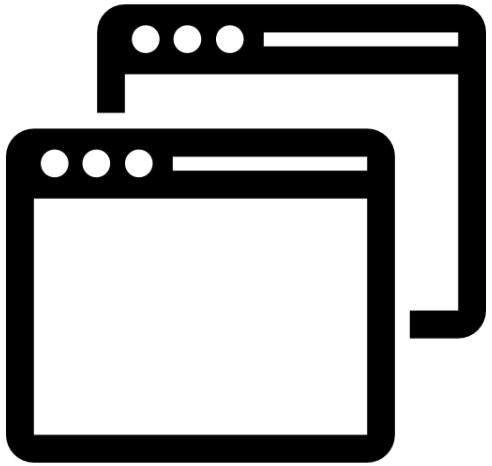
Как устроено тестирование средства статического тестирования

Сергей Васильев

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

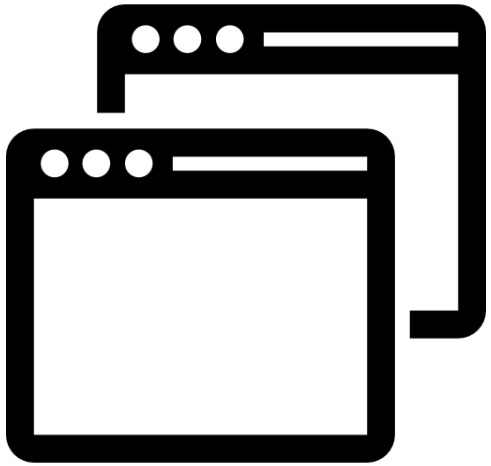


Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

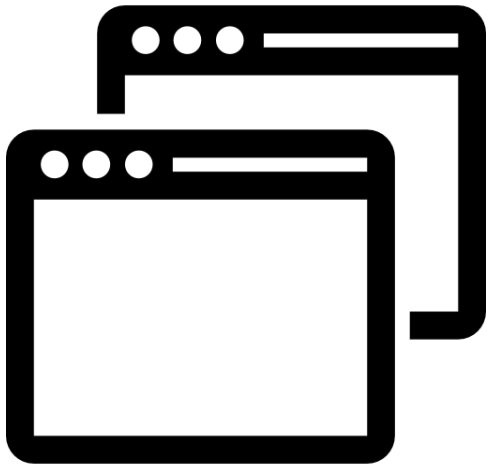


Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....



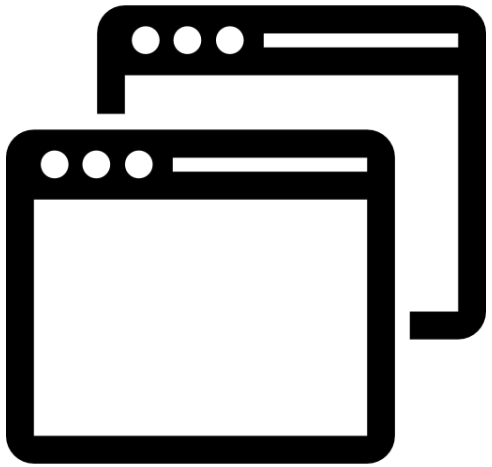
Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

SAST



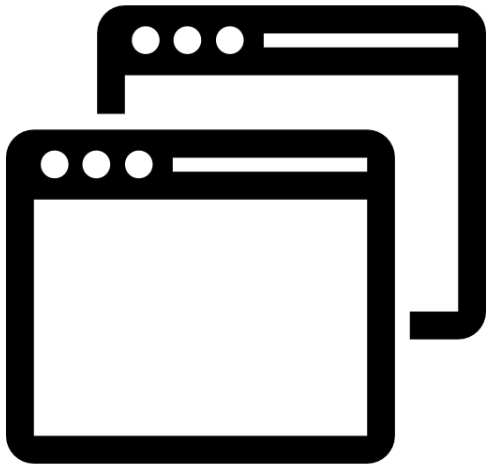
Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

SAST



Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Статический анализатор vs статический анализатор

Спикер

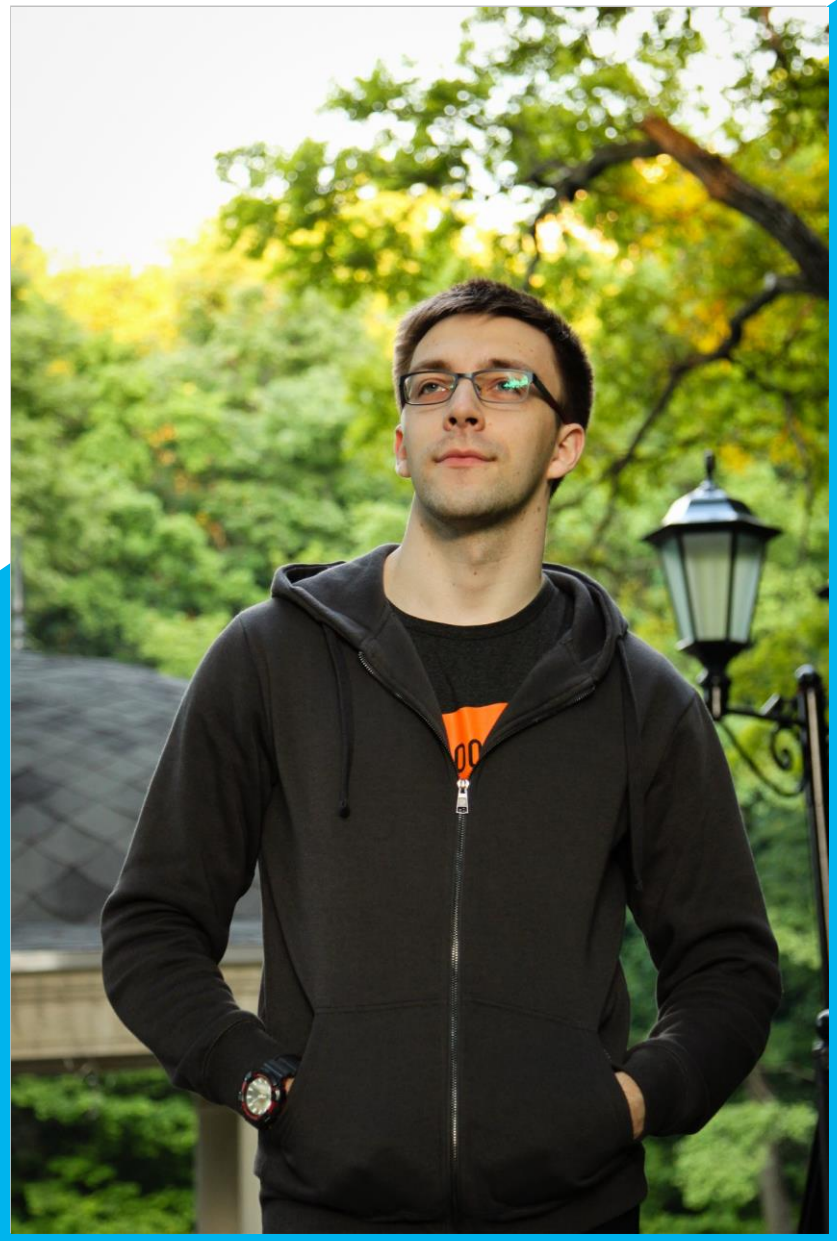
Сергей Васильев

Head of DevRel в PVS-Studio LLC

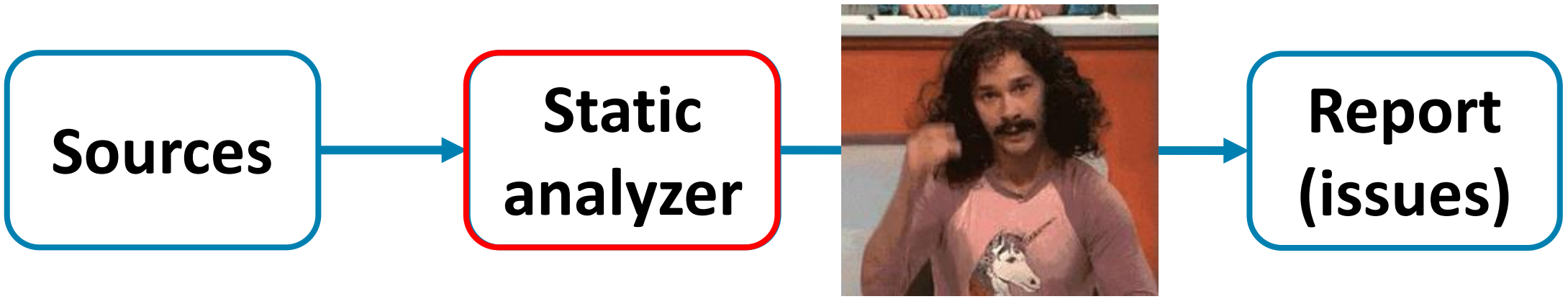
7 лет в статическом анализе

В прошлом:
- C++, C# developer;
- Senior Developer;
- Tools & DevOps Team Leader;
- C# Analyzer Team Leader.

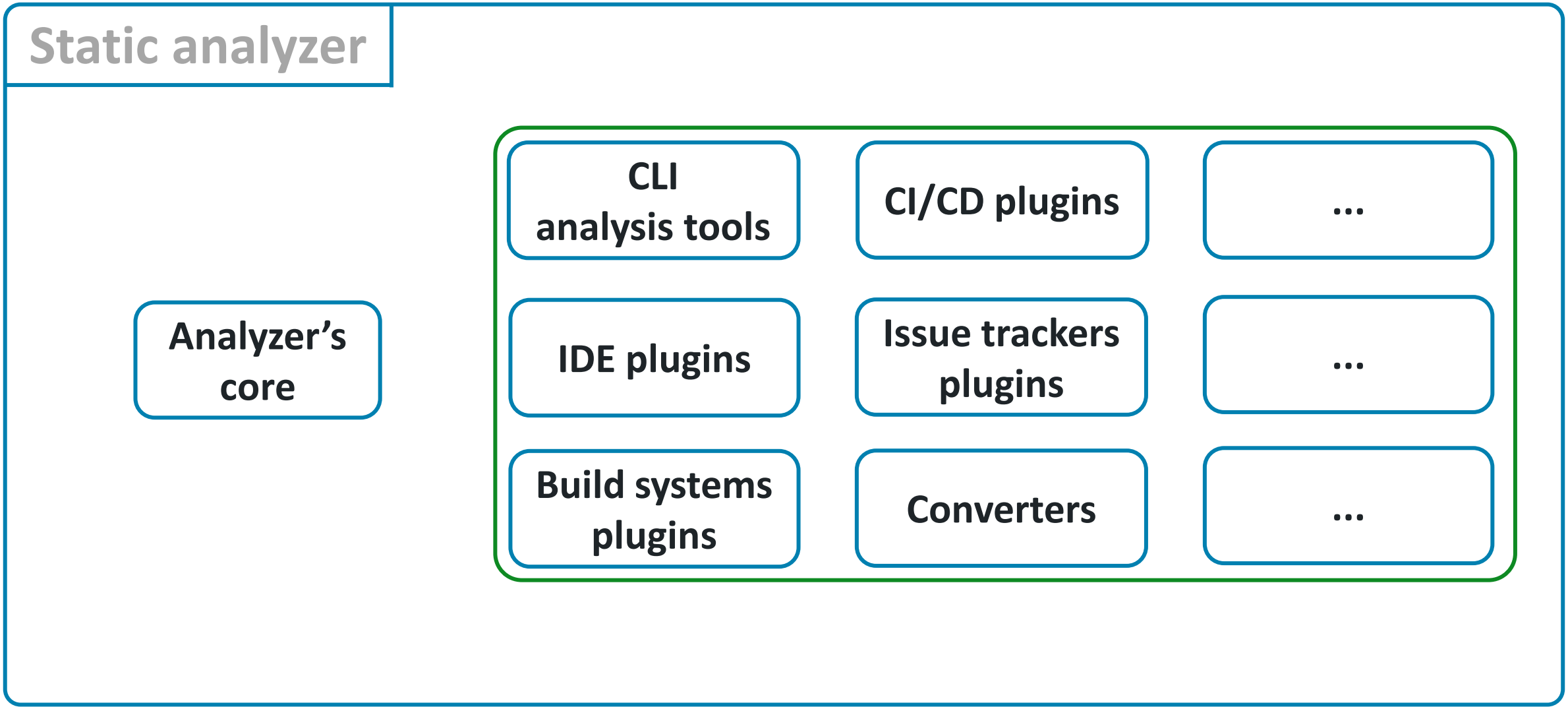
Пишу на habr, выступаю.



Статический анализ



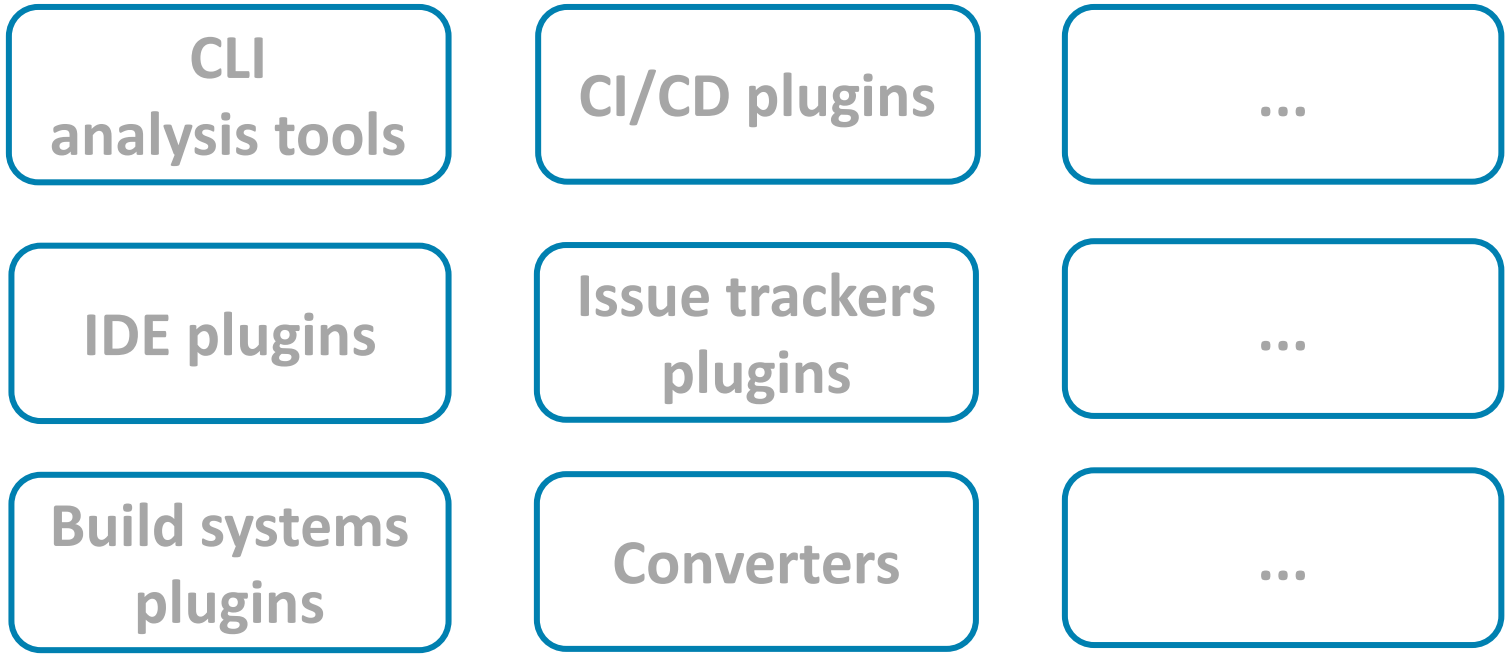
Декомпозиция: продукт



Тестирование

Тестируем:

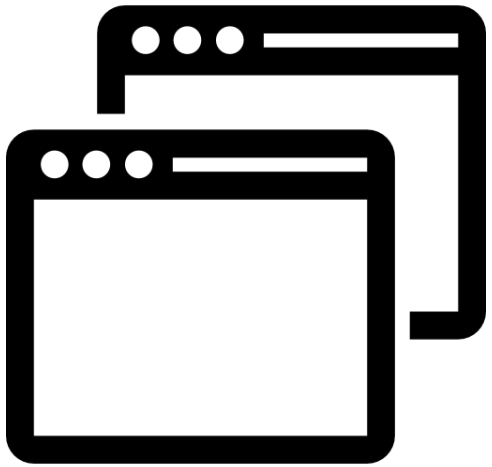
- CLI интерфейсы
- UI плагинов для IDE
- Подавление предупреждений
- Отслеживание запусков компиляторов
- ...



Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

SAST



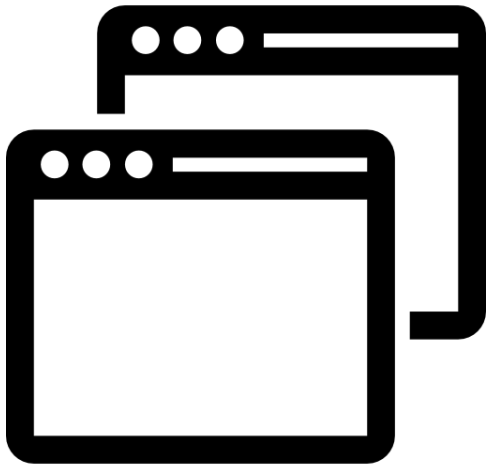
Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Тесты

- Модульные
- Функциональные
- Регрессионные
- UI
- ....

