Getting The Most From Static Analysis

Dave Liddament | Lamp Bristol

@daveliddament

Can we write code in such a way to reduce the chance of introducing bugs?

Can static analysis help us achieve this goal?

#1: Use value objects

#2: Use extended type system

#3: Asserts at the system boundaries

#4: Prevent objects from being in invalid states

#5: Remove default handling

#6: Assume impure functions

#7: Enforce architectural constraints

⚠️ ⚠️ ⚠️ ⚠️ ⚠️ ⚠️

The context for this is:

- application code
- code or requirements evolve
- large projects
- projects with many developers

HIERARCHY OF CONTROL

Most effective

ELIMINATE

SUBSTITUTE

ENGINEERING CONTROLS

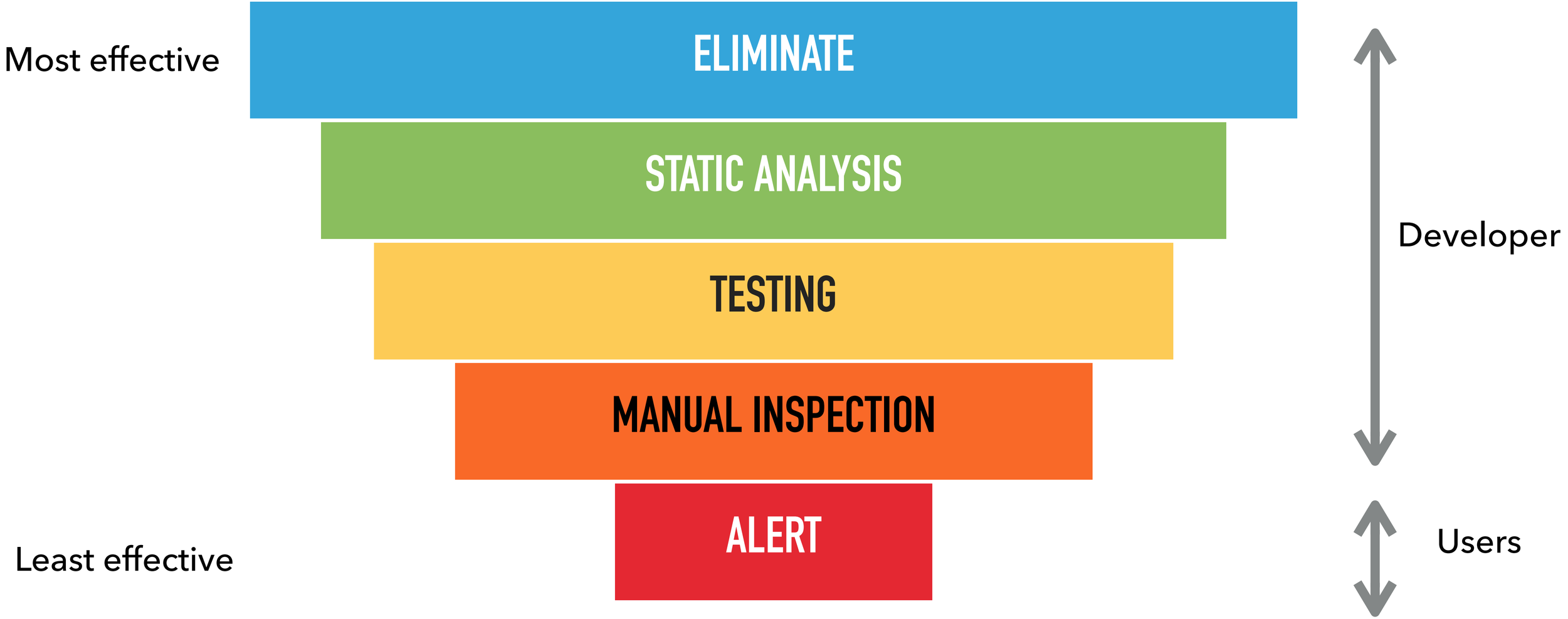
ADMINISTRATIVE CONTROLS

PPE

Least effective

@daveliddament

PREVENTING BUGS IN SOFTWARE



@daveliddament

RISK IN SOFTWARE

New code < Change

Techniques to prevent future bugs

```
function cost(string $type): int
{
    if ($type === "CHILD") {
        $price = 10;
    }
    if ($type === "ADULT") {
        $price = 20;
    }
    return $price;
}
```

Price might not be set

	Input	Output
Test 1	CHILD	10
Test 2	ADULT	20

✅ All tests pass

💯 Code coverage

Static analysis shows you where your code is incorrect.

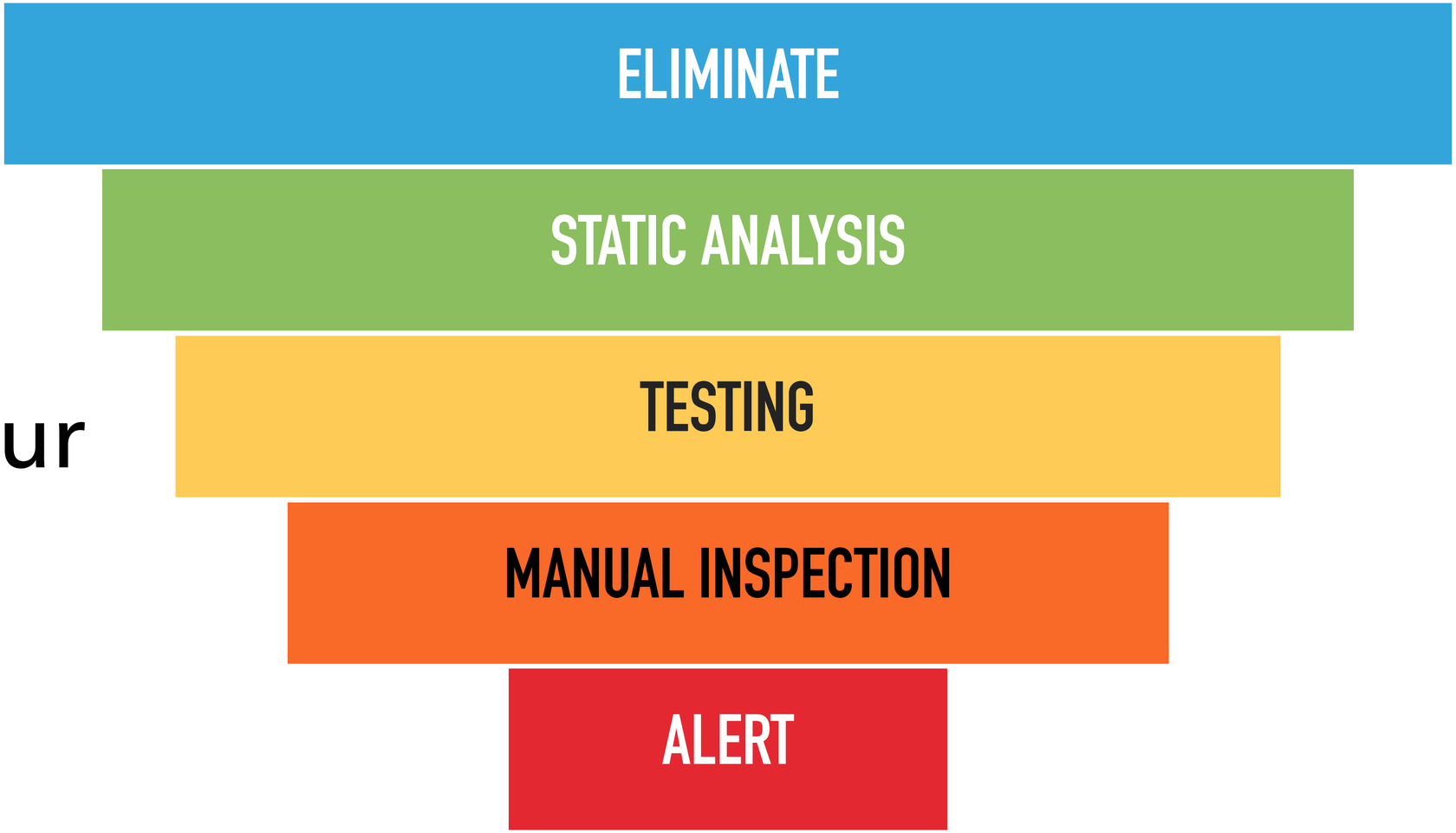
Tests tell you that the behaviour is correct, but ONLY for the scenarios tested.

