Getting The Most From Static Analysis

Dave Liddament | Lamp Bristol

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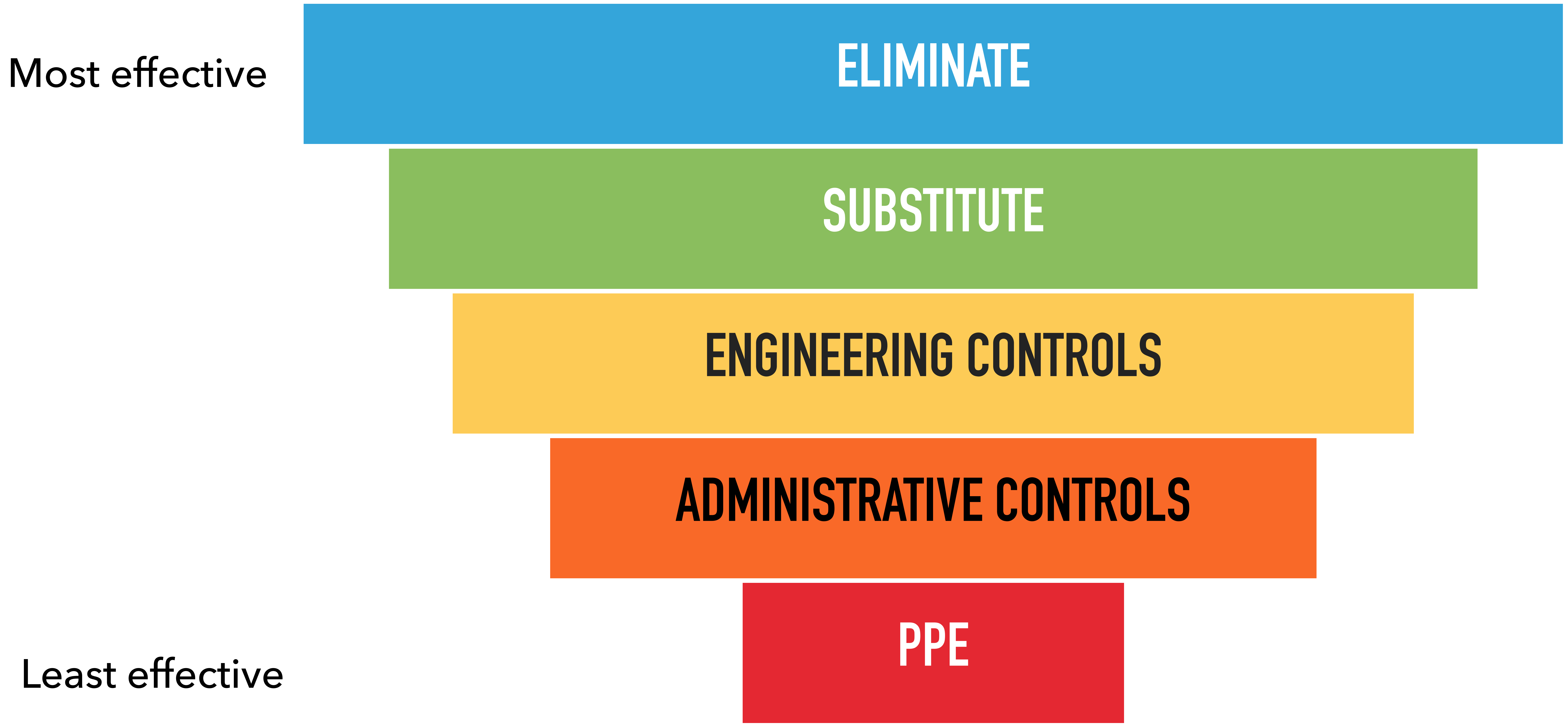
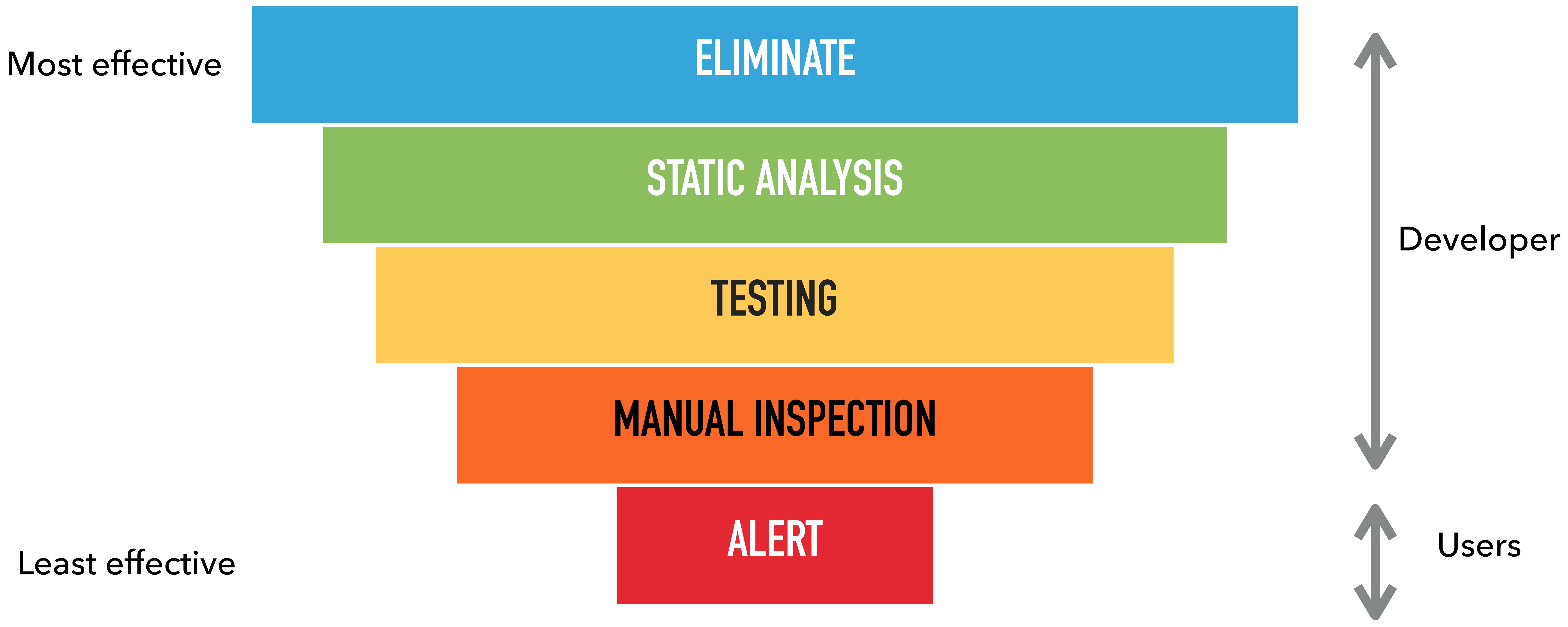
Can we write code in such a way to reduce the chance of introducing bugs?

