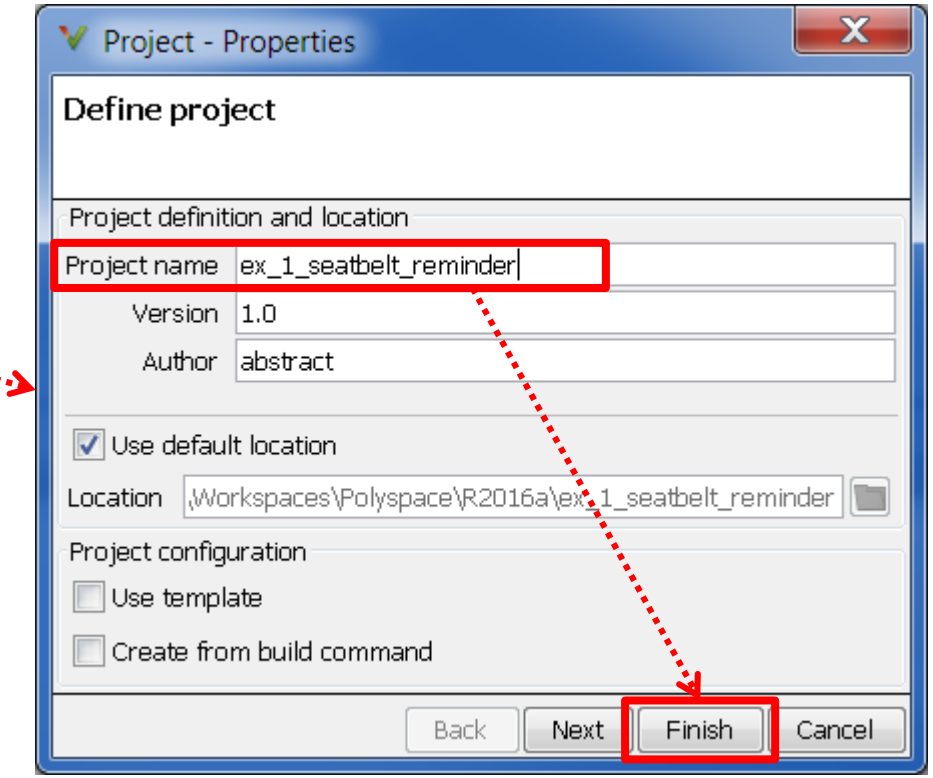


- Default project location
  - C:\polyspace_workshop\Polyspace_Workspace
- Download results to
  - C:\polyspace_workshop\Polyspace_Workspace\DownloadResults
- Text editor configuration
  - Notepad++

Exercise 1 - 创建并运行项目

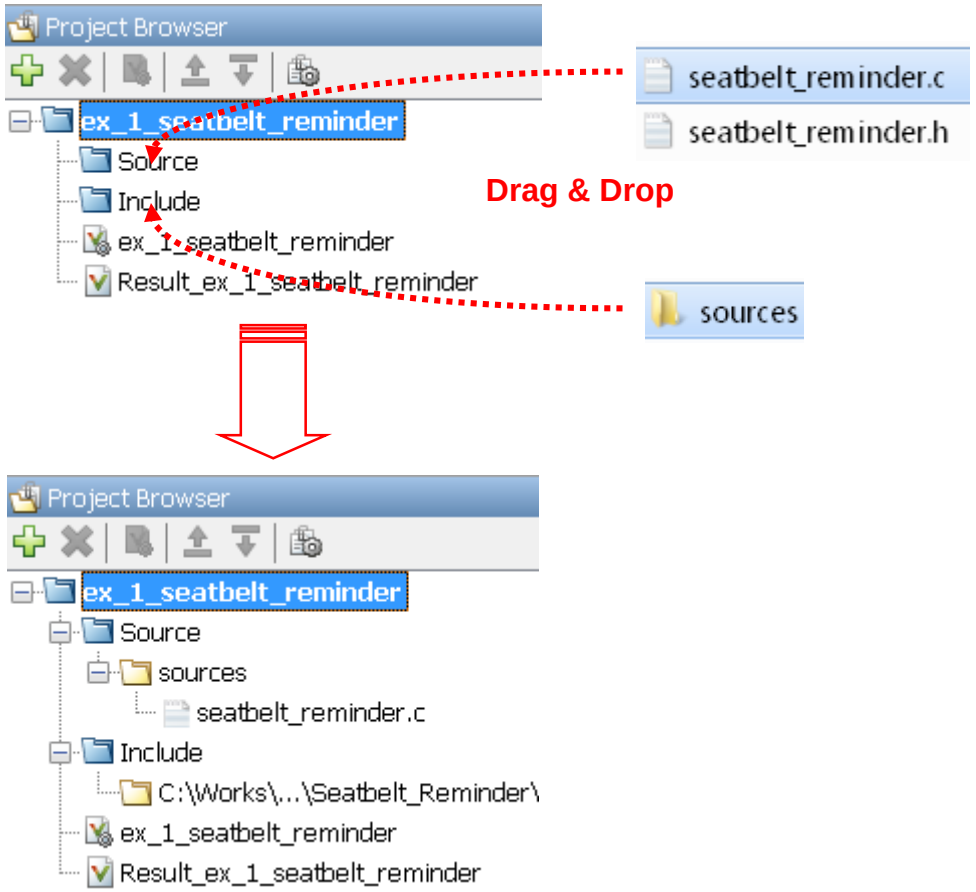
- Create Bug Finder project manually

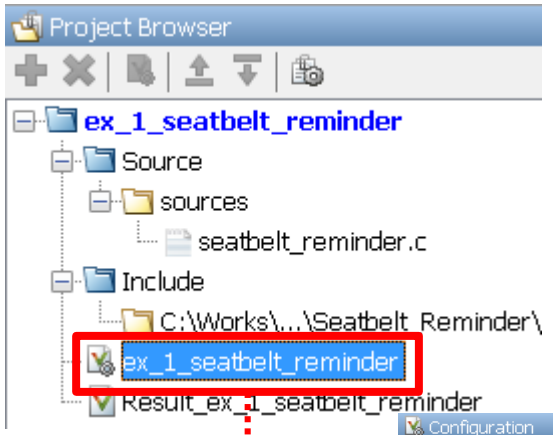




Exercise 1 -创建并运行项目

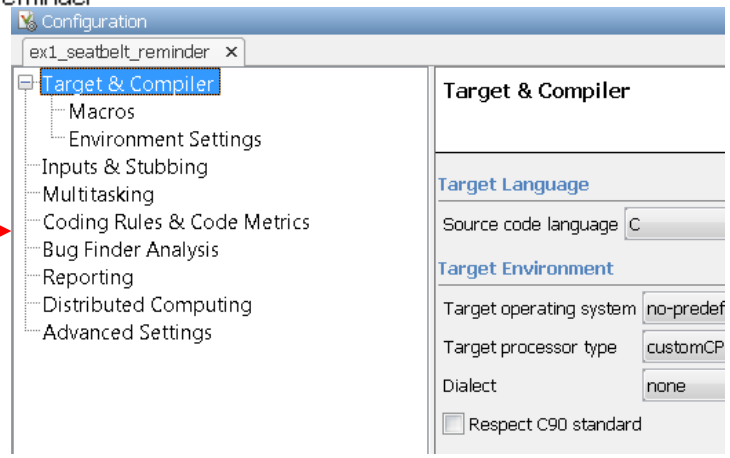
- Add source files in the project, and configure the project



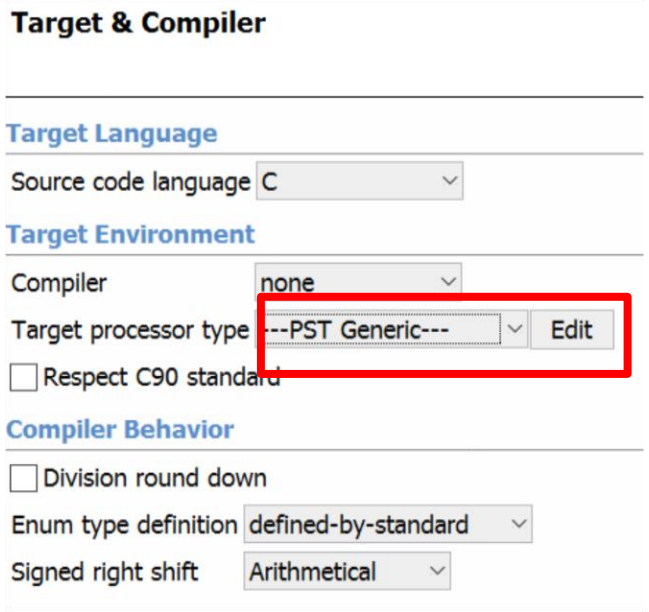


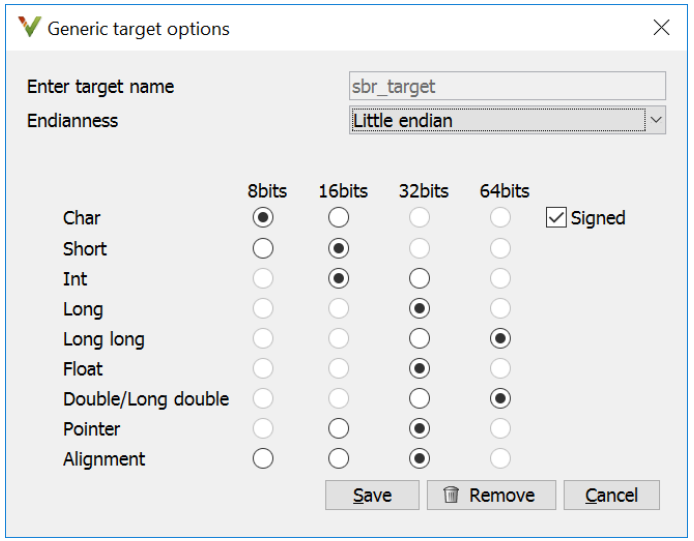
Major configuration

- ✓ Language : C
- ✓ 32bit CPU
  - long long/double/long double: 64 bits
  - pointer: 32 bits
  - align: 32 bits
- ✓ Checked all rules of MISRA C:2012
- ✓ Detect defects customized for all defects except Security and Tainted data



Exercise 1 -创建并运行项目





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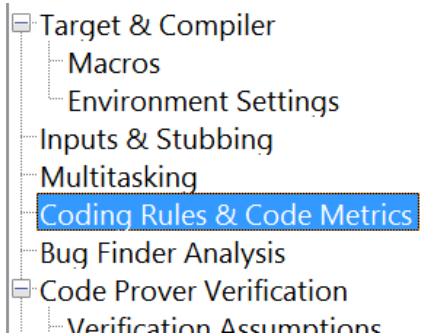
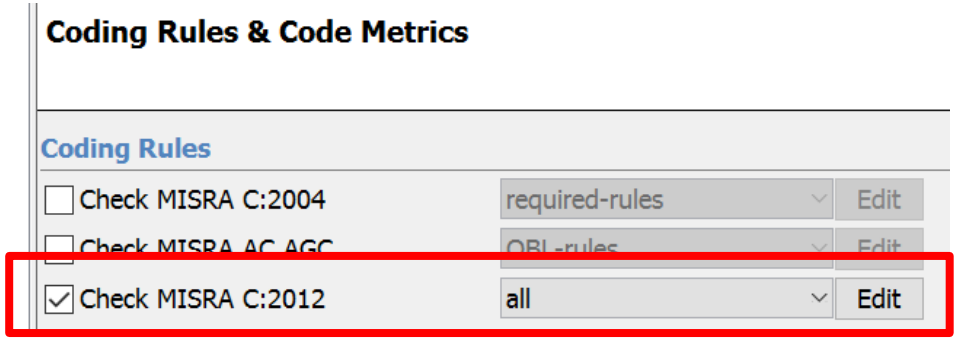
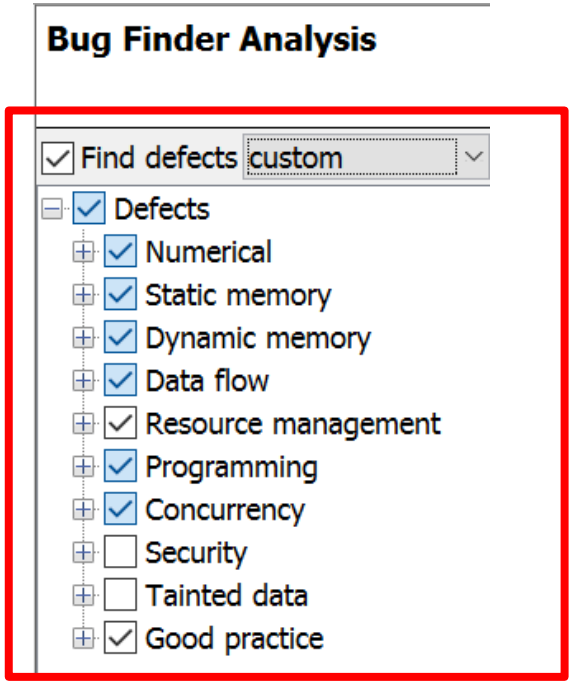




