



So you think you know PHPUnit

Sebastian Bergmann

I can help you

- adopt PHPUnit,
- optimize your tests,
- refine your development processes, and
- write more testable code



	Code Coverage								
	Lines			Functions and Methods			Classes and Traits		
Total		99.84%	634 / 635		99.49%	194 / 195		96.30%	26 / 27
📁 canvas		100.00%	60 / 60		100.00%	16 / 16		100.00%	4 / 4
📁 exceptions		n/a	0 / 0		n/a	0 / 0		n/a	0 / 0
📁 intersection		100.00%	75 / 75		100.00%	30 / 30		100.00%	4 / 4
📁 material		98.59%	70 / 71		96.77%	30 / 31		83.33%	5 / 6
📁 math		100.00%	241 / 241		100.00%	48 / 48		100.00%	4 / 4
📁 shapes		100.00%	57 / 57		100.00%	28 / 28		100.00%	5 / 5
📄 Camera.php		100.00%	39 / 39		100.00%	14 / 14		100.00%	1 / 1
📄 Color.php		100.00%	43 / 43		100.00%	14 / 14		100.00%	1 / 1
📄 PointLight.php		100.00%	5 / 5		100.00%	4 / 4		100.00%	1 / 1
📄 World.php		100.00%	44 / 44		100.00%	10 / 10		100.00%	1 / 1

```
<?php declare(strict_types=1);
namespace SebastianBergmann\Raytracer;

use const M_PI_2;
use const M_PI_4;
use function sqrt;
use PHPUnit\Framework\Attributes\CoversClass;
use PHPUnit\Framework\Attributes\Small;
use PHPUnit\Framework\TestCase;

#[CoversClass(Camera::class)]
#[Small]
final class CameraTest extends TestCase
{
    public function test_constructing_a_camera(): void
    {
        // ...
    }

    // ...
}
```

> XDEBUG_MODE=coverage ./tools/phpunit --testsuite unit --coverage-html /tmp/coverage
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13 with Xdebug 3.4.6
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

R.R.R.R.....	63 / 172 (36%)
.....	126 / 172 (73%)
.....	172 / 172 (100%)

Time: 00:01.359, Memory: 46.05 MB

There were 4 risky tests:

- 1) SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera
This test executed code that is not listed as code to be covered or used:
 - SebastianBergmann\Raytracer\Matrix

/Users/sb/Work/OpenSource/raytracer/tests/unit/CameraTest.php:16

-
-
-

```
<?php declare(strict_types=1);
namespace SebastianBergmann\Raytracer;

use const M_PI_2;
use const M_PI_4;
use function sqrt;
use PHPUnit\Framework\Attributes\CoversClass;
use PHPUnit\Framework\Attributes\Small;
use PHPUnit\Framework\Attributes\UsesClass;
use PHPUnit\Framework\TestCase;

#[CoversClass(Camera::class)]
#[UsesClass(Matrix::class)]
#[Small]
final class CameraTest extends TestCase
{
    public function test_constructing_a_camera(): void
    {
        // ...
    }

    // ...
}
```

```
99      $ambient      = $effectiveColor->multiplyBy($this->ambient);
100
101      if ($inShadow) {
102          return $ambient;
103      }
104
105      $lightv        = $light->position()->minus($point)->normalize();
106      $light_dot_normal = $lightv->dot($normal);
107
108      if ($light_dot_normal < 0) {
109          $diffuse    = Color::from(0, 0, 0);
110          $specular   = Color::from(0, 0, 0);
111      } else {
112          $diffuse     = $effectiveColor->multiplyBy($this->diffuse)->multiplyBy($light_dot_normal);
113          $reflect_dot_eye = $lightv->negate()->reflect($normal)->dot($eye);
114
115          if ($reflect_dot_eye <= 0) {
116              $specular = Color::from(0, 0, 0);
117          } else {
118              $factor    = $reflect_dot_eye ** $this->shininess;
119              $specular = $light->intensity()->multiplyBy($this->specular * $factor);
120          }
121      }
122
123      return $ambient->plus($diffuse)->plus($specular);
124  }
125 }
```

Legend

Covered by small (and larger) tests Covered by medium (and large) tests Covered by large tests (and tests of unknown size) Not covered Not coverable

99
100
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```
$ambient      = $effectiveColor->multiplyBy($this->ambient);  
  
if ($inShadow) {  
    return $ambient;  
}  
  
$lightv      = $light->position()->minus($point)->normalize();  
$light_dot_normal = $lightv->dot($normal);  
  
if ($light_dot_normal < 0) {  
    $diffuse   = Color::from(0, 0, 0);  
    $specular  = Color::from(0, 0, 0);  
} else {  
    $diffuse   = $effectiveColor->multiplyBy($this->diffuse)->multiplyBy($light_dot_normal);  
    $reflect_dot_eye = $lightv->negate()->reflect($normal)->dot($eye);  
  
    if ($reflect_dot_eye <= 0) {  
        $specular = Color::from(0, 0, 0);  
    } else {  
        $factor   = $reflect_dot_eye ** $this->shininess;  
        $specular = $light->intensity()->multiplyBy($this->specular * $factor);  
    }  
}  
  