Can static analysis help us achieve this goal?

HIERARCHY OF CONTROL



PREVENTING BUGS IN SOFTWARE



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The context for this is:

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

#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

# Bonus?

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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

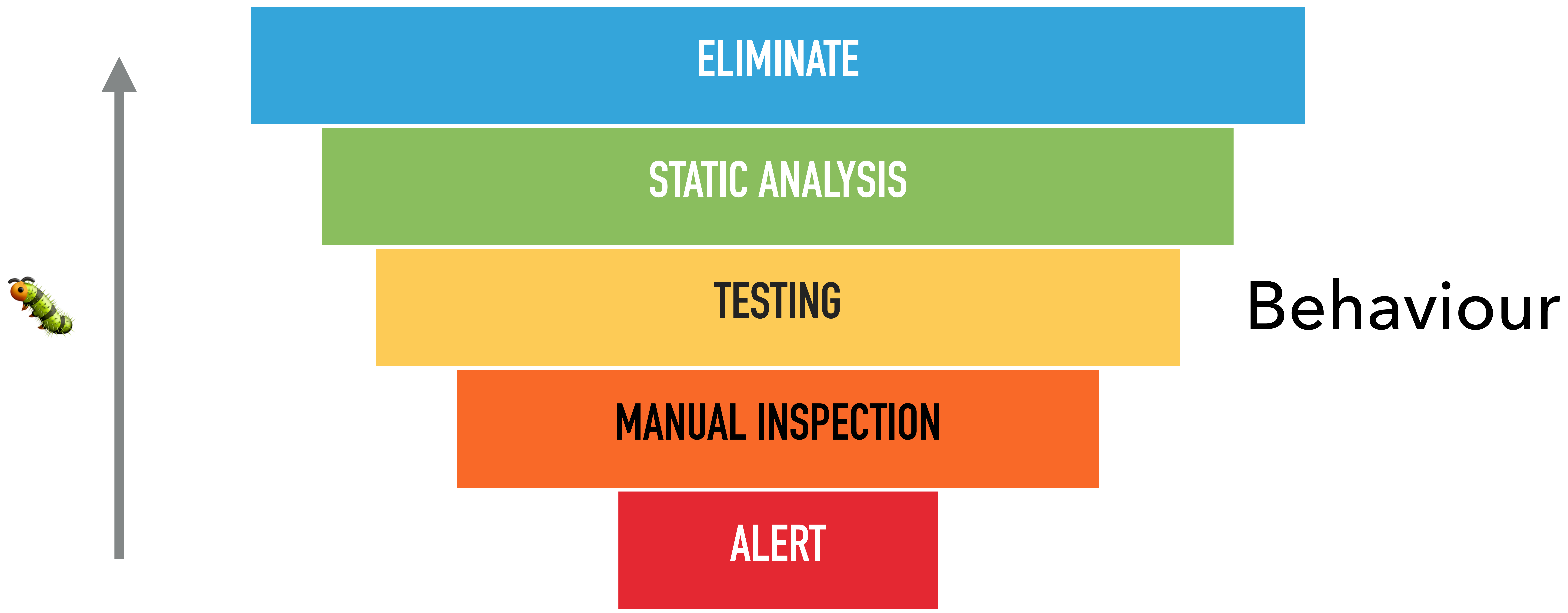
Static analysis shows you where your code is incorrect.

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

Developers make mistakes.

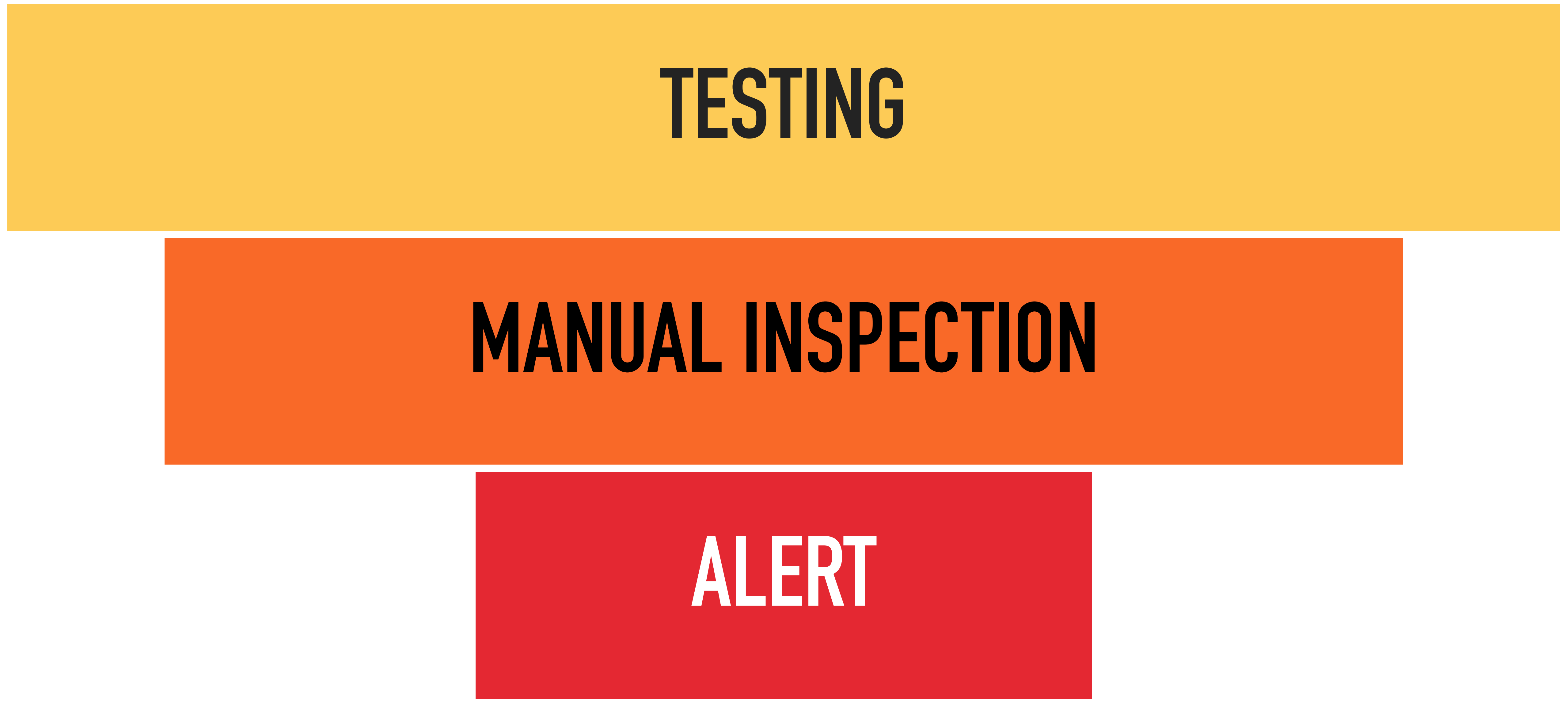
You can still have bugs even if:

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


ELIMINATE
STATIC ANALYSIS
TESTING
MANUAL INSPECTION
ALERT
Behaviour

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


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) {}
}
```

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```php
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

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

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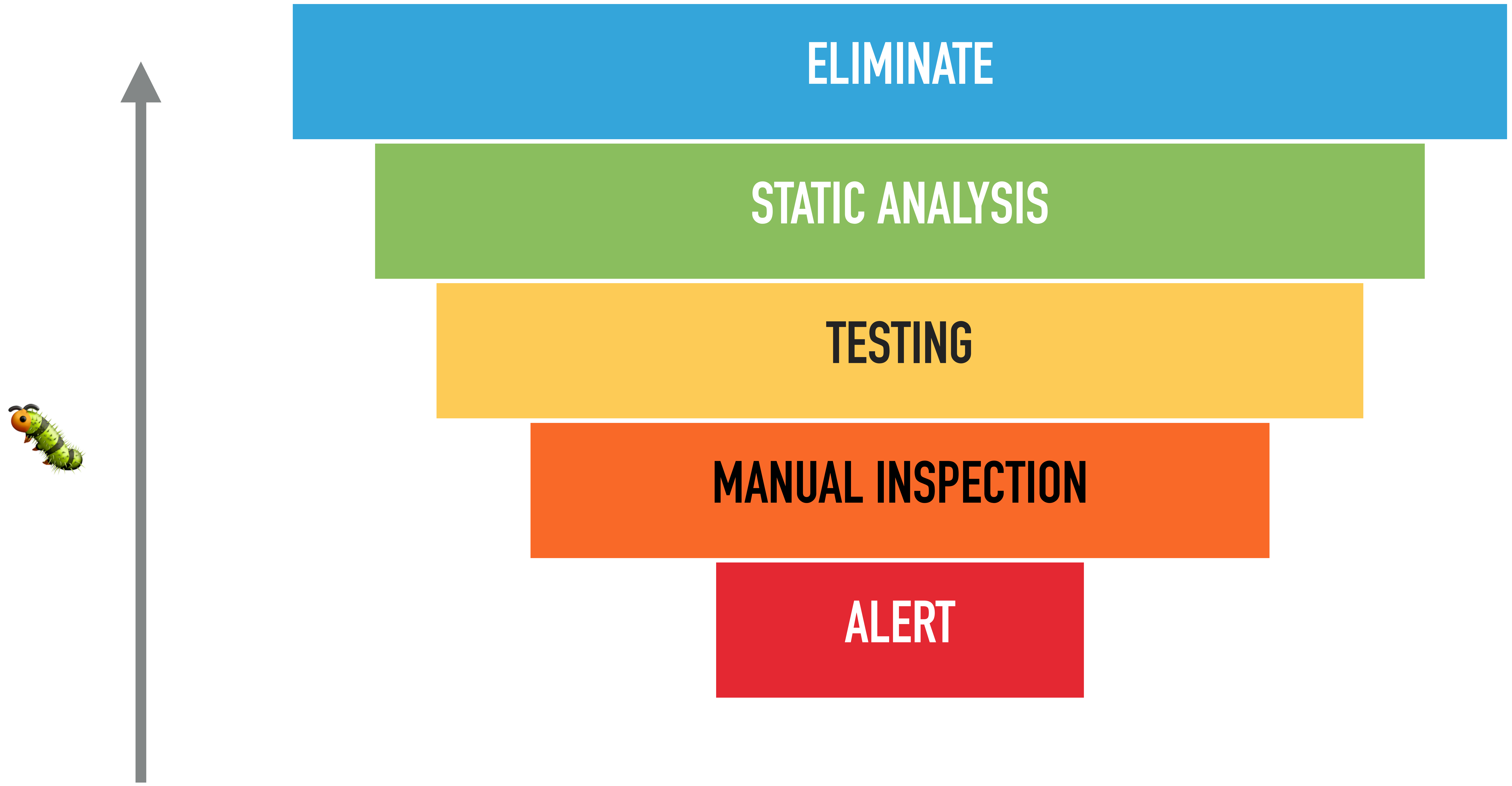
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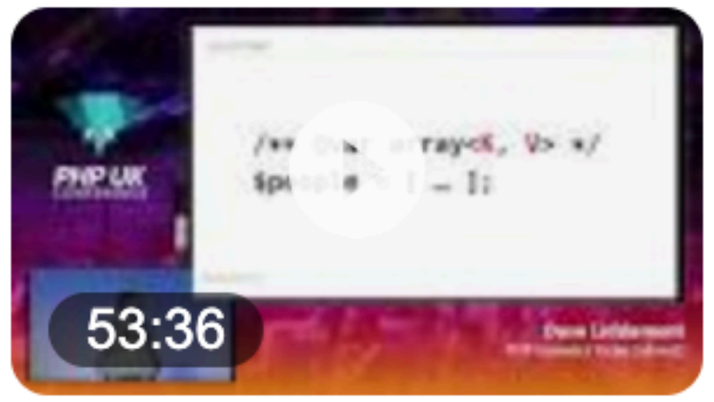
ALERT

#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

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

STATIC ANALYSIS

