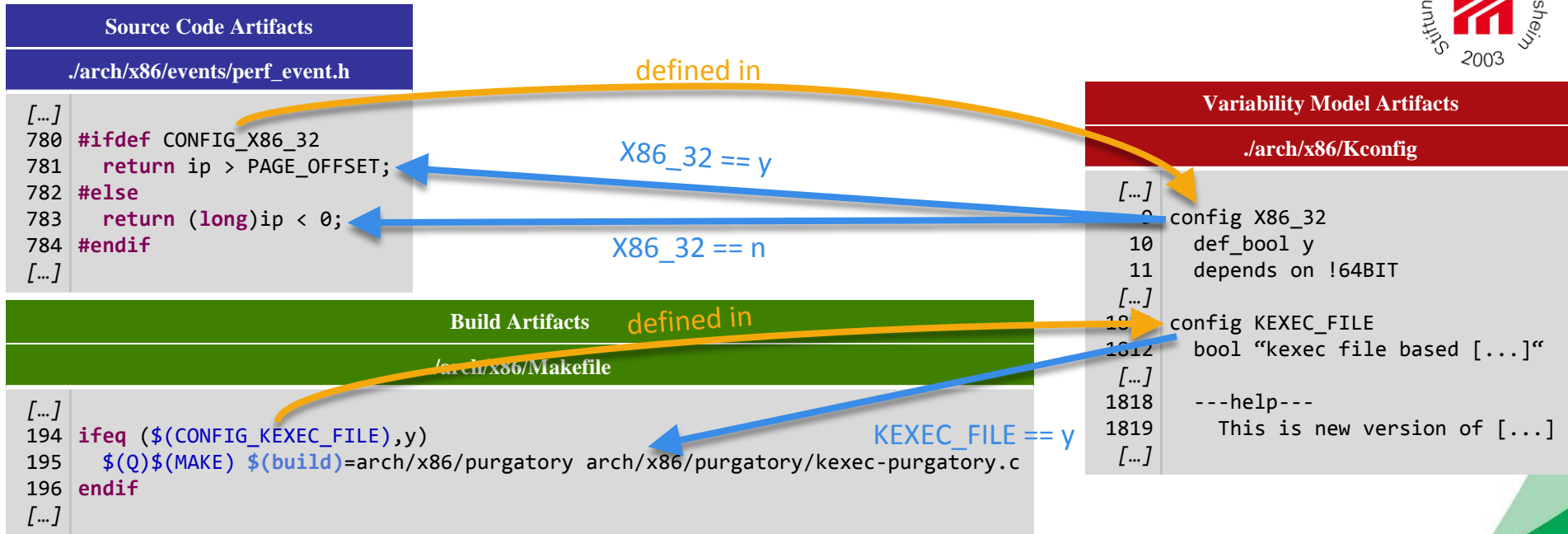


# REVaMP<sup>2</sup>

## PSS-CE

Problem-Solution-Space Co-Evolution  
University of Hildesheim (SUH)

- Desired relations between problem and solution space artifacts:



- But divergences between artifacts may exist, like:

## Source Code Artifacts

./arch/x86/events/perf\_event.h

```
[...]  
780 #ifdef CONFIG_X86_32  
781     return ip > PAGE_OFFSET;  
782 #else  
783     return (long)ip < 0;  
784 #endif  
[...]
```

Find and correct  
unintended divergences

## Build Artifacts

./arch/x86/Makefile

```
[...]  
194  
195  
196  
[...]
```

Unused ?

