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**FGA 0238 Testes de Software - Turma 02**

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**Nome** Nicolas Chagas Souza

**Matrícula** 20/0042327

**Equipe** PassaNada

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#### Atividade 4 – TDD

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## Atividade 4 - TDD

### 1. Funcionalidade

#### 1.1 Identificação da Issue

Devido a dificuldade de encontrar issues com funcionalidades compatíveis com o TDD, uma vez que a maioria das issues se refere à ajustes em componentes visuais e os testes em tais componentes são de complexa implementação devido à utilização de mocks no frontend, optou-se pela elaboração de uma nova funcionalidade não registrada em issue.

#### 1.2 Especificação

Deve ser possível importar dados da plataforma no formato JSON.

Critérios de aceitação:

- Enumeradores (enums) devem ser convertidos para string na conversão.
- A conversão deve ser recursiva, transformando em JSON objetos aninhados.
- Um array de objetos deve ser convertido para um array com objetos JSON.

### 2. Execução

## 2.1 Primeiro Ciclo

Durante o primeiro ciclo de desenvolvimento um objeto do tipo `Student`, cuja especificação está disponível na classe `api-output.ts`, será convertido para JSON.

### api-output.ts

```
1  export interface ApiOutput {
2    requestId?: string;
3  }
4
5  export interface Student extends ApiOutput {
6    email: string;
7    courseId: string;
8    name: string;
9    sectionName: string;
10   teamName: string;
11   googleId?: string;
12   comments?: string;
13   key?: string;
14   institute?: string;
15   joinState?: JoinState;
16 }
```

Por motivos didáticos, a conversão para JSON será feita sem a utilização de bibliotecas e funções próprias, mas para facilitar a verificação serão utilizados os métodos do objeto JSON do typescript.

### Teste - Red State

Após a escrita do primeiro teste, a o arquivo de teste encontrava-se da seguinte maneira:

### json-helper.spec.ts

```
1
```

Para que o teste fosse executado, foi necessário criar uma implementação mínima, obedecendo as regras de compilação do projeto, que exige que as funções declaradas sejam utilizadas assim como os parâmetros da função.

### json-helper.ts

```
1  export class JsonHelper {
2    public static parseObjectToJson(object: Object): string {
3      return object as string
4    }
5  }
```

A primeira execução do teste aponta corretamente o red state, demonstrando que o método testado ainda não está implementado da maneira correta.

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✕ Should parse student to JSON (5 ms)

● JsonHelper › Should parse student to JSON

  expect(received).toEqual(expected) // deep equality

  Expected: "{\\"name\\":\\"John Doe\\",\\"courseId\\":\\"TESTES\\",\\"email\\":\\"email@test.com.zt\\",\\"teamName\\":\\"PassaNada\\",\\"sectionName\\":\\"T01\\"}"
  Received: {"courseId": "TESTES", "email": "email@test.com.zt", "name": "John Doe", "sectionName": "T01", "teamName": "PassaNada"}

   13 |         };
   14 |         const expectedOutput = JSON.stringify(input);
>  15 |         expect(JsonHelper.parseObjectToJSON(input)).toEqual(expectedOutput)
      |                                                         ^
   16 |     })
   17 |
   18 |
```

Figura 1. Primeira execução do teste criado. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

Em seguida, o método `parseObjectToJSON` foi implementado da seguinte maneira:

```
json-helper.ts

1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3      const entries = Object.entries(object)
4      for (const entry of entries) {
5          const [key, value] = entry
6          jsonResponse += `"${key}":"${value}"`;
7          if (entries.indexOf(entry) !== entries.length - 1)
8              jsonResponse += ","
9      }
10     jsonResponse += "}"
11     return jsonResponse
12 }
```

## Teste - Green State

E então foi atingido o green state, com o sucesso ao rodar os testes:

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)

Test Suites: 1 passed, 1 total
Tests: 1 passed, 1 total
Snapshots: 0 total
Time: 3.501 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.
```

Figura 2. Confirmação do green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

Não foi identificada necessidade de refatoração no método, apenas no código de teste, passando-o para a seguinte versão:

### json-helper.spec.ts

```
1  it("Should parse student to JSON", () => {
2      const input: Student = {
3          name: "John Doe",
4          courseId: "TESTES",
5          email: "email@test.com.zt",
6          teamName: "PassaNada",
7          sectionName: "T01"
8      };
9
10     expect(JsonHelper.parseObjectToJson(input)).toEqual(JSON.stringify(input))
11 }
```

## 2.2 Segundo Ciclo

Durante o segundo ciclo, um objeto genérico foi escolhido para o tratamento de valores `null`, que os valores nulos devem aparecer como `null` no JSON.

### Teste - Red State

Foram elaborados dois testes para contemplar as duas situações.