```php
$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 */
```

```php
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); ❌
```

```php
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 {…}

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;
}

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

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

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```
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",
   ];
}
```

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```
/**
 * @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",
        “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"),
  ];
}
```

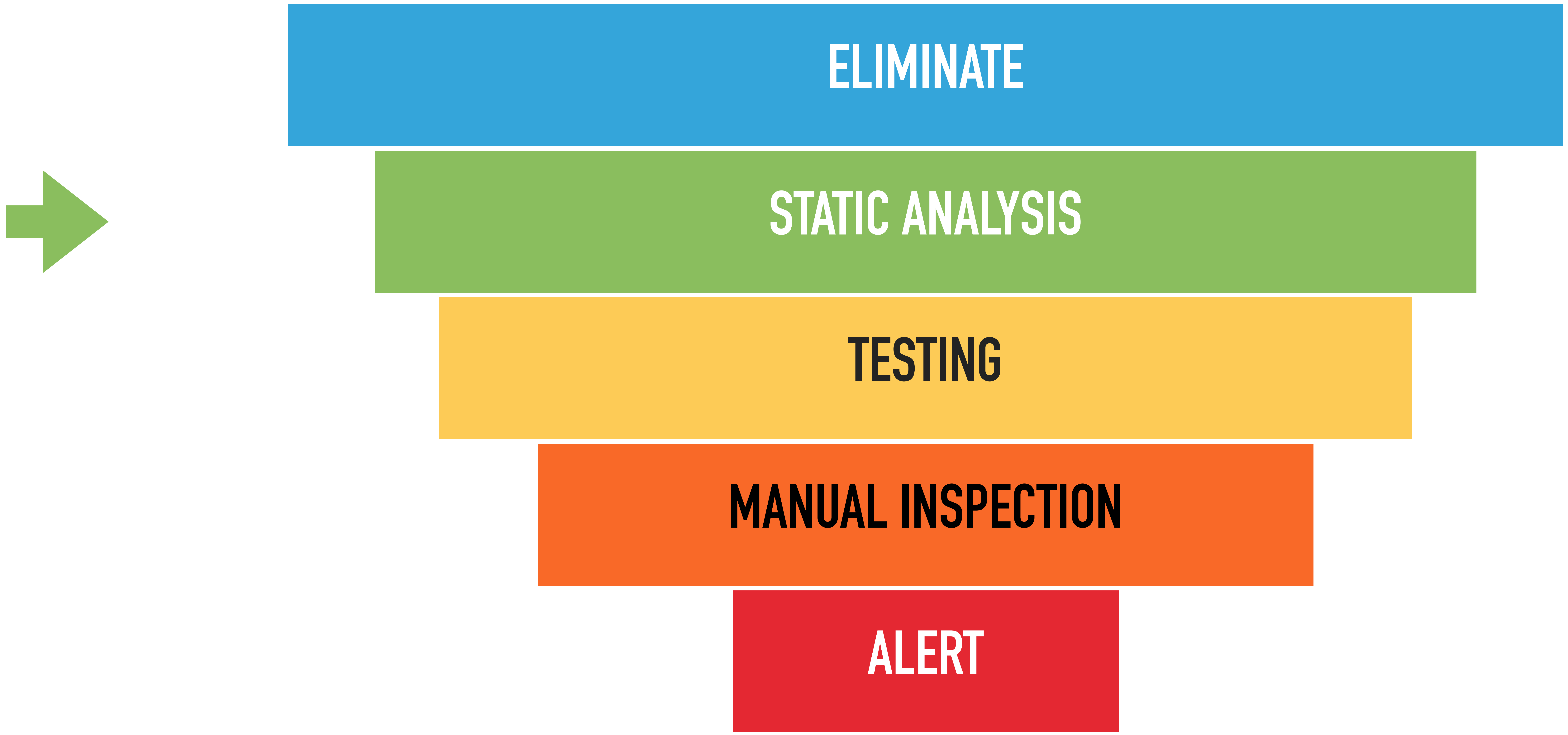
```
/**
 * @return array<int, Person>
 */
function getPersonDetails(): array
{
  return [
   1 => new Person("Jane"),
   10 => new Person("Bob"),
   8 => new Person("Charlie"),
  ];
}
```

```php
/**
 * @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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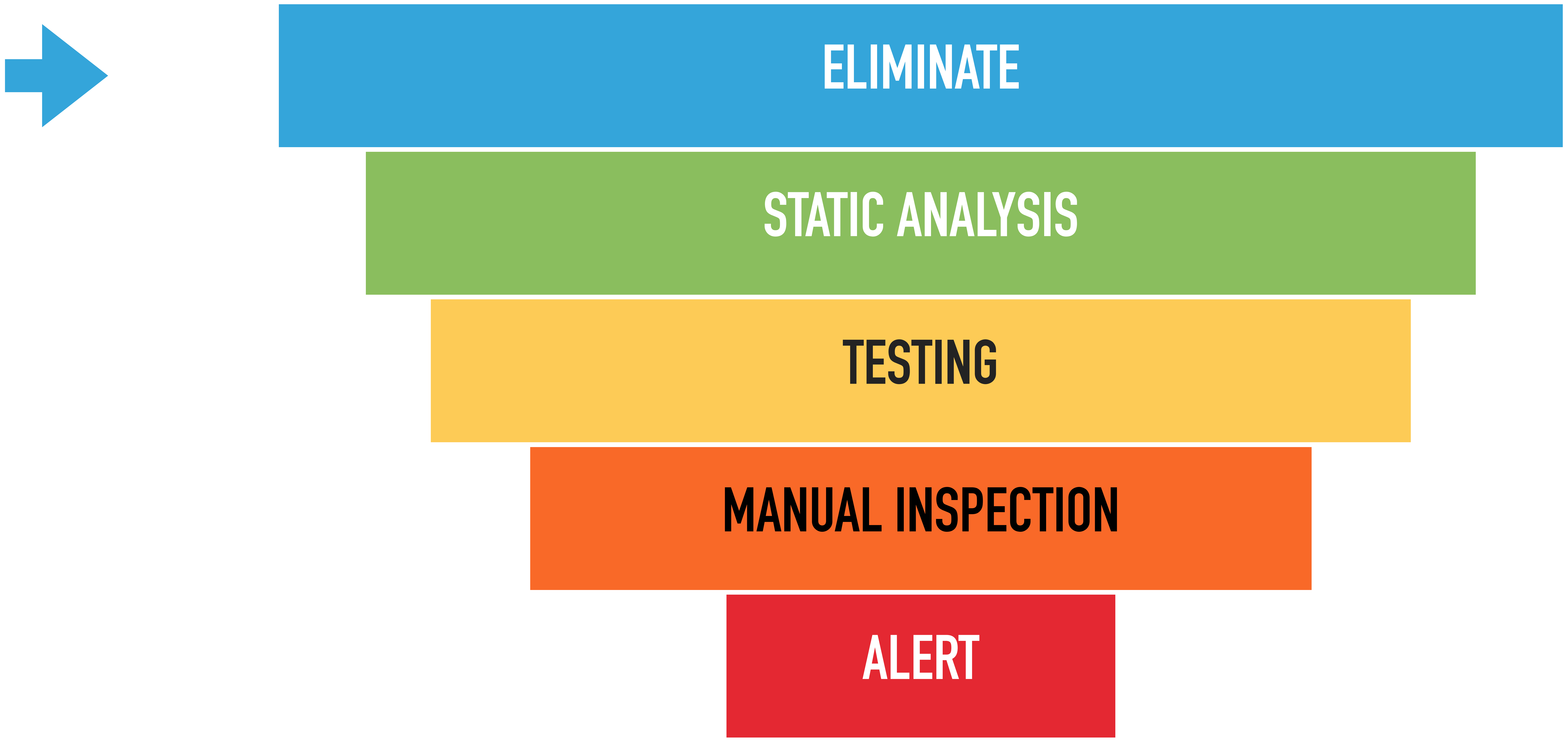

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```
final class Status
{
   public const STATUS_SUCCESS = 0;
   public const STATUS_FILE_ACCESS_ERROR = 255;
   public const STATUS_INVALID_CONTENTS = 254;
}
/** @param Status::* $value */
function processStatus(int $value): void {…}
```