return $ambient->plus($diffuse)->plus($specular);  
}  
}
```

Legend

Covered by small (and larger) tests Covered by medium (and large) tests Covered by large tests (and tests of unknown size) Not covered Not coverable

99	\$ambient	= \$effectiveColor->multiplyBy(\$this->ambient);
100		
101	if (\$inShadow) {	
102	return \$ambient;	
103	}	
104		
105	\$lightv	= \$light->position()->minus(\$point)->normalize();
106	\$light_dot_normal	= \$lightv->dot(\$normal);
107		
108	if (\$light_dot_normal < 0) {	
109	\$diffuse	= Color::from(0, 0, 0);
110	\$specular	= Color::from(0, 0, 0);
111	} else {	
112	\$diffuse	= \$effectiveColor->multiplyBy(\$this->diffuse)->multiplyBy(\$light_dot_normal);
113	\$reflect_dot_eye	= \$lightv->negate()->reflect(\$normal)->dot(\$eye);
114		
115	if (\$reflect_dot_eye <= 0) {	
116	\$specular	= Color::from(0, 0, 0);
117	} else {	
118	\$factor	= \$reflect_dot_eye ** \$this->shininess;
119	\$specular	= \$light->intensity()->multiplyBy(\$this->specular * \$factor);
120	}	
121	}	
122		
123	return \$ambient->plus(\$diffuse)->plus(\$specular);	
124	}	
125	}	

Legend

Covered by small (and larger) tests Covered by medium (and large) tests Covered by large tests (and tests of unknown size) Not covered Not coverable

	Code Coverage															
	Lines			Branches			Paths			Functions and Methods				Classes and Traits		
Total		100.00%	8 / 8		100.00%	7 / 7		12.50%	1 / 8		100.00%	1 / 1	CRAP		100.00%	1 / 1
Example		100.00%	8 / 8		100.00%	7 / 7		12.50%	1 / 8		100.00%	1 / 1	14.72		100.00%	1 / 1
doSomething		100.00%	8 / 8		100.00%	7 / 7		12.50%	1 / 8		100.00%	1 / 1	14.72			

```
1 <?php declare(strict_types=1);
2 final readonly class Example
3 {
4     public function doSomething(bool $a, bool $b, bool $c): int
5     {
6         $x = 0;
7
8         if ($a) {
9             $x += 2;
10        }
11
12        if ($b) {
13            $x -= 1;
14        }
15
16        if ($c) {
17            $x *= 2;
18        }
19
20        return $x;
21    }
22 }
```

Branches

Below are the source code lines that represent each code branch as identified by Xdebug. Please note a branch is not necessarily coterminous with a line, a line may contain multiple branches and therefore show up more than once. Please also be aware that some branches may be implicit rather than explicit, e.g. an **if** statement *always* has an **else** as part of its logical flow even if you didn't write one.

Example->doSomething

```
4      public function doSomething(bool $a, bool $b, bool $c): int
5      {
6          $x = 0;
7
8          if ($a) {
9              $x += 2;
10         }
11
12         if ($b) {
13             $x -= 1;
14         }
15
16         if ($c) {
17             $x *= 2;
18         }
19
20         return $x;
21     }
```



Paths

Below are the source code lines that represent each code path as identified by Xdebug. Please note a path is not necessarily coterminous with a line, a line may contain multiple paths and therefore show up more than once. Please also be aware that some paths may include implicit rather than explicit branches, e.g. an **if** statement *always* has an **else** as part of its logical flow even if you didn't write one.

Example->doSomething

```
4      public function doSomething(bool $a, bool $b, bool $c): int
5      {
6          $x = 0;
7
8          if ($a) {
9              $x += 2;
10         }
11
12         if ($b) {
13             $x -= 1;
14         }
15
16         if ($c) {
17             $x *= 2;
18         }
19
20         return $x;
21     }
```

```
4 public function doSomething(bool $a, bool $b, bool $c): int
5 {
6     $x = 0;
7
8     if ($a) {
```

