

Testy białoskrzynkowe i testowanie mutacyjne – raport.

1. Linki.

Branch z oryginalnymi testami: [branch](#)





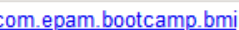
Branch z testami mutacyjnymi: [branch](#)

2. Pokrycie kodu.







2.1. Oryginalne testy.

Wygenerowany raport JaCoCo znajduje się w folderze
/pokrycie_kodu_oryginalnymi_testami.

Jak wykazał raport pokrycie kodu testami nie było stuprocentowe w klasie App,

| Element | Missed Instructions | Cov. | Missed Branches | Cov. |
|---|---|------|---|------|
|  com.epam.bootcamp.bmi_calculator |  | 100% |  | 92% |
|  com.epam.bootcamp.bmi_calculator.interfacesImplements |  | 100% | | n/a |
| Total | 0 of 264 | 100% | 3 of 38 | 92% |

com.epam.bootcamp.bmi_calculator

| Element | Missed Instructions | Cov. | Missed Branches | Cov. |
|---|---|------|---|------|
|  GuessTheUnits |  | 100% |  | 100% |
|  App |  | 100% |  | 83% |
| Total | 0 of 234 | 100% | 3 of 38 | 92% |

a dokładniej w metodach bmiResult() oraz calcualateBMI().

```

    public double calculateBMI() throws Exception{ //végül kiszámoljuk a BMI-t
        ZeroChecker();
        GuessTheUnits gtu = new GuessTheUnits(this.height, this.weight);
        ◆ if(gtu.getUnitType().equals("US")){
            UsBMI ubmi = new UsBMI();
            ubmi.setBMI(gtu.getWeight(), gtu.getHeight());
            this.bmi = ubmi.getBMI();
        ◆ }else if(gtu.getUnitType().equals("metric")){
            MetricBMI mbmi = new MetricBMI();
            mbmi.setBMI(gtu.getWeight(), gtu.getHeight());
            this.bmi = mbmi.getBMI();
        }
        return this.bmi;
    }

    /**
     * A bmi változó értékétől függően kapjuk meg az adott ember értékelését
     * @return Egy string, ami tartalmazza az értékelést
     */
    public String bmiResult(){
        ◆ if(this.bmi < 18.5){ // Sovány
            return "Thinness";
        ◆ }else if(this.bmi >= 18.5 && this.bmi <= 24.9){ // Normál testalkatú
            return "Normal";
        ◆ }else if(this.bmi > 24.9 && this.bmi <= 29.9){ // Túlsúlyos
            return "Overweight";
        }else{ // Erősen túlsúlyos
            return "Heavily overweight";
        }
    }
}

```

2.2. Oryginalne i uzupełnione testy.

Według mojej analizy kodu poprawienie pokrycia testami metody calculateBMI() nie jest możliwe ze względu na budowę kodu. W instrukcji warunkowej

```

◆ }else if(gtu.getUnitType().equals("metric")){

```

pokrycie jest częściowe, ponieważ gtu.getUnitType() zwraca zawsze albo „US” albo „metric”, (chyba, że wcześniej konstruktor zwróci wyjątek), tak więc jeśli pierwszy warunek `if(gtu.getUnitType().equals("US")){` zwróci „false”, to ten warunek zawsze zwróci „true”.

Podobnie z metodą bmiResult(), pokrycie testów jest częściowe, ponieważ wartości mniejsze niż te z przedziałów w instrukcjach „else if” są zawsze wyłapywane przez poprzednią instrukcję warunkową.

Następująca optymalizacja dałaby całkowite pokrycie kodu testami bez konieczności tworzenia nowych testów, nie zmieniając działania aplikacji:

```

    public double calculateBMI() throws Exception{ //végül kiszámoljuk a BMI-t
        ZeroChecker();
        GuessTheUnits gtu = new GuessTheUnits(this.height, this.weight);
        if(gtu.getUnitType().equals("US")){
            UsBMI ubmi = new UsBMI();
            ubmi.setBMI(gtu.getWeight(), gtu.getHeight());
            this.bmi = ubmi.getBMI();
        }else{
            MetricBMI mbmi = new MetricBMI();
            mbmi.setBMI(gtu.getWeight(), gtu.getHeight());
            this.bmi = mbmi.getBMI();
        }
        return this.bmi;
    }

    /**
     * A bmi változó értékétől függően kapjuk meg az adott ember értékelését
     * @return Egy string, ami tartalmazza az értékelést
     */
    public String bmiResult(){
        if(this.bmi < 18.5){ // Sovány
            return "Thinness";
        }else if(this.bmi <= 24.9){ // Normál testalkatú
            return "Normal";
        }else if(this.bmi <= 29.9){ // Túlsúlyos
            return "Overweight";
        }else{ // Erősen túlsúlyos
            return "Heavily overweight";
        }
    }
}