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

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

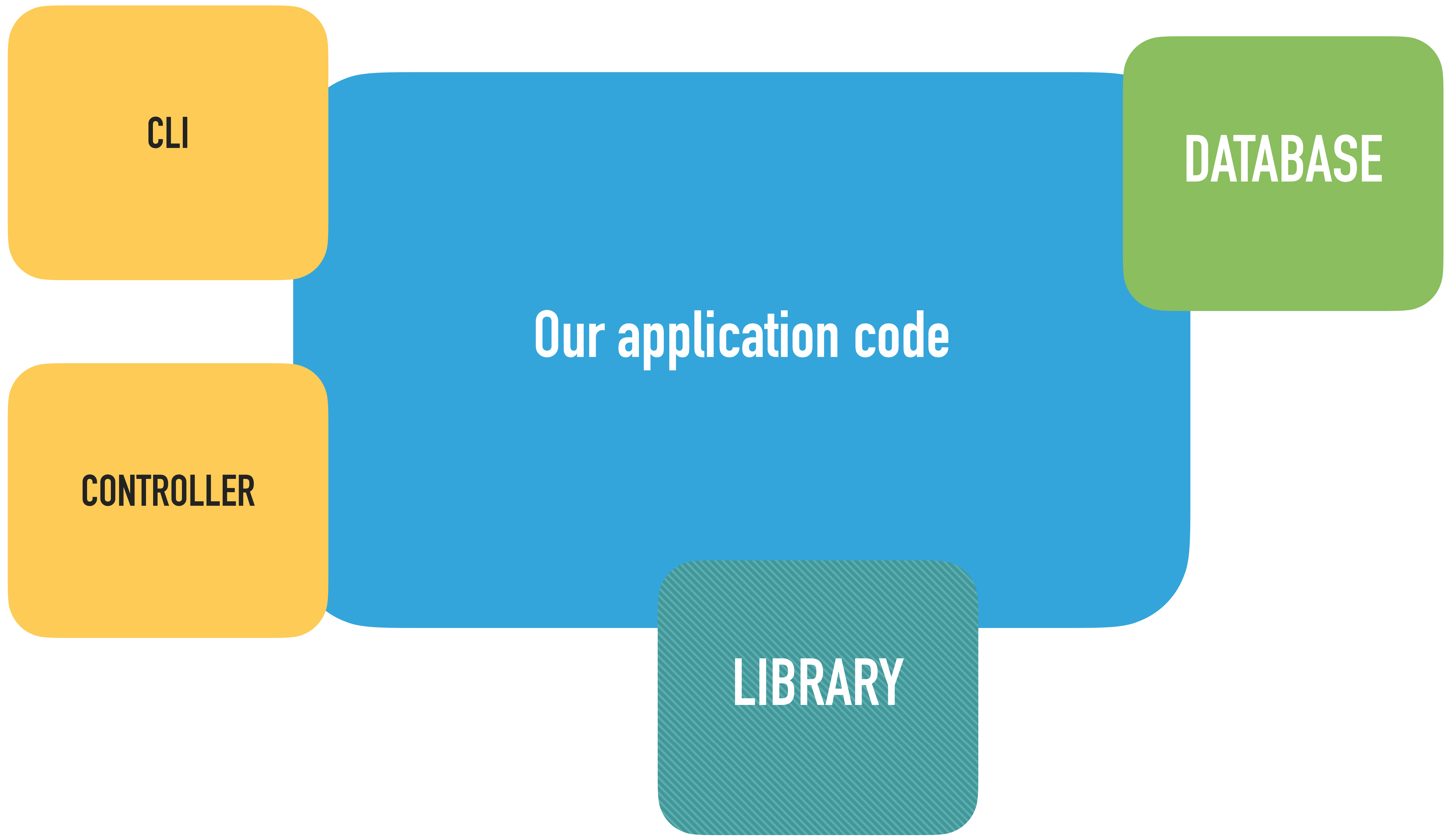
STATIC ANALYSIS

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

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

ELIMINATE

#3: Asserts at the system boundaries



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

```php
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

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```
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

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