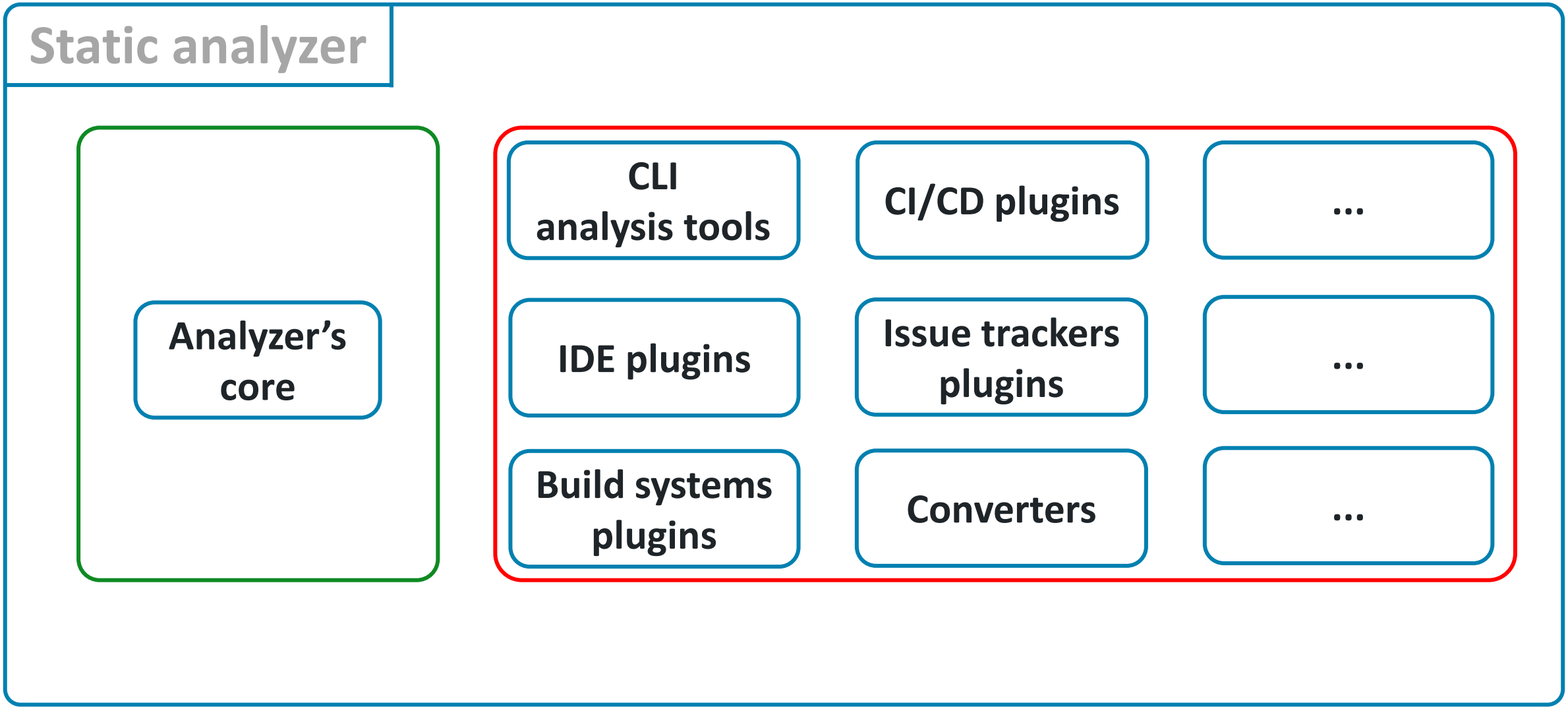
SAST



Инструменты

- SAST
- DAST
- IAST
- SCA
- ....

Декомпозиция: продукт



Декомпозиция: ядро анализатора

Analyzer's core

- Lexer
- Syntax analyzer
- Semantic analyzer
- Data-flow analysis
- Control-flow analysis
- Taint analysis
- Symbolic execution
- Interprocedural analysis
- Intermodular analysis
- Diagnostic rules
- Function annotations

Декомпозиция: ядро анализатора

Analyzer's core

Lexer

Syntax analyzer

Semantic analyzer

Data-flow analysis

Control-flow analysis

Taint analysis

Symbolic execution

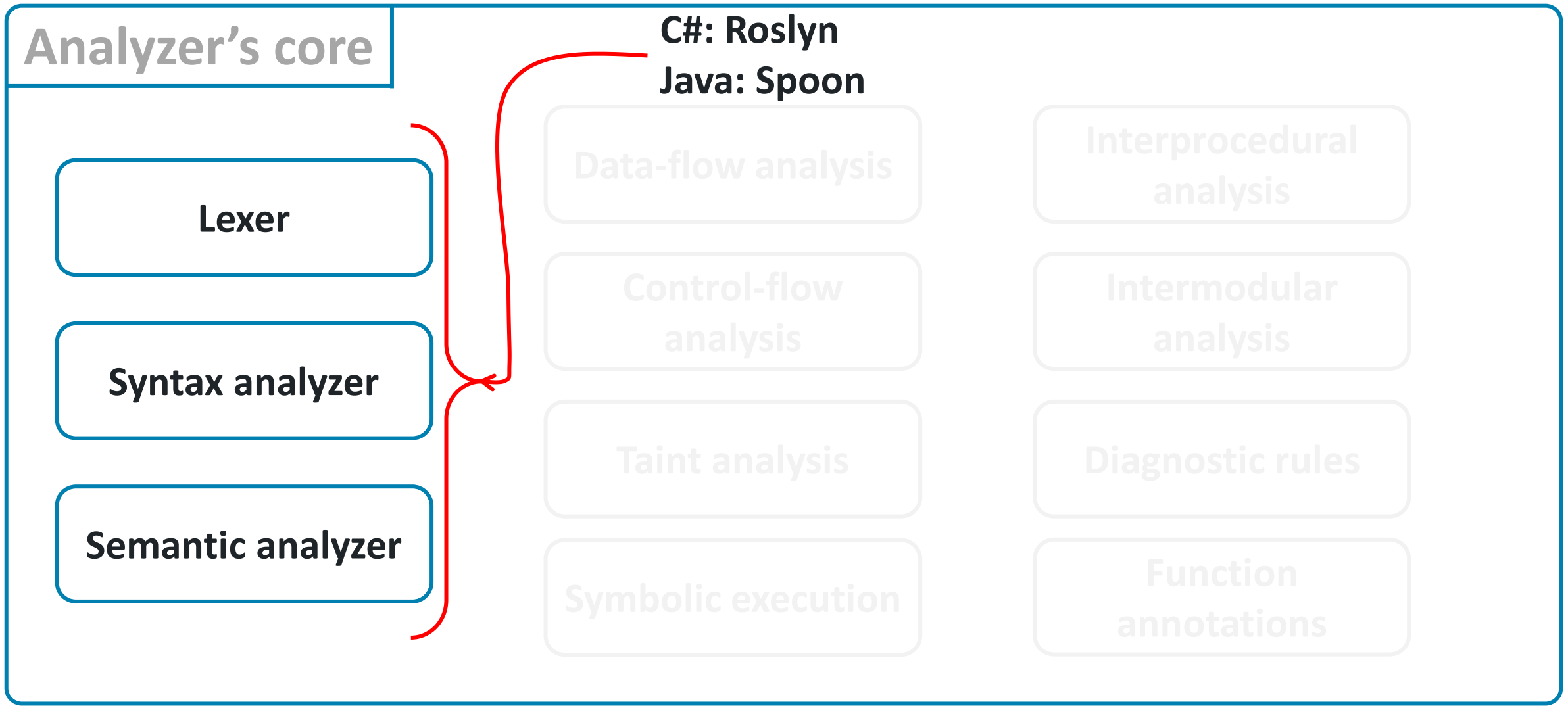
Interprocedural analysis

Intermodular analysis

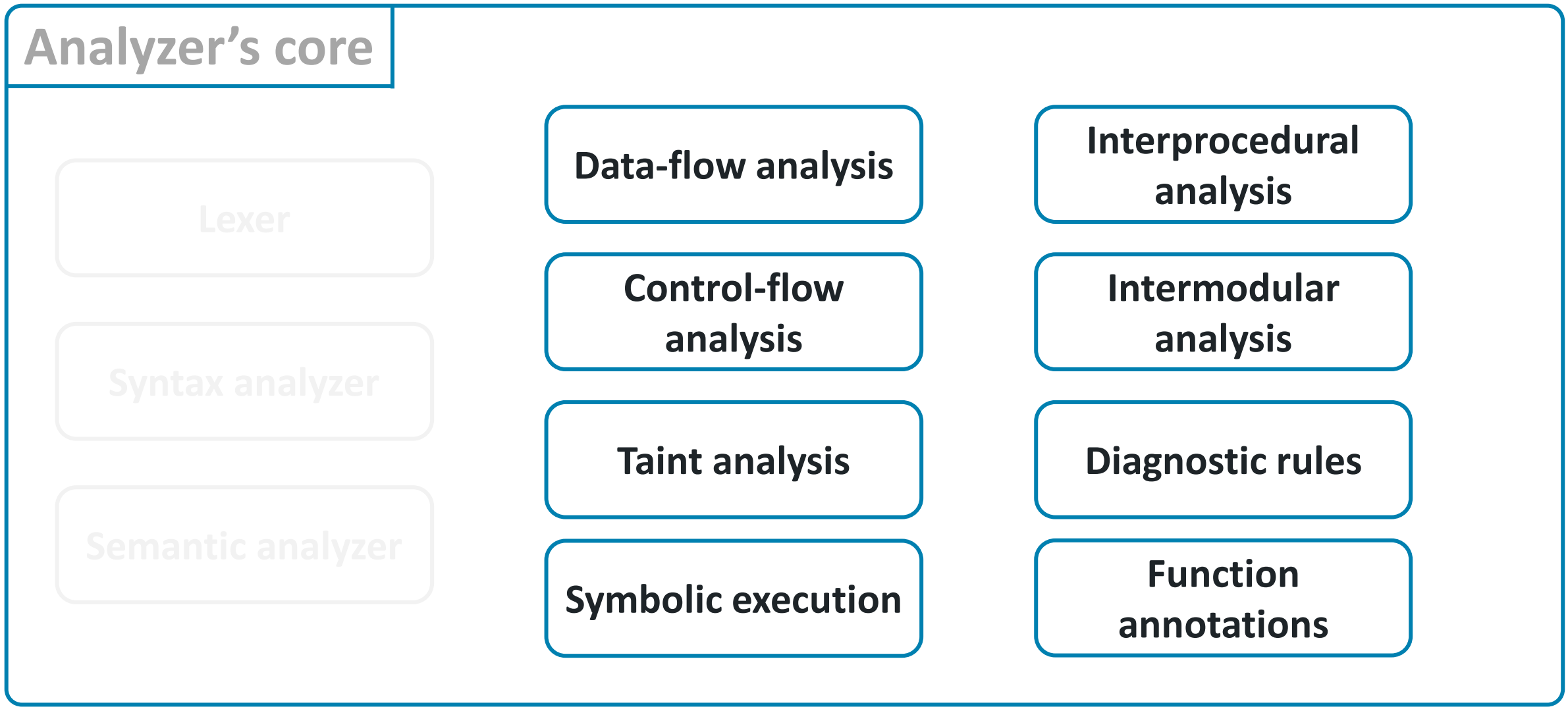
Diagnostic rules

Function annotations

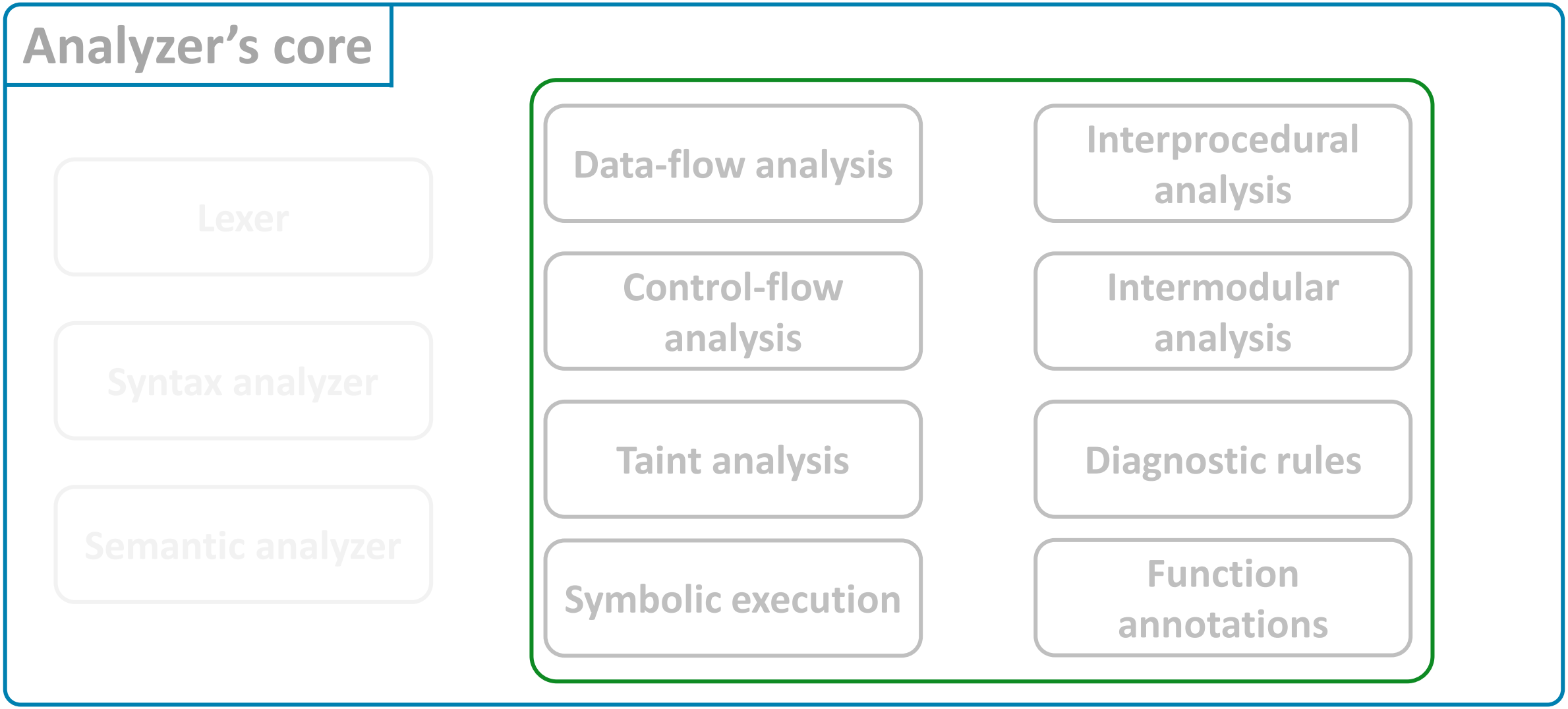
Декомпозиция: ядро анализатора



Декомпозиция: ядро анализатора



Декомпозиция: ядро анализатора



Типы предупреждений

Какие бывают предупреждения?

		Ругается	Не ругается
		Positive	**Negative**
Ожидаемо	**True**	True positive	True negative
Не ожидаемо	**False**	False positive	False negative

Какие бывают предупреждения?

		Ругается	Не ругается
		Positive	**Negative**
Ожидаемо	**True**	True positive	True negative
Не ожидаемо	**False**	False positive	False negative

Какие бывают предупреждения?

		Ругается	Не ругается
		Positive	**Negative**
Ожидаемо	**True**	True positive	True negative
Не ожидаемо	**False**	False positive	False negative

Какие бывают предупреждения?

		Ругается	Не ругается
		Positive	**Negative**
Ожидаемо	**True**	True positive	True negative
Не ожидаемо	**False**	False positive	False negative

Какие бывают предупреждения?

		Ругается	Не ругается
		Positive	**Negative**
Ожидаемо	**True**	True positive	True negative
Не ожидаемо	**False**	False positive	False negative

Same then/else branches of the 'if' statement

```
if (condition)
{
  Bad();
}
else
{
  Bad();
}
```

```
if (condition)
{
  Good();
}
else
{
  Bad();
}
```

Типы предупреждений

```
if (condition)
{
  Bad();
}
else
{
  Bad();
}
```

Issue
V3004 The 'then' statement is equivalent to the 'else' statement.

Ожидаемо?	
Ругается?	

True positive

Типы предупреждений

```
if (condition)
{
  Bad();
}
else
{
  Bad();
}
```

Ожидаемо?	❌
Ругается?	❌

False negative

Типы предупреждений

```
if (condition)
{
  Good();
}
else
{
  Bad();
}
```

Ожидаемо?	
Ругается?	

True negative

Типы предупреждений

```
if (condition)
{
  Good();
}
else
{
  Bad();
}
```

Issue
V3004 The 'then' statement is equivalent to the 'else' statement.

Ожидаемо?	
Ругается?	

False positive

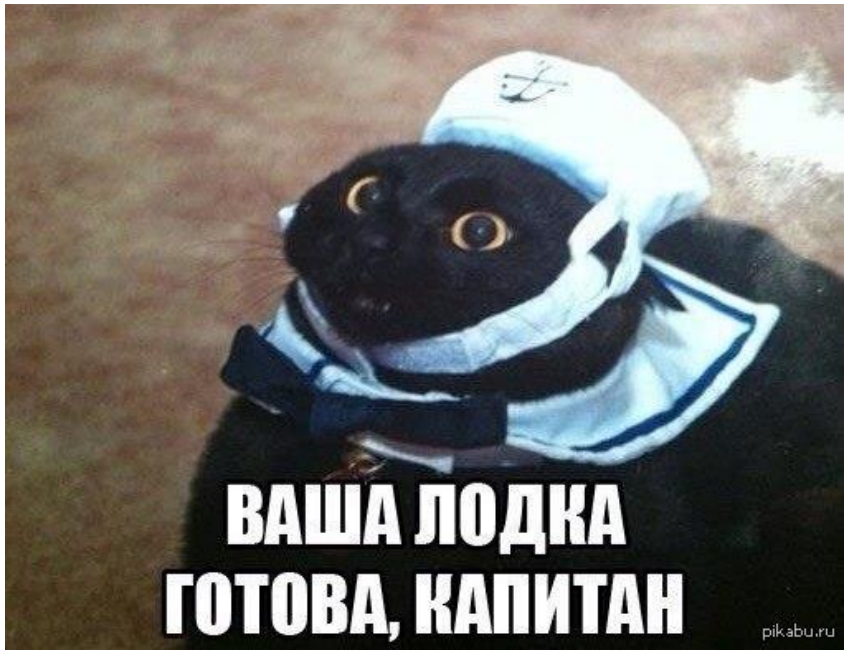
Что делать?