```
9         $x += 2;
10    }
11
12    if ($b) {
```

```
12        if ($b) {
```

```
13            $x -= 1;
14        }
15
16        if ($c) {
```

```
16        if ($c) {
```

```
20        return $x;
21    }
```

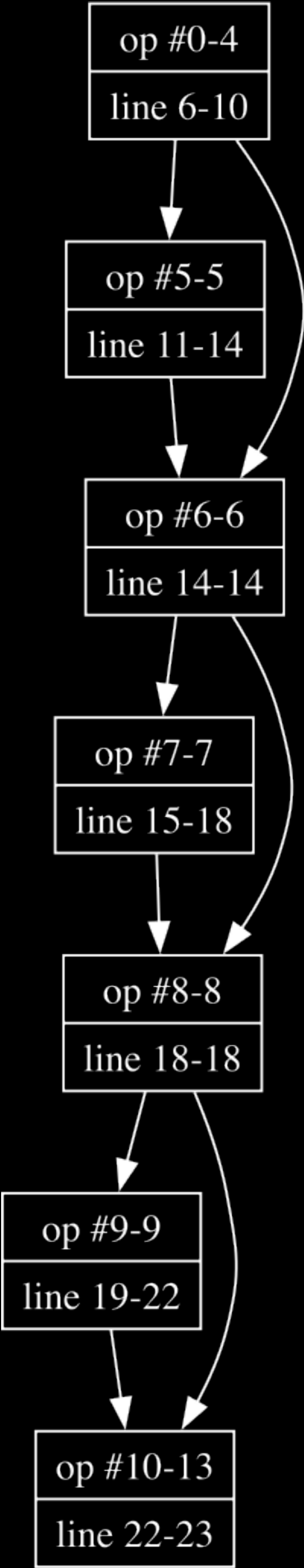
```
4 public function doSomething(bool $a, bool $b, bool $c): int
5 {
6     $x = 0;
7
8     if ($a) {
```

function name: doSomething
number of ops: 14
compiled vars: !0 = \$a, !1 = \$b, !2 = \$c, !3 = \$x

line	#	*	E	I	O	op	fetch	ext	return	operands
6	0		E	>		RECV			!0	
	1					RECV			!1	
	2					RECV			!2	
8	3					ASSIGN				!3, 0
10	4			>		JMPZ				!0, ->6
11	5			>		ASSIGN_OP		1		!3, 2
14	6			>	>	JMPZ				!1, ->8
15	7			>		ASSIGN_OP		2		!3, 1
18	8			>	>	JMPZ				!2, ->10
19	9			>		ASSIGN_OP		3		!3, 2
22	10			>		VERIFY_RETURN_TYPE				!3
	11			>		RETURN				!3
23	12*					VERIFY_RETURN_TYPE				
	13*			>		RETURN				null

branch: # 0; line: 6- 10; sop: 0; eop: 4; out0: 5; out1: 6
branch: # 5; line: 11- 14; sop: 5; eop: 5; out0: 6
branch: # 6; line: 14- 14; sop: 6; eop: 6; out0: 7; out1: 8
branch: # 7; line: 15- 18; sop: 7; eop: 7; out0: 8
branch: # 8; line: 18- 18; sop: 8; eop: 8; out0: 9; out1: 10
branch: # 9; line: 19- 22; sop: 9; eop: 9; out0: 10
branch: # 10; line: 22- 23; sop: 10; eop: 13

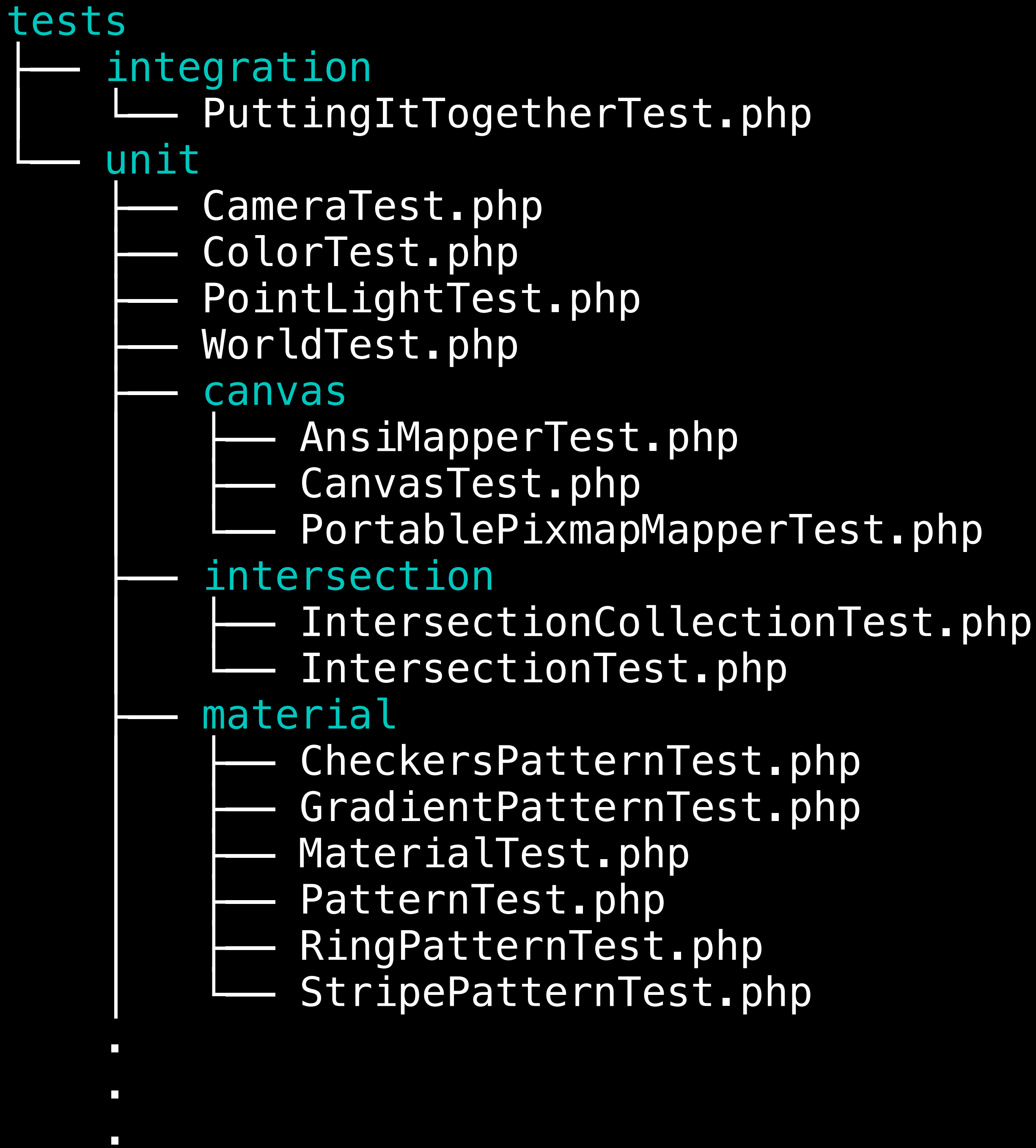
path #1: 0, 5, 6, 7, 8, 9, 10,
path #2: 0, 5, 6, 7, 8, 10,
path #3: 0, 5, 6, 8, 9, 10,
path #4: 0, 5, 6, 8, 10,
path #5: 0, 6, 7, 8, 9, 10,
path #6: 0, 6, 7, 8, 10,
path #7: 0, 6, 8, 9, 10,
path #8: 0, 6, 8, 10,





Selecting Tests

> tree tests