```

bmi-calculator

| Element | Missed Instructions | Cov. | Missed Branches | Cov. |
|--|------------------------|------|------------------------|------|
| com.epam.bootcamp.bmi_calculator | <div><div></div></div> | 100% | <div><div></div></div> | 100% |
| com.epam.bootcamp.bmi_calculator.interfaces.Implements | <div><div></div></div> | 100% | | n/a |
| Total | 0 of 249 | 100% | 0 of 32 | 100% |

Results :

Tests run: 13, Failures: 0, Errors: 0, Skipped: 0

2.3. Wykonanie testów mutacyjnych.

Raport dostępny w folderze /wykonanie_testow_mutacyjnych_przed_neutralizacja.

Pit Test Coverage Report

Project Summary

| Number of Classes | Line Coverage | Mutation Coverage | Test Strength |
|-------------------|-----------------------------------|----------------------------------|----------------------------------|
| 4 | 100% <div><div></div></div> 66/66 | 75% <div><div></div></div> 43/57 | 75% <div><div></div></div> 43/57 |

Breakdown by Package

| Name | Number of Classes | Line Coverage | Mutation Coverage | Test Strength |
|--|-------------------|-----------------------------------|----------------------------------|----------------------------------|
| com.epam.bootcamp.bmi_calculator | 2 | 100% <div><div></div></div> 58/58 | 72% <div><div></div></div> 36/50 | 72% <div><div></div></div> 36/50 |
| com.epam.bootcamp.bmi_calculator.interfaces.Implements | 2 | 100% <div><div></div></div> 8/8 | 100% <div><div></div></div> 7/7 | 100% <div><div></div></div> 7/7 |

Breakdown by Class

| Name | Line Coverage | | Mutation Coverage | | Test Strength | |
|------------------------------------|---------------|-----------------------------|-------------------|-----------------------------|---------------|-----------------------------|
| App.java | 100% | <div><div>28/28</div></div> | 67% | <div><div>16/24</div></div> | 67% | <div><div>16/24</div></div> |
| GuessTheUnits.java | 100% | <div><div>30/30</div></div> | 77% | <div><div>20/26</div></div> | 77% | <div><div>20/26</div></div> |

Mutacje w App.java

| |
|---|
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/App::ZeroChecker → SURVIVED |
| 1. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/interfacesImplements/UsBMI::setBMI → KILLED |
| 1. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/interfacesImplements/MetricBMI::setBMI → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/App::calculateBMI → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. changed conditional boundary → SURVIVED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. changed conditional boundary → SURVIVED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |

Mutacje w GuessTheUnits.java

| |
|--|
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::guessUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. changed conditional boundary → SURVIVED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double multiplication with division → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double multiplication with division → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double division with multiplication → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getWeight → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getHeight → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getUnitType → KILLED |

3. Analiza wybranych pięciu mutantów.

3.1. Mutacja: CONDITIONALS_BOUNDARY_MUTATOR

```
private void ZeroChecker() throws Exception{  
    if(this.weight <= 0){  
        throw new Exception("Weight is equals or less than zero.");  
    }  
}
```

Przyczyna niewykrycia mutacji: zmiana „<=” na „<”.

Sposób neutralizacji mutacji: Test ustawiający wartość atrybut weight na 0, który po mutacji znaku porównania na „<” nie zwróci wyjątku.

```
@Test  
public void BMITest11() throws Exception {  
    try{  
        app.setHeight(-11);  
        app.setWeight(0);  
        app.calculateBMI();  
    }catch(Exception e){  
        assertEquals(e.getMessage(), actual: "Weight is equals or less than zero.");  
    }  
}
```

3.2. Mutacja: CONDITIONALS_BOUNDARY_MUTATOR

```
public String bmiResult(){  
    if(this.bmi < 18.5){ // Sovány  
        return "Thinness";  
    }  
}
```

Przyczyna niewykrycia mutacji: zmiana „<” na „<=”.

Sposób neutralizacji mutacji: ustawienie wartości granicznej dla app.bmi

```
@Test  
public void BMITest12() throws Exception{  
    app.setHeight(1);  
    app.setWeight(18.5);  
    assertEquals(app.calculateBMI(), actual: 18.5, delta: 0.0);  
    assertEquals(app.bmiResult(), actual: "Normal");  
}
```

3.3. Mutacja: CONDITIONALS_BOUNDARY_MUTATOR

```
}else if(this.bmi >= 18.5 && this.bmi <= 24.9){ // Normál testalkatú  
    // to get full line test coverage this should be else if(this.bmi <= 24.9)  
    // as values < 18.5 are caught in previous if statement  
    return "Normal";  
}
```

Przyczyna niewykrycia mutacji: zmiana „>=” na „>”.