## Variability Model Artifacts

./arch/x86/Kconfig

```
[...]  
9  
10  
11  
[...]  
1811 config KEXEC_FILE  
1812     bool "kexec file based [...]"  
[...]  
1818     ---help---  
1819     This is new version of [...]  
[...]
```

? Undefined

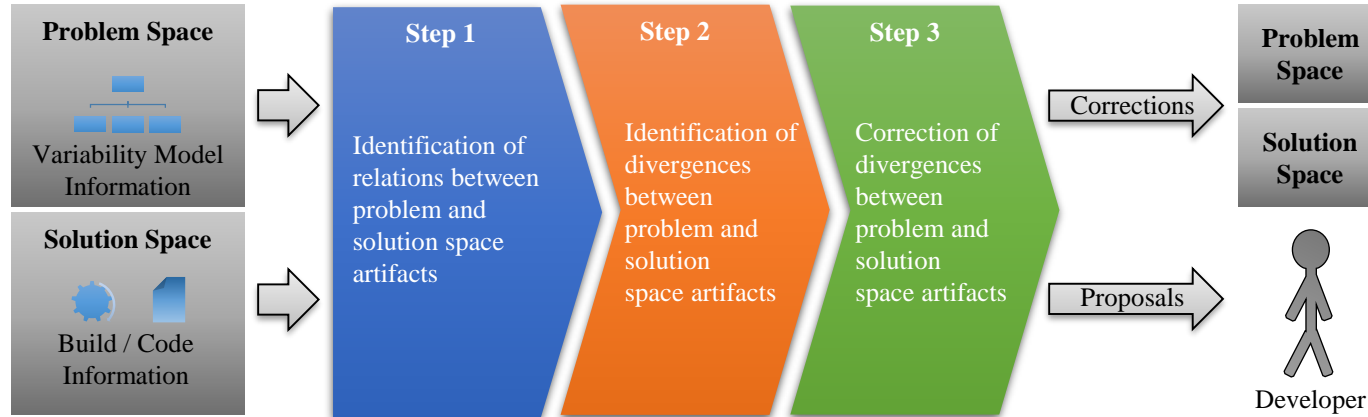
# Main Features

## PSS-CE

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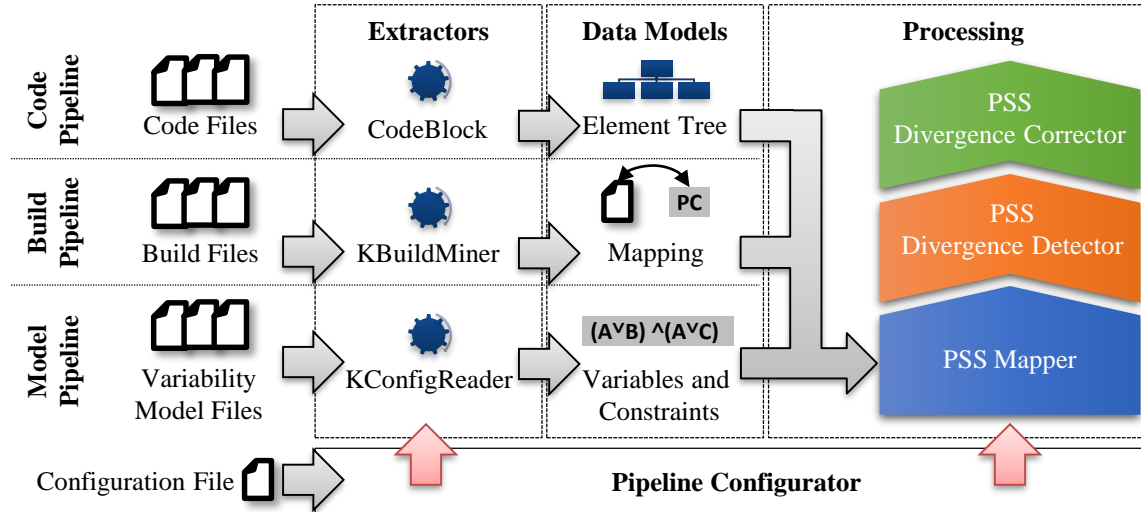
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- Technical realization as plug-ins for KernelHaven:



As progress beyond D5.4,  
we focus on the incremental  
PSS-CE support here

1.  Download and Installation
2.  Preparation of Evolution History
3.  Baseline Creation for Incremental PSS-CE
4.  Incremental PSS-CE Analysis



# 1. Download and Installation

## PSS-CE

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- General requirements:
  - Use machine with at least 16GB internal memory
  - Use Ubuntu as operating system
  - Install:
    - Java 8 or higher
    - Git
    - build-essential
    - libelf-dev
- Example: *sudo apt install openjdk-8-jdk git build-essential libelf-dev*



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# 1. Download and Installation

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- Download latest KernelHaven release:
  - URL: <https://github.com/KernelHaven/KernelHaven>
  - **KernelHaven plus all plugins (GPLv3 and Apache License 2.0)**

### Downloads

#### Core Infrastructure

This archive contains the core infrastructure only. Additional [plugins](#) are needed for a useful execution.

- [KernelHaven infrastructure](#)

#### Bundled Releases

These archives contain the infrastructure as well as all public [plugins](#). These bundles contain more than needed to run most experiments.

- [KernelHaven plus all plugins \(GPLv3 and Apache License 2.0\)](#)
- [KernelHaven plus only plugins available under the Apache License 2.0](#)



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# 1. Download and Installation

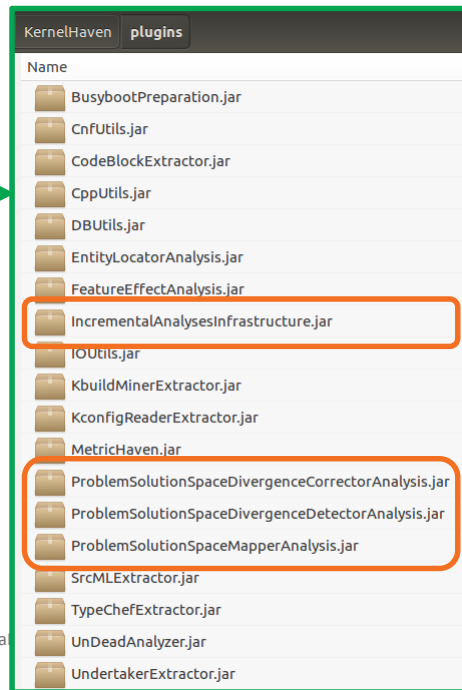
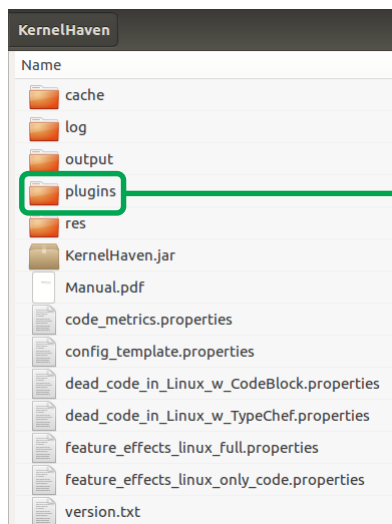
## PSS-CE

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- Extract the KernelHaven archive to your favorite location
- Here we use *KernelHaven/* as location



Plug-in for incremental PSS-CE support  
(Extension to D5.4)

PSS-CE plug-ins



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## 2. Preparation of Evolution History PSS-CE

- Only necessary for illustration of capabilities here
- In practice:
  - Use of general commits to repository
  - Example: calling PSS-CE by a pre-commit hook
- Preparation consists of:
  - Create new repository
  - Commit Linux kernel version 4.10-rc2 (initial commit)
  - Define a new, but unused configuration option
  - Commit the change to the repository (change commit)
  - Extract both commits from the repository
- Extracted commits are input to incremental PSS-CE support