```
<?xml version="1.0" encoding="UTF-8"?>
<phpunit xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
    xsi:noNamespaceSchemaLocation="https://schema.phpunit.de/12.4/phpunit.xsd"
    bootstrap="src/autoload.php"
>
    <testsuites>
        <testsuite name="unit"
            bootstrap="tests/src/unit/autoload.php">
            <directory>tests/unit</directory>
        </testsuite>

        <testsuite name="integration"
            bootstrap="tests/src/integration/autoload.php">
            <directory>tests/integration</directory>
        </testsuite>
    </testsuites>

    <!-- ... -->
</phpunit>
```

```
> ./tools/phpunit --list-suites
```

```
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Available test suites:
```

- integration (5 tests)
- unit (172 tests)

> ./tools/phpunit --testsuite unit
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

..... 63 / 172 (36%)
..... 126 / 172 (73%)
..... 172 / 172 (100%)

Time: 00:00.104, Memory: 25.02 MB

OK (172 tests, 637 assertions)

> ./tools/phpunit --exclude-testsuite unit
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

..... 5 / 5 (100%)

Time: 00:25.061, Memory: 27.02 MB

OK (5 tests, 20 assertions)

```
> ./tools/phpunit --list-groups
```

```
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Available test groups:
```

- canvas (6 tests)
- intersection (10 tests)
- material (26 tests)
- math (77 tests)
- medium (5 tests)
- shape (25 tests)
- small (172 tests)

> ./tools/phpunit --group small
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

..... 63 / 172 (36%)
..... 126 / 172 (73%)
..... 172 / 172 (100%)

Time: 00:00.104, Memory: 25.02 MB

OK (172 tests, 637 assertions)

> ./tools/phpunit --exclude-group small
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

..... 5 / 5 (100%)

Time: 00:25.061, Memory: 27.02 MB

OK (5 tests, 20 assertions)

```
> ./tools/phpunit --list-tests
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

Available tests:

- SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera
- SebastianBergmann\Raytracer\CameraTest::test_the_pixel_size_for_a_horizontal_canvas
- SebastianBergmann\Raytracer\CameraTest::test_the_pixel_size_for_a_vertical_canvas
- SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_through_the_center_of_the_canvas
- SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_through_a_corner_of_the_canvas
- SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_when_the_camera_is_transformed
- SebastianBergmann\Raytracer\CameraTest::test_rendering_a_world_with_a_camera
- SebastianBergmann\Raytracer\ColorTest::test_colors_are_red_green_blue_tuples
- SebastianBergmann\Raytracer\ColorTest::test_float_components_can_be_represented_as_integers
- SebastianBergmann\Raytracer\ColorTest::test_another_color_can_be_added
- SebastianBergmann\Raytracer\ColorTest::test_another_color_can_be_subtracted
- SebastianBergmann\Raytracer\ColorTest::test_can_be_multiplied_by_a_scalar
- SebastianBergmann\Raytracer\ColorTest::test_the_product_of_two_colors_can_be_calculated
- SebastianBergmann\Raytracer\ColorTest::test_can_be_compared_to_another_color
-
-
-

```
> ./tools/phpunit --filter 'SebastianBergmann\Raytracer\CameraTest'  
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
..... 7 / 7 (100%)
```

```
Time: 00:00.064, Memory: 25.02 MB
```

```
OK (7 tests, 17 assertions)
```

```
> ./tools/phpunit --filter CameraTest
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
..... 7 / 7 (100%)
```

```
Time: 00:00.064, Memory: 25.02 MB
```

```
OK (7 tests, 17 assertions)
```

```
> ./tools/phpunit --filter test_constructing_a_camera
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
·                                                    1 / 1 (100%)
```

```
Time: 00:00.005, Memory: 25.02 MB
```

```
OK (1 test, 8 assertions)
```

```
> ./tools/phpunit --covers 'SebastianBergmann\Raytracer\Camera'  
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
..... 7 / 7 (100%)
```

```
Time: 00:00.064, Memory: 25.02 MB
```

```
OK (7 tests, 17 assertions)
```

> ./tools/phpunit --uses 'SebastianBergmann\Raytracer\Matrix'
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

..... 63 / 108 (58%)
..... 108 / 108 (100%)

Time: 00:00.053, Memory: 25.03 MB

OK (108 tests, 238 assertions)

```
> ./tools/phpunit --list-tests-xml tests.xml  
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

Wrote list of tests that would have been run to tests.xml