```php
/** @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 {…}
```

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```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 {…}
```

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#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;
}
```

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

```php
/** @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;
}
```

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

```php
/** @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

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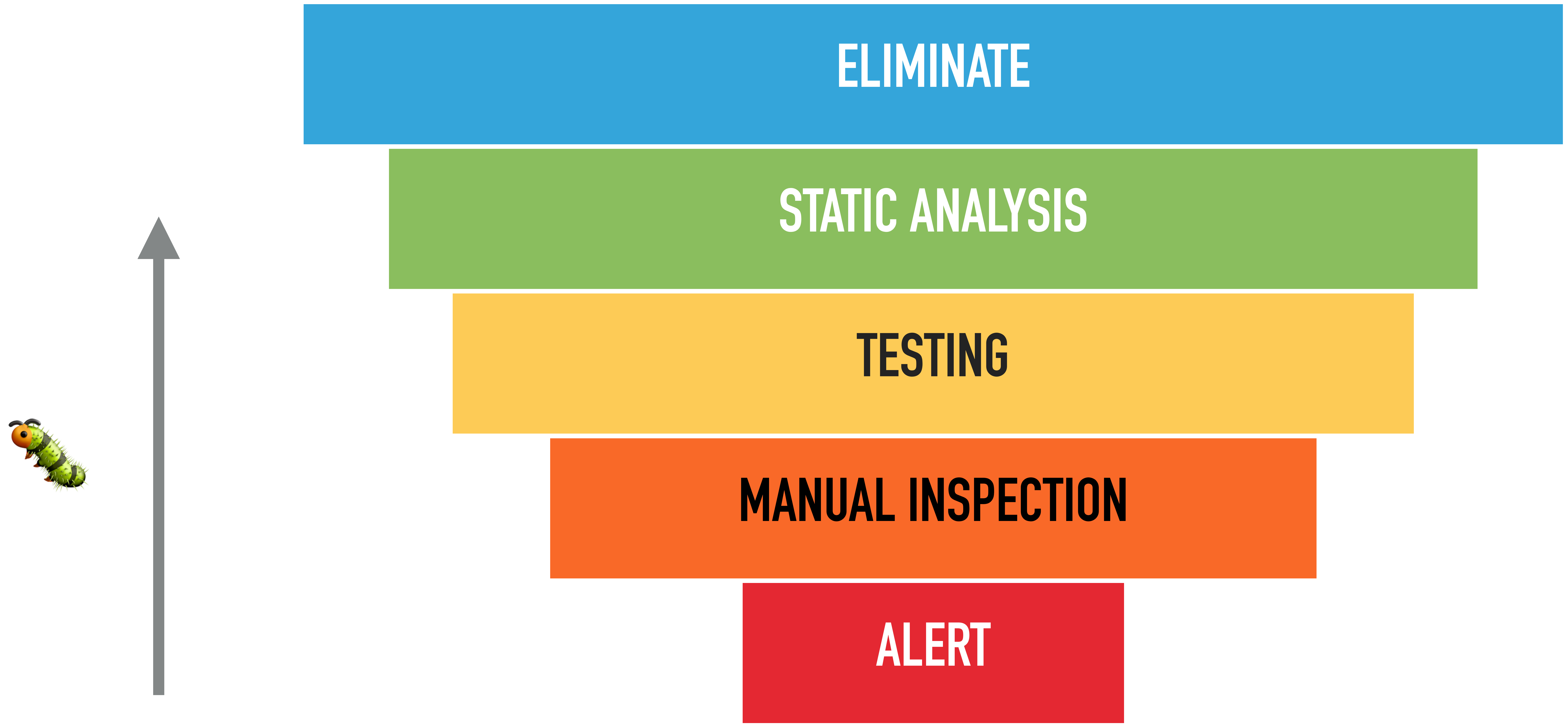

@daveliddament

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

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

No default clause

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

Psalm

STATIC ANALYSIS

MANUAL INSPECTION

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#6: Assume impure functions

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

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

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

✅

Psalm ❌

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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 {…}
```

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```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

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

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

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

✅

Psalm ❌

```
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 {…}
```

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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 {…}
```