Увеличиваем **положительные** срабатывания:

- true positives
- true negative

Уменьшаем **негативные** срабатывания:

- false positives
- false negatives



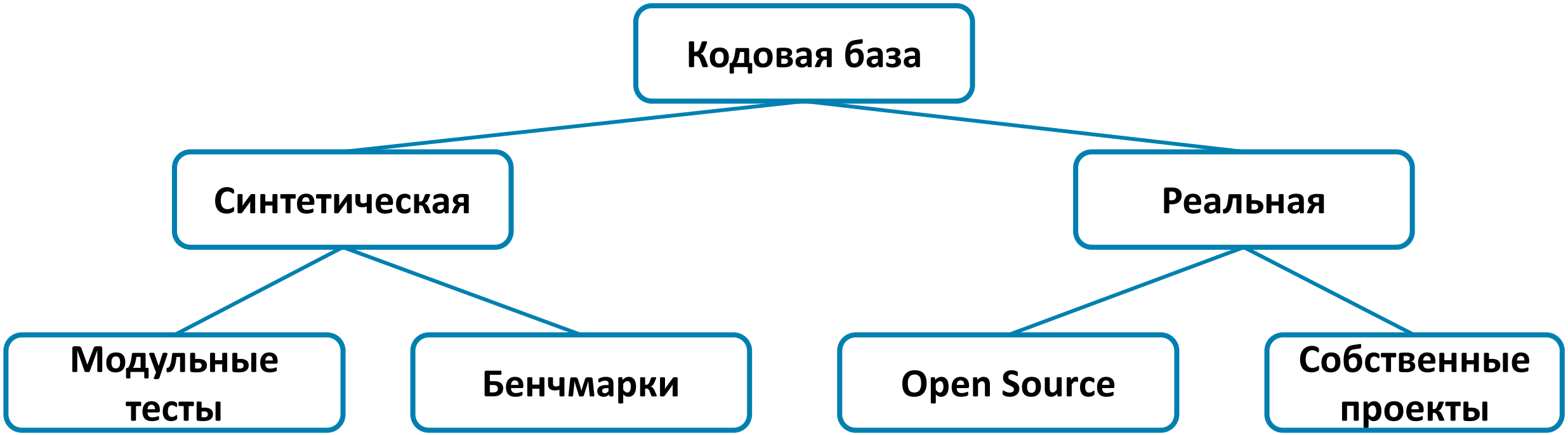
Где нужно – ругаемся,
где не нужно – не ругаемся

Где нужно – ругаемся,
где не нужно – не ругаемся

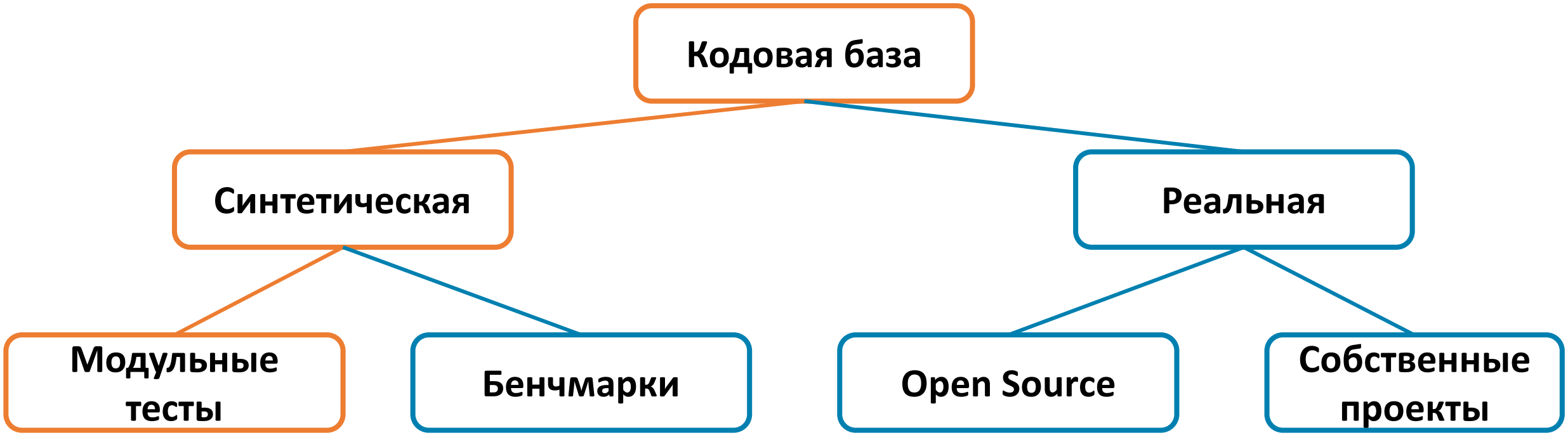
Как?

Тесты на коде

На чём тестировать?



На чём тестировать?



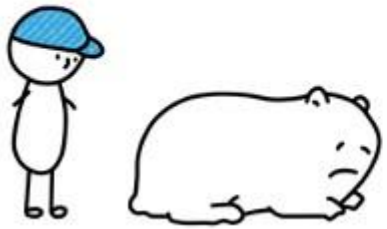
Модульные тесты

Модульные тесты

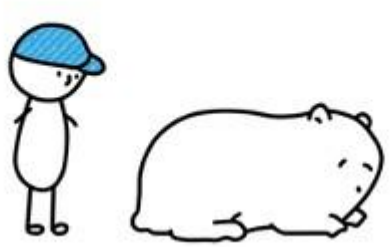
- TDD в действии
- Составляем наборы:
  - true positives
  - true negatives

Не проходит? *False negative*
Не проходит? *False positive*

Разработчик



Тесты



Проходите давайте

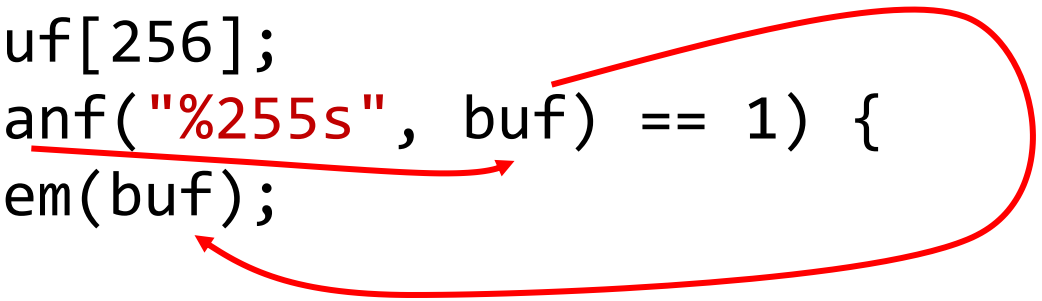
A == A

```
if (A == A)
{ }

if (A == (A))
{ }

if (this.A == this.A)
{ }

if (A == this.A)
{ }
```

```
if (this.A == base.A)
{ }

if (this.A == (base.A))
{ }

if (((this.A)) == (base.A))
{ }

if (((this.A)) != (base.A))
{ }
```

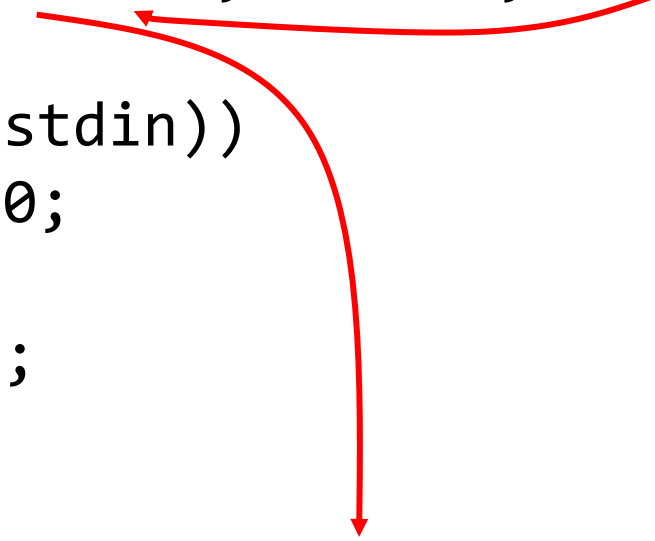
Taint analysis

```
static void F1()
{
  char buf[256];
  if (scanf("%255s", buf) == 1) {
    system(buf);
  }
}
```



Taint analysis

```
char readbuf[BUFSIZ];
if (fgets(readbuf, BUFSIZ, stdin) == NULL)
{
  if (feof(stdin))
    return 0;

  return -1;
}

if (readbuf[strlen(readbuf) - 1] == '\n')
  readbuf[strlen(readbuf) - 1] = '\0';
```



SQLI

```
void InitializerTest(HttpRequest request, String connectionString)
{
  string name = request.Form["product_name"];
  using (var connection = new SqlConnection(connectionString))
  {
    SqlCommand sqlCommand = new SqlCommand()
    {
      CommandText =
        "SELECT ProductId FROM Products WHERE ProductName = '" + name + "'",

      CommandType = CommandType.Text
    };

    SqlDataReader reader = sqlCommand.ExecuteReader();
  }
}
```

SQLI

```
void InitializerTest(HttpRequest request, String connectionString)
{
  string name = request.Form["product_name"];
  using (var connection = new SqlConnection(connectionString))
  {
    SqlCommand sqlCommand = new SqlCommand()
    {
      CommandText =
        "SELECT ProductId FROM Products WHERE ProductName = '" + name + "'",

      CommandType = CommandType.Text
    };

    SqlDataReader reader = sqlCommand.ExecuteReader();
  }
}
```

SQLI

```
void InitializerTest(HttpRequest request, String connectionString)
{
  string name = request.Form["product_name"];
  using (var connection = new SqlConnection(connectionString))
  {
    SqlCommand sqlCommand = new SqlCommand()
    {
      CommandText =
        "SELECT ProductId FROM Products WHERE ProductName = '" + name + "'",

      CommandType = CommandType.Text
    };

    SqlDataReader reader = sqlCommand.ExecuteReader();
  }
}
```

XXE

```
private static string
ParseRequest(System.Web.HttpContext context)
{
  var buffer = new byte[context.Request
                                .InputStream.Length];
  context.Request.InputStream.Read(buffer,
                                   0,
                                   buffer.Length);

  return Encoding.Default.GetString(buffer);
}

void CVE_2018_14485(System.Web.HttpContext input)
{
    var inputXml = ParseRequest(input);

    LoadXmlRequest(inputXml); //+V5614
}
```

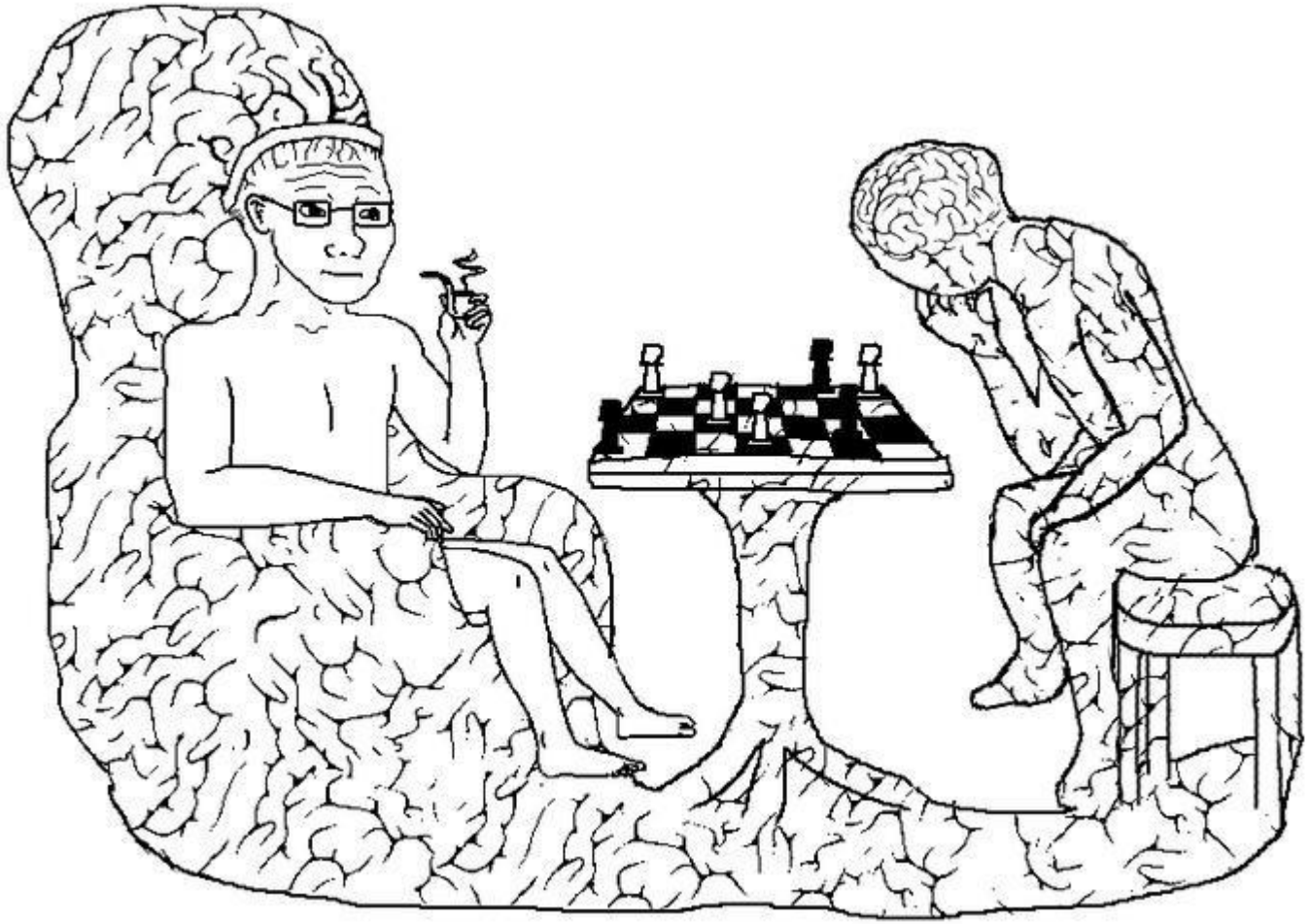
```
private void LoadXmlRequest(string xml)
{
  var request = new XmlDocument()
  {
    XmlResolver = new XmlUrlResolver()
  };

  try
  {
    if (!(xml.StartsWith("<?xml") ||
          xml.StartsWith("<method")))
    {
      xml = xml.Substring(xml.IndexOf("<?xml"));
    }

    request.LoadXml(xml);
  }
  catch (Exception ex)
  {
    throw new Exception(/*...*/);
  }
  //....
}
```

XXE: CVE-2018-14485

```
private static string
ParseRequest(System.Web.HttpContext context)
{
  var buffer = new byte[context.Request
                                .InputStream.Length];
  context.Request.InputStream.Read(buffer,
                                   0,
                                   buffer.Length);

  return Encoding.Default.GetString(buffer);
}

void CVE_2018_14485(System.Web.HttpContext input)
{
    var inputXml = ParseRequest(input);

    LoadXmlRequest(inputXml); //+V5614
}
```

```
private void LoadXmlRequest(string xml)
{
  var request = new XmlDocument()
  {
    XmlResolver = new XmlUrlResolver()
  };

  try
  {
    if (!(xml.StartsWith("<?xml") ||
          xml.StartsWith("<method")))
    {
      xml = xml.Substring(xml.IndexOf("<?xml"));
    }

    request.LoadXml(xml);
  }
  catch (Exception ex)
  {
    throw new Exception(/*...*/);
  }
  //....
}
```

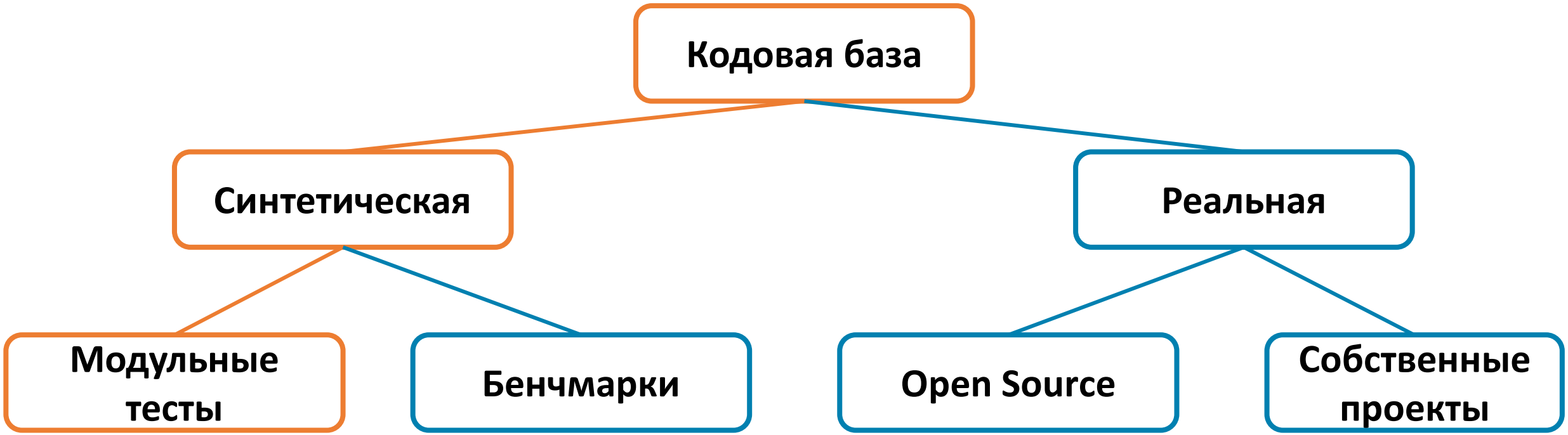
Когда придумываешь синтетические примеры уязвимостей



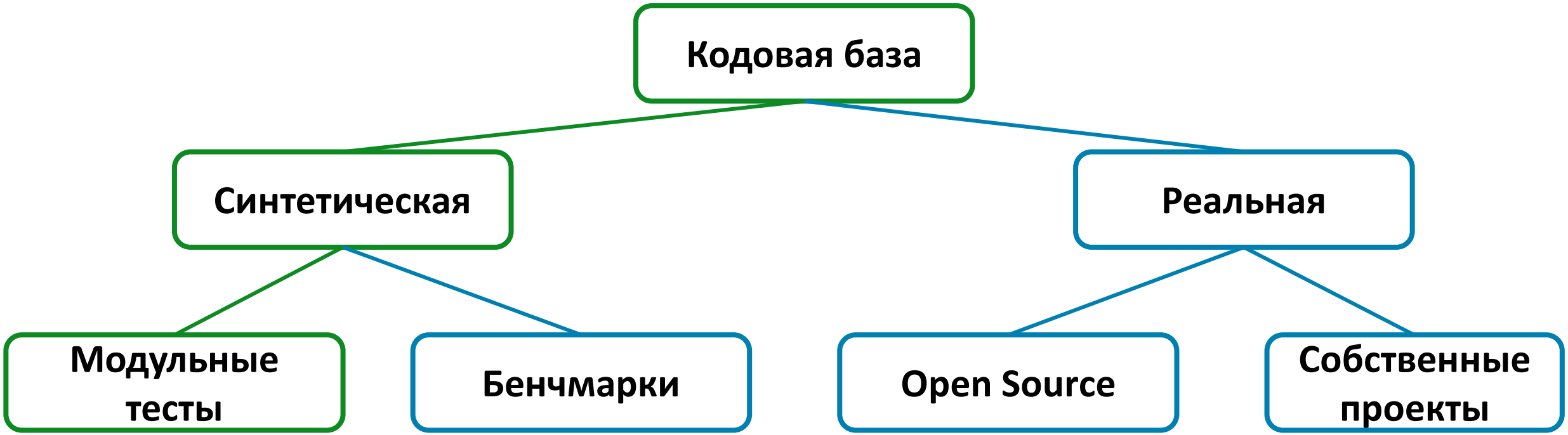
Синтетика подойдёт для старта.