```
<?xml version="1.0"?>
<testSuite xmlns="https://xml.phpunit.de/testSuite">
  <tests>
    <testClass name="SebastianBergmann\Raytracer\CameraTest"
      file="/Users/sb/Work/OpenSource/raytracer/tests/unit/CameraTest.php">
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera"
        name="test_constructing_a_camera"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_the_pixel_size_for_a_horizontal_canvas"
        name="test_the_pixel_size_for_a_horizontal_canvas"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_the_pixel_size_for_a_vertical_canvas"
        name="test_the_pixel_size_for_a_vertical_canvas"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_through_the_center_of_the_canvas"
        name="test_constructing_a_ray_through_the_center_of_the_canvas"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_through_a_corner_of_the_canvas"
        name="test_constructing_a_ray_through_a_corner_of_the_canvas"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_constructing_a_ray_when_the_camera_is_transformed"
        name="test_constructing_a_ray_when_the_camera_is_transformed"/>
      <testMethod id="SebastianBergmann\Raytracer\CameraTest::test_rendering_a_world_with_a_camera"
        name="test_rendering_a_world_with_a_camera"/>
    </testClass>
    <!-- ... -->
  </tests>
  <groups>
    <group name="canvas">
      <test id="SebastianBergmann\Raytracer\AnsiMapperTest::test_can_map_Canvas_to_ANSI_string"/>
      <test id="SebastianBergmann\Raytracer\CanvasTest::test_has_width_and_height"/>
      <test id="SebastianBergmann\Raytracer\CanvasTest::test_is_initially_black"/>
      <test id="SebastianBergmann\Raytracer\CanvasTest::test_a_pixel_can_be_written_to_a_canvas"/>
      <test id="SebastianBergmann\Raytracer\CanvasTest::test_can_be_iterated"/>
      <test id="SebastianBergmann\Raytracer\PortablePixmapMapperTest::test_can_map_Canvas_to_PPM_string"/>
    </group>
    <!-- ... -->
  </groups>
</testSuite>
```

```

    $this->assertSame(1, $this->playerBoard->heat());

    return $this->playerBoard;
}

/**
 * @depends testFirstProductionPhaseIsPerformedCorrectly
 */
public function testSecondProductionPhaseIsPerformedCorrectly($playerBoard)
{
    $playerBoard->performProductionPhase(28);

    $this->assertSame(84, $playerBoard->megaCredits());
    $this->assertSame(2, $playerBoard->steel());
    $this->assertSame(2, $playerBoard->titanium());
    $this->assertSame(2, $playerBoard->plants());
    $this->assertSame(1, $playerBoard->energy());
    $this->assertSame(3, $playerBoard->heat());
}

```

- ✓ Plants production can be modified
- ✓ Has initially 0 energy
- ✓ Energy cannot become negative
- ✓ Has an initial energy production of 1
- ✓ Energy production cannot become negative
- ✓ Energy production can be modified
- ✓ Has initially 0 heat
- ✓ Heat cannot become negative
- ✓ Has an initial heat production of 1
- ✓ Heat production cannot become negative
- ✓ Heat production can be modified
- ✓ First production phase is performed correctly
- ✓ Second production phase is performed correctly

Time: 00:00.010, Memory: 22.31 MB

OK (32 tests, 42 assertions)

> █

Output

```
> ./tools/phpunit --filter TupleTest --no-progress  
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
Time: 00:00.005, Memory: 27.77 MB
```

```
OK (25 tests, 78 assertions)
```

```
> ./tools/phpunit --filter TupleTest --no-progress --no-results  
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
```

```
Time: 00:00.005, Memory: 27.77 MB
```

```
> ./tools/phpunit --filter TupleTest --no-output
```

```
> ./tools/phpunit --filter TupleTest --no-progress --testdox
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

Runtime: PHP 8.4.13

Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml

Time: 00:00.005, Memory: 27.77 MB

Tuple (SebastianBergmann\Raytracer\Tuple)

- ✓ A tuple with w=1.0 is a point
- ✓ A tuple with w=0.0 is a vector
- ✓ A tuple with w!=1.0 and w!=0.0 is neither a point nor a vector
- ✓ A vector can be added to a point
- ✓ A vector can be added to another vector
-
-
- ✓ The magnitude of vector (1.0, 0.0, 0.0) is calculated to be 1.0
- ✓ The magnitude of vector (0.0, 1.0, 0.0) is calculated to be 1.0
- ✓ The magnitude of vector (0.0, 0.0, 1.0) is calculated to be 1.0
-
-

OK (25 tests, 78 assertions)

```
<?php declare(strict_types=1);
namespace SebastianBergmann\Raytracer;

// ...

#[CoversClass(Tuple::class)]
#[Small]
final class TupleTest extends TestCase
{
    public function test_a_vector_can_be_added_to_a_point(): void
    {
        // ...
    }

    // ...
}
```

✓ A vector can be added to a point

```
<?php declare(strict_types=1);
namespace SebastianBergmann\Raytracer;

// ...

#[CoversClass(Tuple::class)]
#[Small]
final class TupleTest extends TestCase
{
    #[TestDox('A tuple with w=1.0 is a point')]
    public function test_a_tuple_with_w_equal_to_one_is_a_point(): void
    {
        // ...
    }

    // ...
}
```

✓ A tuple with w=1.0 is a point

```
<?php declare(strict_types=1);
namespace SebastianBergmann\Raytracer;

// ...

#[CoversClass(Tuple::class)]
#[Small]
final class TupleTest extends TestCase
{
    #[DataProvider('magnitudeProvider')]
    #[TestDox(
        'The magnitude of vector ($x, $y, $z) is calculated to be $magnitude'
    )]
    public function test_the_magnitude_of_a_vector_can_be_calculated(
        float $magnitude, float $x, float $y, float $z): void
    {
        // ...
    }

    // ...
}
```

✓ The magnitude of vector (1.0, 0.0, 0.0) is calculated to be 1.0

```
// ...

public static function formatter
(int $minutes, DateTimeImmutable $a, DateTimeImmutable $b): string
{
    return sprintf(
        'Duration for %s - %s: %d minutes',
        $a->format('Y-m-d H:i'),
        $b->format('Y-m-d H:i'),
        $minutes,
    );
}

#[DataProvider('provider')]
#[TestDoxFormatter('formatter')]
public function testDurationCanBeCalculated
(int $minutes, DateTimeImmutable $a, DateTimeImmutable $b): void
{
    // ...
}

// ...
```