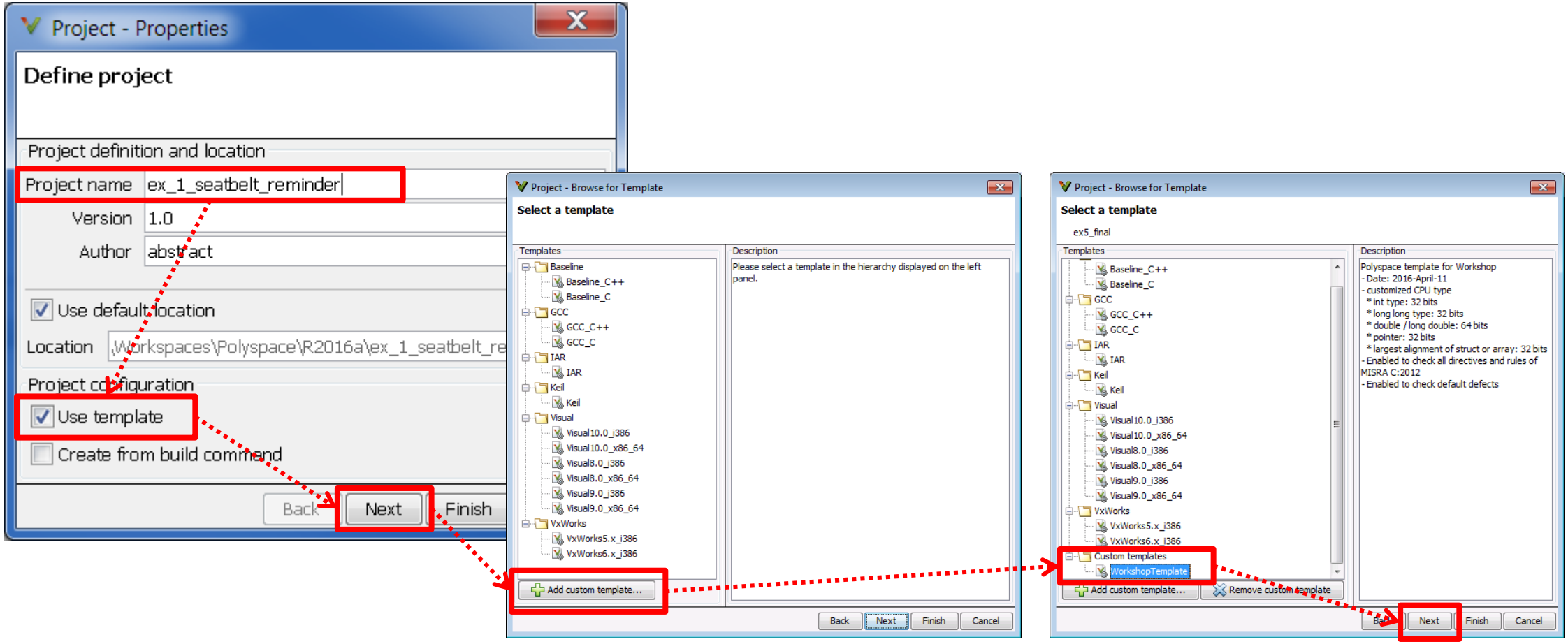


Exercise 1 -创建并运行项目

- Run the project in Bug Finder

Tip #1 – 项目模板

- Create Bug Finder project by using Configuration Template

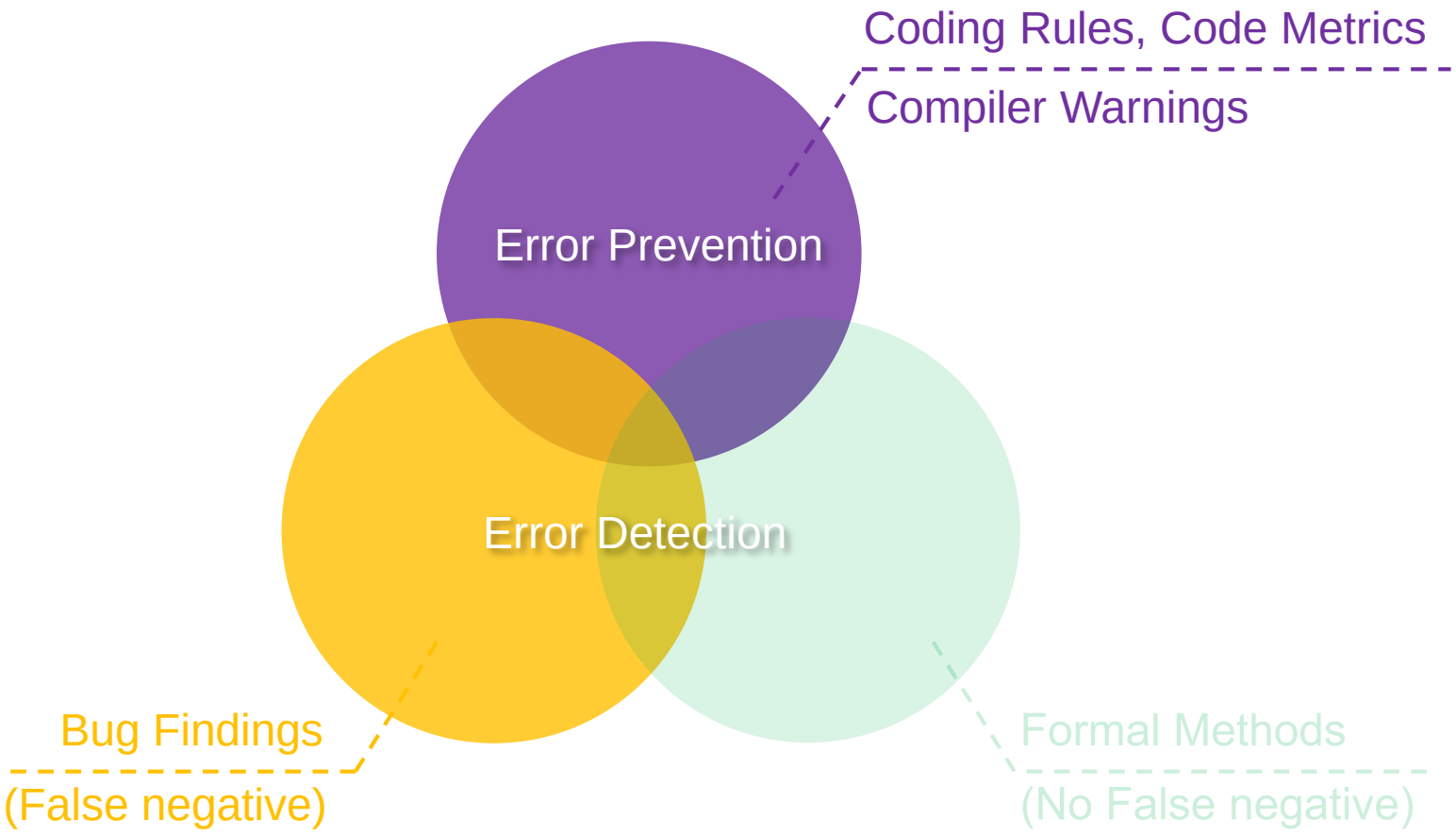


Exercise 2

Remove MISRA Violations and Defects

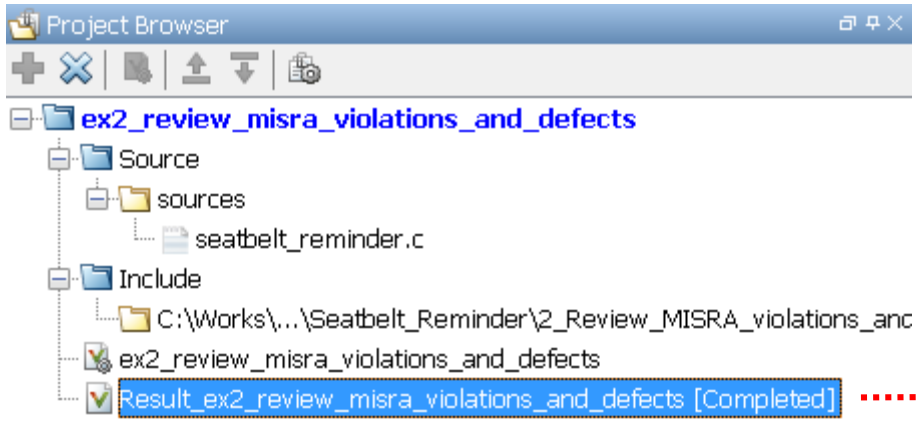
- Create new project file for this exercise
- Remove/Justify MISRA C:2012 Rule violations

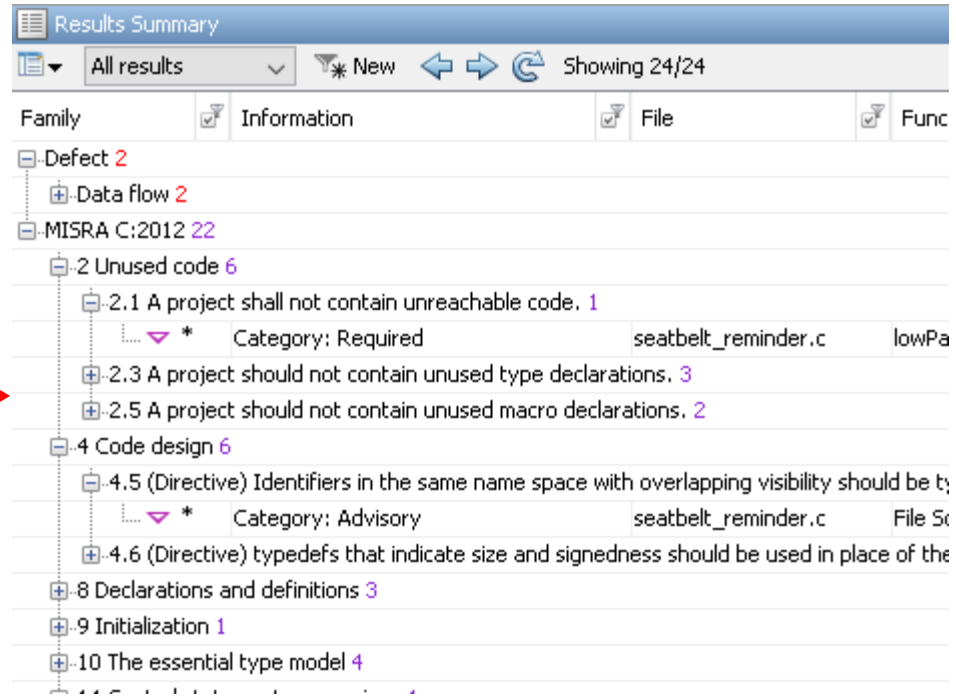
Exercise 2 & 3 – 覆盖内容



Exercise 2 – MISRA检查和软件缺陷查找

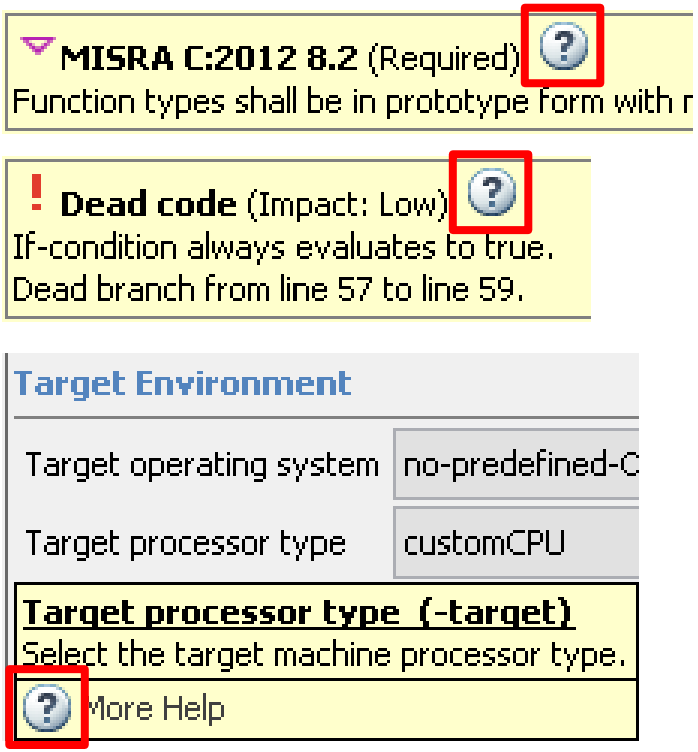
- Review all MISRA violations with Bug Finder
  - Create new project with source files in *2_Review_MISRA_violations_and_Defects*
  - Review MISRA violations first