Developers make mistakes.

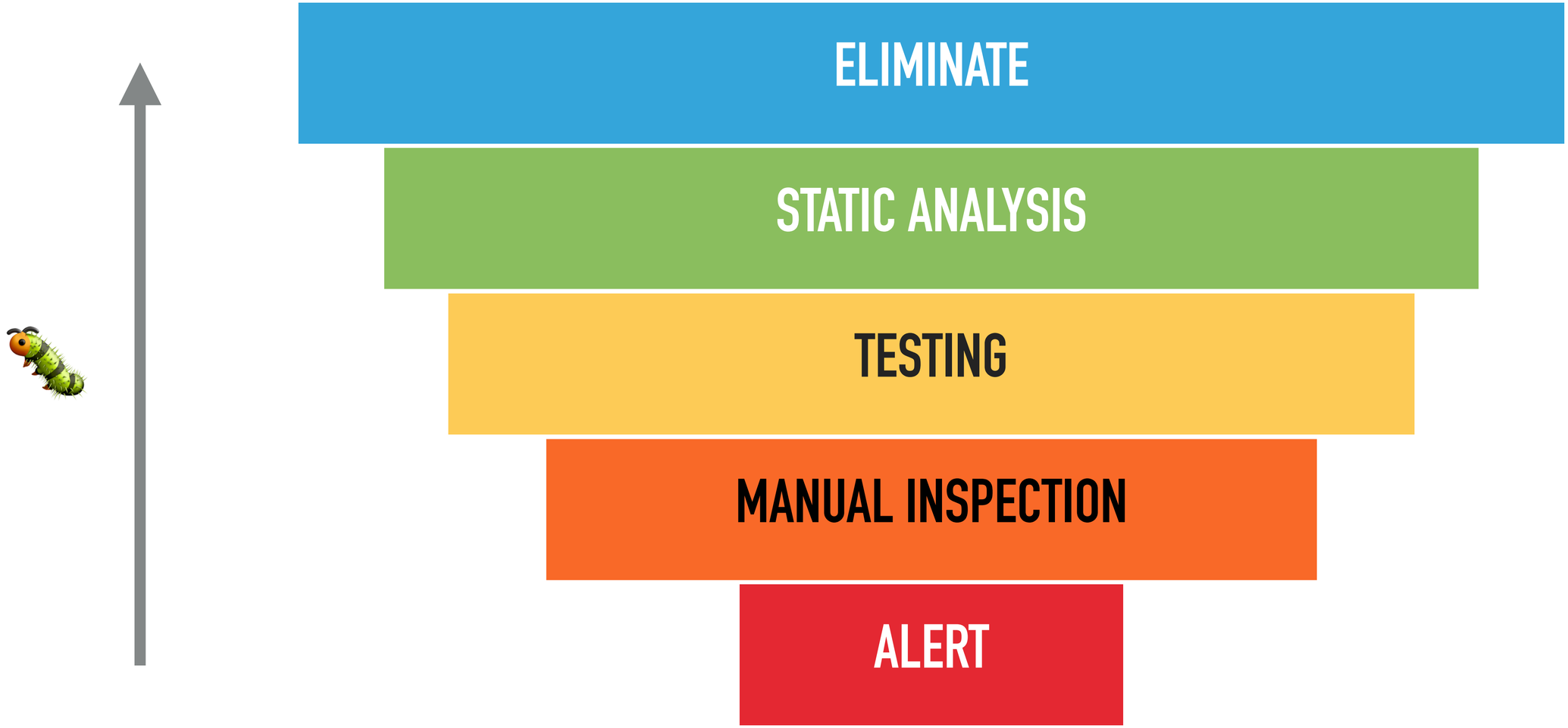
You can still have bugs even if:

- Tests have 100% code coverage
- You've used TDD

Behaviour



@daveliddament



@daveliddament

```
function addDetails(
    string $name, string $email, string $address
): void { … }
```

TESTING

MANUAL INSPECTION

ALERT

```
addDetails(
    "dave@example.com",
    "dave",
    "123 Some Street, Some City, AB1 2CD",
);
```

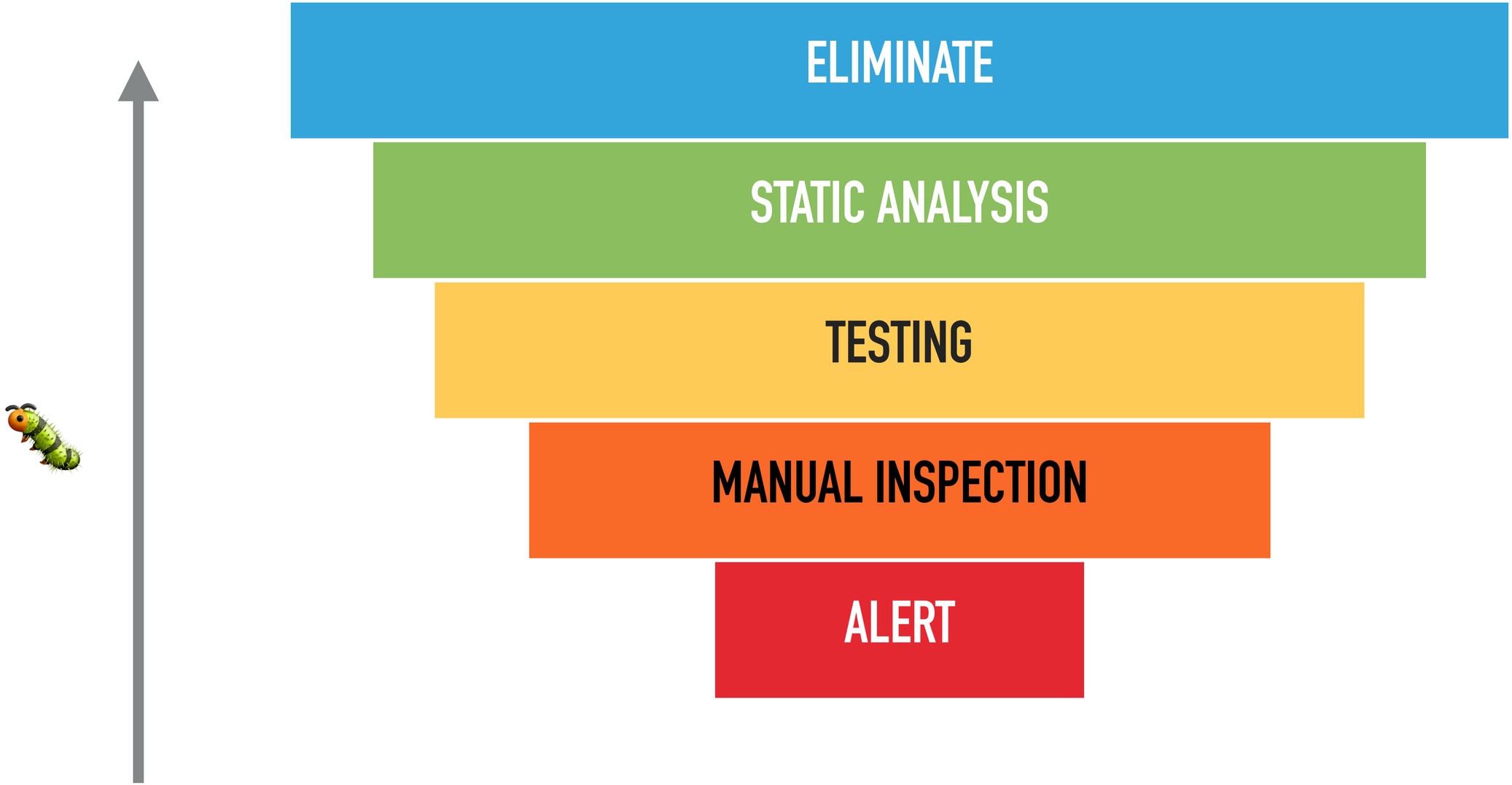
#1: Use value objects

```
final readonly class Name
{
    public function __construct(public string $value) {}
}
```

```
function addDetails(
    Name $name, Email $email, Address $address
): void { … }


$email = new Email("dave@example.com");
$name = new Name("dave");
$address = new Address("123 Some Street, Some City, AB1 2CD");
```