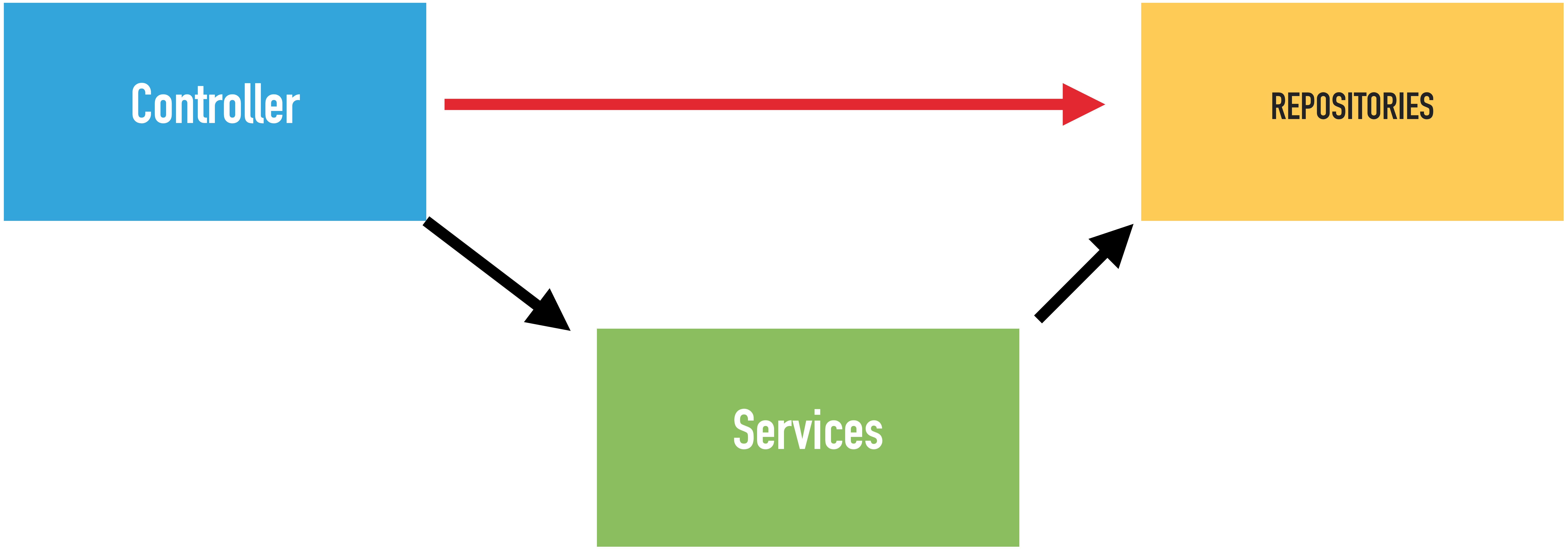
#7: Enforce architectural constraints

phpat PHP ARCHITECTURE TESTER

https://github.com/carlosas/phpat

Deptrac

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')
       );
}
```

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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

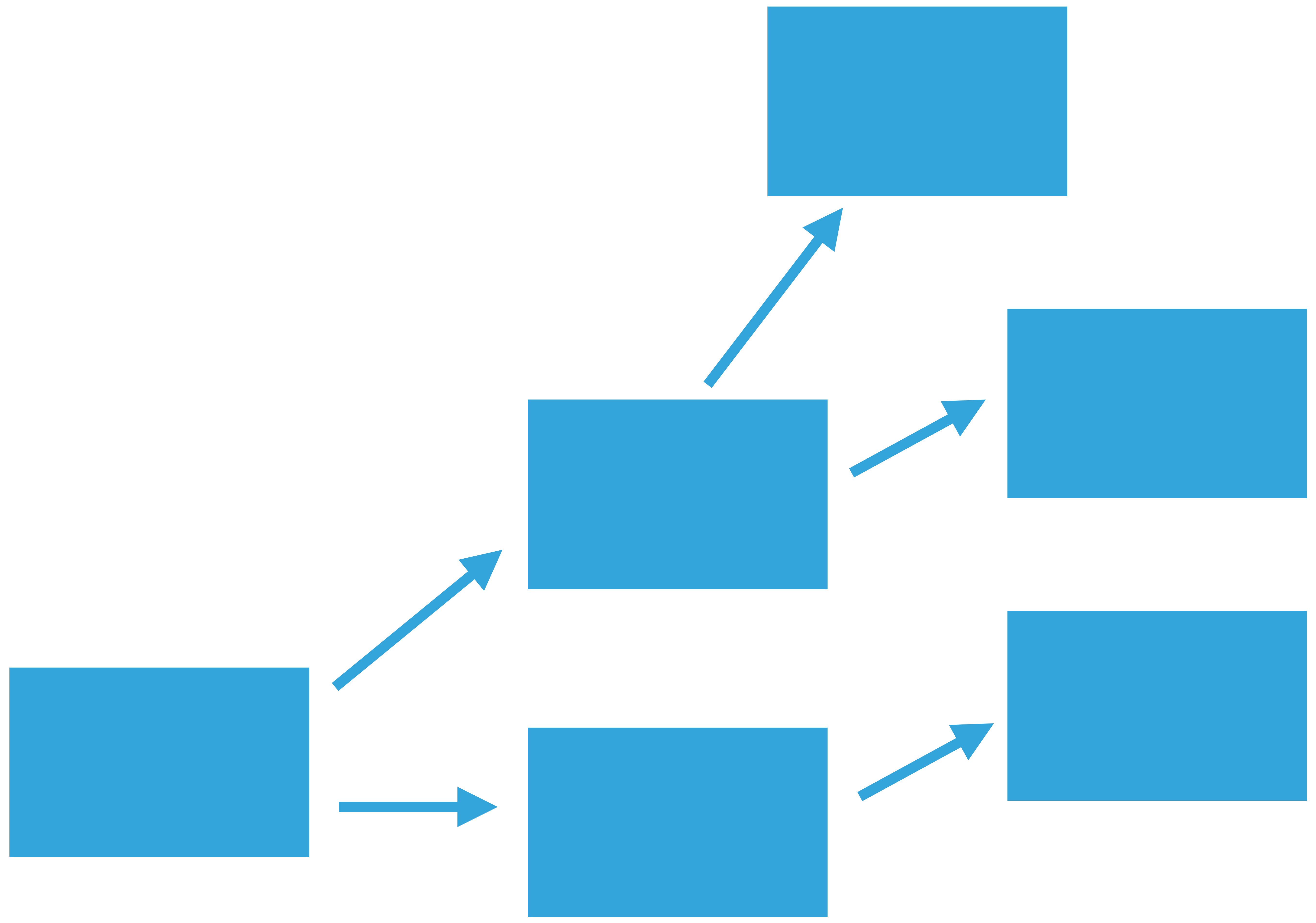
#4: Prevent objects from being in invalid states

#5: Remove default handling

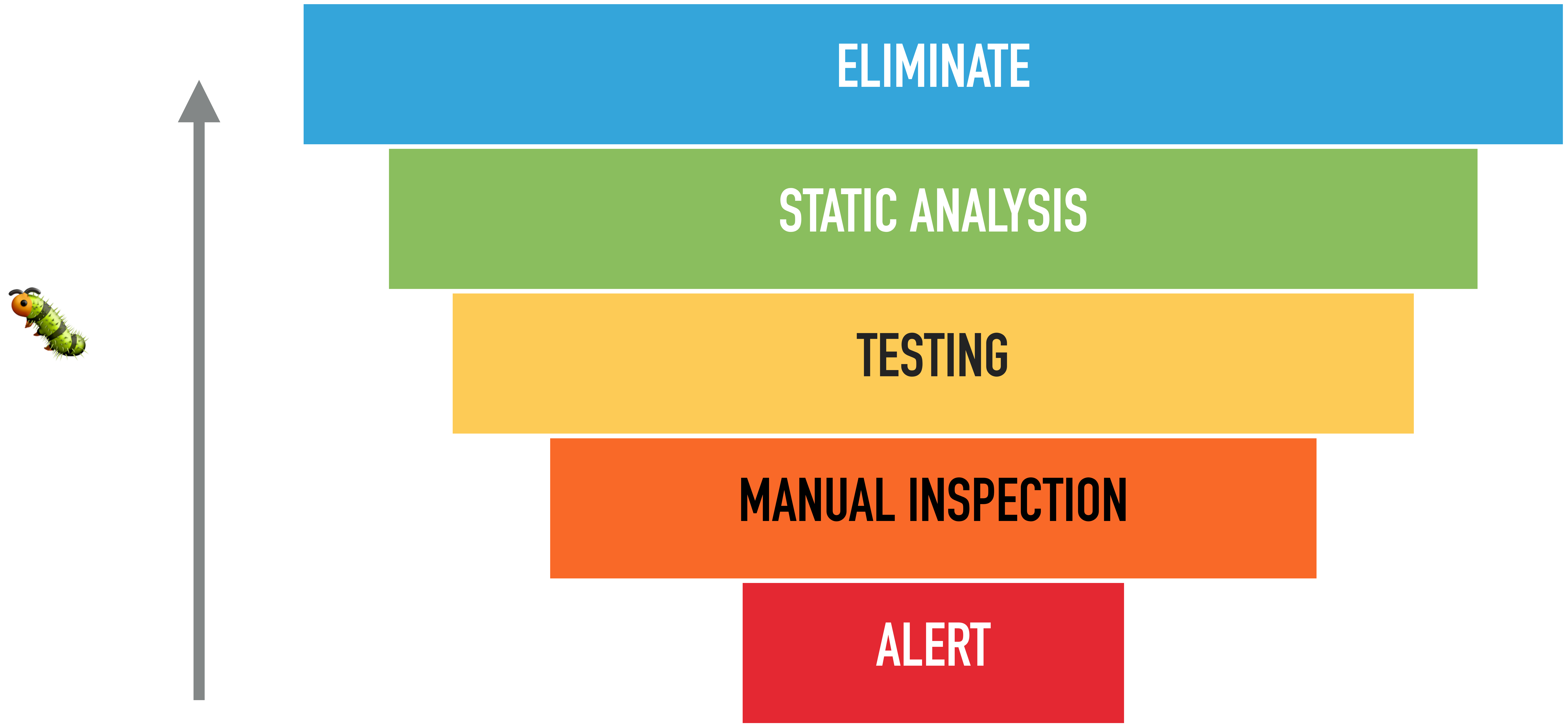
#6: Assume impure functions

#7: Enforce architectural constraints

WILL DOING THIS MAKE CHANGE HARD?



- Use this advice if project needs it
- If changes are made, developers are shown possible bugs