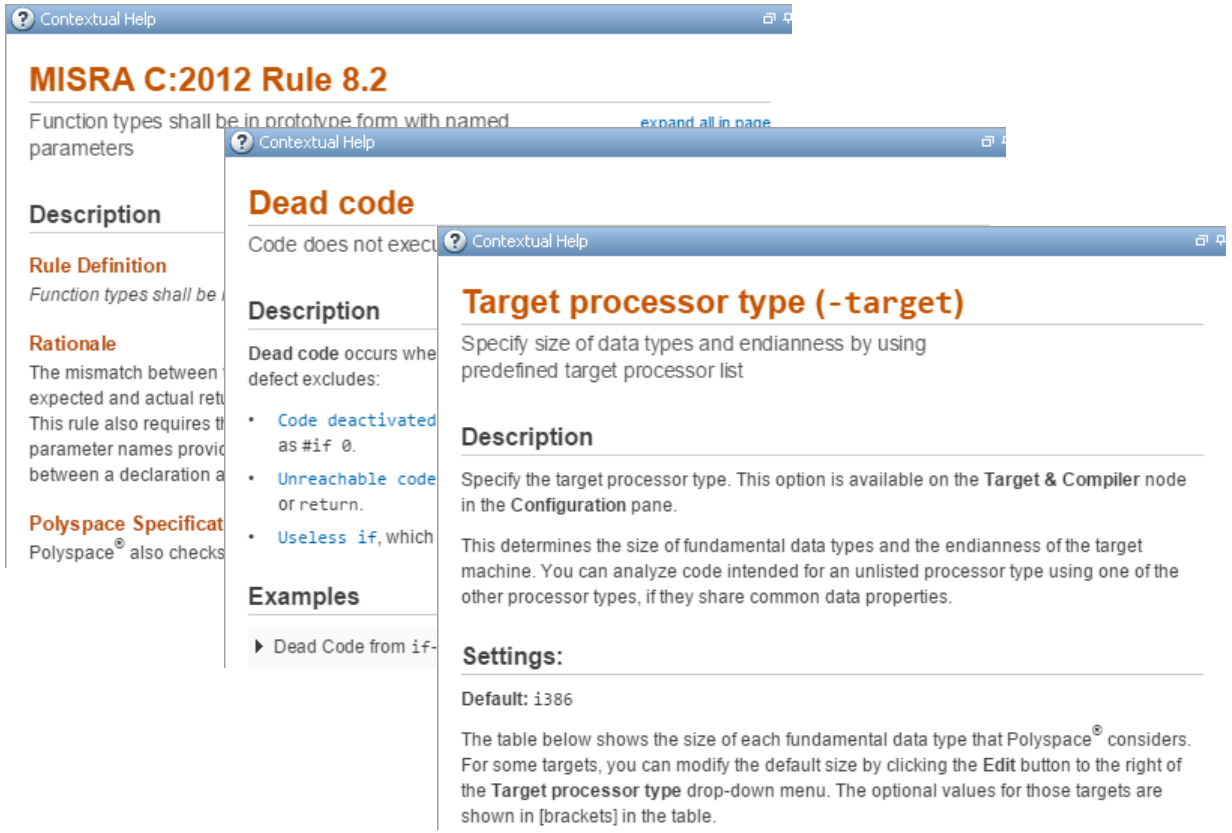




Tip #2 – 获取帮助

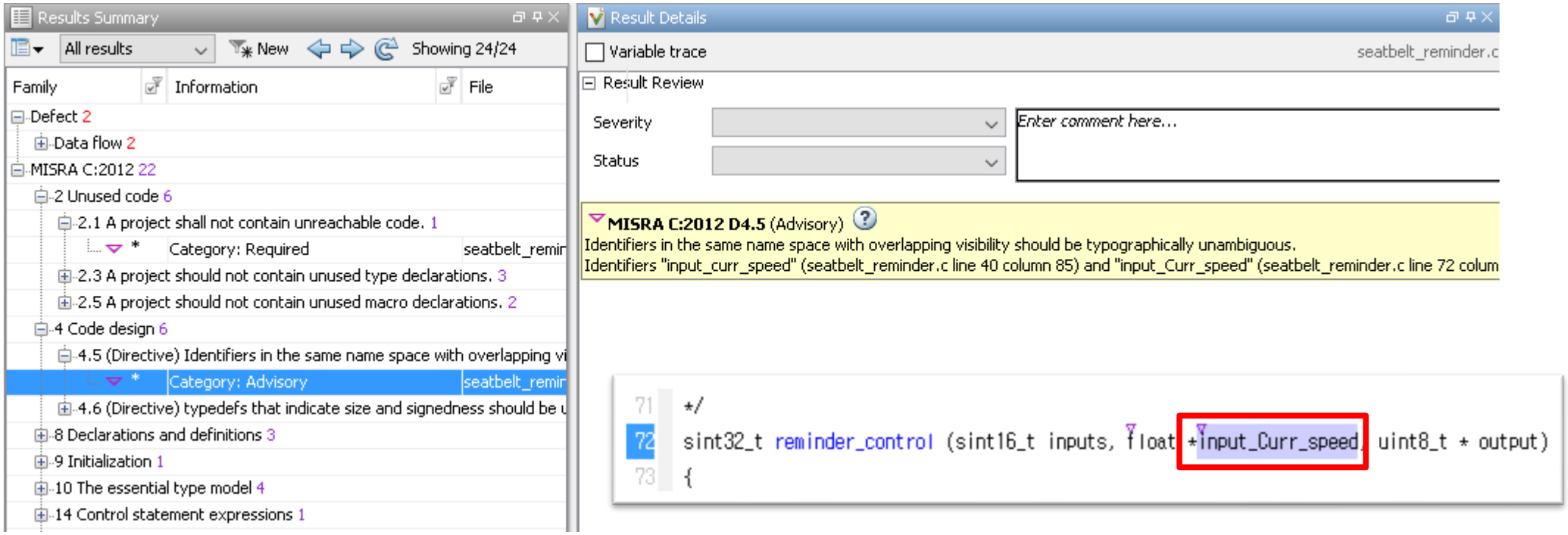
- Click ? to see Contextual Help
  - Modify the code as you wish to remove this violation





Exercise 2 – MISRA检查和软件缺陷查找

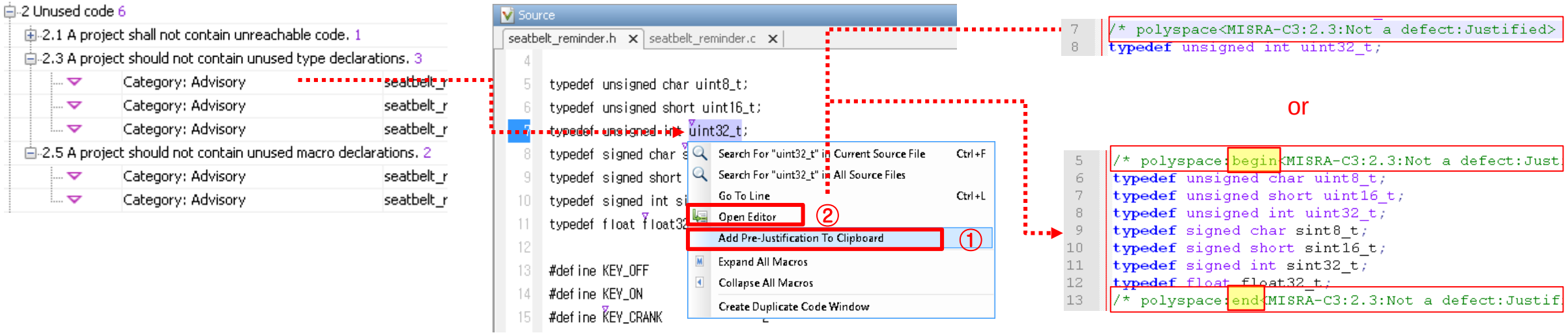
- Review an easy MISRA violation and fix it
  - Check violation related to Directive 4.5 and Directive 4.6



  - Modify the code as you wish to remove this violation

Exercise 2 – MISRA检查和软件缺陷查找

- Review some MISRA violations, and justify it by using pre-justification if necessary
  - Justify violations related to Rule 2.3 and Rule 2.5.

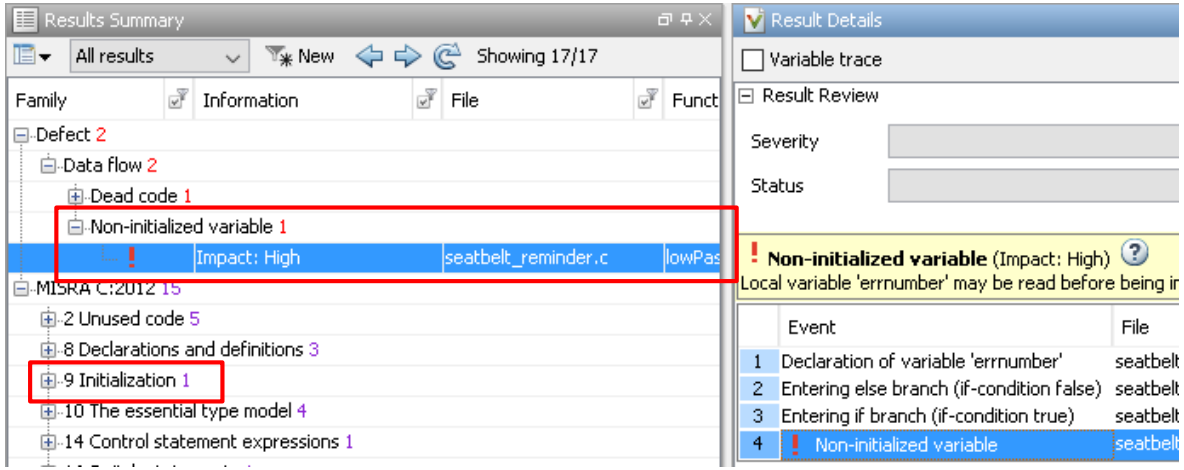


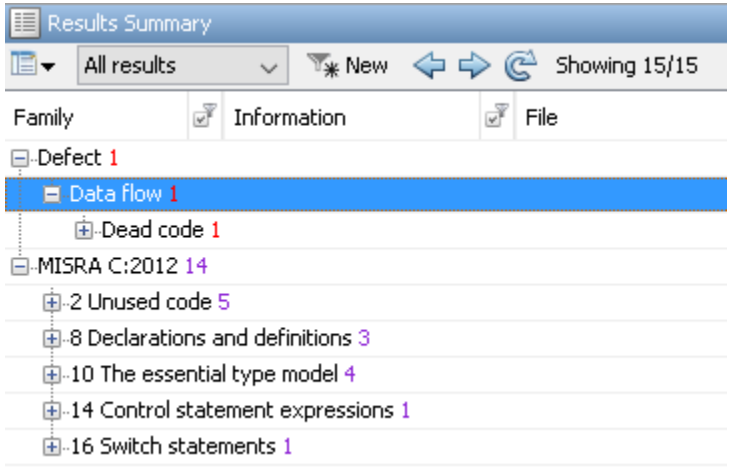
  - Justify violations through Polyspace client GUI or comments
  - Add comments in source code to justify violations.
    - You can use pre-justification for a line or a section.