ELIMINATE

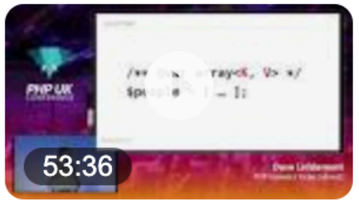
```
addDetails($email, $name, $address);
```



@daveliddament

#2: Use extended type system

```
/** @template T */
class Queue
{
  /** @param T $item */
  public function add($item): void {…}

  /** @return T */
  public function next(): {…}
}
```



PHP Generics Today (**almost**) ... Support for generics is high up many PHP developers' wish lists. This talk is a deep dive into generics, their benefits a…

PHP UK Conference · PHP UK Conference · 18 Mar 2020

```
final readonly class Power
{
    /** @param int<0,100> $value */
    public function __construct(public int $value) {}
}
```

STATIC ANALYSIS

```
$validPower = new Power(76);
```

✅

```
$invalidPower = new Power(101);
```

❌

```
/** @var int<0,100> */

/** @var int<min,7> $value */

/** @param positive-int $value */

/** @return 4|6|18 */

/** @param 8|negative-int $value */

/** @return 'red'|'green' $value */

/** @return non-empty-string $value */
```

```
final class Status
{
   public const STATUS_SUCCESS = 0;
   public const STATUS_FILE_ACCESS_ERROR = 255;
   public const STATUS_INVALID_CONTENTS = 254;
}

/** @param Status::* $value */
function processStatus(int $value): void {…}

processStatus(Status::STATUS_SUCCESS);  ✅
processStatus(255); ✅
processStatus(8); ❌
```

```
final class Flags
{
   public const FLAG_SORT = 1;
   public const FLAG_VERBOSE = 2;
   public const FLAG_ENCODE = 4;
}

/** @param int-mask<1,2,4> $flags */
function takesFlags(int $value): void {…}

takesFlag(Flags::FLAG_VERBOSE|Flags::FLAG_ENCODE);  ✅
takesFlag(7); ✅
takesFlag(8); ❌
```

```
final class Flags
{
   public const FLAG_SORT = 1;
   public const FLAG_VERBOSE = 2;
   public const FLAG_ENCODE = 4;
}

/** @param int-mask-of<Flags::*> $flags */
function takesFlags(int $flags): void {…}

takesFlags(Flags::FLAG_VERBOSE|Flags::FLAG_ENCODE);  ✅
takesFlags(7); ✅
takesFlags(8); ❌
```

```
final class Flags
{
   public const FLAG_SORT = 1;
   public const FLAG_VERBOSE = 2;
   public const FLAG_ENCODE = 4;

   public const STATUS_SUCCESS = 0;
   public const STATUS_FILE_ACCESS_ERROR = 255;
   public const STATUS_INVALID_CONTENTS = 254;
}

/** @param int-mask-of<Flags::FLAG_*> $flags */
function takesFlags(int $flags): void {…}
```

```
function getAddress(): array
{
    return [
        “Street”: “1 Some street”,
        “City”: “Bristol”,
        “Postcode”: “BS1 1AB”,
    ];
}
```

```
/**
 * @return string[]
 */
function getAddress(): array
{
    return [
        “Street”: “1 Some street”,
        “City”: “Bristol”,
        “Postcode”: “BS1 1AB”,
    ];
}
```

```
/**
 * @return array{string, string, string}
 */
function getAddress(): array
{
    return [
        “Street”: “1 Some street”,
        “City”: “Bristol”,
        “Postcode”: “BS1 1AB”,
    ];
}
```

```
/**
 * @return array{street:string, city:string, postcode: string}
 */
function getAddress(): array
{
    return [
        “street”: “1 Some street”,
        “city”: “Bristol”,
        “postcode”: “BS1 1AB”,
    ];
}
```

```
/**
 * @return array{name:string, age:int, registered:bool}
 */
function getPersonDetails(): array
{
    return [
        “name”: “Dave”,
        “age”: 21,
        “registered”: true,
    ];
}
```

```
/**
 * @return array{name:string, age:int, registered:bool}
 */
function getPersonDetails(): array
{
    return [
        "name": "Dave",
        "registered": false,
    ];
}
```

```
/**
 * @return array{name:string, ?age:int, registered:bool}
 */
function getPersonDetails(): array
{
    return [
        “name”: “Dave”,
        “registered”: false,
   ];
}
```

✅

```
/**
 * @return Person[]
 * @return array<Person>
 * @return array<string, Person>
 */
function getPersonDetails(): array
{
  return [
   “Jane” => new Person(“Jane”),
   “Bob” => new Person(“Bob”),
   “Charlie” => new Person(“Charlie”),
  ];
}
```

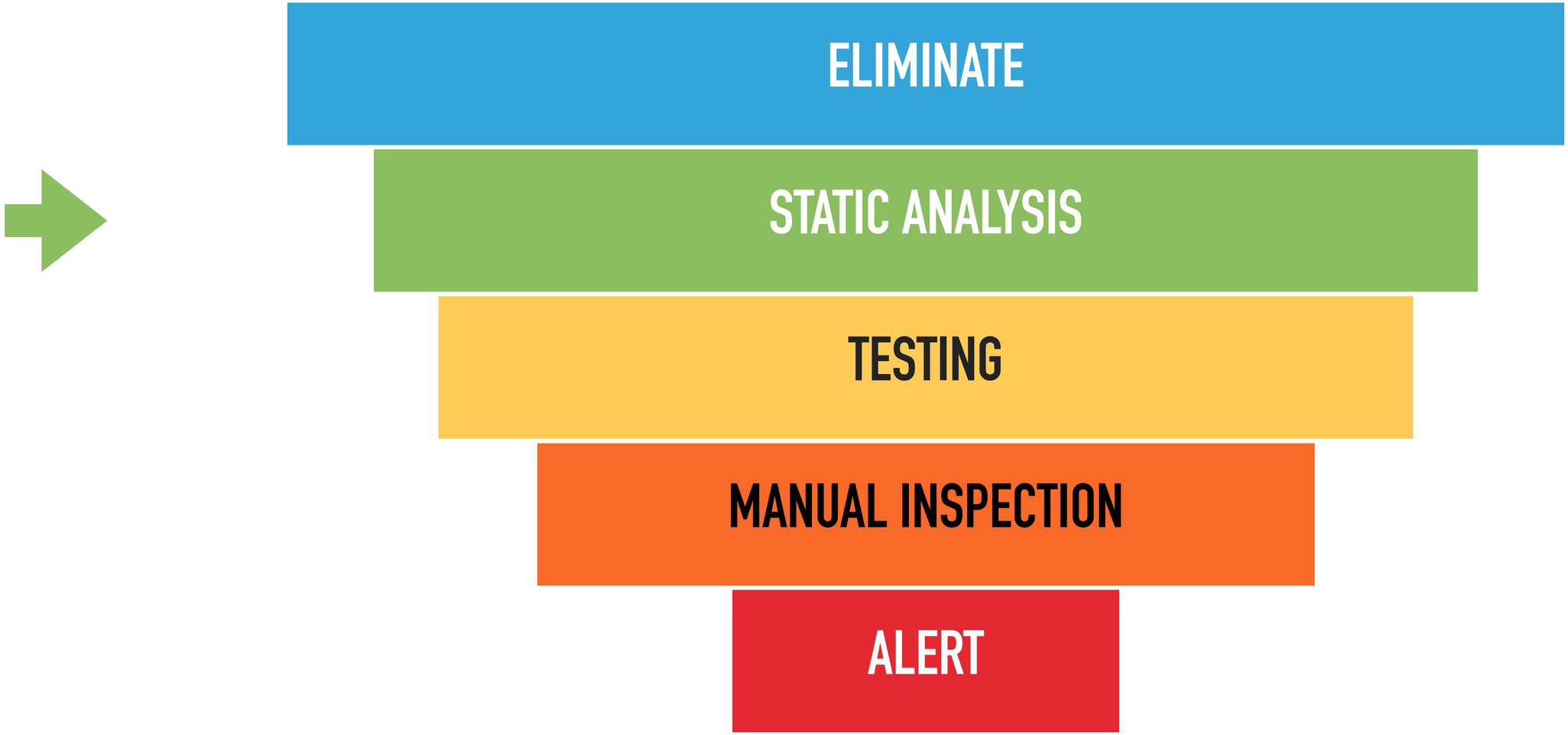
```
/**
 * @return array<int, Person>
 */
function getPersonDetails(): array
{
  return [
   1 => new Person(“Jane”),
   10 => new Person(“Bob”),
   8 => new Person(“Charlie”),
  ];
}
```

```
/**
 * @return array<int,Person>
 * @return list<Person>
 */
function getPersonDetails(): array
{
  return [
   new Person("Jane"),
   new Person("Bob"),
   new Person("Charlie"),
  ];
}
```