Newer versions  
may not be  
supported by  
KernelHaven  
extractors

### 1. Create new repository

- Create empty directory at your favorite location
- Absolute path here: */home/suh/WP5-Demo-incr/Linux*
- Initialize Git repository:
  - Open Terminal
  - Navigate to */home/suh/WP5-Demo-incr/Linux*
  - Execute command *git init*

```
suh@ubuntu: ~/WP5-Demo-incr/Linux
suh@ubuntu:~$ cd /home/suh/WP5-Demo-incr/Linux
suh@ubuntu:~/WP5-Demo-incr/Linux$ git init
Initialized empty Git repository in /home/suh/WP5-Demo-incr/Linux/.git/
suh@ubuntu:~/WP5-Demo-incr/Linux$
```

## 2. Commit Linux kernel version 4.10-rc2 (initial commit)

- Copy entire Linux kernel into */home/suh/WP5-Demo-incr/Linux*
- Commit the files to the Git repository:
  - Open Terminal
  - Navigate to */home/suh/WP5-Demo-incr/Linux*
  - Execute command *git add .*
  - Execute command *git commit*

```
suh@ubuntu: ~/WP5-Demo-incr/Linux
suh@ubuntu:~$ cd /home/suh/WP5-Demo-incr/Linux
suh@ubuntu:~/WP5-Demo-incr/Linux$ git add .
suh@ubuntu:~/WP5-Demo-incr/Linux$ git commit
```

## 3. Define a new, but unused configuration option

- Open file *Kconfig* in */home/suh/WP5-Demo-incr/Linux* in text editor
- Add the following lines at the end of the file:

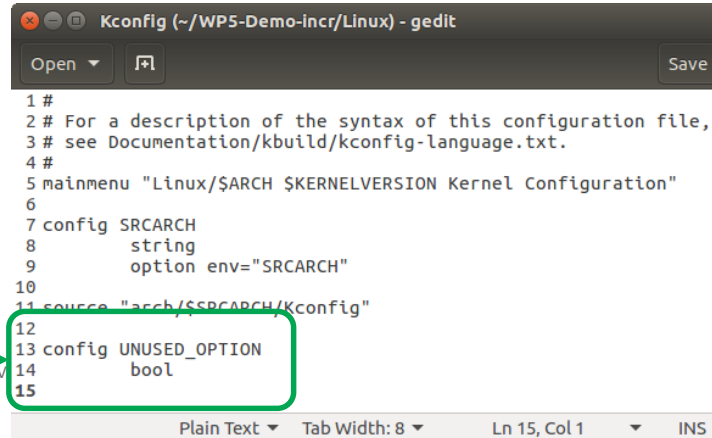
`config UNUSED_OPTION`

`bool`

No indentation

Single tab indentation

- Save the changes and close text editor



```
1 #
2 # For a description of the syntax of this configuration file,
3 # see Documentation/kbuild/kconfig-language.txt.
4 #
5 mainmenu "Linux/$ARCH $KERNELVERSION Kernel Configuration"
6
7 config SRCARCH
8     string
9     option env="SRCARCH"
10
11 source "arch/$SRCARCH/Kconfig"
12
13 config UNUSED_OPTION
14     bool
15
```

### 4. Commit the change to the repository (change commit)

- Open Terminal
- Navigate to `/home/suh/WP5-Demo-incr/Linux`
- Execute command `git add .`
- Execute command `git commit`

```
suh@ubuntu: ~/WP5-Demo-incr/Linux
suh@ubuntu:~$ cd /home/suh/WP5-Demo-incr/Linux
suh@ubuntu:~/WP5-Demo-incr/Linux$ git add .
suh@ubuntu:~/WP5-Demo-incr/Linux$ git commit
[master 913beb5] Addition of new, but unused configuration option
1 file changed, 4 insertions(+)
suh@ubuntu:~/WP5-Demo-incr/Linux$
```