Exercise 2 – MISRA检查和软件缺陷查找

- ***Review all MISRA violations***
  - You may modify source code to <u>remove violations and defects!</u>
  - Refer documentation through Contextual Help

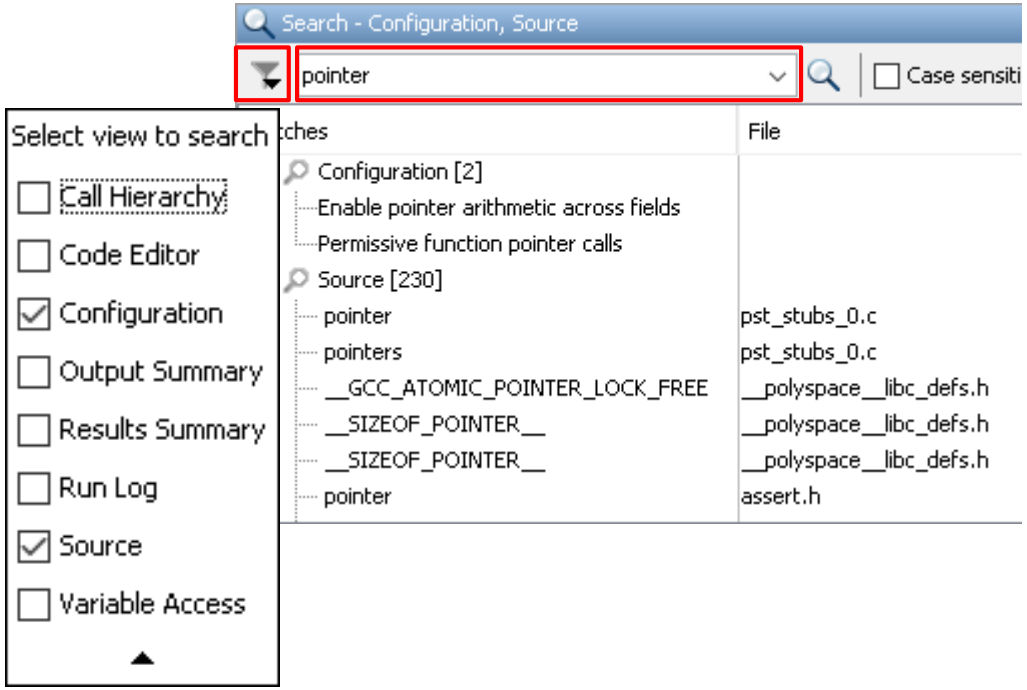
- ***Review all defects in the same way***
  - If you <u>remove a defect</u>, MISRA violation can be disappeared.

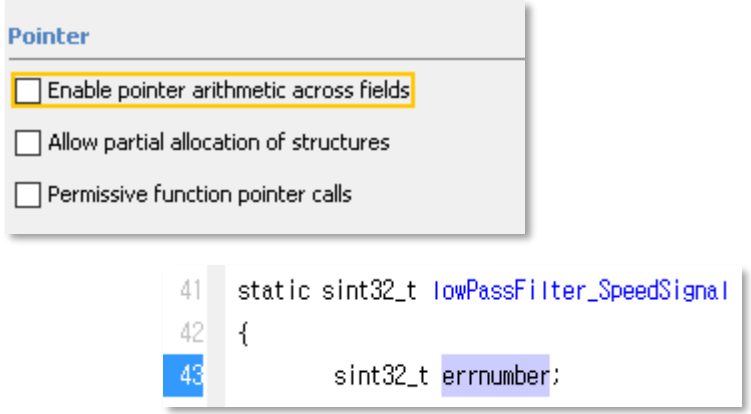




Tip #3 – 查找功能

- Search whatever you want in Polyspace
  - **Ctrl + F** enables you may search anything in Polyspace project
  - When you select a item, it highlights the location of the item





Exercise 2 – MISRA检查和软件缺陷查找

- Example answer - MISRA C:2012 - Rule 8.2

```
extern sint32_t reminder_control (sint16_t , float *, uint8_t *);
```

```
extern sint32_t reminder_control (sint16_t inputs, float32_t *curr_speed, uint8_t * output);
```

- Example answer - MISRA C:2012 - Rule 8.7

```
float32_t gPrev_speed;
```

```
static float32_t gPrev_speed;
```

- Example answer - MISRA C:2012 - Rule 8.13

```
static sint32_t lowPassFilter_SpeedSignal (sint32_t * output_Filtered_speed, float32_t * input_curr_speed)
```

```
static sint32_t lowPassFilter_SpeedSignal (sint32_t * output_Filtered_speed, const float32_t * input_curr_speed)
```

Exercise 2 – MISRA检查和软件缺陷查找

- Example answer - MISRA C:2012 - Rule 9.1 and Non-initialized variable

```
    } else {
        if (tmp_filtered_speed < 0.5F) {
            *output_Filtered_speed = 0;
        } else {
            *output_Filtered_speed = 0;
        }
    }

    gPrev_speed = tmp_filtered_speed;

    return errnumber;
}
```

```
    } else {
        if (tmp_filtered_speed < 0.5F) {
            *output_Filtered_speed = 0;
        } else {
            *output_Filtered_speed = 0;
        }
        errnumber = 0;
    }

    gPrev_speed = tmp_filtered_speed;

    return errnumber;
}
```

Exercise 2 – MISRA检查和软件缺陷查找

- Example answer - MISRA C:2012 - Rule 16.4

```
switch ((((uint16_t)inputs&0xFF00)>>8)) {
case 0:
    input_KEY = 0;
    break;
case 1:
    input_KEY = 1;
    break;
case 2:
    input_KEY = 2;
    break;
}
```

```
switch ((((uint16_t)inputs&0xFF00)>>8)) {
case 0:
    input_KEY = 0;
    break;
case 1:
    input_KEY = 1;
    break;
case 2:
    input_KEY = 2;
    break;
default:
    input_KEY = 3;
    break;
}
```

Exercise 2 – MISRA检查和软件缺陷查找

- Example answer - MISRA C:2012 - Rule 10.1 and 10.4

```
if (((uint16_t)inputs&0x00FF) == 1) {
    input_SeatBeltFasten = 1;
} else {
    input_SeatBeltFasten = 0;
}

switch ((((uint16_t)inputs&0xFF00)>>8)) {
```

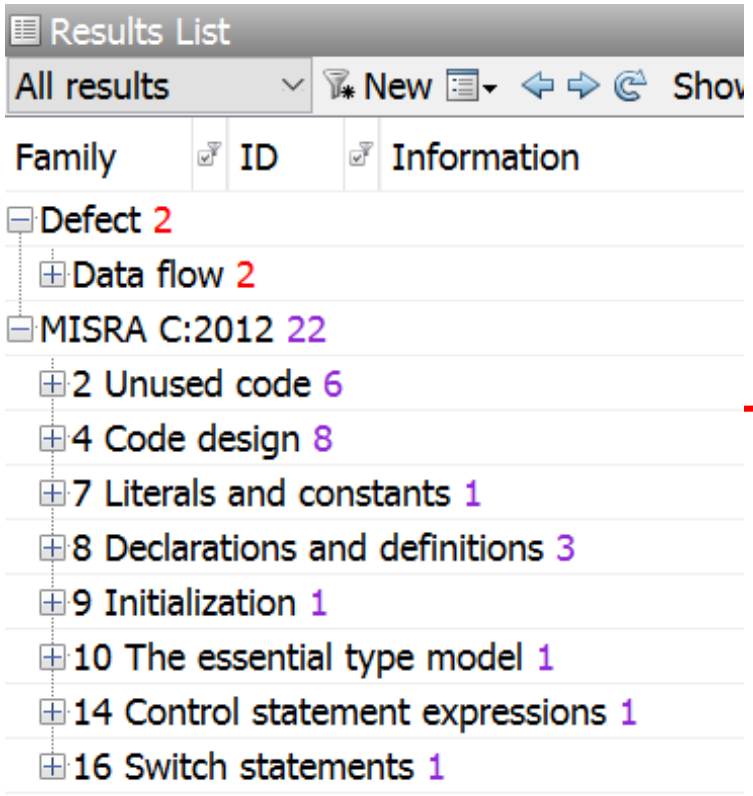
```
if (((uint16_t)inputs&0x00FFU) == 1) {
    input_SeatBeltFasten = 1;
} else {
    input_SeatBeltFasten = 0;
}

switch ((((uint16_t)inputs&0xFF00U)>>8)) {
```

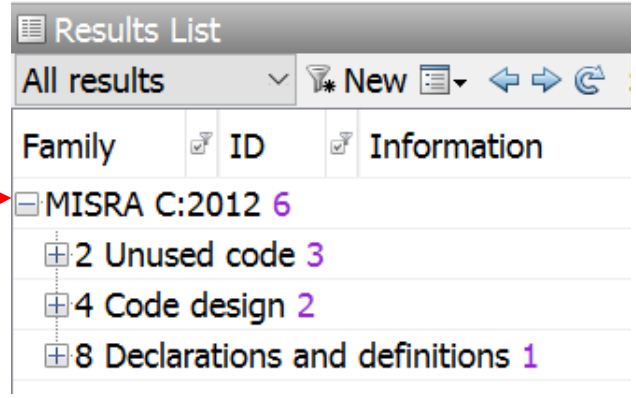
- Example answer - MISRA C:2012 - Rule 16.4 and Dead Code

```
} else {
    if (tmp_filtered_speed < 0.5F) {
        *output_Filtered_speed = 0;
    } else {
        *output_Filtered_speed = 0;
    }
    errnumber = 0;
}
```

```
} else {
    *output_Filtered_speed = 0;
    errnumber = 0;
}
```