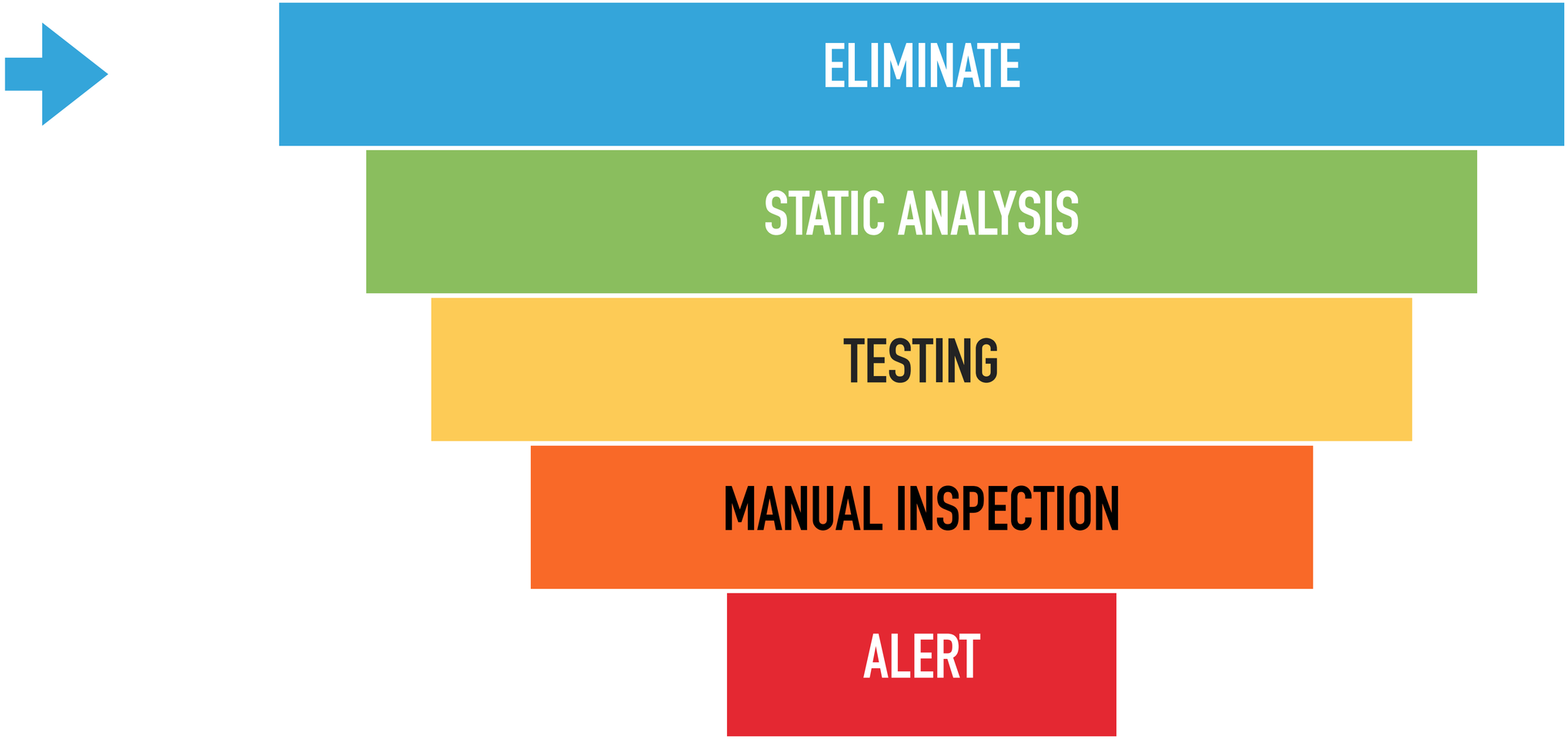
- Array keys are ints
- Array keys increment by 1
- Array is zero indexed

$i >= 0 && < count($array)

$array[$i] must exist



@daveliddament



@daveliddament

```
final class Status
{
   public const STATUS_SUCCESS = 0;
   public const STATUS_FILE_ACCESS_ERROR = 255;
   public const STATUS_INVALID_CONTENTS = 254;
}
/** @param Status::* $value */
function processStatus(int $value): void {…}
```

STATIC ANALYSIS

```
enum Status: int
{
   case STATUS_SUCCESS = 0;
   case STATUS_FILE_ACCESS_ERROR = 255;
   case STATUS_INVALID_CONTENTS = 254;
}

function processStatus(Status $value): void {…}
```

ELIMINATE

```
final class Flags
{
   public const FLAG_SORT = 1;
   public const FLAG_VERBOSE = 2;
   public const FLAG_ENCODE = 4;
}
/** @param int-mask-of<Flags::*> $flags */
function process(int $flags): void {…}
```

STATIC ANALYSIS

```
final readonly class Flags
{
  public function __construct(
    public bool $sort = false,
    public bool $verbose = false,
    public bool $encode = false,
  } {}
}

function process(Flags $flags): void {…}
```