### json-helper.spec.ts

```
1  it("Should parse null values as null", () => {
2      const input: Object = {
```

```

3         name: "John Doe",
4         email: null,
5     }
6
7     expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
8 })

```

Como esperado, a execução deste teste ocasiona o red state:

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✗ Should parse null values as null (4 ms)

  ● JsonHelper › Should parse null values as null

    expect(received).toEqual(expected) // deep equality

    Expected: "{\"name\":\"John Doe\",\"email\":null}"
    Received: "{\"name\":\"John Doe\",\"email\":null}"

      23 |         email: null,
      24 |     }
    > 25 |     expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
         |                                                ^
      26 |
      27 |     })
      28 |

      at src/web/services/json-helper.spec.ts:25:53
      at ZoneDelegate.Object.<anonymous>._ZoneDelegate.invoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:409:30)
      at ProxyZoneSpec.Object.<anonymous>.ProxyZoneSpec.onInvoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:3830:43)
      at ZoneDelegate.Object.<anonymous>._ZoneDelegate.invoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:408:56)
      at Zone.Object.<anonymous>.Zone.run (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:169:47)
      at Object.wrappedFunc (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:4330:34)

Test Suites: 1 failed, 1 total
Tests:       1 failed, 1 passed, 2 total

```

Figura 3. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

json-helper.ts

```

1     public static parseObjectToJSON(object: Object): string {
2         let jsonResponse = "{"
3         const entries = Object.entries(object)
4         for (const entry of entries) {
5             const [key, value] = entry
6             jsonResponse += `${key}:"`;
7             if (!value)
8                 jsonResponse += `null`
9             else
10                jsonResponse += `${value}`
11            if (entries.indexOf(entry) !== entries.length - 1)
12                jsonResponse += ","
13        }
14        jsonResponse += "}"
15        return jsonResponse
16    }

```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (2 ms)
    ✓ Should parse null values as null (1 ms)

Test Suites: 1 passed, 1 total
Tests:       2 passed, 2 total
Snapshots:   0 total
Time:        3.537 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 4. Teste no green state. (Fonte: elaborado pelo autor, 2023)

### Refatoração

Não foi identificada necessidade de refatoração nesse ciclo.

## 2.3 Terceiro Ciclo

Durante o terceiro ciclo, um objeto genérico foi escolhido para o tratamento de valores `undefined`, que não devem aparecer no JSON.

### Teste - Red State

**json-helper.spec.ts**

```

1  it("Shouldn't contain undefined values", () => {
2      const input: Object = {
3          name: "John Doe",
4          age: undefined
5      }
6
7      expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })

```

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (4 ms)
    ✓ Should parse null values as null (1 ms)
    ✗ Shouldn't contain undefined values (3 ms)

● JsonHelper › Shouldn't contain undefined values

  expect(received).toEqual(expected) // deep equality

  Expected: "{\\"name\\":\\"John Doe\\"}"
  Received: "{\\"name\\":\\"John Doe\\",\\"age\\":null}"

   31 |         age: undefined
   32 |       }
>  33 |       expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
      |                                         ^
   34 |     })
   35 |
   36 |

   at src/web/services/json-helper.spec.ts:33:53
   at _ZoneDelegate.Object.<anonymous>._ZoneDelegate.invoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:409:30)
   at ProxyZoneSpec.Object.<anonymous>.ProxyZoneSpec.onInvoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:3830:43)
   at _ZoneDelegate.Object.<anonymous>._ZoneDelegate.invoke (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:408:56)
   at Zone.Object.<anonymous>.Zone.run (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:169:47)
   at Object.wrappedFunc (node_modules/zone.js/bundles/zone-testing-bundle.umd.js:4330:34)

Test Suites: 1 failed, 1 total
Tests: 1 failed, 2 passed, 3 total
Snapshots: 0 total
Time: 3.603 s, estimated 4 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 5. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

### json-helper.ts

```

1      public static parseObjectToJSON(object: Object): string {
2          let jsonResponse = "{}"
3          const entries = Object.entries(object).filter(entry => entry[1] !==
4      undefined)
5          for (const entry of entries) {
6              const [key, value] = entry
7              jsonResponse += `${key}:"`;
8              if (!value)
9                  jsonResponse += `null`
10             else
11                 jsonResponse += `${value}`
12             if (entries.indexOf(entry) !== entries.length - 1)
13                 jsonResponse += ","
14         }
15         jsonResponse += "}"
16         return jsonResponse

```

## Teste - Green State

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values

Test Suites: 1 passed, 1 total
Tests:       3 passed, 3 total
Snapshots:   0 total
Time:        3.097 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.
```

Figura 6. Teste no green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

Uma pequena mudança foi realizada durante a refatoração.