Exercise 2 – 结果对比





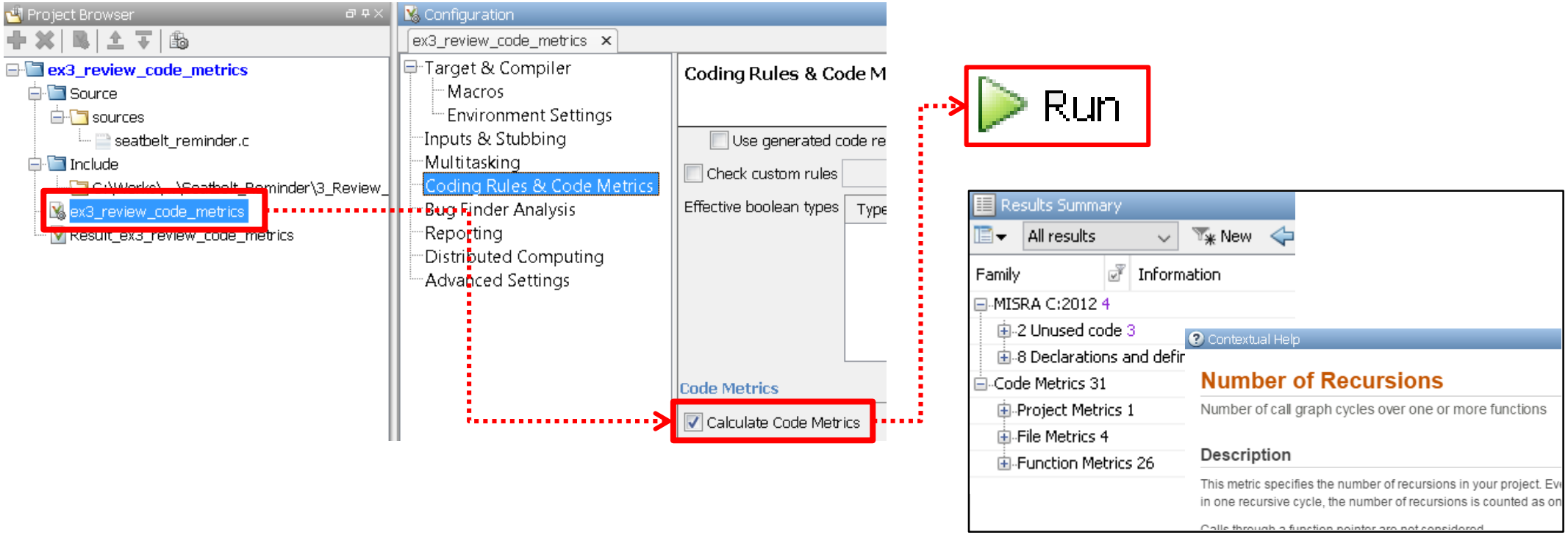
Exercise 3

Review Code Metrics and Increase/Decrease it

- Create new project file for this exercise
- Comply with HIS metrics

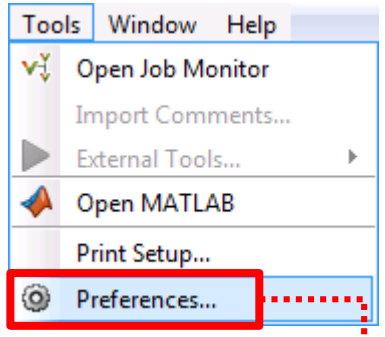
Exercise 3 - 代码度量

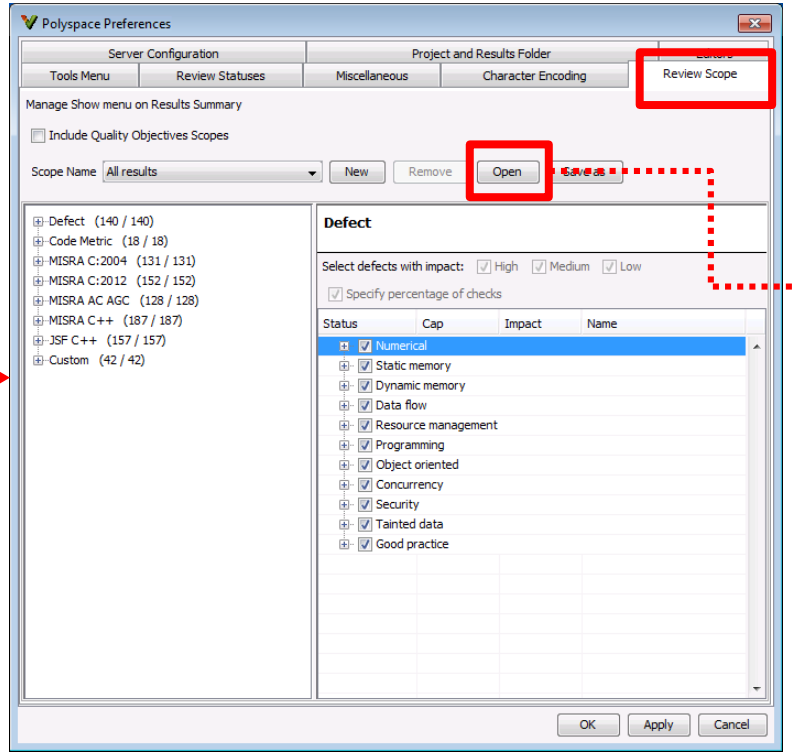
- Review all Code Metrics and refer documentation through Contextual Help
  - Create new project with source files in *3_Review_Code_Metrics*
  - Enable option to calculate Code Metrics and Run analysis

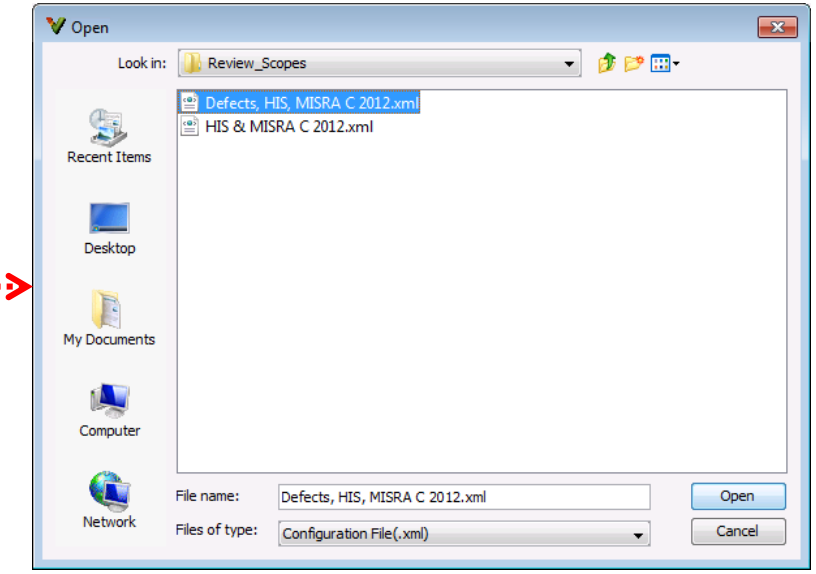


Exercise 3 - 代码度量

- Check which metrics cannot comply with HIS metrics
  - Apply review scope for HIS
  - Open user-defined review scope to see MISRA violations and Code Metrics together.



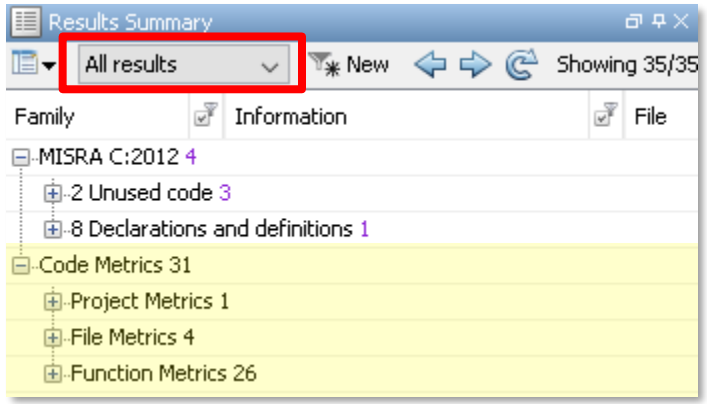


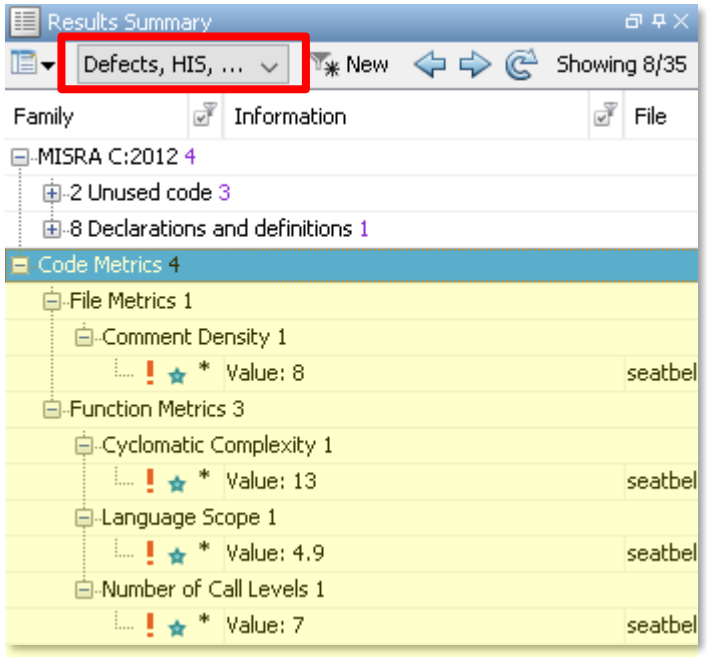


☞ **C:\ps_workshop\sources\3_Review_Code_Metrics\Review_Scopes**

Exercise 3 - 代码度量

- Apply user-defined review scope for Defects, MISRA and HIS metrics
  - You may make a new review scope to see MISRA violations and Code Metrics together.





  - How do you make it to comply with HIS metrics?

Exercise 3 - 代码度量

- Consider how to decrease/increase code metrics
  - Let’s see Cyclomatic Complexity and Number of Call Levels

Cyclomatic Complexity

Number of linearly independent paths through source code expand all in page

Description

This metric specifies the number of linearly independent paths through the source code.

To calculate this metric, add 1 to the number of decision points in your code. A decision point is a statement that causes your program to branch into two paths. For example, at an `if` statement, your program can either enter the `if` branch or not.

The recommended upper limit for this metric is 10. If the cyclomatic complexity is high, the code is both difficult to read and can cause more orange checks. Therefore, try to limit the value of this metric.

Number of Call Levels

Maximum depth of nesting of control flow structures expand all in page

Description

This metric specifies the maximum nesting depth of control flow statements such as `if`, `switch`, `for`, or `while` in a function. A function without control-flow statements has a call level 1.

The recommended upper limit for this metric is 4. For better readability of your code, try to enforce an upper limit for this metric.

- Recommended upper limit : 10 for Cyclomatic Complexity, 4 for Number of Call Levels
- If you want to decrease calculated value,
  - ✓ Decrease the number of decision points such as if condition, switch/case and for/while loop.

Exercise 3 - 代码度量

- Let’s see example code to improve code metrics - ***1***
  - This is not the best answer but an example answer.
  - Replacement of left code with right code can decrease another metrics.

```c
/* 0(LSB) ~ 7th bit of inputs variable means status of SeatBeltFasten. */
if (((uint16_t)inputs&0x00FFU) == 1) {
    input_SeatBeltFasten = 1;
} else {
    input_SeatBeltFasten = 0;
}

/* 8 ~ 15th bit(MSB) of inputs variable means status of Key. */
switch ((((uint16_t)inputs&0xFF00U)>>8)) {
case 0:
    /* Key is at Off position */
    input_KEY = 0;
    break;
case 1:
    /* Key is at On position */
    input_KEY = 1;
    break;
case 2:
    /* Key is at Crank position */
    input_KEY = 2;
    break;
default:
    /* erroneous status */
    input_KEY = 3;
    break;
}
```

```c
/*
* Below code separates the incoporated inputs for Key and SeatBeltFasten.
*   - 0(LSB) ~ 7th bit of inputs variable means status of SeatBeltFasten.
*   - 8 ~ 15th bit(MSB) of inputs variable means status of Key.
*/
input_KEY = (uint8_t)(((uint16_t)inputs&0xFF00U)>>8);
input_SeatBeltFasten = (uint8_t)((uint16_t)inputs&0x00FFU);

if ((input_KEY > 2)&&(input_SeatBeltFasten > 1)){
    /* all inputs are strange */
    errnumber = -4;
} else if (input_KEY > 2) {
    /* input_KEY input is strange */
    errnumber = -5;
} else if (input_SeatBeltFasten > 1) {
    /* input_SeatBeltFasten is strange */
    errnumber = -6;
} else {
    errnumber = 0;
}
```

Exercise 3 - 代码度量

- Let’s see example code to improve code metrics - ***1***
  - Replacement of left code with right code can decrease some metrics.

```
if (errnumber == 0) {
    if (KEY_OFF == input_KEY) {
        output_SeatBeltIcon = SB_ICON_OFF;
    } else if (KEY_ON == input_KEY) {
        if (SB_UNFASTENED == input_SeatBeltFasten) {
            if (gFiltered_speed < 15) {
                output_SeatBeltIcon = SB_ICON_ON;
            } else {
                if (timer_cnt > COUNT_FOR_BLINK)
                {
                    if (output_SeatBeltIcon == SB_ICON_OFF) {
                        output_SeatBeltIcon = SB_ICON_ON;
                    } else {
                        output_SeatBeltIcon = SB_ICON_OFF;
                    }
                }
                timer_cnt++;
            }
        } else {
            output_SeatBeltIcon = SB_ICON_OFF;
        }
    } else if (KEY_CRANK == input_KEY) {
        output_SeatBeltIcon = SB_ICON_ON;
    } else {
        errnumber = -4;
    }
}
```

```
if (errnumber == 0) {
    if ((KEY_ON == input_KEY)&&(SB_UNFASTENED == input_SeatBeltFasten)) {
        if (gFiltered_speed >= 15) {
            if (timer_cnt > COUNT_FOR_BLINK)
            {
                output_SeatBeltIcon ^= 0x1U;
            }
            timer_cnt++;
        } else {
            output_SeatBeltIcon = SB_ICON_ON;
        }
    } else if (KEY_CRANK == input_KEY) {
        output_SeatBeltIcon = SB_ICON_ON;
    } else {
        output_SeatBeltIcon = SB_ICON_OFF;
    }
}
```

Exercise 3 - 代码度量

- Consider how to decrease Language Scope

Language Scope

Language scope

expand all in page

Description

This metric measures the cost of maintaining or changing a function. It is calculated as:

```
(N1 + N2)/(n1 + n2)
```

Here:

- N1 is the number of occurrences of operators.
- N2 is the number of occurrences of operands.
- n1 is the number of distinct operators.
- n2 is the number of distinct operands.

The recommended upper limit for this metric is 10. For lower maintenance cost for a function, try to enforce an upper limit on this metric. For instance, if the same operand occurs many times, to change the operand name, you have to make many substitutions.

- Recommended upper limit : 4
- If you want to decrease calculated value,
  - ✓ Increase the number of distinct operators/operands
  - ✓ Decrease the number of occurrences of operator/operands
  - ❖ <u>If a function has very high value, it's better to separate the function to multiple functions.</u>

- Previous activities already affected this metrics to be decreased.
- BUT! *It doesn't comply with limit of HIS metrics. What will you do?*

Exercise 3 - 代码度量

- Let’s see example code to improve Language Scope
  - Separate a part of source code as a function.