## 5. Extract both commits from the repository (1/2)

- Identify the commit hashes:
  - Open Terminal
  - Navigate to `/home/suh/WP5-Demo-incr/Linux`
  - Execute command `git log --oneline`
- Copy the commit hashes for actual extraction

```
suh@ubuntu: ~/WP5-Demo-incr/Linux
suh@ubuntu:~$ cd /home/suh/WP5-Demo-incr/Linux
suh@ubuntu:~/WP5-Demo-incr/Linux$ git log --oneline
913beb5 Addition of new, but unused configuration option
5bf13de Initial commit of Linux kernel version 4.10-rc2
suh@ubuntu:~/WP5-Demo-incr/Linux$
```

### 5. Extract both commits from the repository (2/2)

- Extract the commits into individual files:
  - Execute command `git show -U100000 [COMMIT] > [FILE]`
  - `[COMMIT]` being one of the identified commit hashes
  - `[FILE]` being the file to print the commit content to; here:
    - Initial commit: `/home/suh/WP5-Demo-incr/Linux-Diffs/Initial-git.diff`
    - Change commit: `/home/suh/WP5-Demo-incr/Linux-Diffs/Change-git.diff`

```
suh@ubuntu: ~/WP5-Demo-incr/Linux
suh@ubuntu:~$ cd /home/suh/WP5-Demo-incr/Linux
suh@ubuntu:~/WP5-Demo-incr/Linux$ git log --oneline
913beb5 Addition of new, but unused configuration option
suh@ubuntu:~/WP5-Demo-incr/Linux$ git show -U100000 5bf13de > ../Linux-Diffs/Initial-git.diff
suh@ubuntu:~/WP5-Demo-incr/Linux$ git show -U100000 913beb5 > ../Linux-Diffs/Change-git.diff
suh@ubuntu:~/WP5-Demo-incr/Linux$
```







### 3. Baseline Creation for Incremental PSS-CE

## PSS-CE

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- Incremental variant requires initial models as baseline
- Baseline is mandatory input for:
  - Detecting changes (in detail)
  - Determining necessary (but potentially partial) re-analyses
- Baseline creation consists of:
  - Creation of required directory
  - Definition of PSS-CE setup for initial commit
  - Execution of PSS-CE using initial commit



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### 3. Baseline Creation for Incremental PSS-CE PSS-CE

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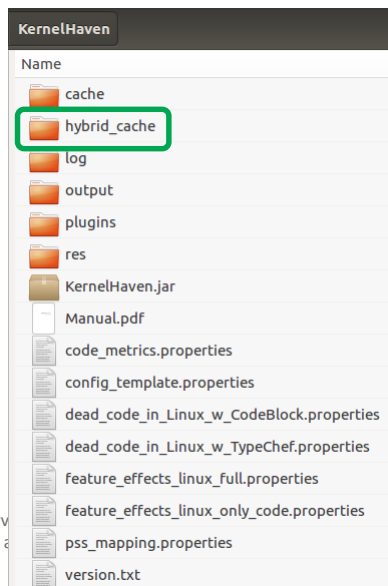
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#### 1. Creation of required directory

- Create a new and empty directory in *KernelHaven/*
- Required by the incremental variant
- Storage of (partial) models for reuse

The directory name does not matter, but we need the path to and name of it on the next slide



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# 3. Baseline Creation for Incremental PSS-CE

## PSS-CE

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## 2. Definition of PSS-CE setup for initial commit

- Create file *pss\_ce.properties* in *KernelHaven/*
- Open that file with a text editor:
  - Specify required configuration options, in particular:
    - “source\_tree” must point to an empty directory
    - “incremental.hybrid\_cache.dir” must be the directory from previous slide
    - “incremental.input.source\_tree\_diff” must be */home/suh/WP5-Demo-incr/Linux-Diffs/Initial-git.diff*
  - Full examples: <https://github.com/KernelHaven/ProblemSolutionSpaceCorrectorAnalysis>
- Save the changes and close text editor