ELIMINATE

@daveliddament

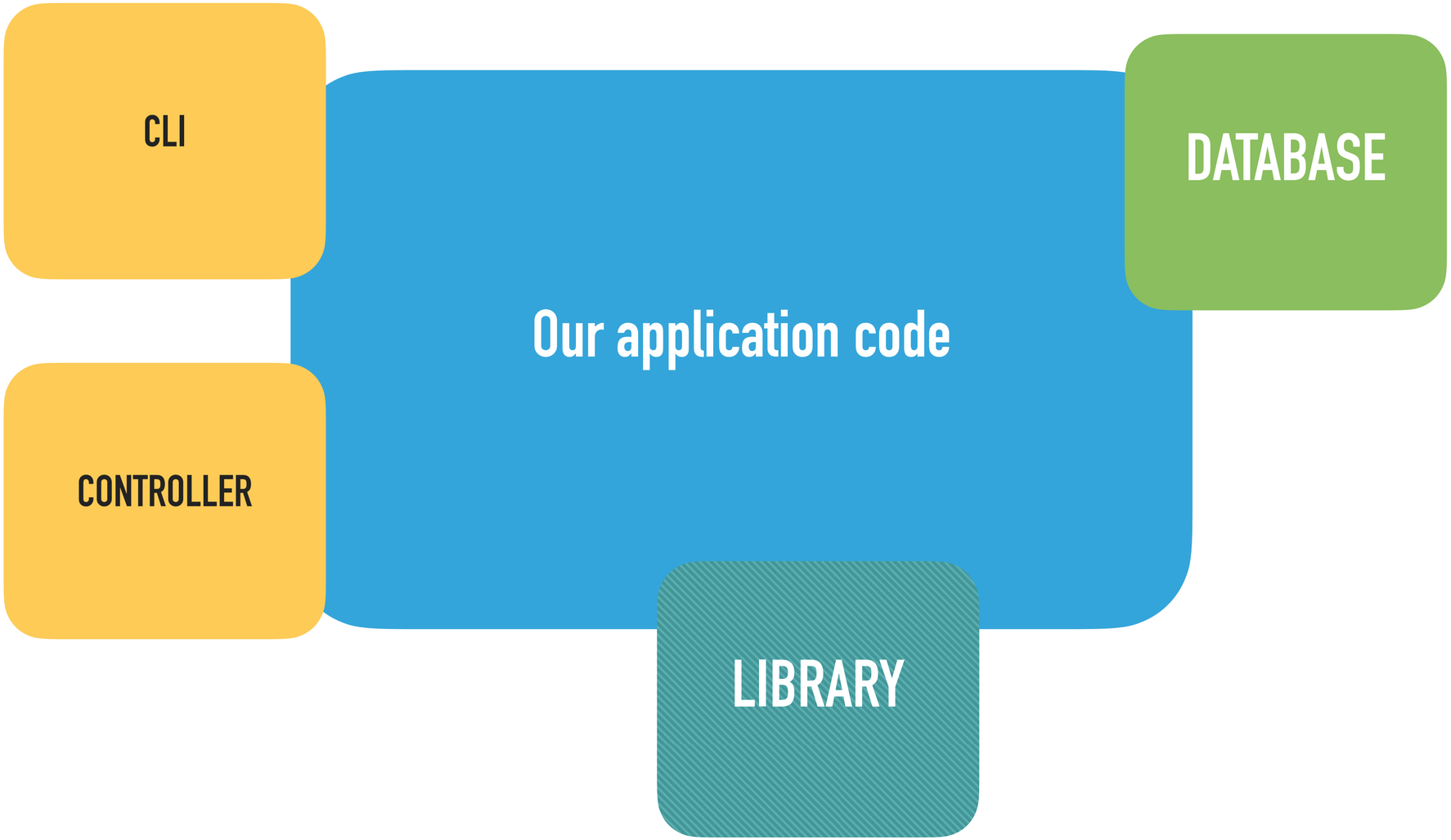
```
/** @return array{name:string, age:int} */
function getPersonDetails(): array {…}
```

STATIC ANALYSIS

```
final readonly class PersonDetails
{
  public function __construct(
    public string $name,
    public int $age,
  ) {}
}

function getPersonDetails(): PersonDetails {…}
```

ELIMINATE

#3: Asserts at the system boundaries



```
final readonly class Power
{
    /** @param int<0,100> $value */
    public function __construct(public int $value) {}
}
```

```
final readonly class Power
{
    /** @param int<0,100> $value */
    public function __construct(public int $value) {}
}

interface Request
{
    public function getInt(string $key): int;
}

$powerAsInt = $request->getInt("power");
$power = new Power($powerAsInt);
```

Expect int<0,100> got int

```
function validate(int $power): void
{
    if ($power < 0 || $power > 100) {
        throw new InvalidValue();
    }
}

$powerAsInt = $request->getInt("power");
validate($powerAsInt);
$power = new Power($powerAsInt);
```

Expect int<0,100> got int

```php
/** @phpstan-assert int<0,100> $power */
function validate(int $power): void
{
    if ($power < 0 || $power > 100) {
        throw new InvalidValue();
    }
}
```

```
/** @phpstan-assert int<0,100> $power */
function validate(int $power): void
{
    if ($power < 0 || $power > 100) {
        throw new InvalidValue();
    }
}

$powerAsInt = $request->getInt("power");
validate($powerAsInt);
$power = new Power($powerAsInt);
```

```
/** @phpstan-assert int<0,100> $power */
```

```
/** @psalm-assert int<0,100> $power */
```

```
/** @psalm-assert int<1,6> $value */
function validateDiceValue(int $value): void
{
    if ($value <= 1 || $value >= 6) {
        throw new InvalidArgumentException();
    }
}
```

MANUAL INSPECTION

```
/** @psalm-assert-if-true int<0,100> $power */
function isValid(int $power): bool
{
    return ($power >= 0 && $power <= 100);
}
```

```
/** @psalm-assert-if-true int<0,100> $power */
function isValid(int $power): bool
{
    return ($power >= 0 && $power <= 100);
}


$powerAsInt = $request->getInt("power");
if (isValid($powerAsInt)) {
    $power = new Power($powerAsInt);
} else {
    // Handle invalid data
}
```

ASSERTIONS

```
/** @phpstan-assert !null $value */

/** @psalm-assert-if-true string $value */

/** @psalm-assert-if-false string $value */
```

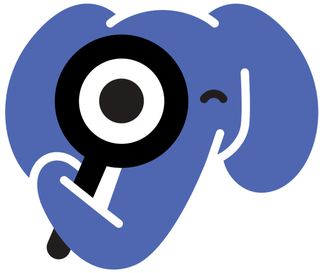
```
final class Person {
  public function __construct(private ?string $email) {}


  public function hasEmail(): bool {
    return $this->email !== null;
  }

  public function getEmail(): ?string {
    return $this->email;
  }
}

function process(Person $person): void {
  if ($person->hasEmail()) {
    sendEmail($person->getEmail());
  }
}

function sendEmail(string $email): void {…}
```

```php
final class Person {
  public function __construct(private ?string $email) {}

  /** @psalm-assert-if-true string $this->getEmail() */
  public function hasEmail(): bool {
    return $this->email !== null;
  }

  public function getEmail(): ?string {
    return $this->email;
  }
}

function process(Person $person): void {
  if ($person->hasEmail()) {
    sendEmail($person->getEmail());
  }
}

function sendEmail(string $email): void {…}
```

#4: Prevent objects from being in invalid states

```
class Person {

  private string $name;

  public function setName(string $name): void {
    $this->name = $name;
  }

  public function getName(): string {
    return $this->name;
  }
}
```

Psalm



phpstan.neon

```
parameters:
  checkUninitializedProperties: true
```

```
class Person {

  public function __construct(
    private string $name,
  ) {}

  public function setName(string $name): void {
    $this->name = $name;
  }

  public function getName(): string {
    return $this->name;
  }
}
```

ELIMINATE

STATIC ANALYSIS

```
class Job
{
    public function completedBy(User $user): void {…}

    public function completedAt(int $timestamp): void {…}
}
```

```
class Job
{
  public function completed(
      User $user,
      int $timestamp,
    ): void {…}
}
```

ELIMINATE

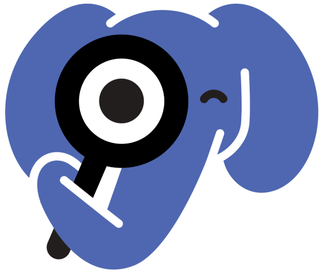
#5: Remove default handling

```
function cost(string $type): int
{
    if ($type === "CHILD") {
        $price = 10;
    }
    if ($type === "ADULT") {
        $price = 20;
    }
    return $price;
}
```

```
function cost(string $type): int
{
    $price = null;
    if ($type === "CHILD") {
        $price = 10;
    }
    if ($type === "ADULT") {
        $price = 20;
    }
    if ($price === null) {
        throw new LogicException("Invalid type [$type]”);
    }
    return $price;
}
```

ALERT

```php
/** @param "CHILD"|"ADULT" $type */
function cost(string $type): int
{
    $price = null;
    if ($type === "CHILD") {
        $price = 10;
    }
    if ($type === "ADULT") {
        $price = 20;
    }
    if ($price === null) {
        throw new LogicException("Invalid type [$type]”);
    }
    return $price;
}
```



```
final class Type
{
    public const ADULT = “ADULT”;
    public const CHILD = “CHILD”;
}
```

```
/** @param Type::* $type */
function cost(string $type): int
{
    $price = null;
    if ($type === Type::CHILD) {
        $price = 10;
    }
    if ($type === Type::ADULT) {
        $price = 20;
    }
    if ($price === null) {
        throw new LogicException("Invalid type [$type]");
    }
    return $price;
}
```

```
final class Type
{
    public const ADULT = “ADULT”;
    public const CHILD = “CHILD”;
    public const OAP = “OAP”;
}
```

```
/** @param Type::* $type */
function cost(string $type): int
{
    $price = null;
    if ($type === Type::CHILD) {
        $price = 10;
    }
    if ($type === Type::ADULT) {
        $price = 20;
    }
    if ($price === null) {
        throw new LogicException("Invalid type [$type]");
    }
    return $price;
}
```