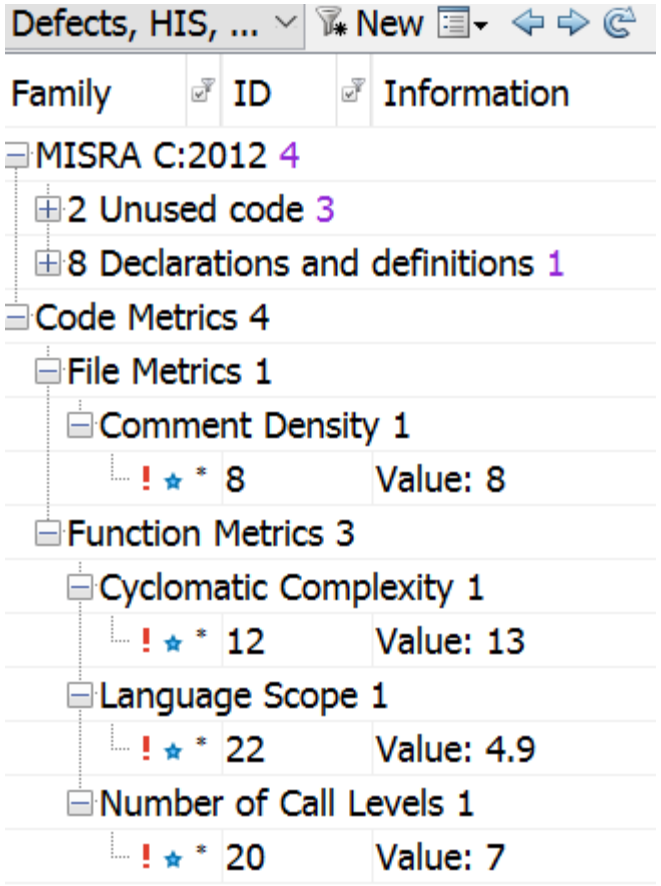
```
errnumber = separate_inputs_to_Key_and_SeatBeltFasten(inputs, &input_SeatBeltFasten, &input_KEY);
```

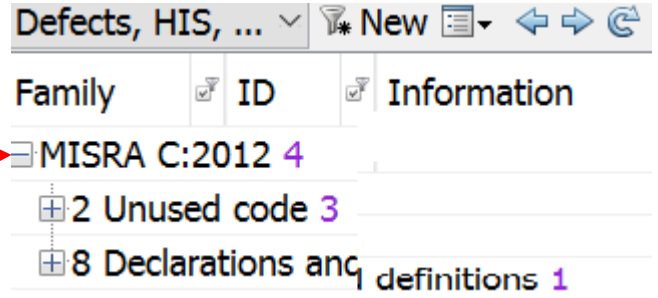
+

```
input_KEY = (uint8_t)(((uint16_t)inputs&0xFF00U)>>8);
input_SeatBeltFasten = (uint8_t)((uint16_t)inputs&0x00FFU);

if ((input_KEY > 2)&&(input_SeatBeltFasten > 1)){
    /* all inputs are strange */
    errnumber = -4;
} else if (input_KEY > 2) {
    /* input_KEY input is strange */
    errnumber = -5;
} else if (input_SeatBeltFasten > 1) {
    /* input_SeatBeltFasten is strange */
    errnumber = -6;
} else {
    errnumber = 0;
}
```

```
static sint32_t separate_inputs_to_Key_and_SeatBeltFasten (sint16_t inputs,
{
    sint32_t errnumber = 0;
    uint8_t SeatBeltFasten, KEY;

    KEY = (uint8_t)(((uint16_t)inputs&0xFF00U)>>8);
    SeatBeltFasten = (uint8_t)((uint16_t)inputs&0x00FFU);

    if ((KEY > 2)&&(SeatBeltFasten > 1)){
        /* all inputs are strange */
        errnumber = -4;
    } else if (KEY > 2) {
        /* Key input is strange */
        errnumber = -5;
    } else if (SeatBeltFasten > 1) {
        /* SeatBeltFasten is strange */
        errnumber = -6;
    } else {
        *input_SeatBeltFasten = SeatBeltFasten;
        *input_KEY = KEY;
        errnumber = 0;
    }

    return errnumber;
}
```

Exercise 3 – 结果对比



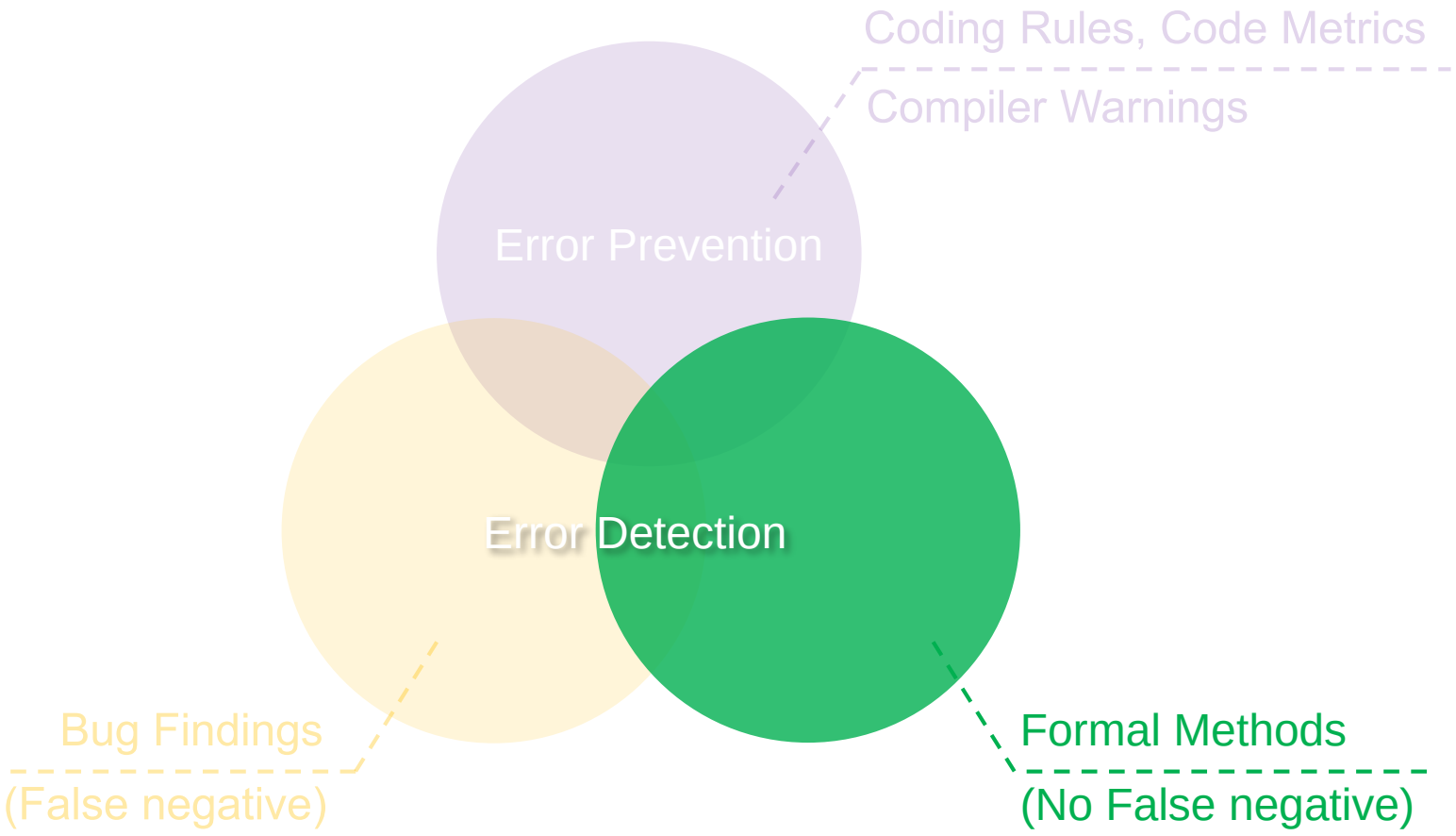


Exercise 4

Review Runtime errors and additional issues

- Import previously used project file for this exercise
- Review red or orange checks
- Do anything to make ALL **GREEN**

Exercise 4 – 内容



功能对比

Bug Finder

Nothing Found

Probable Bug

vs.

Code Prover

Orange - Vulnerability

Green - Reliable

Grey – Unreachable / Dead

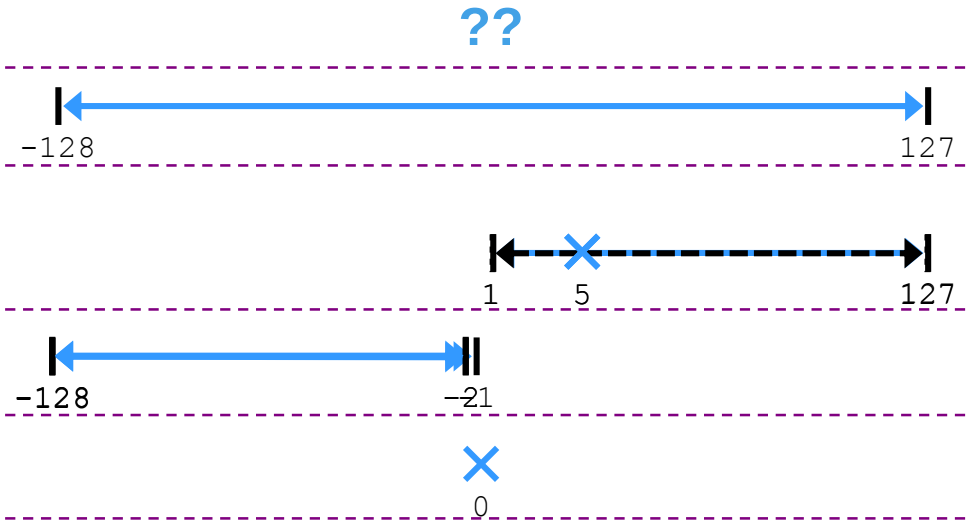
Red - Faulty

Purple - coding rule violations

理解抽象解释

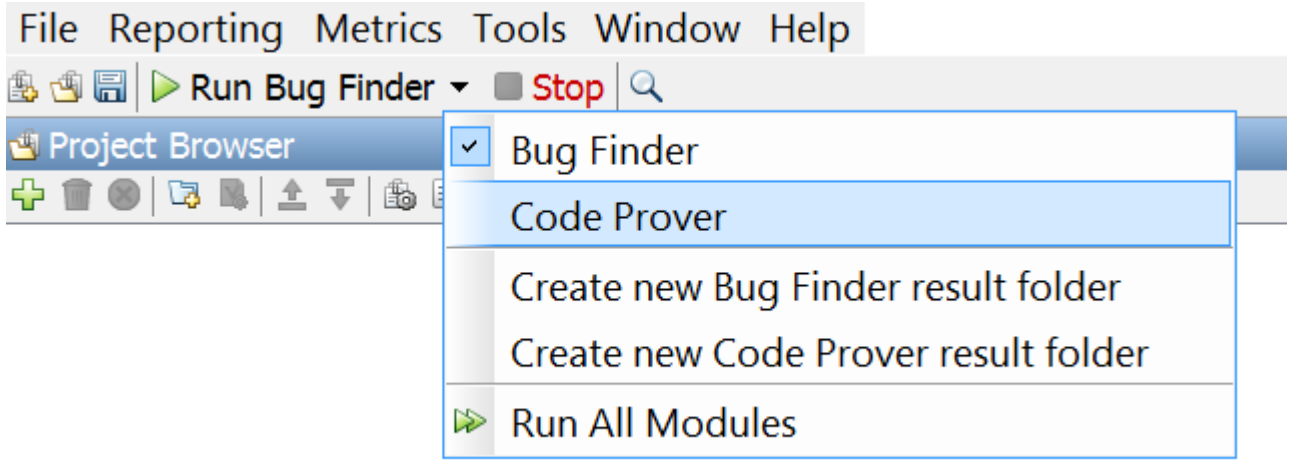
- To prove the absence of errors, the Polyspace verification accounts for all possible execution paths using abstract interpretation.

```
signed char x, y;

x = random_char();

if (x > 0) {
    x = 5;
} else if (x != 0){
    y = 100 / (x + 1);
} else {
    y = 200 / x;
}

printf("%d",x);
```