Но её недостаточно.

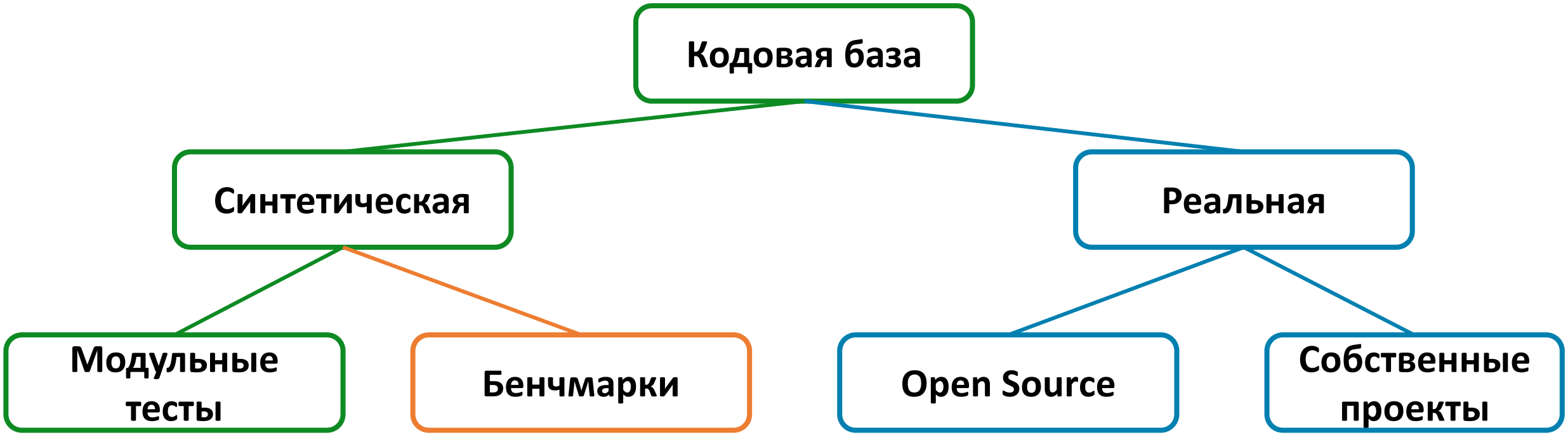
На чём тестировать?



На чём тестировать?



На чём тестировать?



Бенчмарки стат. анализаторов

Бенчмарки стат. анализаторов

- Оценка покрытия
- “Тренировка анализатора”
- Сравнение инструментов

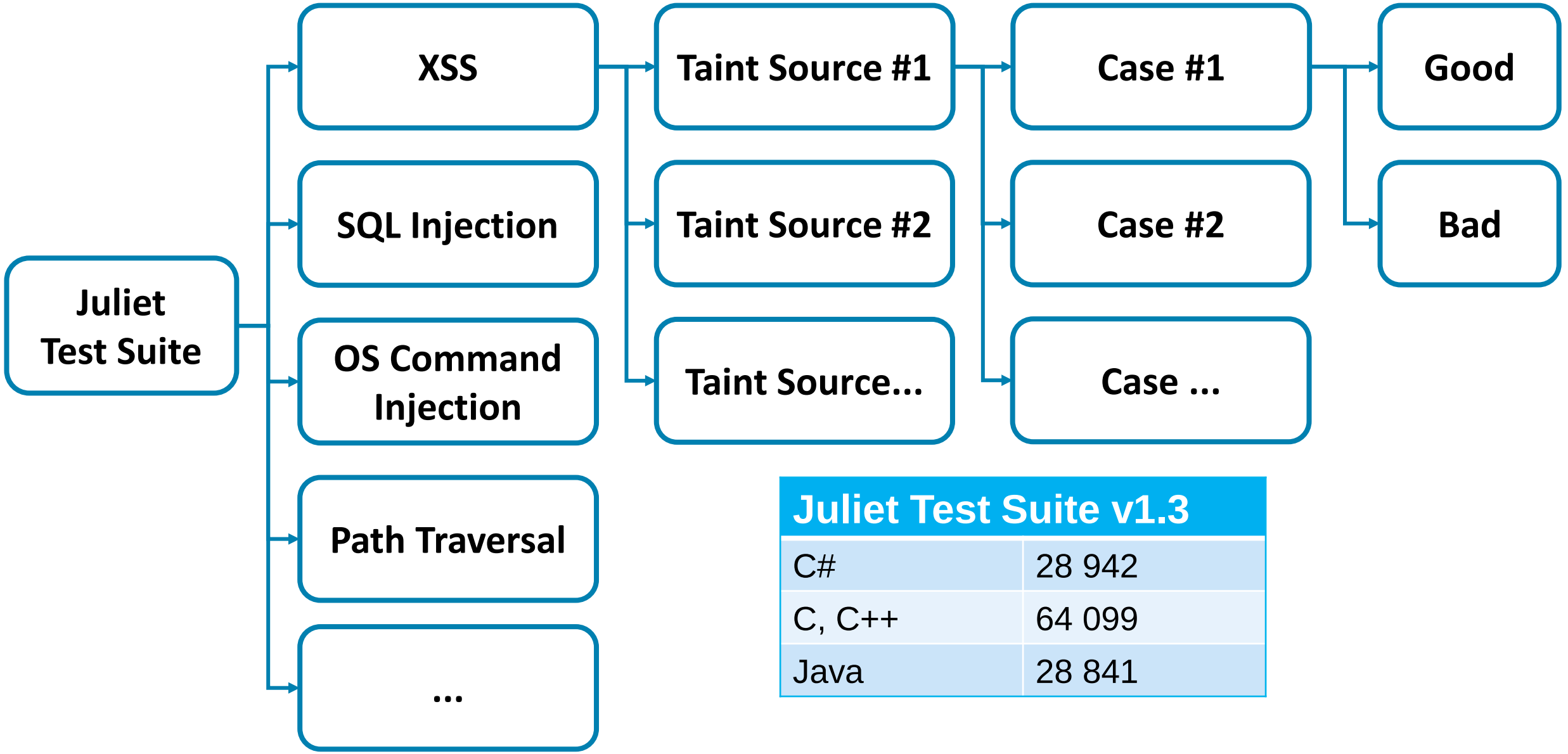
Примеры:

- Juliet Test Suite;
- Toyota ITC Benchmark;
- PHP Vulnerability Test Suite;

Juliet Test Suite

- Test suites от NIST (National Institute of Standards and Technology)
- Тест-кейсы для разных CWE:
  - C#: 105
  - C/C++: 118
  - Java: 112

Juliet Test Suite



Juliet Test Suite v1.3	
C#	28 942
C, C++	64 099
Java	28 841

Juliet Test Suite: CWE-89 SQLI - *Bad*

```
public override void Bad(HttpRequest req, HttpResponse resp) {
    string data;
    data = ""; /* Initialize data */
    /* Read data using an outbound tcp connection */
    {
        try {
            /* Read data using an outbound tcp connection */
            using (TcpClient tcpConn = new TcpClient("host.example.org", 39544)) {
                /* read input from socket */
                using (StreamReader sr = new StreamReader(tcpConn.GetStream())) {
                    /* POTENTIAL FLAW: Read data using an outbound tcp connection */
                    data = sr.ReadLine();
                }
            }
        }
        catch (IOException exceptIO) {
            IO.Logger.Log(NLog.LogLevel.Warn, exceptIO, "Error with stream reading");
        }
    }
    if (data != null) {
        string[] names = data.Split('-');
        int successCount = 0;
        SqlCommand badSqlCommand = null;
        try {
            using (SqlConnection dbConnection = IO.GetDBConnection())
            {
                badSqlCommand.Connection = dbConnection;
                dbConnection.Open();
                for (int i = 0; i < names.Length; i++) {
                    /* POTENTIAL FLAW: data concatenated into SQL statement used in CommandText, which could result in SQL Injection */
                    badSqlCommand.CommandText += "update users set hitcount=hitcount+1 where name='" + names[i] + "';";
                }
                var affectedRows = badSqlCommand.ExecuteNonQuery();
                successCount += affectedRows;
                IO.WriteLine("Succeeded in " + successCount + " out of " + names.Length + " queries.");
            }
        }
        catch (SqlException exceptSql) {
            IO.Logger.Log(NLog.LogLevel.Warn, "Error getting database connection", exceptSql);
        }
        finally {
            try {
                if (badSqlCommand != null) {
                    badSqlCommand.Dispose();
                }
            }
            catch (SqlException exceptSql) {
                IO.Logger.Log(NLog.LogLevel.Warn, "Error disposing SqlCommand", exceptSql);
            }
        }
    }
}
```

Juliet Test Suite: CWE-89 SQLI - *Bad*

```
public override void Bad(HttpRequest req, HttpResponse resp)
{
  data = ReadUsingTcpConnection(); // Taint source
  names = data.Split('-');

  SqlCommand badCommand;

  for (int i = 0; i < names.Length; ++i)
  {
    /* POTENTIAL FLAW: data concatenated into SQL statement used in CommandText,
       which could result in SQL Injection */
    badCommand.CommandText
      += "update users set hitcount=hitcount+1 where name='" + names[i] + "';";
  }

  rows = badCommand.Execute()
}
```

Juliet Test Suite: CWE-89 SQLI - *Bad*

```
public override void Bad(HttpRequest req, HttpResponse resp)
{
  data = ReadUsingTcpConnection(); // Taint source
  names = data.Split('-');

  SqlCommand badCommand;

  for (int i = 0; i < names.Length; ++i)
  {
    /* POTENTIAL FLAW: data concatenated into SQL statement used in CommandText,
       which could result in SQL Injection */
    badCommand.CommandText
      += "update users set hitcount=hitcount+1 where name='" + names[i] + "';";
  }

  rows = badCommand.Execute()
}
```

Juliet Test Suite: CWE-89 SQLI - *Good*

```
public override void Good(HttpRequest req, HttpResponse resp)
{
  data = "data";
  names = data.Split('-');

  SqlCommand badCommand;

  for (int i = 0; i < names.Length; ++i)
  {


    badCommand.CommandText
      += "update users set hitcount=hitcount+1 where name='" + names[i] + "';";
  }

  rows = badCommand.Execute()
}
```

Juliet Test Suite: CWE-89 SQLI - *Good*

```
public override void Good(HttpRequest req, HttpResponse resp)
{
  data = ReadUsingTcpConnection(); // Taint source
  names = data.Split('-');

  SqlCommand goodSqlCommand;

  for (int i = 0; i < names.Length; ++i)
  {
    SqlParameter nameParam = new SqlParameter("@name", SqlDbType.VarChar, 100);
    nameParam.Value = names[i];
    goodSqlCommand.CommandText
      += "update users set hitcount=hitcount+1 where name=@name;";
  }

  rows = badCommand.Execute()
}
```

Toyota ITC Benchmarks

Бенчмарк от Toyota InfoTechnology Center для C/C++

Прим. С сайта NIST SAMATE:

*Please note that test cases contain coincidental weaknesses flagged by SAMATE team, each described accordingly and **individually**.*

*Also please note that the SAMATE team determined that in a few cases, the code that was marked as weakness originally was in fact correct code. We describe these cases accordingly and **individually**.*

Toyota ITC Benchmarks: dead code

```
void dead_code_002 ()
{
  int flag = 0;
  int a = 0;
  int ret;
  if (flag)
  {
    a ++; /*Tool should detect this line as error*/
          /*ERROR:Dead Code*/
  }
  ret = a;
  sink = ret;
}
```

Toyota ITC Benchmarks: dead code

```
void dead_code_002 ()
{
  int flag = 0;
  int a = 0;
  int ret;
  if (flag)
  {
    a ++; /*Tool should detect this line as error*/
          /*ERROR:Dead Code*/
  }
  ret = a;
  sink = ret;
}
```

Toyota ITC Benchmarks: dead code

```
void dead_code_002 ()
{
  int flag = 0;
  int a = 0;
  int ret;
  if (flag) // V547: expression is always false
  {
    a ++; /*Tool should detect this line as error*/
          /*ERROR:Dead Code*/
  }
  ret = a;
  sink = ret;
}
```

Toyota ITC Benchmarks: dead code

```
void dead_code_001 ()
{
  int a = 0;
  int ret;
  if (0) // No warn V547: expression is always false
  {
    a ++; /*Tool should detect this line as error*/
          /*ERROR:Dead Code*/
  }
  ret = a;
  sink = ret;
}
```

Бенчмарки: выводы

Полезны, но без фанатизма

Бенчмарки: выводы

Анализатор
на бенчмарках

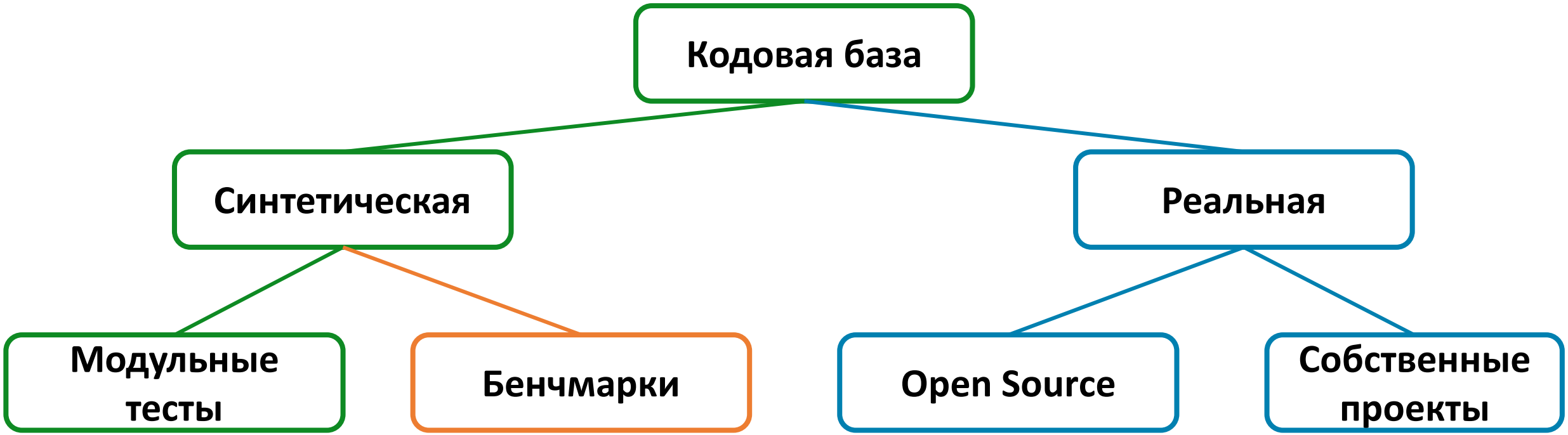
Анализатор
на реальных проектах

Бенчмарки: выводы

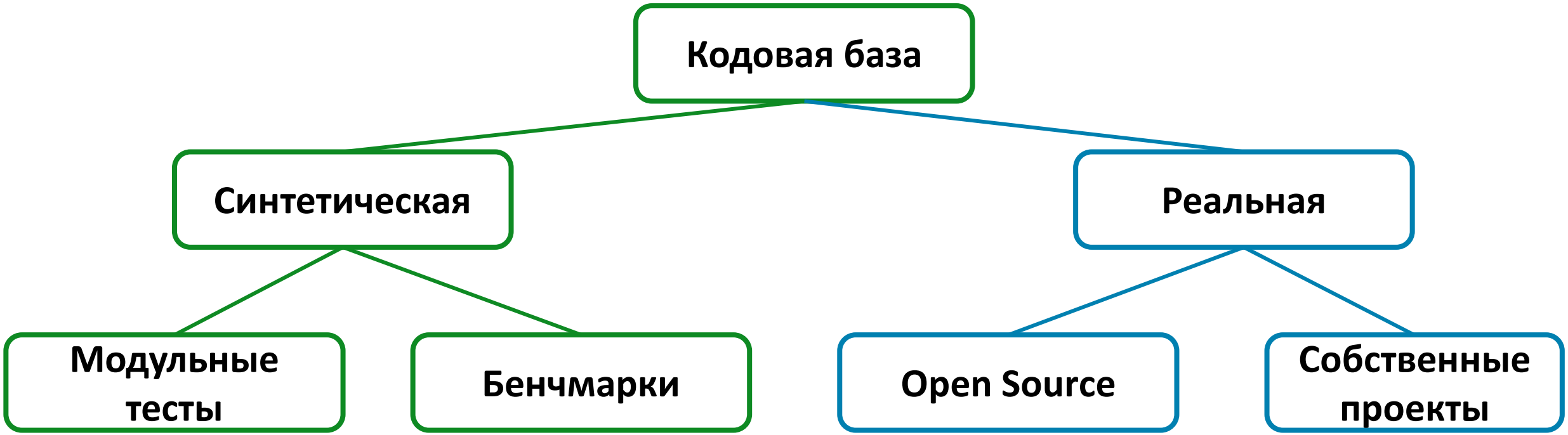
Анализатор
на бенчмарках

Анализатор
на реальных проектах

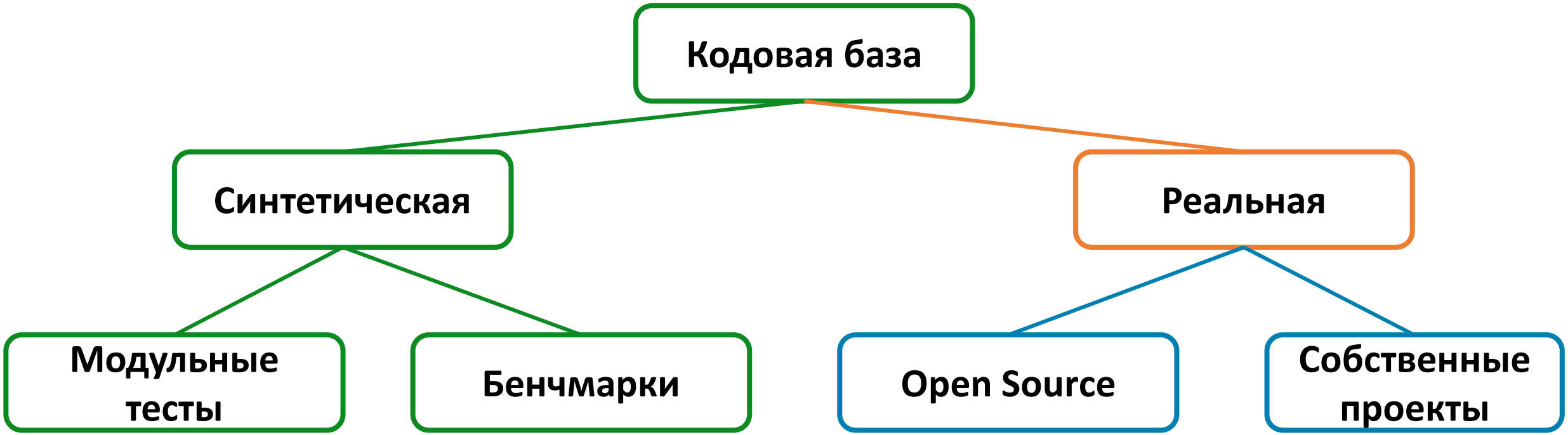
На чём тестировать?