- OK to alter past decisions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STATIC ANALYSIS
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MANUAL INSPECTION
ALERT

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)

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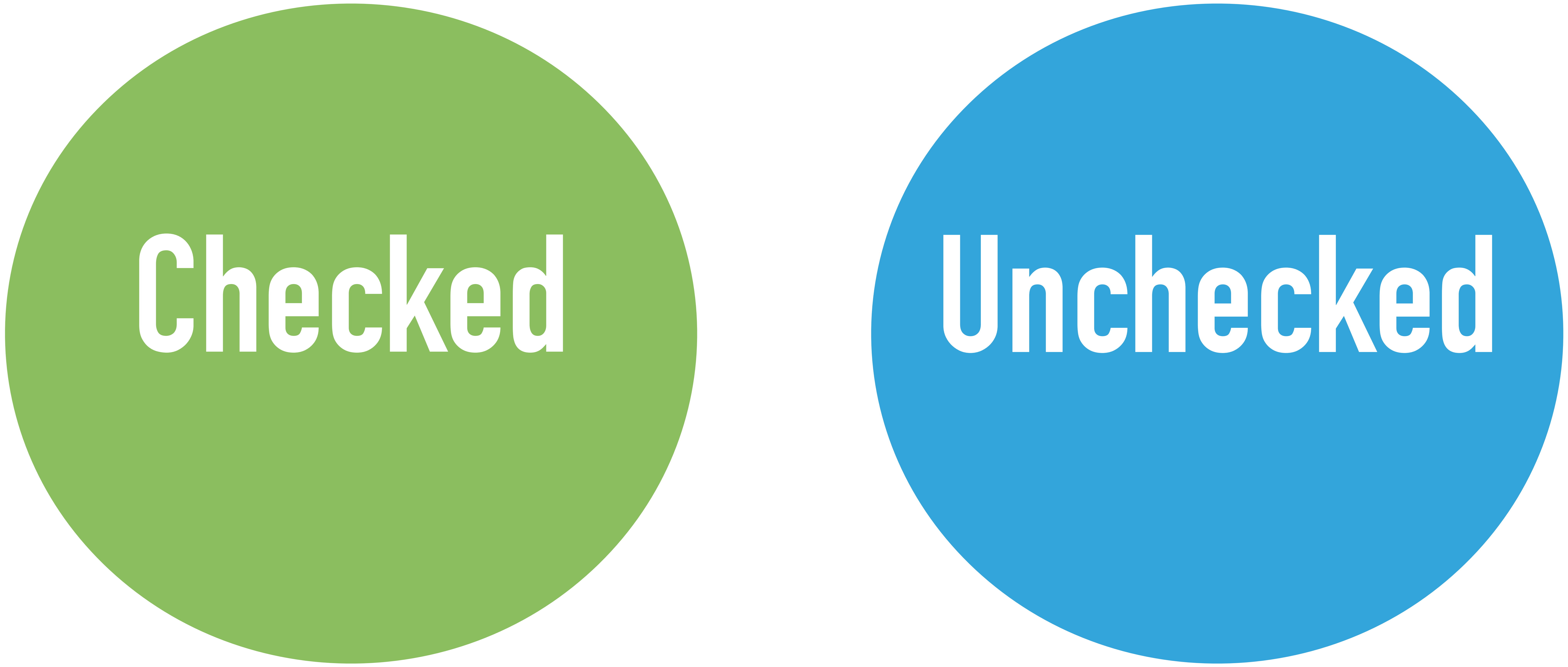
#Bonus: Check exceptions are handled



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```
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();
}
```

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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>
```

@daveliddament

phpstan.neon

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