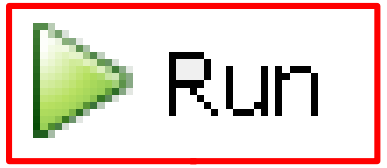
Exercise 4 – 运行时错误检查

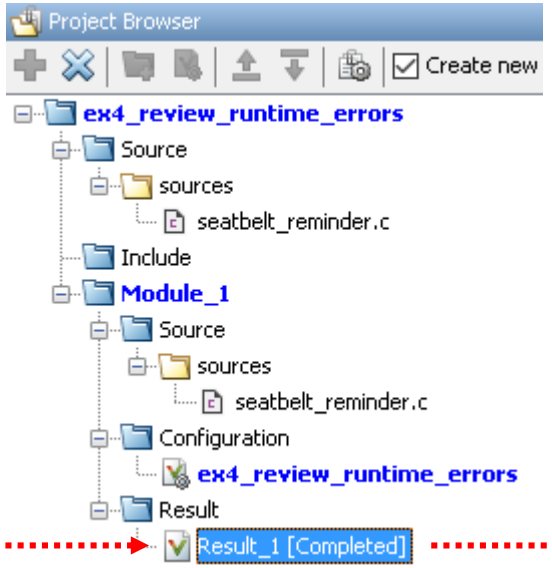
- How to run from Bug Finder to Code Prover in 2017a

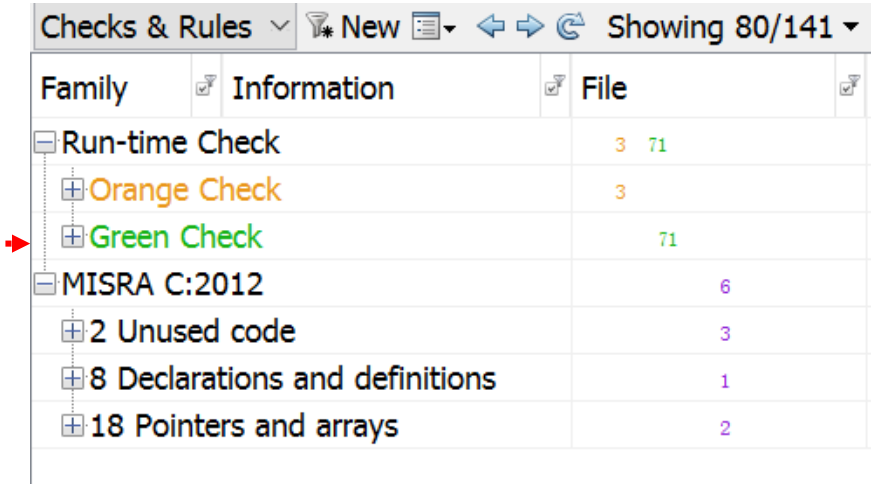


Exercise 4 – 运行时错误检查

- Run the project in Code Prover

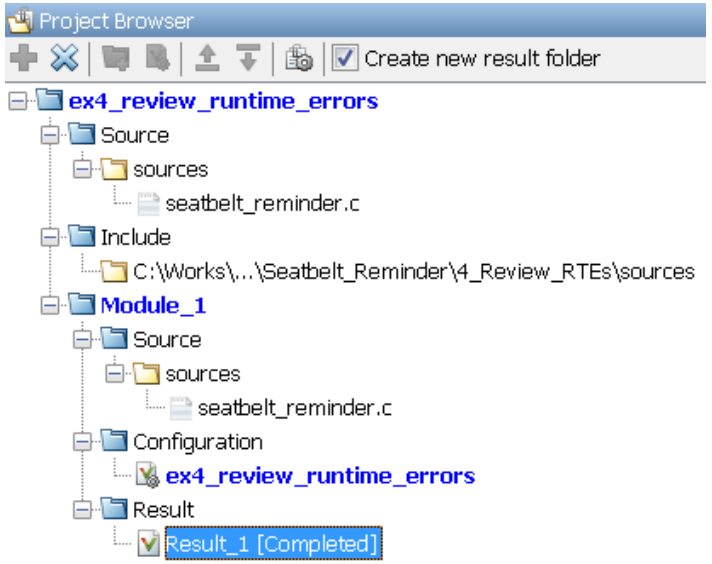


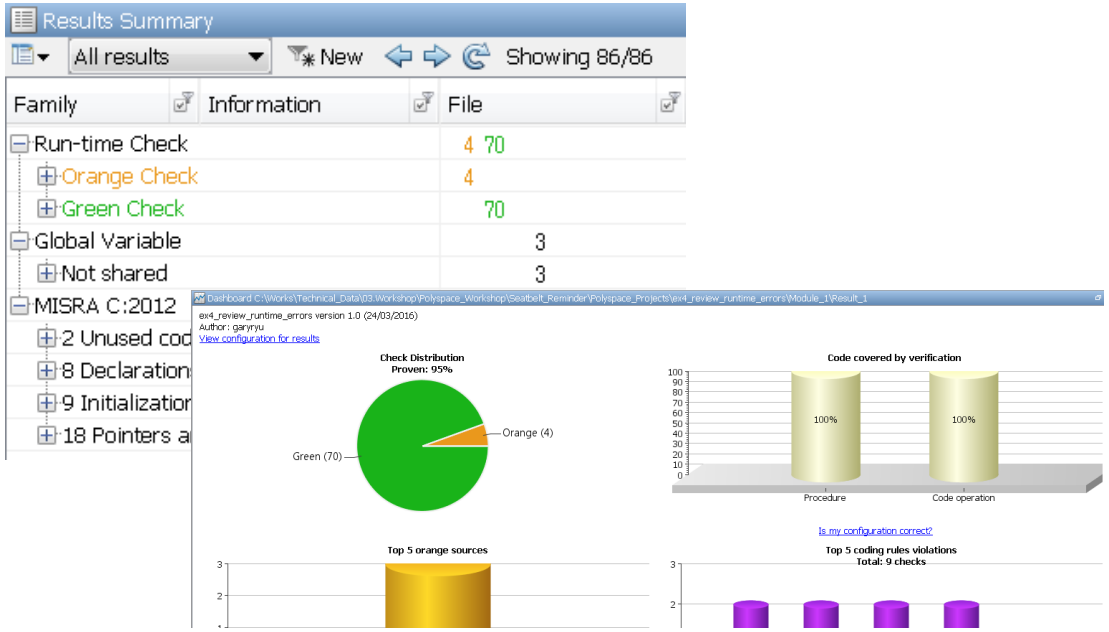




Exercise 4 – 运行时错误检查

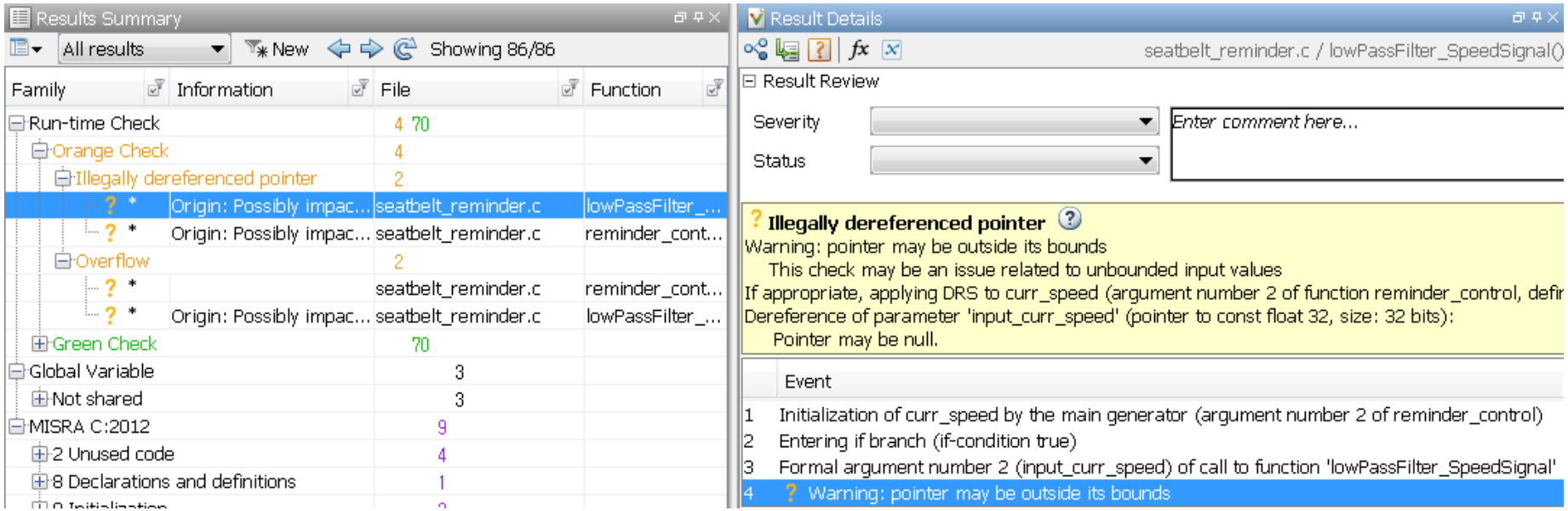
- Review all orange checks and additional MISRA violations
  - Use the imported project
  - Or Create new project with source files in *4_Review_RTEs*
  - Code Prover considers all of possible inputs and paths by default





Exercise 4 – 运行时错误检查

- Review all orange checks and additional MISRA violations
  - Analyze orange checks if it’s really problem or not
  - For instance, let’s see Illegally dereferenced pointer (IDP)



Exercise 4 – 运行时错误检查

- Review all orange checks and additional MISRA violations
  - Analyze orange checks if it’s really problem or not
  - For instance, let’s see Illegally dereferenced pointer (IDP)

```
41  static sint32_t lowPassFilter_SpeedSignal (sint32_t * output_Filtered_speed, const float32_t * input_curr_speed)
42  {
43          sint32_t errnumber;
44          float32_t tmp_filtered_speed;
45
46          /* This is relevant to requirement 5.5.
47           * weight for previous input is 0.9 and weight for current input is 0.1.
48          */
49          tmp_filtered_speed = (0.1F * (*input_curr_speed)) + (0.9F * (gPrev_speed));
```

Illegally dereferenced pointer

Warning: pointer may be outside its bounds

This check may be an issue related to unbounded input values

If appropriate, applying DRS to curr_speed (argument number 2 of function reminder_control, defir

Dereference of parameter 'input_curr_speed' (pointer to const float 32, size: 32 bits):

Pointer may be null.

Exercise 4 – 运行时错误检查

- Add a code to check NULL pointer
  - Modify source code to add NULL_PTR
  - Check pointer before use if it's not NULLs

```
tmp_filtered_speed = (0.1F * (*input_curr_speed)) + (0.9F * (gPrev_speed));
```

```
if (((void*)0) != input_curr_speed) {
    tmp_filtered_speed = (0.1F * (*input_curr_speed)) + (0.9F * (gPrev_speed));
```

- You may use Constraint setup to specify data range for function inputs
  - It can specify data range for global variable and return values of stubbed function