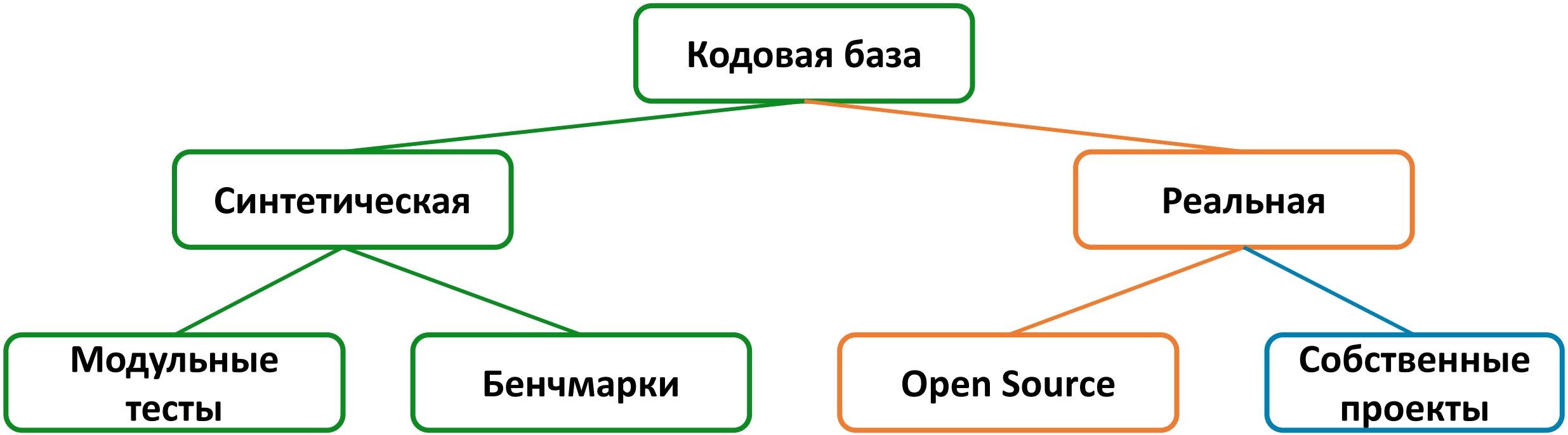
На чём тестировать?



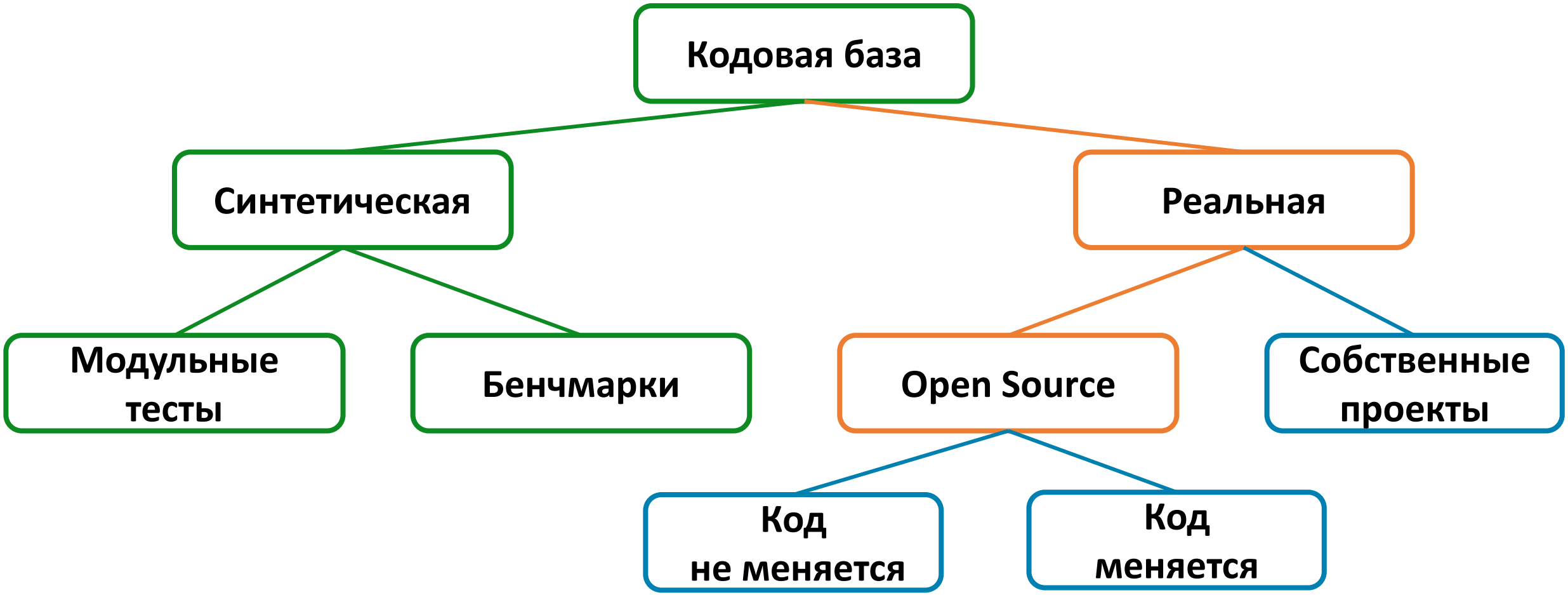
На чём тестировать?



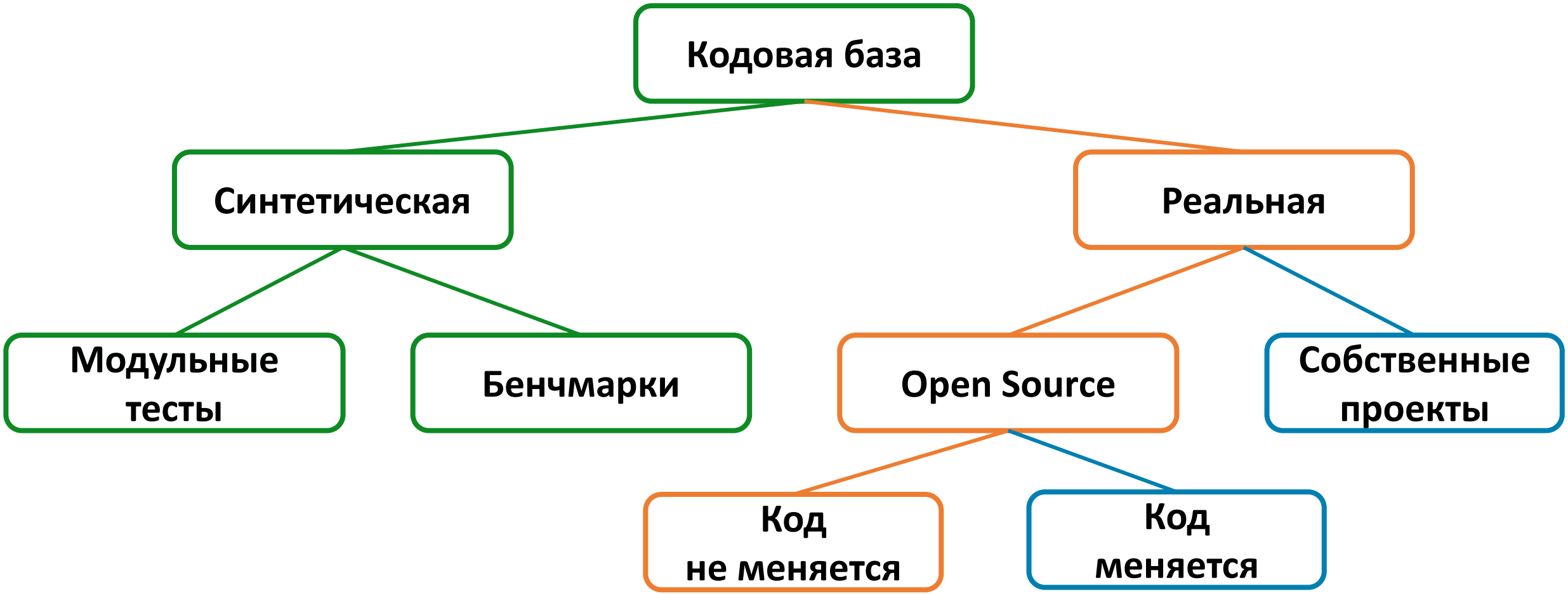
На чём тестировать?



На чём тестировать?



На чём тестировать?



Тестирование на Open Source проектах

Тестирование на OSS: зачем?

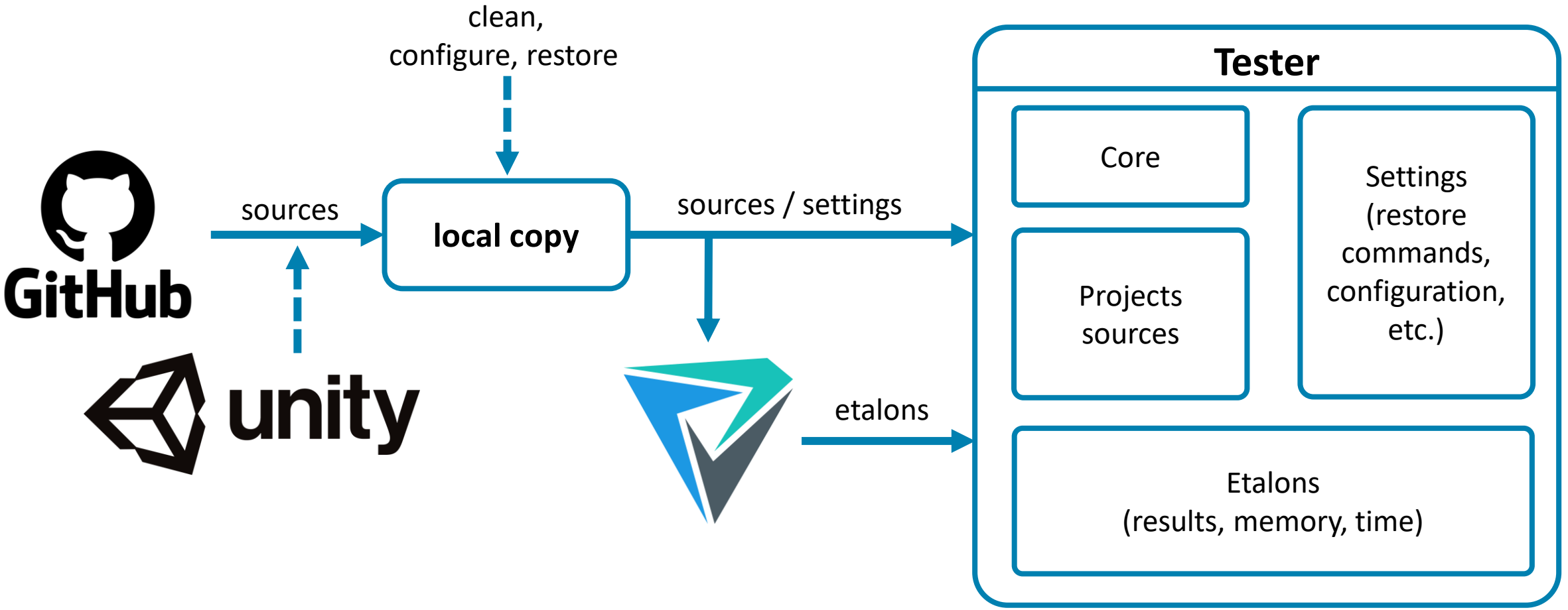
```
....
while (    service is IServiceHolder<TService>
        && caller is TService callerService)
{
  return callerService;
}
....
```

Тестирование на OSS: зачем?

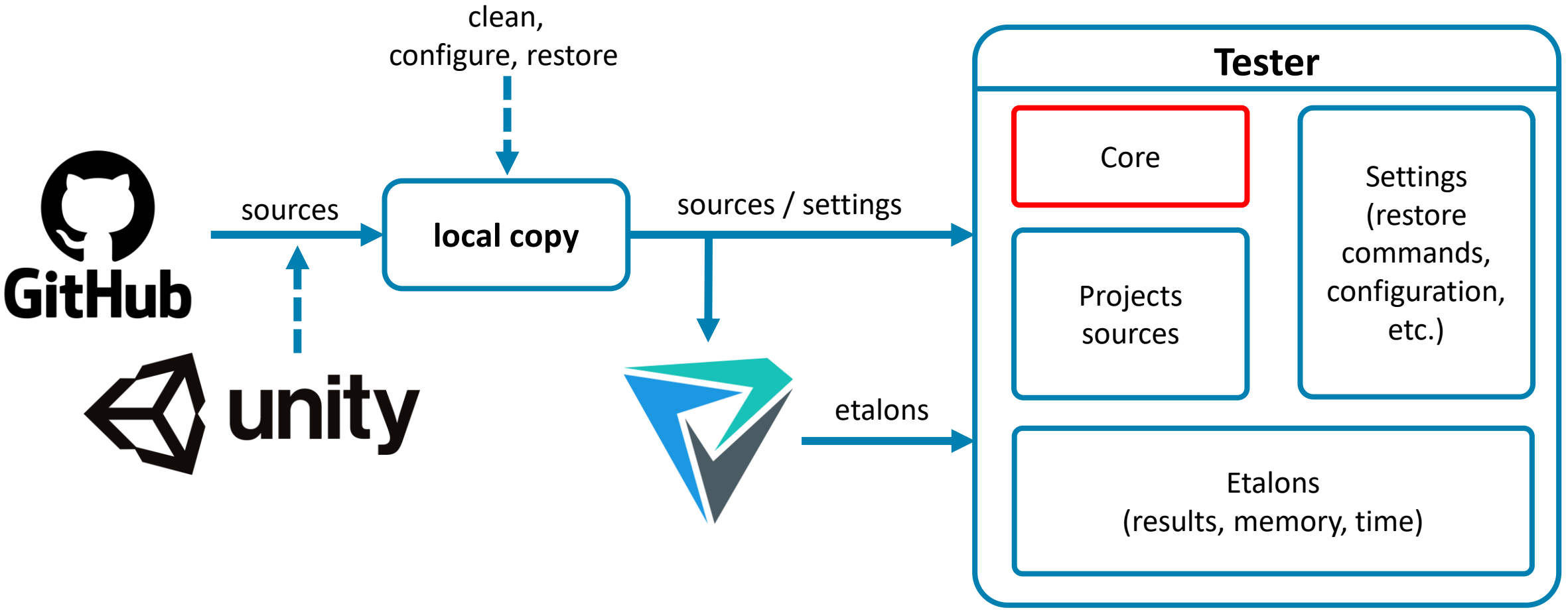
- Реальные кейсы использования:
  - разных фич языка
  - подходов
  - фреймворков

- Тестирование анализатора
  на условиях, близких к реальным

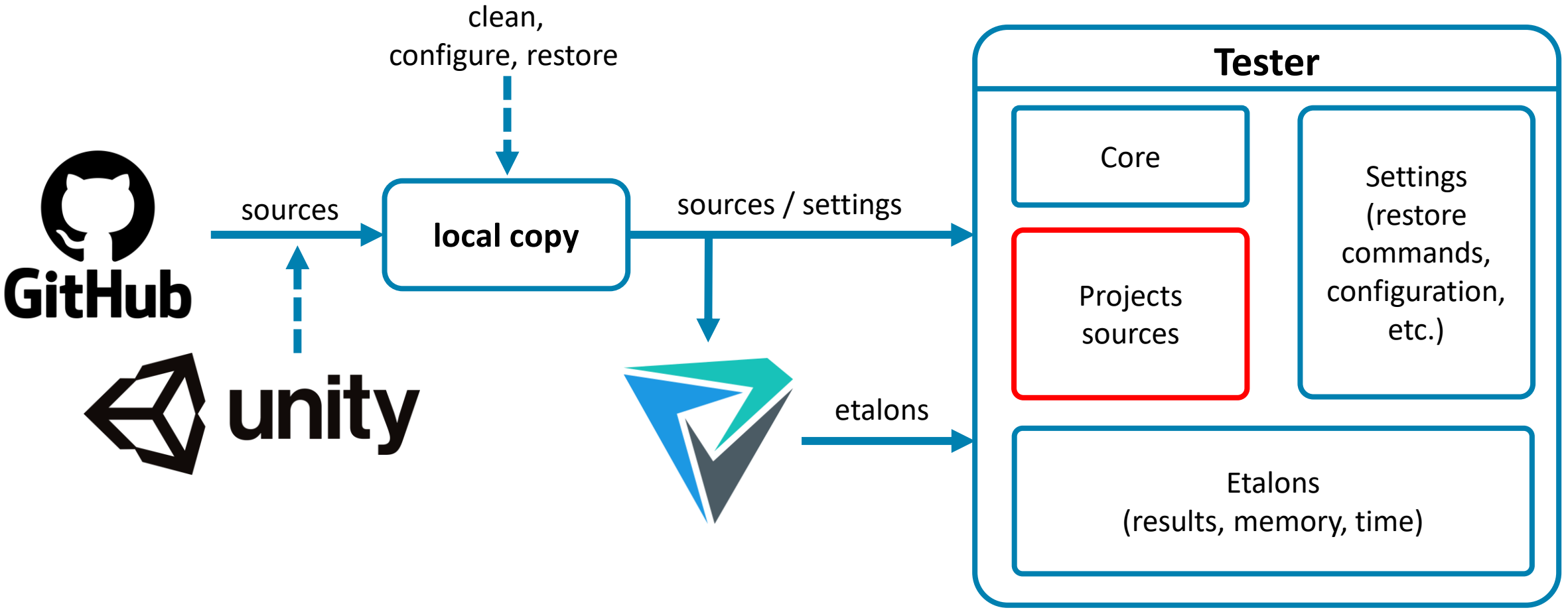
Тестирование на OSS: как?