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## 3. Baseline Creation for Incremental PSS-CE PSS-CE

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### 3. Execution of PSS-CE using initial commit

- Execute KernelHaven with the *pss\_ce.properties*:
  - Open a terminal
  - Navigate to *KernelHaven/*
  - Execute command *java -Xmx12G -jar KernelHaven.jar pss\_ce.properties*



```
suh@ubuntu: ~/WP5-Demo-incr/KernelHaven
suh@ubuntu:~/WP5-Demo-incr/KernelHaven$ java -Xmx12G -jar KernelHaven.jar pss-ce.properties
```



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## 4. Incremental PSS-CE Analysis

### PSS-CE

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- Purpose:
  - Identify the changes introduced by change commit
  - Re-analyze only those changes
- This requires only:
  - Change property “incremental.input.source\_tree\_diff” in *pss\_ce.properties* to */home/suh/WP5-Demo-incr/Linux-Diffs/Change-git.diff*
  - Execute KernelHaven with changed *pss\_ce.properties* again

```
suh@ubuntu: ~/WP5-Demo-incr/KernelHaven
suh@ubuntu:~/WP5-Demo-incr/KernelHaven$ java -Xmx12G -jar KernelHaven.jar pss-ce.properties
```



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# 4. Incremental PSS-CE Analysis

## PSS-CE

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- The result is located in */KernelHaven/output*
- Excel sheet now contains new, but unused configuration option as introduced by the change commit



Analysis\_2019-11-28\_11-16-29.xlsx - LibreOffice Calc

Libration Sans 10

A6781 f\_x Σ = UndefinedVariableDivergence

	A	B	C	
1	Type	Problem Space Symptom	Solution Space Symptom	Correction
6782	UnusedVariableDivergence	"CONFIG_SAMPLE_BLACKFIN_GPTIMERS" defined in va	"CONFIG_SAMPLE_BLACKFIN_GPTIMERS" not referenced by any build o	Define at least one reference to "CONFIG_SAMPLE_BLACKFIN_GPTIMERS" in a build o
6783	UndefinedVariableDivergence	"CONFIG_BINEMT_ELE32" not defined in variability model	"CONFIG_BINEMT_ELE32" used to constrain presence of code element(s)	Remove references to "CONFIG_BINEMT_ELE32" in the conditions controlling the pres
6784	UnusedVariableDivergence	"CONFIG_UNUSED_OPTION" defined in variability model	"CONFIG_UNUSED_OPTION" not referenced by any build or code artifact	Define at least one reference to "CONFIG_UNUSED_OPTION" in a build or code artifact
6785	UndefinedVariableDivergence	"CONFIG_SERIO_SUN4I_PS2_MODULE" not defined in va	"CONFIG_SERIO_SUN4I_PS2_MODULE" used to constrain presence of file	Remove references to "CONFIG_SERIO_SUN4I_PS2_MODULE" in the build artifacts co
6786	UndefinedVariableDivergence	"CONFIG_VIDEO_VIM2M_MODULE" not defined in variabl	"CONFIG_VIDEO_VIM2M_MODULE" used to constrain presence of file(s)	Remove references to "CONFIG_VIDEO_VIM2M_MODULE" in the build artifacts controll

Sheet 1 of 1 PageStyle\_PSS\_Corrections I Sum=0 100%



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### ■ Partners involved

- University of Hildesheim (SUH), Germany

### ■ Contact Information

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### ■ Download

- KernelHaven: <https://github.com/KernelHaven>
- PSS-Mapper: <https://github.com/KernelHaven/ProblemSolutionSpaceMapperAnalysis>
- PSS-DivergenceDetector:  
<https://github.com/KernelHaven/ProblemSolutionSpaceDivergenceDetectorAnalysis>
- PSS-DivergenceCorrector:  
<https://github.com/KernelHaven/ProblemSolutionSpaceDivergenceCorrectorAnalysis>