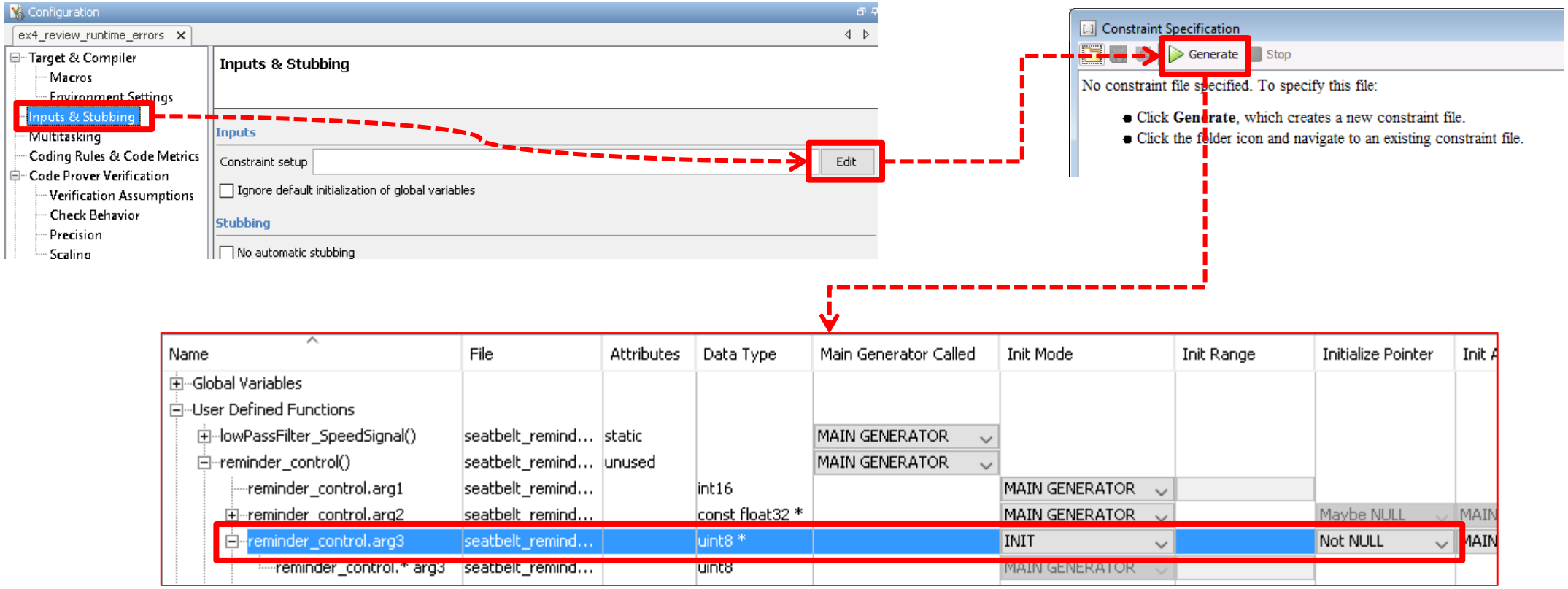
```
tmp_filtered_speed = (0.1F * (*input_curr_speed)) + (0.9F * (gPrev_speed));

if (tmp_filtered_speed >= 0.5F)
    if (tmp_filtered_speed
        errnumber = -1;
```

Dereference of parameter 'input_curr_speed' (pointer to const float 32, size: 32 bits):
Pointer is not null.
Dereferenced value (float 32): full-range [$-3.4029E^{+38}$ .. $3.4029E^{+38}$]

- <u>What will you do for the variable for `*output` ?</u>

Tip #5 - 数据约束设置

- Specify constraints for global variables, function inputs and return values of stubbed functions



Exercise 4 –运行时错误检查

- Review another orange check (Overflow)
  - What is the problem of orange overflow check?

```
if (gFiltered_speed >= 15) {
        if (timer_cnt > COUNT_FOR_BLINK)
        {
                output_SeatBeltIcon ^= 0x1U;
        }
        timer_cnt++;
```

Overflow
Unproven: operation [+] on scalar may overflow (result strictly greater than MAX INT32)
operator + on type int 32
left: [0 .. 2^{31}-1]
right: 1
result: [1 .. 2^{31}-1]
(result is truncated)

  - Signed integer overflow leads to undefined behavior. **How can I fix it?**
  - ***Oops***, I forgot to set it to zero when the value exceeds COUNT_FOR_BLINK.

```
if (gFiltered_speed >= 15) {
        if (timer_cnt > COUNT_FOR_BLINK)
        {
                output_SeatBeltIcon ^= 0x1U;
Add this code ---------->timer_cnt = 0;
        }
        timer_cnt++;
```

Overflow
Operation [+] on scalar does not overflow in INT32 range
operator + on type int 32
left: [0 .. 2000]
right: 1
result: [1 .. 2001]
(result is truncated)

Exercise 4 – 结果对比

Run-time Check	3	71
Orange Check	3	
Green Check		71
MISRA C:2012		6
2 Unused code		3
8 Declarations and definitions		1
18 Pointers and arrays		2

Run-time Check	76
Green Check	76
MISRA C:2012	4
2 Unused code	3
8 Declarations and definitions	1

☞ Two ISRA violations are disappeared by removal of orange checks.

内容

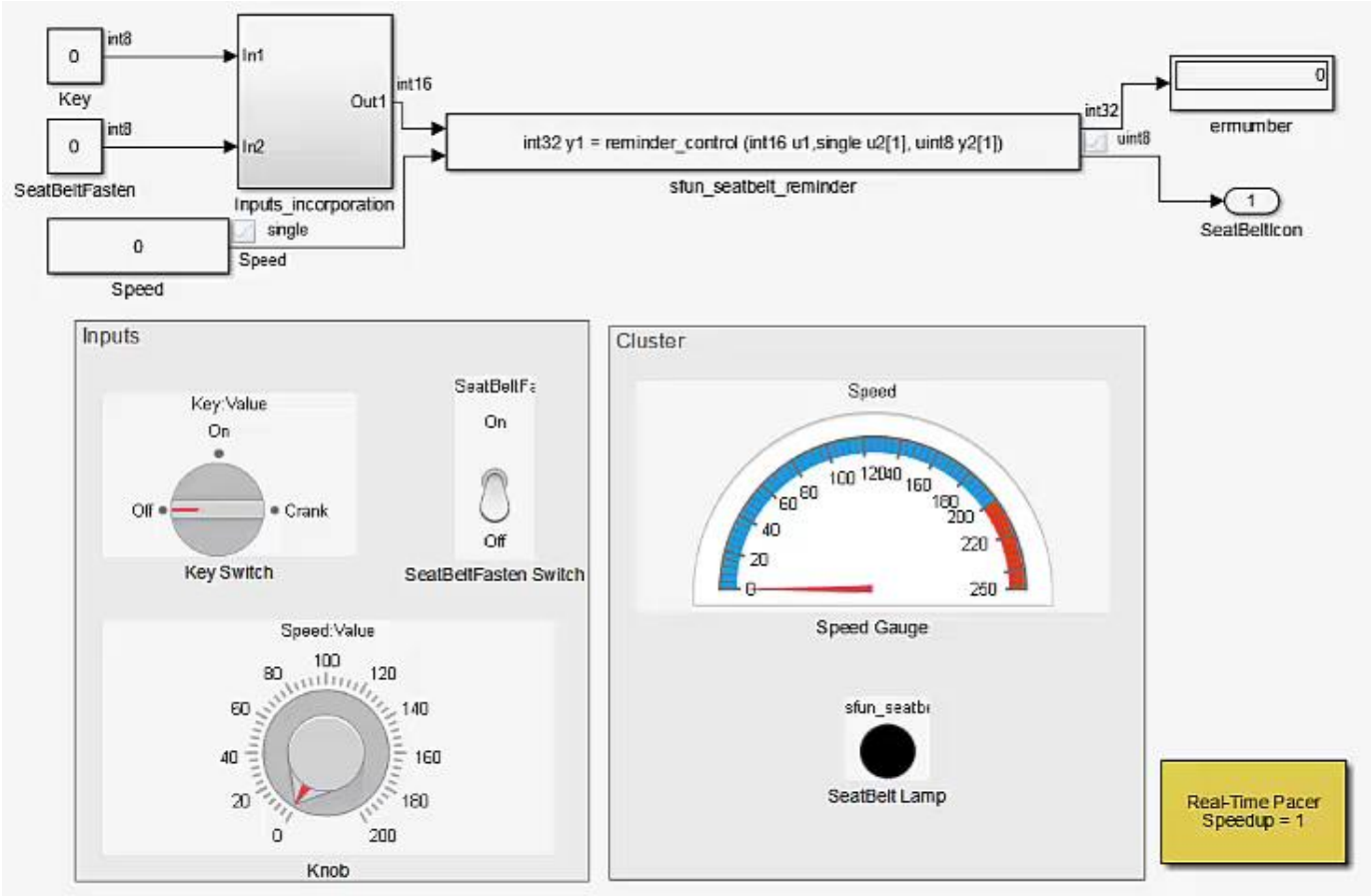
- Polyspace Overview
  - Category of Static analysis
  - Use case of Polyspace products
- **Polyspace Hands-on workshop**
  - Description of the logic
  - Exercise 1 / 2 / 3 / 4 (Review MISRA, Defect, Code Metrics, Runtime Error)
  - **Conclusion**
- Q&A

Conclusion

Let’s simulate the final version of source code

Conclusion – 最终结果仿真

- Simulate the final version of source code



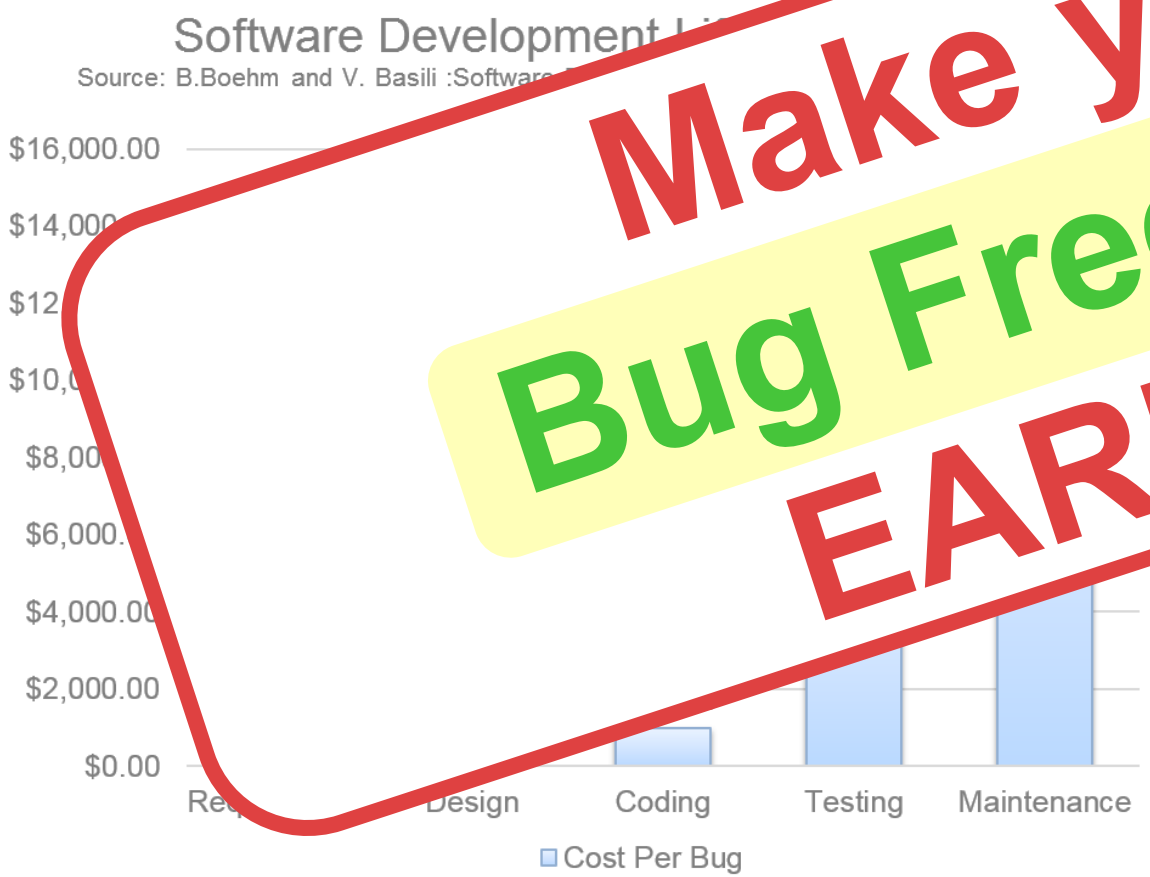
问题回顾

- Summary of Issues…

Issues we faced!	What's improved!
Lamp doesn't work if speed is slower than 0.5. or Errnumber shows strange value.	Remove Non-initialized variable and dead code • Initialize *errnumber* in *lowPassFilter_SpeedSignal* • This is detected by Bug Finder's Defects and MISRA C:2012 checker. • Dead code is directly related to this bug but it's meaningless.
Lamp flickers too fast if speed is faster than 15.	Remove overflow occurs by timer_cnt • Set *timer_cnt* to zero(0) in *reminder_control* function. • This runtime error is detected as orange overflow check by Code Prover.
MISRA C:2012 Guide line	Modify / Justify source code • It's helpful to avoid runtime errors.
Code Metrics	Improve structure of source code by modification • It's good to improve readability and maintenance cost.

早期验证

Use Verification tools early in the lif



Make yours
Bug Free ZONE
EARLIER!

progress of a project

External quality assessor
- Audit supplier's code

- Model-Based Design
  - On generated code

Q & A