Sposób neutralizacji mutacji:

```
@Test
public void BMITest12() throws Exception{
    app.setHeight(1);
    app.setWeight(18.5);
    assertEquals(app.calculateBMI(), actual: 18.5, delta: 0.0);
    assertEquals(app.bmiResult(), actual: "Normal");
}
```

3.4. Mutacja: CONDITIONALS_BOUNDARY_MUTATOR

```
if(this.height < 100){
    if(this.height < 10 && this.height > 3){ // feet
        convertUnit("feet"); //átkonvertáljuk inch-re
        this.unitType = "US";
    }else if(this.height >= 10){ // inch
        this.unitType = "US";
    }else{ // meter
        this.unitType = "metric";
    }
}else{ // centimeter
```

Przyczyna niewykrycia mutacji: zmiana „> 3” na „>= 3”.

Sposób neutralizacji mutacji:

```
@Test
public void GuessTheUnitsTest5() throws Exception{
    GuessTheUnits gtu = new GuessTheUnits( height: 3, weight: 176);
    assertEquals(gtu.getUnitType(), actual: "metric");
}
```

Dla wartości 3 zmutowany kod zwróci „US” zamiast „metric” (>= 3 -> this.unitType = „US”)

3.5. Mutacja: CONDITIONALS_BOUNDARY_MUTATOR

```
}else if(this.bmi > 24.9 && this.bmi <= 29.9){ // Túlsúlyos
    // to get full line test coverage this should be "else if(this.bmi <= 29.9)"
    // as values <= 24.9 are caught in previous if statement
    return "Overweight";
}
```

Przyczyna niewykrycia mutacji: zmiana „<= 29.9” na „< 29.9”.

Sposób neutralizacji mutacji:

```
@Test
public void BMITest14() throws Exception{
    app.setHeight(1);
    app.setWeight(29.9);
    assertEquals(app.calculateBMI(), actual: 29.9, delta: 0.0);
    assertEquals(app.bmiResult(), actual: "Overweight");
}
```

4. Pokrycie kodu po neutralizacji mutacji

Raport dostępny w folderze /wykonanie_testow_mutacyjnych_po_neutralizacji

Pit Test Coverage Report

Project Summary

| Number of Classes | Line Coverage | Mutation Coverage | Test Strength |
|-------------------|----------------------------------|---------------------------------|---------------------------------|
| 4 | 100% <div><div>66/66</div></div> | 86% <div><div>49/57</div></div> | 86% <div><div>49/57</div></div> |

Breakdown by Package

| Name | Number of Classes | Line Coverage | Mutation Coverage | Test Strength |
|--|-------------------|----------------------------------|---------------------------------|---------------------------------|
| com.epam.bootcamp.bmi_calculator | 2 | 100% <div><div>58/58</div></div> | 84% <div><div>42/50</div></div> | 84% <div><div>42/50</div></div> |
| com.epam.bootcamp.bmi_calculator.interfaces.Implements | 2 | 100% <div><div>8/8</div></div> | 100% <div><div>7/7</div></div> | 100% <div><div>7/7</div></div> |

Udało się zneutralizować 6 mutacji.

App.java

| |
|--|
| 1. changed conditional boundary → KILLED |
| 2. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/App::ZeroChecker → SURVIVED |
| 1. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/interfaces/Implements/UsBMI::setBMI → KILLED |
| 1. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/interfaces/Implements/MetricBMI::setBMI → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/App::calculateBMI → KILLED |
| 1. changed conditional boundary → KILLED |
| 2. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. changed conditional boundary → KILLED |
| 2. changed conditional boundary → KILLED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. changed conditional boundary → KILLED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/App::bmiResult → KILLED |

GuessTheUnits.java

| |
|--|
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::guessUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. changed conditional boundary → KILLED |
| 3. negated conditional → KILLED |
| 4. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. negated conditional → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. removed call to com/epam/bootcamp/bmi_calculator/GuessTheUnits::convertUnit → KILLED |
| 1. changed conditional boundary → SURVIVED |
| 2. negated conditional → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double multiplication with division → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double multiplication with division → KILLED |
| 1. negated conditional → KILLED |
| 1. Replaced double division with multiplication → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getWeight → KILLED |
| 1. replaced double return with 0.0d for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getHeight → KILLED |
| 1. replaced return value with "" for com/epam/bootcamp/bmi_calculator/GuessTheUnits::getUnitType → KILLED |