✓ Duration for 2025-08-28 19:10 – 2025-08-28 20:00: 50 minutes

```
> ./tools/phpunit --filter test_constructing_a_camera --debug
PHPUnit Started (PHPUnit 12.4.1 using PHP 8.4.13 (cli) on Darwin)
Test Runner Configured
Bootstrap Finished (/Users/sb/Work/OpenSource/raytracer/src/autoload.php)
Bootstrap Finished (/Users/sb/Work/OpenSource/raytracer/tests/src/unit/autoload.php)
Bootstrap Finished (/Users/sb/Work/OpenSource/raytracer/tests/src/integration/autoload.php)
Extension Loaded from PHAR (ergebnis/phpunit-slow-test-detector 2.19.0)
Extension Bootstrapped (Ergebnis\PHPUnit\SlowTestDetector\Extension)
Event Facade Sealed
Data Provider Method Called (SebastianBergmann\Raytracer\MatrixTest::matrixInversionProvider for test method
SebastianBergmann\Raytracer\MatrixTest::test_the_inverse_of_a_matrix_can_be_calculated_for)
Data Provider Method Finished for SebastianBergmann\Raytracer\MatrixTest::test_the_inverse_of_a_matrix_can_be_calculated_for:
- SebastianBergmann\Raytracer\MatrixTest::matrixInversionProvider
Data Provider Method Called (SebastianBergmann\Raytracer\TupleTest::magnitudeProvider for test method
SebastianBergmann\Raytracer\TupleTest::test_the_magnitude_of_a_vector_can_be_calculated)
Data Provider Method Finished for SebastianBergmann\Raytracer\TupleTest::test_the_magnitude_of_a_vector_can_be_calculated:
- SebastianBergmann\Raytracer\TupleTest::magnitudeProvider
Data Provider Method Called (SebastianBergmann\Raytracer\TupleTest::normalizationProvider for test method
SebastianBergmann\Raytracer\TupleTest::test_a_vector_can_be_normalized)
Data Provider Method Finished for SebastianBergmann\Raytracer\TupleTest::test_a_vector_can_be_normalized:
- SebastianBergmann\Raytracer\TupleTest::normalizationProvider
Test Suite Loaded (177 tests)
Test Runner Started
Test Suite Sorted
Test Suite Filtered (1 test)
Test Runner Execution Started (1 test)
Test Suite Started (/Users/sb/Work/OpenSource/raytracer/phpunit.xml, 1 test)
Test Suite Started (unit, 1 test)
Test Suite Started (SebastianBergmann\Raytracer\CameraTest, 1 test)
Test Preparation Started (SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera)
Test Prepared (SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera)
Test Passed (SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera)
Test Finished (SebastianBergmann\Raytracer\CameraTest::test_constructing_a_camera)
Test Suite Finished (SebastianBergmann\Raytracer\CameraTest, 1 test)
Test Suite Finished (unit, 1 test)
Test Suite Finished (/Users/sb/Work/OpenSource/raytracer/phpunit.xml, 1 test)
Test Runner Execution Finished
Test Runner Finished
PHPUnit Finished (Shell Exit Code: 0)
```

```
> ./tools/phpunit --filter test_constructing_a_camera --debug --with-telemetry
[00:00:00.000010459 / 00:00:00.000010459] [14589504 bytes] PHPUnit Started (PHPUnit 12.4.1 using PHP 8.4.13 (cli) on Darwin)
[00:00:00.012072625 / 00:00:00.012062166] [14589504 bytes] Test Runner Configured
[00:00:00.012174667 / 00:00:00.000102042] [14589504 bytes] Bootstrap Finished (.../tests/bootstrap.php
[00:00:00.019797125 / 00:00:00.000129291] [15010224 bytes] Event Facade Sealed
[00:00:00.024378167 / 00:00:00.004581042] [16276256 bytes] Data Provider Method Called ...
[00:00:00.024520000 / 00:00:00.000141833] [16276256 bytes] Data Provider Method Finished ...
[00:00:00.026245084 / 00:00:00.001725084] [16742888 bytes] Data Provider Method Called ...
[00:00:00.026259792 / 00:00:00.000014708] [16742888 bytes] Data Provider Method Finished
[00:00:00.026439417 / 00:00:00.000179625] [16742888 bytes] Data Provider Method Called ...
[00:00:00.026452584 / 00:00:00.000013167] [16742888 bytes] Data Provider Method Finished ...
[00:00:00.028119042 / 00:00:00.001666458] [17158600 bytes] Test Suite Loaded (177 tests)
[00:00:00.028210167 / 00:00:00.000091125] [17158600 bytes] Test Runner Started
[00:00:00.029412500 / 00:00:00.001202333] [17194112 bytes] Test Suite Sorted
[00:00:00.029764792 / 00:00:00.000352292] [17194112 bytes] Test Suite Filtered (1 test)
[00:00:00.029981750 / 00:00:00.000216958] [17194112 bytes] Test Runner Execution Started (1 test)
[00:00:00.030287042 / 00:00:00.000305292] [17194112 bytes] Test Suite Started (.../phpunit.xml, 1 test)
[00:00:00.029528875 / 00:00:00.000223209] [17194112 bytes] Test Suite Started (unit, 1 test)
[00:00:00.029561208 / 00:00:00.000032333] [17194112 bytes] Test Suite Started (SebastianBergmann\Raytracer\CameraTest, 1 test)
[00:00:00.029664083 / 00:00:00.000102875] [17194112 bytes] Test Preparation Started ...
[00:00:00.029710875 / 00:00:00.000046792] [17098408 bytes] Test Prepared ...
[00:00:00.030068041 / 00:00:00.000357166] [18468392 bytes] Test Passed ...
[00:00:00.030117541 / 00:00:00.000049500] [18468392 bytes] Test Finished ...
[00:00:00.030137333 / 00:00:00.000019792] [18468392 bytes] Test Suite Finished (SebastianBergmann\Raytracer\CameraTest, 1 test)
[00:00:00.030283958 / 00:00:00.000146625] [18468392 bytes] Test Suite Finished (unit, 1 test)
[00:00:00.030302375 / 00:00:00.000018417] [18468392 bytes] Test Suite Finished (.../phpunit.xml, 1 test)
[00:00:00.030463333 / 00:00:00.000160958] [18468392 bytes] Test Runner Execution Finished
[00:00:00.030471333 / 00:00:00.000008000] [18468392 bytes] Test Runner Finished
[00:00:00.030500291 / 00:00:00.000028958] [18468392 bytes] PHPUnit Finished (Shell Exit Code: 0)
```