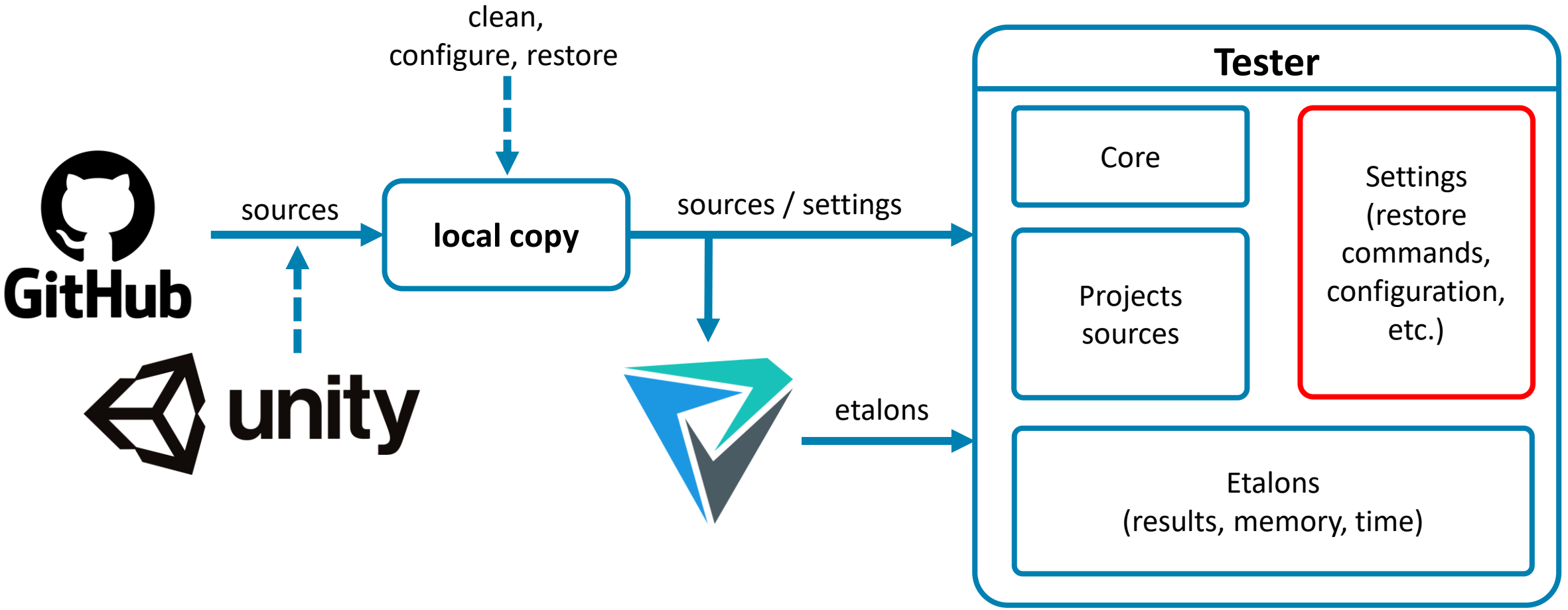
Тестирование на OSS: как?



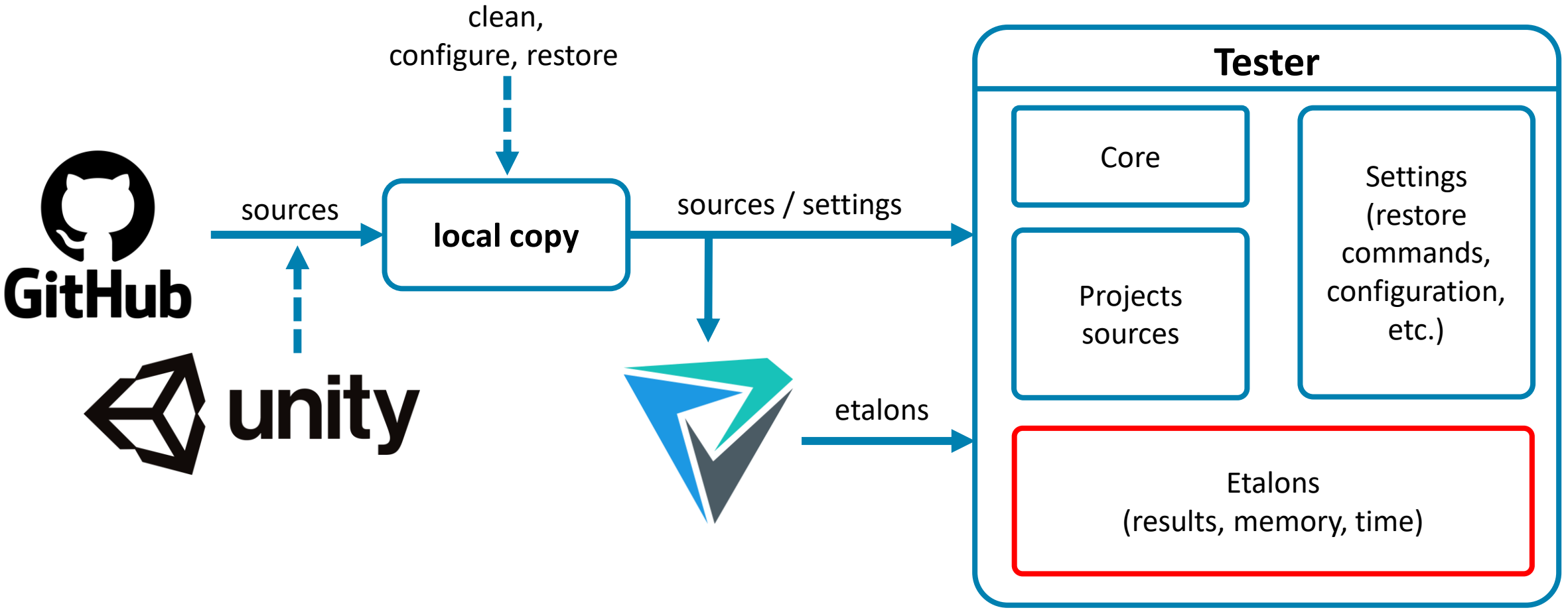
Тестирование на OSS: как?



Тестирование на OSS: как?



Тестирование на OSS: как?



```
1/78  XXETests                    00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps       00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject      00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs              00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject              00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                      00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                   00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                      00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp            00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                  00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                  00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop                00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth              00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker    00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3             00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                    00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps       00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject      00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs              00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject              00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                      00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                   00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                      00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp            00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                  00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                  00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop                00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth              00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker    00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3             00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                  00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps     00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject    00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs            00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject            00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                    00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                 00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                    00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp          00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop              00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth            00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker  00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3           00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                  00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps     00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject    00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs            00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject            00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                    00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                 00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                    00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp          00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop              00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth            00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker  00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3           00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                    00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps       00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject      00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs              00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject              00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                      00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                   00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                      00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp            00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                  00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                  00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop                00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth              00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker    00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3             00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                    00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps       00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject      00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs              00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject              00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                      00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                   00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                      00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp            00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                  00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                  00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop                00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth              00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker    00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3             00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

```
1/78  XXETests                    00:00:11 (+ 0s)   0.7GiB (+ 0.1GiB) Ok
2/78  ComplexTransitiveDeps       00:01:11 (+12s)   1.8GiB (- 0.1GiB) Ok
3/78  TestTFMResolverProject      00:00:13 (+ 3s)   0.3GiB (+ 0.0GiB) Ok
4/78  NoMetadataRefs              00:00:11 (- 1s)   0.3GiB (+ 0.0GiB) Ok
5/78  TFSTestProject              00:00:09 (+ 2s)   0.3GiB (+ 0.0GiB) Ok
6/78  CoreWF                      00:01:45 (+ 7s)   2.1GiB (+ 0.1GiB) Diff
7/78  Cofoundry                   00:00:39 (+ 8s)   1.3GiB (- 0.1GiB) Diff
8/78  Npgsql                      00:00:58 (+ 7s)   1.2GiB (- 0.2GiB) Ok
9/78  ConfigTestCSharp            00:00:09 (+ 2s)   0.2GiB (+ 0.0GiB) Ok
10/78 VS2017Test                  00:00:18 (+ 6s)   0.9GiB (- 0.2GiB) Diff
11/78 VS2019Test                  00:00:18 (+ 6s)   0.4GiB (- 0.1GiB) Ok
....
24/78 SharpDevelop                00:12:30 (+ 3m)   6.4GiB (+ 0.4GiB) Diff
....
27/78 DotNetOpenAuth              00:01:09 (+19s)   2.3GiB (- 0.7GiB) Fail
28/78 Hearthstone Deck Tracker    00:01:04 (+16s)   0.9GiB (- 0.1GiB) Ok
29/78 IdentityServer3             00:00:40 (+16s)   1.0GiB (+ 0.0GiB) Ok
```

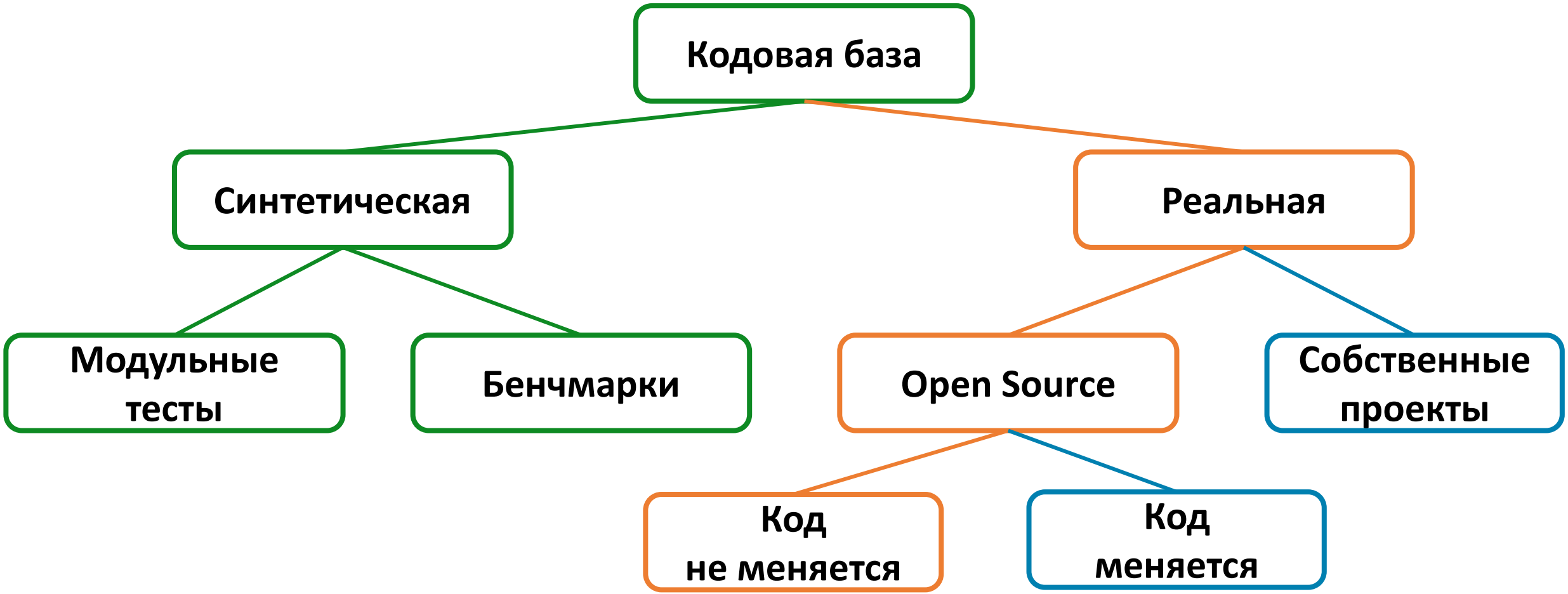
BouncyCastle C#

```
public static string ToString(object[] a)
{
  StringBuilder sb = new StringBuilder('[');
  if (a.Length > 0)
  {
    sb.Append(a[0]);
    for (int index = 1;
         index < a.Length; ++index)
    {
      sb.Append(", ").Append(a[index]);
    }
  }
  sb.Append(']');
  return sb.ToString();
}
```

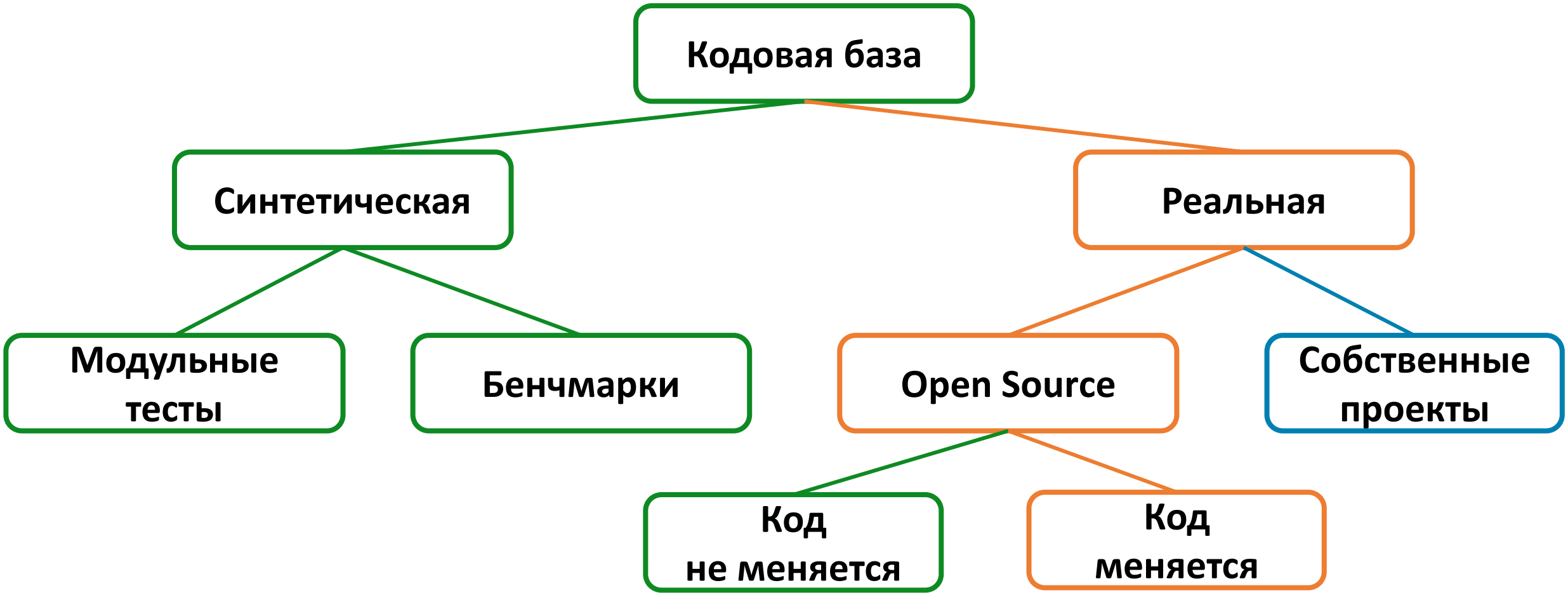
```
public StringBuilder(int capacity)
```

Тестирование на OSS близко к реальному использованию

На чём тестировать?



На чём тестировать?



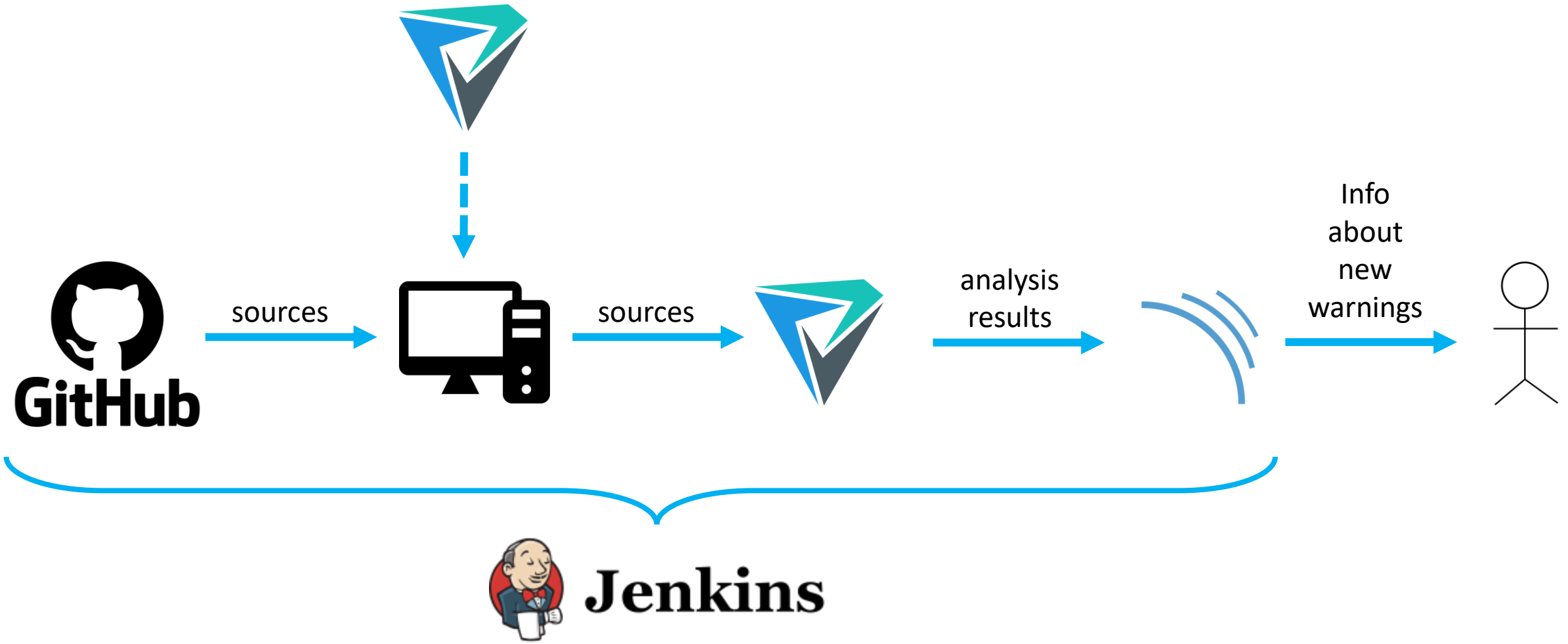
PVS-Studio & SonarQube & Open Source

Зачем?

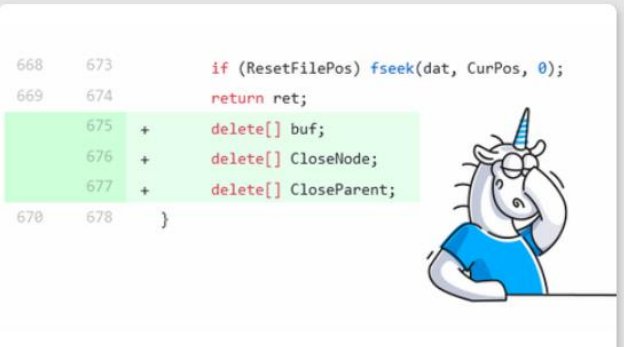
- Тестирование ещё ближе к реальным условиям
- Демонстрация пользы статического анализа

sonarqube

Как?


GitHub
sources
sources
analysis
results
Info
about
new
warnings
Jenkins

Защита от поспешных правок кода



#Cpp 24 Мар 2021

Как PVS-Studio защищает от поспешных правок кода

Андрей Карпов

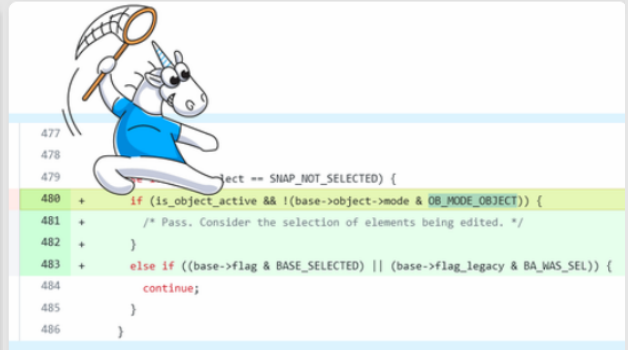
Хотя только недавно была заметка про проект CovidSim, есть хороший повод вновь про него вспомнить и продемонстрировать пользу регулярного использования PVS-Studio. Бывает, что все мы спешим и вносим правки в код, потеряв сосредоточенность. Статический анализатор может...

#Cpp 18 Янв 2022

Как PVS-Studio защищает от поспешных правок кода, пример N2

Андрей Карпов

Большое количество ошибок программистами допускается просто по невнимательности или из-за спешки. Хорошо это видно на небольших неправильных изменениях, вносимых в код. Рассмотрим как раз такой случай, когда, исправляя одну ошибку, программист добавляет новую.

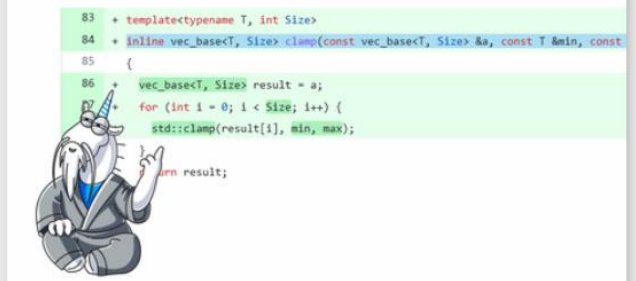


#Cpp 16 Фев 2022

Как PVS-Studio защищает от поспешных правок кода, пример N3

Андрей Карпов

Продолжаем серию маленьких заметок про то, как анализатор PVS-Studio может быстро находить новые ошибки в коде. При условии, конечно, что он регулярно используется :). Итак, перед нами очередной баг в проекте Blender.



#Cpp 18 Фев 2022

Как PVS-Studio защищает от поспешных правок кода, пример N4

Андрей Карпов

Если регулярно использовать статический анализатор кода, то можно сократить время на гадание, почему новый код работает как-то не так, как задумывалось. Рассмотрим очередную интересную ошибку, когда в процессе рефакторинга сломалась функция и это осталось не замеченным...

Example №1

Blender