ALERT

@daveliddament

```
final class Type
{
    public const ADULT = “ADULT”;
    public const CHILD = “CHILD”;
}
```

```
/** @param Type::* $type */
function cost(string $type): int
{
  if ($type === Type::CHILD) {
        $price = 10;
   }
   if ($type === Type::ADULT) {
        $price = 20;
   }
  return $price;
}
```

Psalm

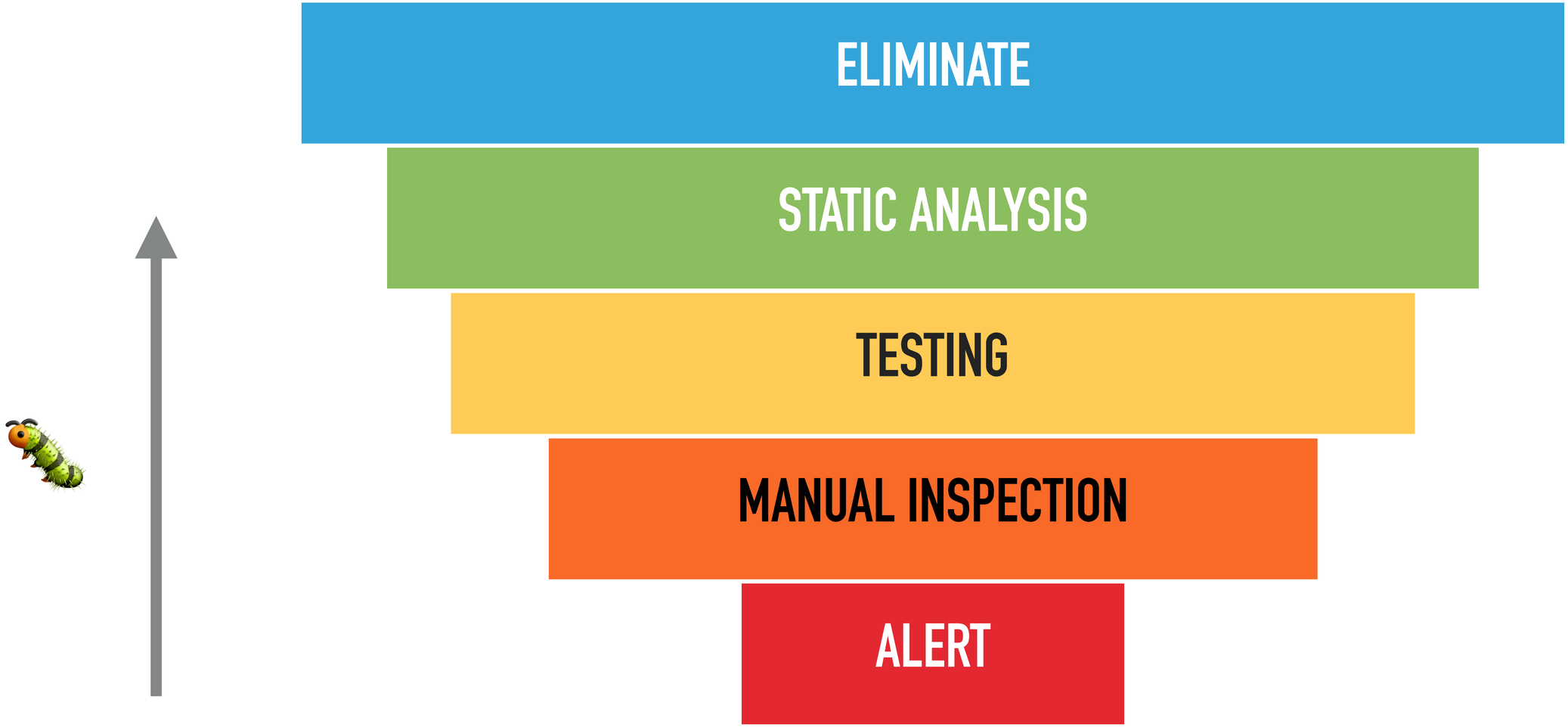
```
final class Type
{
    public const ADULT = "ADULT";
    public const CHILD = "CHILD";
}
```

```
/** @param Type::* $type */
function cost(string $type): int
{
  return match($type) {
    Type::CHILD => 10,
    Type::ADULT => 20,
  };
}
```

STATIC ANALYSIS

MANUAL INSPECTION

Psalm



@daveliddament

#6: Quiz first. Part 1

```
class Person {
   public function getName(): ?string {…}
}

function process(Person $person): void {
  if ($person->getName() !== null) {
    takesString($person->getName());
  }
}

function takesString(string $value): void {…}
```

#6: Quiz first. Part 2

```
class Queue {
   public function getNext(): ?string {…}
}

function process(Queue $queue): void {
  if ($queue->getNext() !== null) {
    takesString($person->getNext());
  }
}

function takesString(string $value): void {…}
```

#6: Assume impure functions

```
class Foo {
    public function bar(): ?string {…}
}

function process(Foo $foo): void {
   if ($foo->bar() !== null) {
      takesString($foo->bar());
   }
}

function takesString(string $value): void {…}
```

✅

Psalm ❌

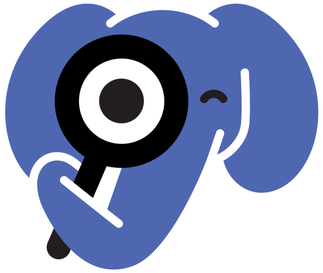
Psalm

```
class Person {
   /** @psalm-pure */
   public function getName(): ?string {…}
}

function process(Person $person): void {
  if ($person->getName() !== null) {
    takesString($person->getName());
  }
}

function takesString(string $value): void {…}
```

```php
final readonly class Person {
  public function __construct(private ?string $name) {}

  public function getName(): ?string {
    return $this->name;
  }
}

function process(Person $person): void {
  if ($person->getName() !== null) {
    takesString($person->getName());
  }
}

function takesString(string $value): void {…}
```

Psalm

```php
class Queue {
    /** @phpstan-impure */
    public function getNext(): ?string {…}
}

function process(Queue $queue): void {
  if ($queue->getNext() !== null) {
    takesString($person->getNext());
  }
}

function takesString(string $value): void {…}
```