Deprecations (and other issues)

```
<?php declare(strict_types=1);  
namespace example;  
  
use vendor\ThirdPartyClass;  
  
final class FirstPartyClass  
{  
    public function method(): true  
    {  
        (new ThirdPartyClass)->method();  
  
        @trigger_error(  
            'deprecation in first-party code',  
            E_USER_DEPRECATED  
        );  
  
        return true;  
    }  
}
```

```
<?php declare(strict_types=1);  
namespace vendor;  
  
use example\FirstPartyClass;  
  
final class ThirdPartyClass  
{  
    public function method(): void  
    {  
        @trigger_error(  
            'deprecation in third-party code',  
            E_USER_DEPRECATED  
        );  
    }  
  
    public function anotherMethod(): true  
    {  
        return (new FirstPartyClass)->method();  
    }  
}
```

```
<?php declare(strict_types=1);
namespace example;

use PHPUnit\Framework\TestCase;
use vendor\ThirdPartyClass;

final class FirstPartyClassTest extends TestCase
{
    public function testOne(): void
    {
        $this->assertTrue((new FirstPartyClass)->method());
    }

    public function testTwo(): void
    {
        $this->assertTrue((new ThirdPartyClass)->anotherMethod());
    }
}
```

```
<?xml version="1.0" encoding="UTF-8"?>
<phpunit xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation=
    "https://schema.phpunit.de/12.4/phpunit.xsd"
  bootstrap="vendor/autoload.php"
>
  <testsuites>
    <testsuite name="default">
      <directory>tests</directory>
    </testsuite>
  </testsuites>

  <source ignoreSuppressionOfDeprecations="true"
    ignoreDirectDeprecations="true"
    ignoreIndirectDeprecations="true">
    <include>
      <directory>src</directory>
    </include>
  </source>
</phpunit>
```

```
> ./tools/phpunit --display-deprecations
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
Configuration: /Users/sb/example/phpunit.xml
```

```
D. 2 / 2 (100%)
```

```
Time: 00:00.014, Memory: 12.00 MB
```

```
1 test triggered 1 deprecation:
```

```
1) /Users/sb/example/src/FirstPartyClass.php:12
deprecation in first-party code
```

```
Triggered by:
```

```
* example\FirstPartyClassTest::testOne
  /Users/sb/example/tests/FirstPartyClassTest.php:9
```

```
OK, but there were issues!
```

```
Tests: 2, Assertions: 2, Deprecations: 1.
```

```
> ./tools/phpunit --generate-baseline phpunit-baseline.xml
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
Configuration: /Users/sb/example/phpunit.xml
```

```
D. 2 / 2 (100%)
```

```
Time: 00:00.006, Memory: 8.00 MB
```

```
OK, but there were issues!
```

```
Tests: 2, Assertions: 2, Deprecations: 1.
```

```
Baseline written to /Users/sb/example/phpunit-baseline.xml.
```

```
> ./tools/phpunit --use-baseline phpunit-baseline.xml
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Runtime:      PHP 8.4.13
```

```
Configuration: /Users/sb/example/phpunit.xml
```

```
..                                                    2 / 2 (100%)
```

```
Time: 00:00.006, Memory: 8.00 MB
```

```
OK (2 tests, 2 assertions)
```

```
1 issue was ignored by baseline.
```



Best Practice Configuration

```
> ./tools/phpunit --check-php-configuration
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Checking whether PHP is configured according to
https://docs.phpunit.de/en/12.4/installation.html#configuring-php-for-development
```

```
display_errors = 0n          ... ok
display_startup_errors = 0n  ... ok
error_reporting = -1         ... not ok (0)
xdebug.show_exception_trace = 0 ... ok
zend.assertions = 1          ... ok
assert.exception = 1         ... ok
memory_limit = -1            ... ok
```

```
> ./tools/phpunit --generate-configuration
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.
```

```
Generating phpunit.xml in /Users/sb/example
```

```
Bootstrap script (relative to path shown above; default: vendor/autoload.php):
```

```
Tests directory (relative to path shown above; default: tests):
```

```
Source directory (relative to path shown above; default: src):
```

```
Cache directory (relative to path shown above; default: .phpunit.cache):
```

```
Generated phpunit.xml in /Users/sb/example.
```

```
Make sure to exclude the .phpunit.cache directory from version control.
```

```
<?xml version="1.0" encoding="UTF-8"?>
<phpunit xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="https://schema.phpunit.de/12.4/phpunit.xsd"
  bootstrap="vendor/autoload.php"
  cacheDirectory=".phpunit.cache"
  executionOrder="depends,defects"
  shortenArraysForExportThreshold="10"
  requireCoverageMetadata="true"
  beStrictAboutCoverageMetadata="true"
  beStrictAboutOutputDuringTests="true"
  displayDetailsOnPhpunitDeprecations="true"
  failOnPhpunitDeprecation="true"
  failOnRisky="true"
  failOnWarning="true">
  <testsuites>
    <testsuite name="default">
      <directory>tests</directory>
    </testsuite>
  </testsuites>

  <source ignoreIndirectDeprecations="true"
    restrictNotices="true" restrictWarnings="true">
    <include>
      <directory>src</directory>
    </include>
  </source>
</phpunit>
```