```
#define CLAMP(a, b, c) \
  { \
    if ((a) < (b)) { \
      (a) = (b); \
    } \
    else if ((a) > (c)) { \
      (a) = (c); \
    } \
  } \
  (void)0

template <typename T> inline T
clamp(const T &a, const bT &min_v, const bT &max_v)
{
  T result = a;
  for (int i = 0; i < T::type_length; i++) {
    CLAMP(result[i], min_v, max_v);
  }
  return result;
}
```

Blender

```
#define CLAMP(a, b, c) \
  { \
    if ((a) < (b)) { \
      (a) = (b); \
    } \
    else if ((a) > (c)) { \
      (a) = (c); \
    } \
  } \
  (void)0
```

[MIN_VAL >= CUR_VAL <= MAX_VAL]

```
template <typename T> inline T
clamp(const T &a, const bT &min_v, const bT &max_v)
{
  T result = a;
  for (int i = 0; i < T::type_length; i++) {
    CLAMP(result[i], min_v, max_v);
  }
  return result;
}
```

Blender

```
#define CLAMP(a, b, c) \
  { \
    if ((a) < (b)) { \
      (a) = (b); \
    } \
    else if ((a) > (c)) { \
      (a) = (c); \
    } \
  } \
  (void)0
```

[MIN_VAL >= CUR_VAL <= MAX_VAL]

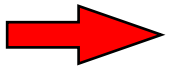
```
template <typename T> inline T
clamp(const T &a, const bT &min_v, const bT &max_v)
{
  T result = a;
  for (int i = 0; i < T::type_length; i++) {
    CLAMP(result[i], min_v, max_v);
  }
  return result;
}
```

Blender

```
template <typename T, int Size>
inline vec_base<T, Size>
clamp(const vec_base<T, Size> &a, const T &min, const T &max)
{
  vec_base<T, Size> result = a;
  for (int i = 0; i < Size; i++) {
    std::clamp(result[i], min, max);
  }
  return result;
}
```

Blender

```
template <typename T, int Size>
inline vec_base<T, Size>
clamp(const vec_base<T, Size> &a, const T &min, const T &max)
{
  vec_base<T, Size> result = a;
  for (int i = 0; i < Size; i++) {
    std::clamp(result[i], min, max);
  }
  return result;
}
```



Blender

```
template <typename T, int Size>
inline vec_base<T, Size>
clamp(const vec_base<T, Size> &a, const T &min, const T &max)
{
  vec_base<T, Size> result = a;
  for (int i = 0; i < Size; i++) {
    result[i] = std::clamp(result[i], min, max);
  }
  return result;
}
```

Example №2

COVID-19 CovidSim Model

```
int GetXMLNode(....)
{
  char buf[65536], CloseNode[2048], CloseParent[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
}
```

COVID-19 CovidSim Model

```
int GetXMLNode(....)
{
  char buf[65536], CloseNode[2048], CloseParent[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
}
```

COVID-19 CovidSim Model

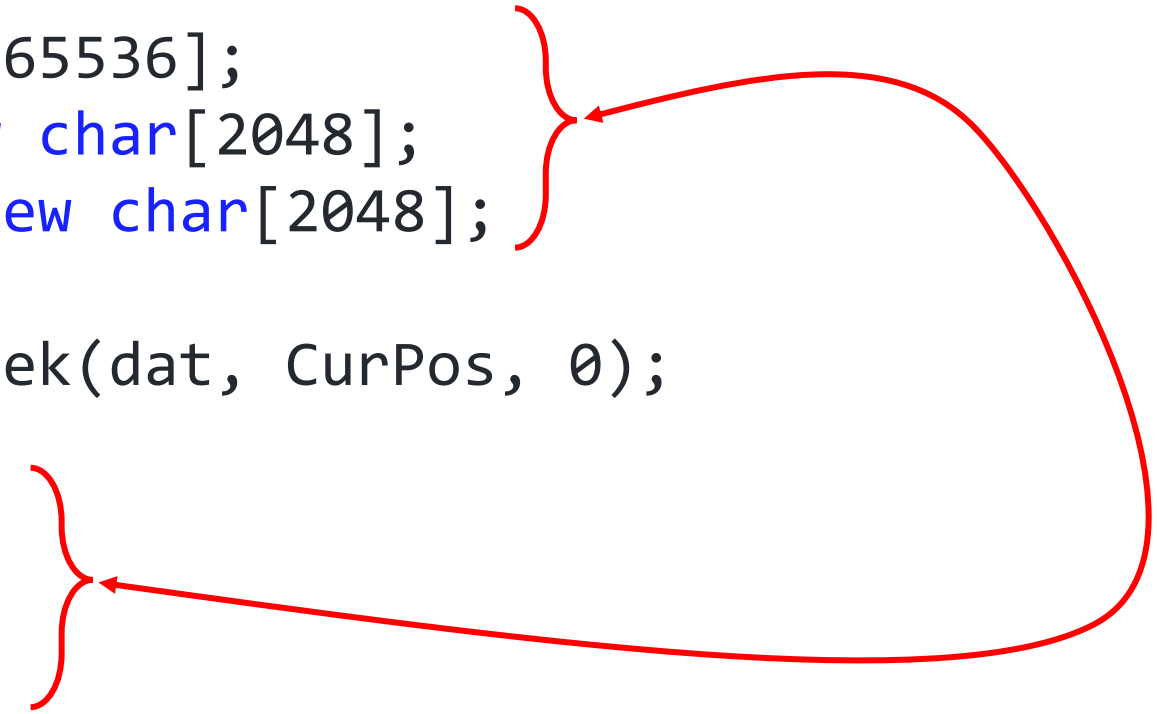
```
int GetXMLNode(....)
{
  char buf[65536], CloseNode[2048], CloseParent[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
}
```

COVID-19 CovidSim Model

```
int GetXMLNode(....)
{
  char* buf = new char[65536];
  char* CloseNode = new char[2048];
  char* CloseParent = new char[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
  delete[] buf;
  delete[] CloseNode;
  delete[] CloseParent;
}
```

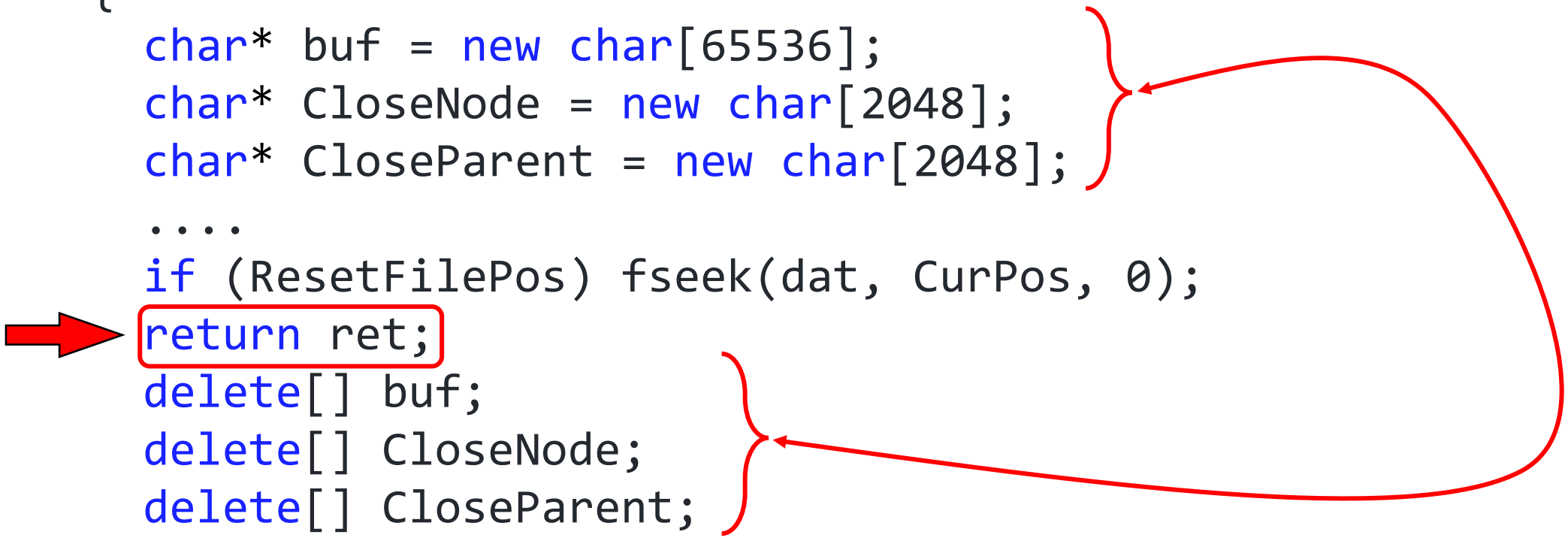
COVID-19 CovidSim Model

```
int GetXMLNode(....)
{
  char* buf = new char[65536];
  char* CloseNode = new char[2048];
  char* CloseParent = new char[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
  delete[] buf;
  delete[] CloseNode;
  delete[] CloseParent;
}
```



COVID-19 CovidSim Model

```
int GetXMLNode(....)
{
  char* buf = new char[65536];
  char* CloseNode = new char[2048];
  char* CloseParent = new char[2048];
  ....
  if (ResetFilePos) fseek(dat, CurPos, 0);
  return ret;
  delete[] buf;
  delete[] CloseNode;
  delete[] CloseParent;
}
```



Example №3

Blender

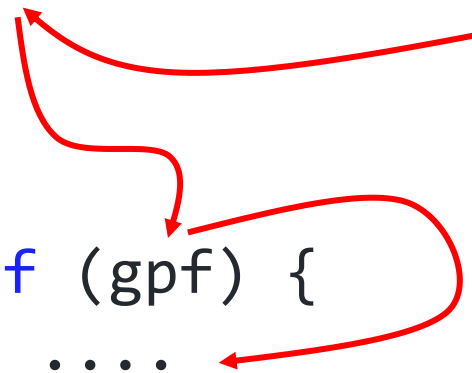
```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  if (gpf) {
    ....
  }
  ....
}
```

Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  if (gpf) {
    ....
  }
  ....
}
```

Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  if (gpf) {
    ....
  }
  ....
}
```



Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);
  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```

Blender

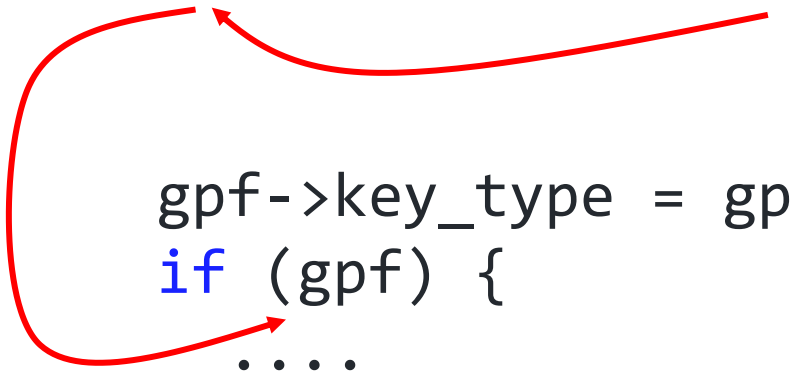
```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```

Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);
  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```

Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```

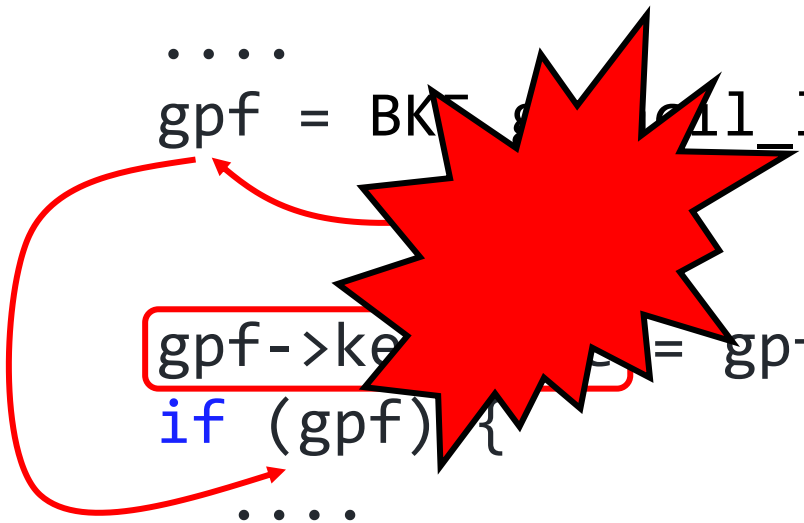


Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);

  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```

Blender

```
bool ED_gpencil_anim_copybuf_paste(....)
{
  ....
  gpf = BKE_gpencil_layer_frame_get(gpld,
                                    gpfs->framenum,
                                    GP_GETFRAME_ADD_NEW);
  gpf->key_type = gpfs->key_type;
  if (gpf) {
    ....
  }
  ....
}
```



Example №4

Akka.NET

```
case ShardId shardId:
  _shards.Add(shardId);
  return true;
case SnapshotOffer offer when (offer.Snapshot is ShardCoordinator.CoordinatorState state):
  _shards.UnionWith(state.Shards.Keys.Union(state.UnallocatedShards));
  return true;
case SnapshotOffer offer when (offer.Snapshot is State state):
  _shards.Union(state.Shards);
  _writtenMarker = state.WrittenMigrationMarker;
  return true;
case RecoveryCompleted _:
  Log.Debug("Recovery complete. Current shards [{0}]. Written Marker {1}",
            string.Join(", ", _shards), _writtenMarker);

  if (!_writtenMarker) {
    Persist(MigrationMarker.Instance, _ => {
          Log.Debug("Written migration marker");
          _writtenMarker = true;
        });
   }
   return true;
case MigrationMarker _:
  _writtenMarker = true;
  return true;
```

Akka.NET

```
case ....:
  _shards.Add(shardId);
  ....
case ....:
  _shards.UnionWith(state.Shards.Keys.Union(state.UnallocatedShards));
  ....
case ....:
  _shards.Union(state.Shards);
  ....

// _shards: HashSet<T>
```

VasilievSerg commented on Apr 21

Hi,
I found the suspicious code via the PVS-Studio analyzer.

Here is the code:

```
...
case ShardId shardId:
  _shards.Add(shardId); // <=
  return true;
case SnapshotOffer offer when (offer.Snapshot is ShardCoordinator.CoordinatorState state):
  _shards.UnionWith(state.Shards.Keys.Union(state.UnallocatedShards)); // <=
  return true;
case SnapshotOffer offer when (offer.Snapshot is State state):
  _shards.Union(state.Shards); // <=
...
```

Here is the link to the sources.

Several methods were called for the `_shards` variable. The last invocation looks suspicious.

`Add` and `UnionWith` are methods of the `HashSet<T>` type. They change the `_shards` object state. But `Union` is the extension method which does not change the `_shards` state. The result of this invocation is not used as well.

Aaron Stannard @Aaronontheweb · Apr 25

Replying to @_SergVasiliev_ and @AkkaDotNET

I really appreciated this issue being opened on the repo too because it was extremely subtle but important to how a complex part of @AkkaDotNET works. That change was introduced in a big PR that touched 100+ files and I spent more than 10 hours reviewing it.