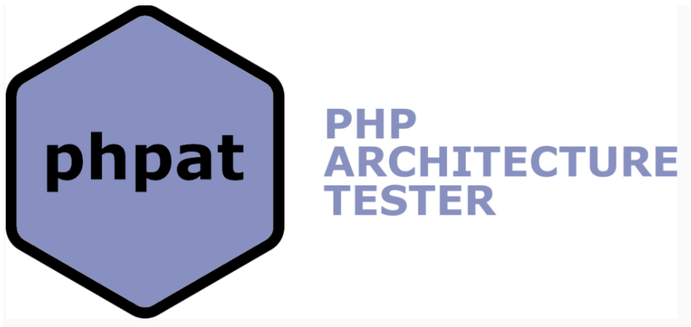


phpstan.neon

```
parameters:
  rememberPossiblyImpureFunctionValues: false
```

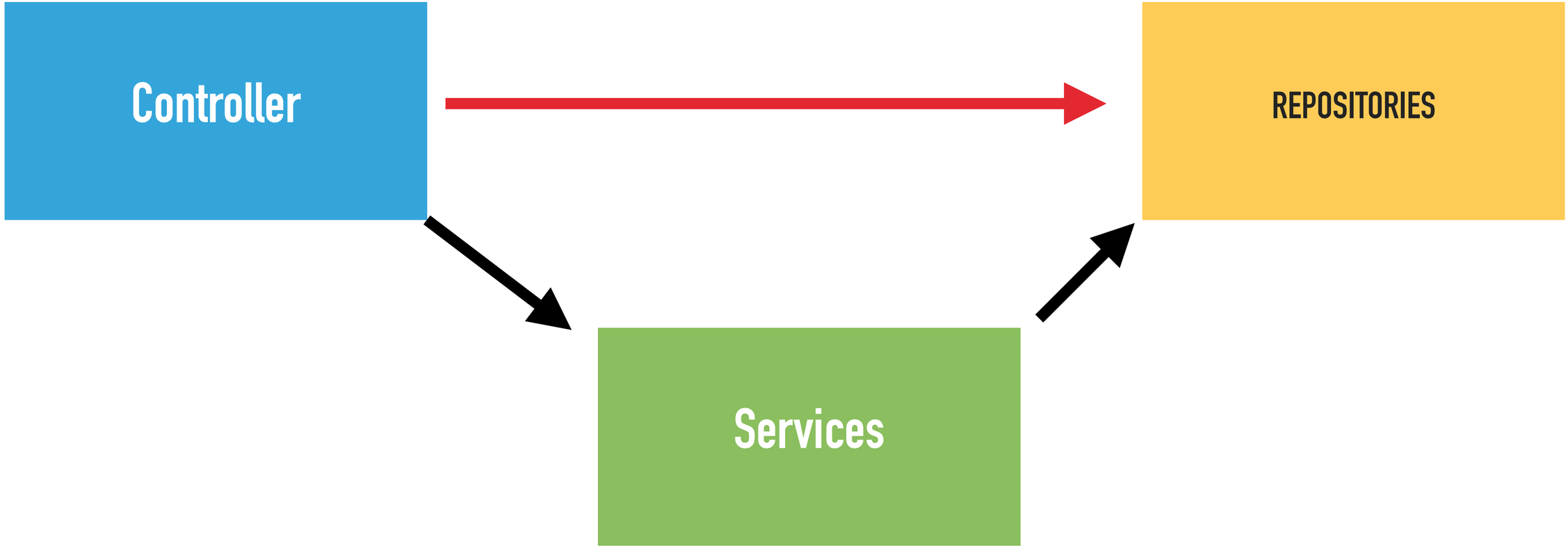
```
class Foo {
   public function bar(): ?string {…}
}

function process(Foo $foo): void {
  $value = $foo->bar();
  if ($value !== null) {
    takesString($value);
  }
}

function takesString(string $value): void {…}
```

#7: Enforce architectural constraints



https://github.com/carlosas/phpat

https://qossmic.github.io/deptrac/


Controller
REPOSITORIES
Services

```
public function testDomain(): Rule
{
    return PHPat::rule()
        ->classes(Selector::namespace('App\Domain'))
        ->shouldNotDependOn()
        ->classes(
            Selector::namespace('App\Application'),
            Selector::namespace('App\Infrastructure')
        );
}
```

https://github.com/DaveLiddament/php-language-extensions

```
#[Friend]
#[NamespaceVisibility]
#[Package]
#[TestTag]
#[InjectableVersion]
```

```
class Person
{
  #[Friend(PersonBuilder::class)]
  public function __construct() {…}

}
```

#1: Use value objects

#2: Use extended type system

#3: Asserts at the system boundaries

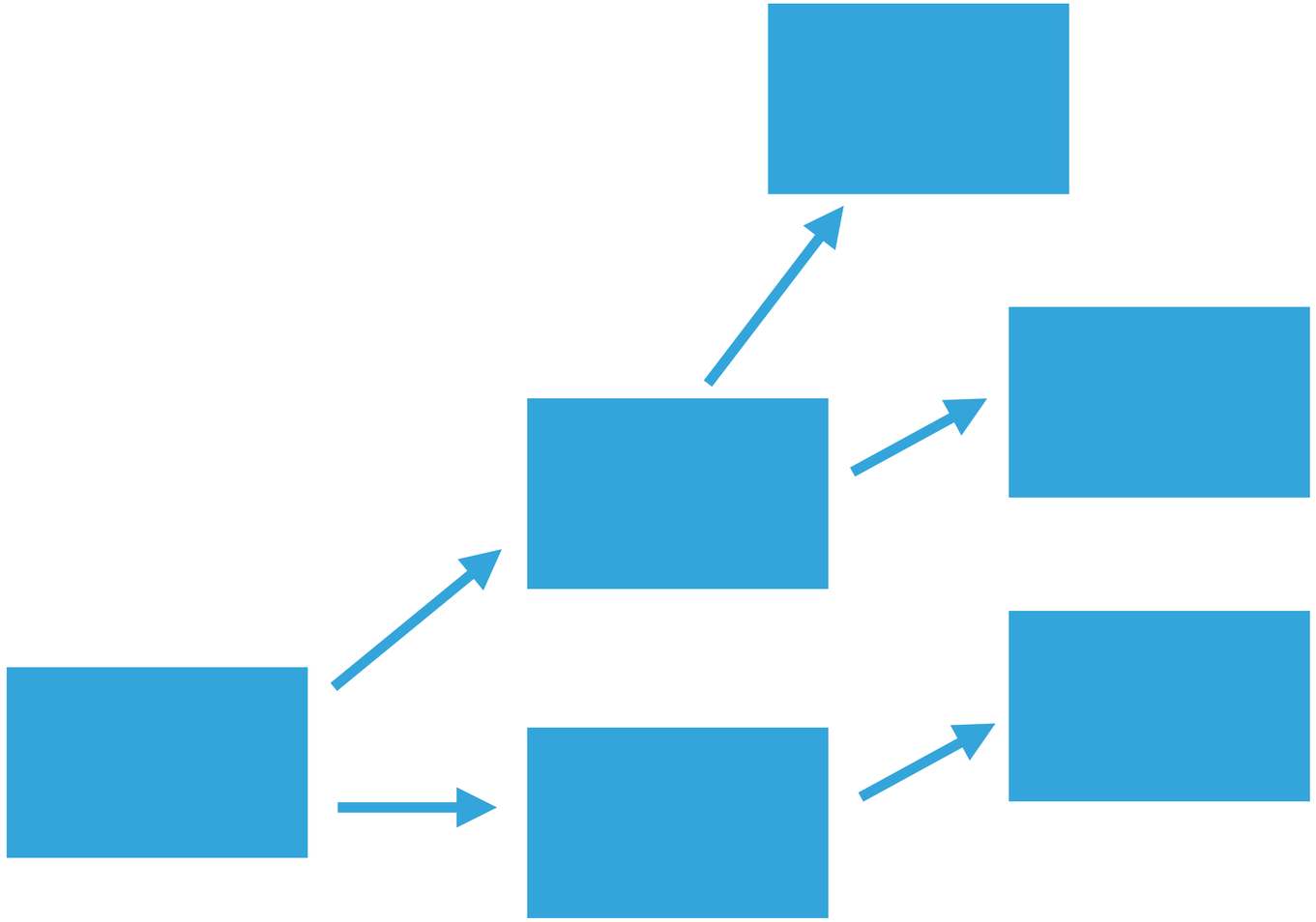
#4: Prevent objects from being in invalid states