Ecosystem around PHPUnit

<https://github.com/ergebnis/phpunit-slow-test-detector>

```
<?xml version="1.0" encoding="UTF-8"?>
<phpunit xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
  xsi:noNamespaceSchemaLocation="https://schema.phpunit.de/12.4/phpunit.xsd"
  bootstrap="vendor/autoload.php"
  cacheDirectory=".phpunit.cache"
  extensionsDirectory="tools/phpunit.d"
  executionOrder="depends,defects"
  shortenArraysForExportThreshold="10"
  requireCoverageMetadata="true"
  beStrictAboutCoverageMetadata="true"
  beStrictAboutOutputDuringTests="true"
  displayDetailsOnPhpunitDeprecations="true"
  failOnPhpunitDeprecation="true"
  failOnRisky="true"
  failOnWarning="true"
  colors="true">
  <extensions>
    <bootstrap class="Ergebnis\PHPUnit\SlowTestDetector\Extension">
      <parameter name="maximum-count" value="3"/>
      <parameter name="maximum-duration" value="250"/>
    </bootstrap>
  </extensions>

  <!-- ... -->
</phpunit>
```

> ./tools/phpunit --testsuite unit
PHPUnit 12.4.1 by Sebastian Bergmann and contributors.

Runtime: PHP 8.4.13
Configuration: /Users/sb/Work/OpenSource/raytracer/phpunit.xml
Extension: ergebnis/phpunit-slow-test-detector 2.15.1

.....	63 / 177 (35%)
.....	126 / 177 (71%)
.....	177 / 177 (100%)

Detected 4 tests where the duration exceeded the maximum duration.

- 1. 10.863 (0.250) SebastianBergmann\Raytracer\PuttingItTogetherTest::test_chapter_8
- 2. 9.157 (0.250) SebastianBergmann\Raytracer\PuttingItTogetherTest::test_chapter_6
- 3. 3.293 (0.250) SebastianBergmann\Raytracer\PuttingItTogetherTest::test_chapter_5

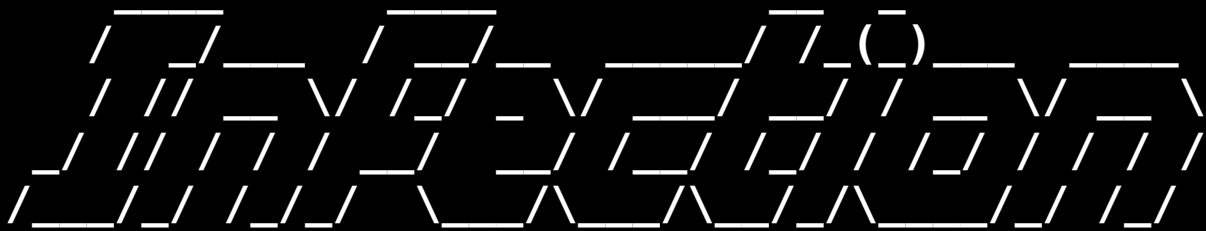
There is 1 additional slow test that is not listed here.

Time: 00:25.537, Memory: 31.02 MB

OK (177 tests, 657 assertions)

<https://github.com/infection/infection>

> ./tools/infection --threads=max --ignore-msi-with-no-mutations --only-covered



#StandWithUkraine

Infection – PHP Mutation Testing Framework version 0.31.2

Running initial test suite...

PHPUnit version: 12.4.1

51 [=====] < 1 sec

Running initial Static Analysis...

PHPStan version: 2.1.31

5 [=====] < 1 sec

Generate mutants...

Processing source code files: 16/16

.: killed by tests, A: killed by SA, M: escaped, U: uncovered,
E: fatal error, X: syntax error, T: timed out, S: skipped, I: ignored

..... (50 / 124)
..... (100 / 124)
..... (124 / 124)

124 mutations were generated:
124 mutants were killed
0 mutants were configured to be ignored
0 mutants were not covered by tests
0 covered mutants were not detected
0 errors were encountered
0 syntax errors were encountered
0 time outs were encountered
0 mutants required more time than configured

Metrics:
Mutation Code Coverage: 100%
Covered Code MSI: 100%

Note: to see escaped mutants run Infection with "--show-mutations" or configure file loggers.

Please note that some mutants will inevitably be harmless (i.e. false positives).

Time: 3s. Memory: 22.00MB. Threads: 7

<https://github.com/paratestphp/paratest>

<https://pestphp.com/>

This presentation has a home on the web:



Thank you!

🔗 <https://phpunit.expert>

✉ sebastian@thephp.cc

📱 [@sebastian@phpc.social](https://twitter.com/sebastian@phpc.social)



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