1 1

Aaron Stannard @Aaronontheweb · Apr 25

Replying to @Aaronontheweb @_SergVasiliev_ and @AkkaDotNET

I probably wouldn't have caught that error without:

1. A user writing a detailed bug report about an intermittent issue that is very hard to replicate and us spending tens of hours repro-ing it after this was released

or

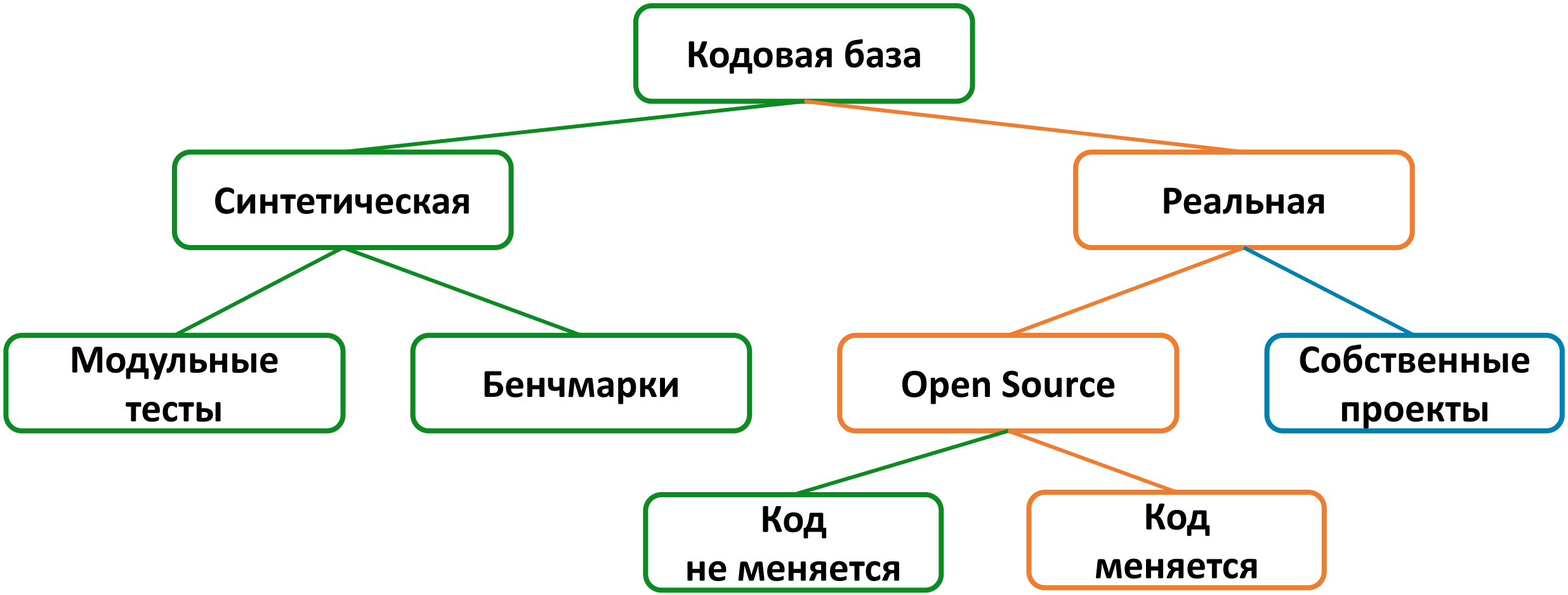
2. Your static analysis tool

1 1 2

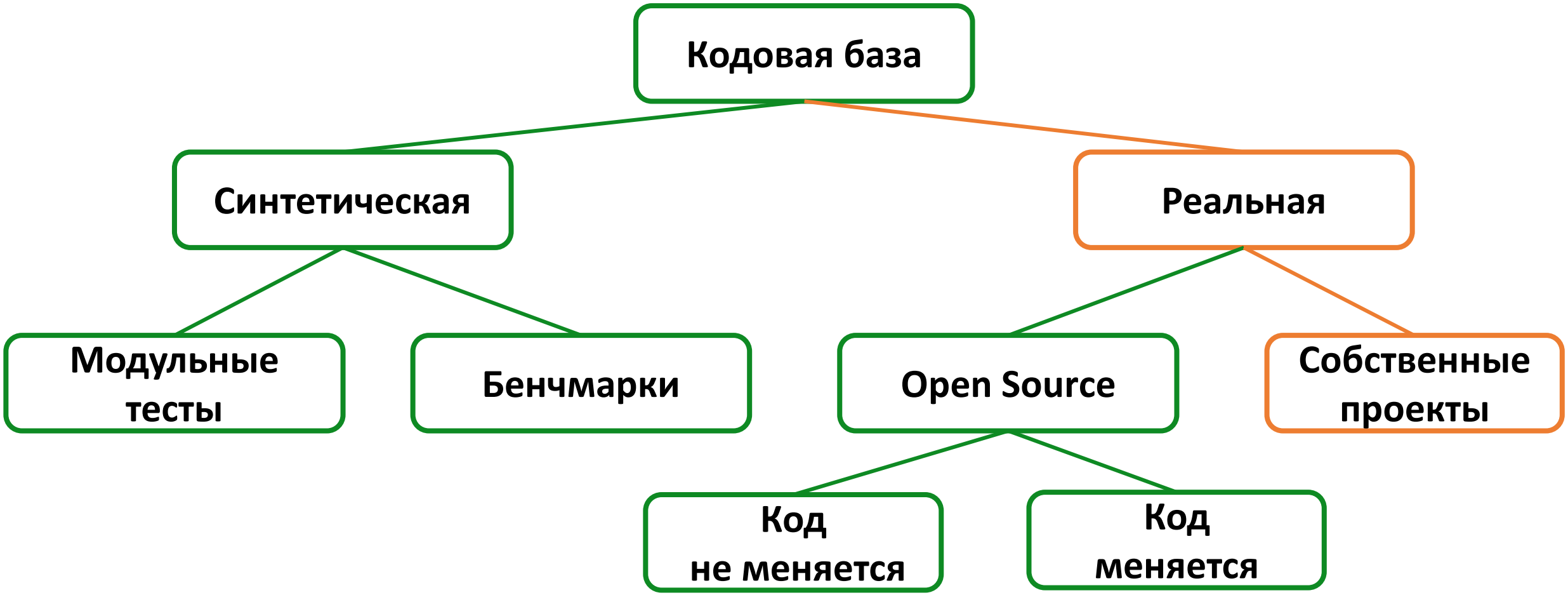
Akka.NET

```
case ShardId shardId:
  _shards.Add(shardId);
  return true;
case SnapshotOffer offer when (offer.Snapshot is ShardCoordinator.CoordinatorState state):
  _shards.UnionWith(state.Shards.Keys.Union(state.UnallocatedShards));
  return true;
case SnapshotOffer offer when (offer.Snapshot is State state):
  _shards.Union(state.Shards);
  _writtenMarker = state.WrittenMigrationMarker;
  return true;
case RecoveryCompleted _:
  Log.Debug("Recovery complete. Current shards [{0}]. Written Marker {1}",
            string.Join(", ", _shards), _writtenMarker);

  if (!_writtenMarker) {
    Persist(MigrationMarker.Instance, _ => {
          Log.Debug("Written migration marker");
          _writtenMarker = true;
        });
   }
   return true;
case MigrationMarker _:
  _writtenMarker = true;
  return true;
```

На чём тестировать?



На чём тестировать?



Static analyzer vs own sources

А вы проверяете PVS-Studio с помощью PVS-Studio?

PVS-Studio vs PVS-Studio

```
public override void
VisitAnonymousObjectCreationExpression(
  AnonymousObjectCreationExpressionSyntax node)
{
  foreach (var initializer in node?.Initializers)
    initializer?.Expression?.Accept(this);
}
```

PVS-Studio vs PVS-Studio

```
public override void
VisitAnonymousObjectCreationExpression(
  AnonymousObjectCreationExpressionSyntax node)
{
  foreach (var initializer in node?.Initializers)
    initializer?.Expression?.Accept(this);
}
```

PVS-Studio vs PVS-Studio

```
public override void
VisitAnonymousObjectCreationExpression(
  AnonymousObjectCreationExpressionSyntax node)
{
  foreach (var initializer
            in (node == null ? null : node.Initializers))
    initializer?.Expression?.Accept(this);
}
```

PVS-Studio vs PVS-Studio

```
public override void
VisitAnonymousObjectCreationExpression(
  AnonymousObjectCreationExpressionSyntax node)
{
  foreach (var initializer
            in (node == null ? null : node.Initializers))
    initializer?.Expression?.Accept(this);
}
```

PVS-Studio vs PVS-Studio

roslyn

RAVENDB

NETHERMIND®

PVS-Studio vs PVS-Studio

```
public bool GeneratePreprocessedFile(....) {
  ....
  if (info.PreprocessorCommandLine.Contains(" /arch:SSE"))
    ClangCommandLine += " /D \"_M_IX86_FP=1\"";
  else if (info.PreprocessorCommandLine.Contains(" /arch:SSE2"))
    ClangCommandLine += " /D \"_M_IX86_FP=2\"";
  else if (info.PreprocessorCommandLine.Contains(" /arch:IA32"))
    ClangCommandLine += " /U \"_M_IX86_FP\"";
  else if (info.PreprocessorCommandLine.Contains(" /arch:AVX"))
    ClangCommandLine += " /D \"_M_IX86_FP=2\"";
  ....
}
```

PVS-Studio vs PVS-Studio

```
if (info.PreprocessorCommandLine.Contains(" /arch:SSE"))
  ClangCommandLine += " /D \"_M_IX86_FP=1\"";
else if (info.PreprocessorCommandLine.Contains(" /arch:SSE2"))
  ClangCommandLine += " /D \"_M_IX86_FP=2\"";
```

PVS-Studio vs PVS-Studio

```
if (info.PreprocessorCommandLine.Contains(" /arch:SSE"))
  ClangCommandLine += " /D \"_M_IX86_FP=1\"";
else if (info.PreprocessorCommandLine.Contains(" /arch:SSE2"))
  ClangCommandLine += " /D \"_M_IX86_FP=2\"";
```

PVS-Studio vs PVS-Studio

```
if (info.PreprocessorCommandLine.Contains(" /arch:SSE"))
  ClangCommandLine += " /D \"_M_IX86_FP=1\"";
else if (info.PreprocessorCommandLine.Contains(" /arch:SSE2"))
  ClangCommandLine += " /D \"_M_IX86_FP=2\"";
```

Expression is always false
/ unreachable statement

PVS-Studio vs PVS-Studio

```
public void ProcessFiles(....) {
  ....
  int RowsCount = DynamicErrorListControl.Instance
                                         .Plog.NumberOfRows;
  if (RowsCount > 20000)
    DatatableUpdateInterval = 30000; //30s
  else if (RowsCount > 100000)
    DatatableUpdateInterval = 60000; //1min
  else if (RowsCount > 200000)
    DatatableUpdateInterval = 120000; //2min
  ....
}
```

PVS-Studio vs PVS-Studio

```
public void ProcessFiles(....) {
  ....
  int RowsCount = DynamicErrorListControl.Instance
                                         .Plog.NumberOfRows;
  if (RowsCount > 20000)
    DatatableUpdateInterval = 30000; //30s
  else if (RowsCount > 100000)
    DatatableUpdateInterval = 60000; //1min
  else if (RowsCount > 200000)
    DatatableUpdateInterval = 120000; //2min
  ....
}
```

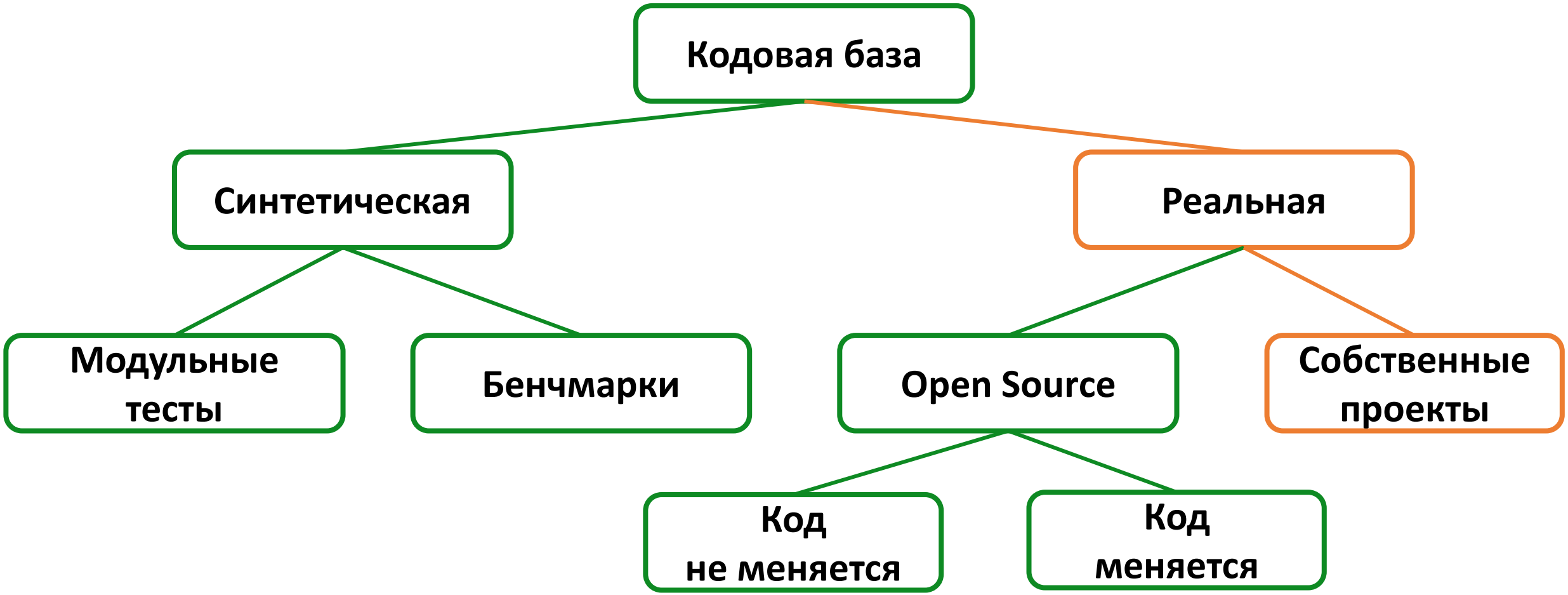
PVS-Studio vs PVS-Studio

```
if (RowsCount > 20000)
  ....
else if (RowsCount > 100000)
  ....
else if (RowsCount > 200000)
  ....
```

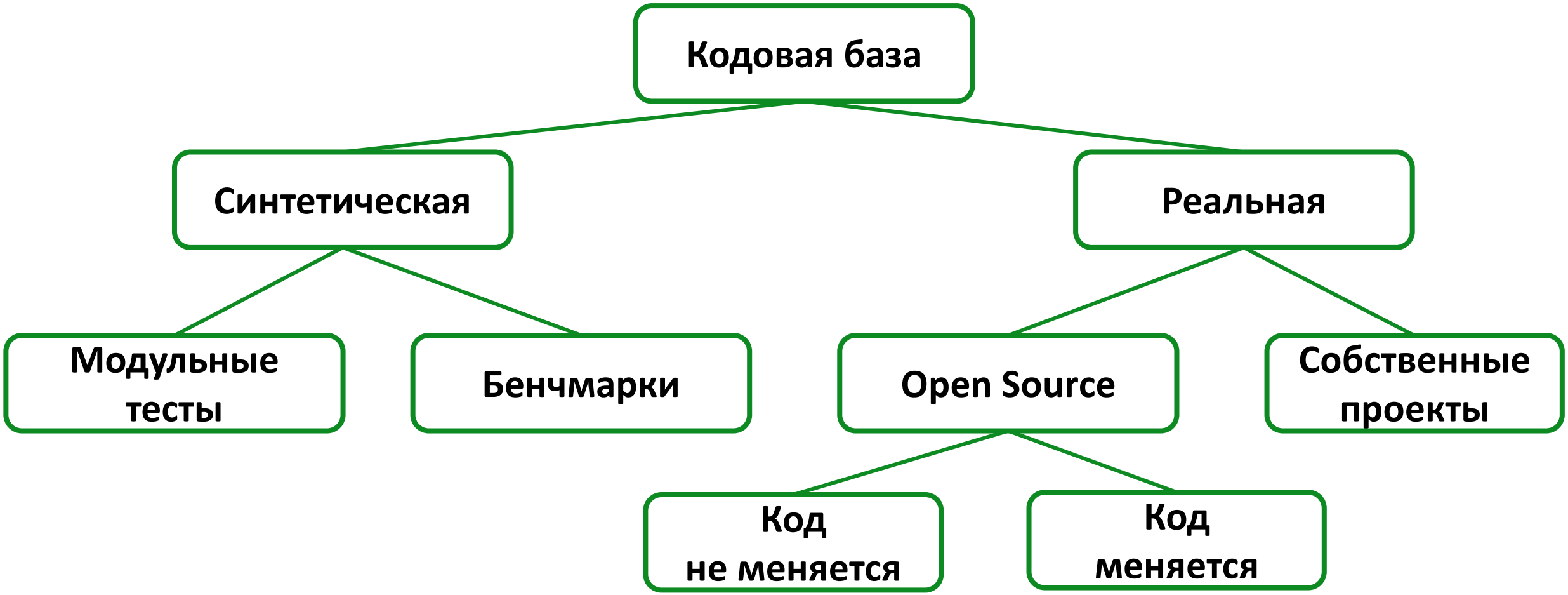
PVS-Studio vs PVS-Studio

```
if (RowsCount > 20000)
  ....
// RowsCount <= 20 000
else if (RowsCount > 100000)
  ....
else if (RowsCount > 200000)
  ....
```

На чём тестировать?



На чём тестировать?



#CSharp 09 Сен 2019

Лучшее - враг хорошего

Сергей Хренов

Эта статья о том, как однажды мы решили немного улучшить внутренний инструмент SelfTester, применяемый для проверки качества работы анализатора PVS-Studio. Улучшение было несложным и выглядело полезным, но создало нам много проблем, и впоследствии выяснилось, что лучше...

07 Дек 2017

Когда дворецкий - жертва

Сергей Хренов

Сегодня мы отойдём от классического клише второсортных детективов и расскажем вам о случае из нашей практики, когда дворецкий сам выступил в роли жертвы, а поиски настоящего преступника привели нас к неожиданному результату. Но не стоит пугаться. Речь, конечно же...

Сергей Васильев

@_SergVasiliev_

pvs-studio.com

vasiliev@viva64.com