#5: Remove default handling

#6: Assume impure functions

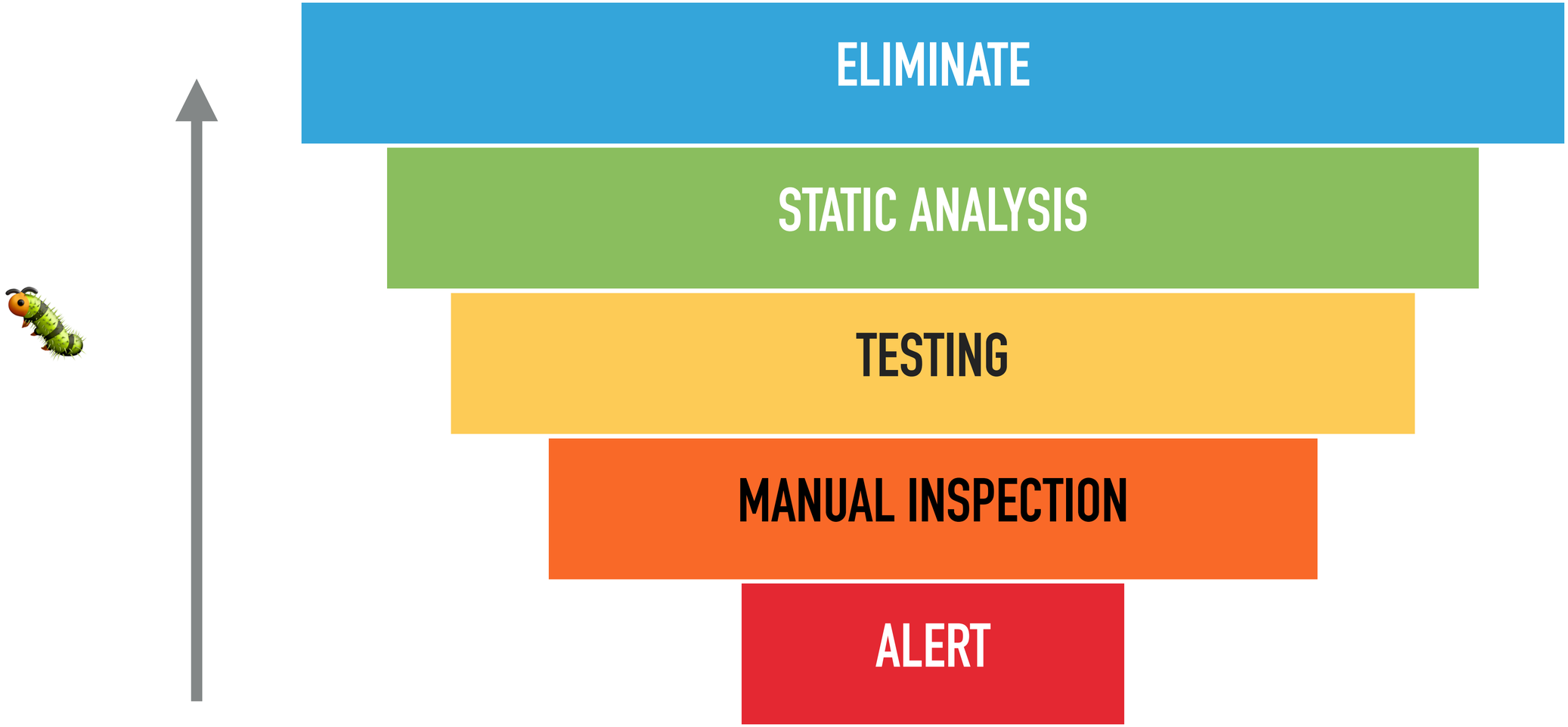
#7: Enforce architectural constraints

WILL DOING THIS MAKE CHANGE HARD?



@daveliddament

- **Use this advice if project needs it**
- **If changes are made, developers are shown possible bugs**
- **OK to alter past decisions**



@daveliddament

Dave Liddament

Lamp Bristol

Thank you for listening

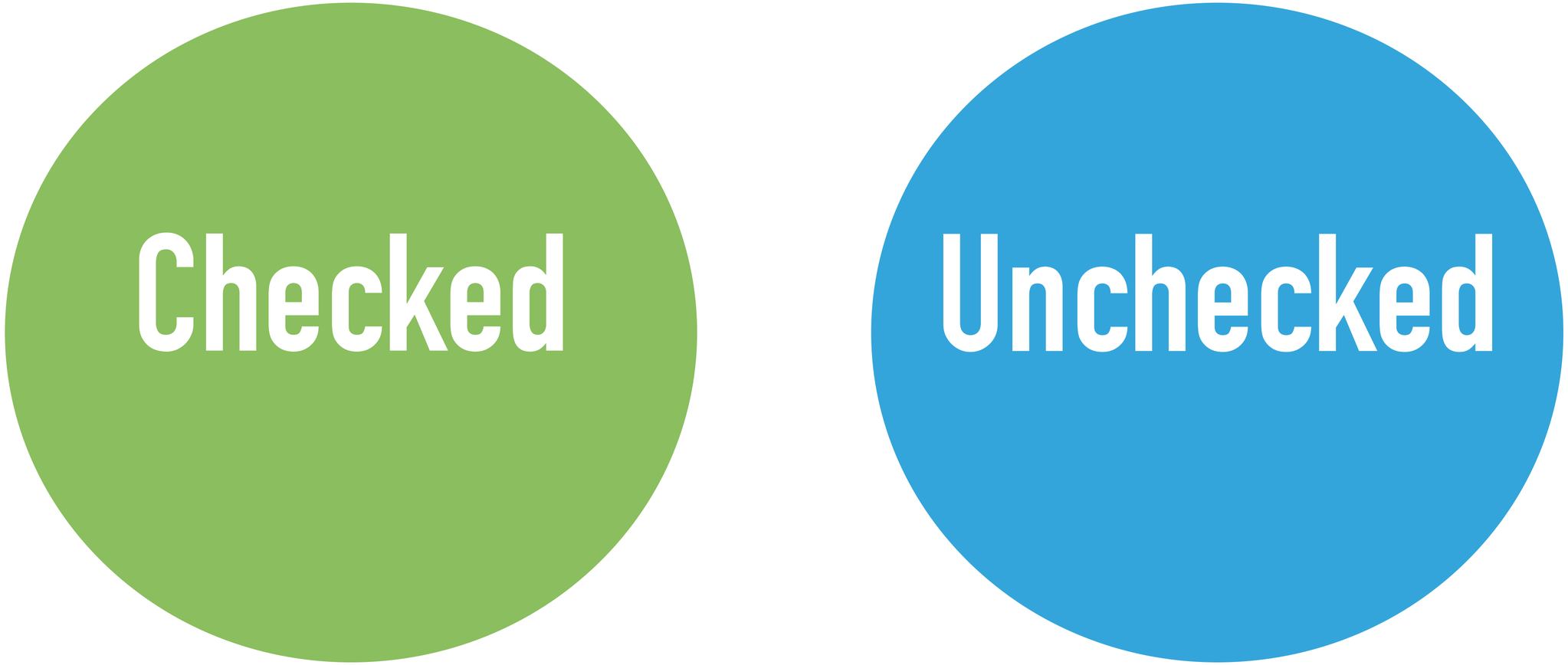
Organise PHP-SW

Author of Static Analysis Results Baseliner (SARB)

20 years of writing software (C, Java, Python, PHP)

@daveliddament

#Bonus: Check exceptions are handled



```
function doSomething(): void {
  // Some code
  throw new MyException();
}
```

```
/** @throws MyException */
function doSomething(): void {

  // Some code
  throw new MyException();
}
```

```
function process(): void {
  doSomething();
}


/** @throws MyException */
function doSomething(): void {

  // Some code
  throw new MyException();
}
```

```
function process(): void {
  try {
     doSomething();
  } catch (MyException) {
    // process error
  }
}


/** @throws MyException */
function doSomething(): void {

  // Some code
  throw new MyException();
}
```

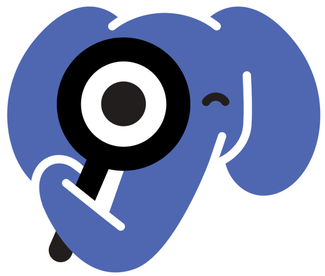
psalm.xml

Psalm

```
<issueHandlers>
    <MissingThrowsDocblock>
        <errorLevel type="suppress">
            <directory name="tests/"/>
        </errorLevel>
    </MissingThrowsDocblock>
</issueHandlers>
```

```
<ignoreExceptions>
    <class name="Webmozart\Assert\InvalidArgumentException" />
    <class name="InvalidArgumentException" />
    <class name="LogicException" />
</ignoreExceptions>
```

phpstan.neon



```
parameters:
  exceptions:
    check:
      missingCheckedExceptionInThrows: true
      tooWideThrowType: true
    uncheckedExceptionClasses:
      - InvalidArgumentException
```