### json-helper.ts

```
1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{}"
3
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5      undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += `"${key}":`;
9          if (!value)
10             jsonResponse += value
11         else
12             jsonResponse += `"${value}"`
13         if (entries.indexOf(entry) !== entries.length - 1)
14             jsonResponse += ", "
15     }
16     jsonResponse += "}"
17     return jsonResponse
18 }
```

Validada pela execução correta dos testes.



```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values

Test Suites: 1 passed, 1 total
Tests:       3 passed, 3 total
Snapshots:   0 total
Time:        3.097 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 7. Testes em green state. (Fonte: elaborado pelo autor, 2023)

## 2.4 Quarto Ciclo

Durante o quarto ciclo será feito o tratamento de números, que não devem ser rodeados por aspas em JSON.

### Teste - Red State

Foram escritos três testes, para tratar números que são nativamente do tipo `number` e números em string.

#### json-helper.spec.ts

```

1      it("Shouldn't quote numeric values", () => {
2          const input: Object = {
3              name: "John Doe",
4              age: 25
5          };
6
7          expect(JsonHelper.parseObjectToJson(input)).toEqual(JSON.stringify(input))
8      })
9      it("Shouldn't quote float values", () => {
10         const input: Object = {
11             name: "John Doe",
12             score: 50.2
13         };
14
15         expect(JsonHelper.parseObjectToJson(input)).toEqual(JSON.stringify(input))
16     })
17     it("Should quote string numbers", () => {
18         const input: Object = {
19             name: "John Doe",
20             age: "25"

```

```

20     };
21     expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })

```

A execução destes testes indicou que a última opção já está contemplada no código.

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (2 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✗ Shouldn't quote numeric values (3 ms)
    ✗ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers

```

Figura 8. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

### json-helper.ts

```

1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5  undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += `${key}":`;
9          if (!value)
10             jsonResponse += value
11          else if (typeof value === 'number')
12             jsonResponse += `${value}`
13          else
14             jsonResponse += `${value}`
15          if (entries.indexOf(entry) !== entries.length - 1)
16             jsonResponse += ","
17      }
18      jsonResponse += "}"
19      return jsonResponse
    }

```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)

Test Suites: 1 passed, 1 total
Tests:       6 passed, 6 total
Snapshots:  0 total
Time:        3.309 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 9. Teste no green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

json-helper.ts

```

1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5      undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += ` "${key}": `;
9          if (!value || typeof value === 'number')
10             jsonResponse += value
11         else
12             jsonResponse += ` "${value}"`
13         if (entries.indexOf(entry) !== entries.length - 1)
14             jsonResponse += ", "
15     }
16     jsonResponse += "}"
17     return jsonResponse
18 }

```

Validada pela execução correta dos testes.

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)

Test Suites: 1 passed, 1 total
Tests:       6 passed, 6 total
Snapshots:   0 total
Time:        3.567 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 10. Testes em green state. (Fonte: elaborado pelo autor, 2023)

## 2.5 Quinto Ciclo

Durante o quinto ciclo os enums serão tratados, para isso foi escolhido um enum do próprio projeto, disponível na classe `api-output.ts`, o `JoinState`, que corresponde a um dos atributos de `Student`.

### api-output.ts

```

1  export enum JoinState {
2    JOINED = "JOINED",
3    NOT_JOINED = "NOT_JOINED",
4  }

```

### Teste - Red State

#### json-helper.spec.ts

```

1  it("Should parse enum as string", () => {
2    const input: Student = {
3      name: "John Doe",
4      courseId: "TESTES",
5      email: "email@test.com.zt",
6      teamName: "PassaNada",
7      sectionName: "T01",
8      joinState: JoinState.JOINED
9    };
10

```

```

11
12 expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })

```

A execução dos testes apontou que essa especificação já estava contemplada na implementação. Portanto, o ciclo foi encerrado nesse instante.

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (6 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string (1 ms)

Test Suites: 1 passed, 1 total
Tests:       7 passed, 7 total
Snapshots:   0 total
Time:        3.503 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 11. Indicação de Green State (Fonte: elaborado pelo autor, 2023)

## 2.6 Sexto Ciclo

Durante o sexto ciclo, foi implementada o tratamento de valores do tipo `boolean`. Para isso foi utilizado um objeto do tipo `InstructorPermissionSet`.

### api-output.ts

```

1  export interface InstructorPermissionSet {
2    canModifyCourse: boolean;
3    canModifyInstructor: boolean;
4    canModifySession: boolean;
5    canModifyStudent: boolean;
6    canViewStudentInSections: boolean;
7    canViewSessionInSections: boolean;
8    canSubmitSessionInSections: boolean;
9    canModifySessionCommentsInSections: boolean;
10 }

```

### Teste - Red State

#### json-helper.spec.ts

```
1  it("Shouldn't quote boolean values", () => {
2      const input: InstructorPermissionSet = {
3          canModifyCourse: true,
4          canModifyInstructor: true,
5          canModifySession: true,
6          canModifyStudent: true,
7          canViewStudentInSections: false,
8          canViewSessionInSections: false,
9          canSubmitSessionInSections: true,
10         canModifySessionCommentsInSections: true,
11     };
12
13
14     expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
15 })
```

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (4 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers
    ✓ Should parse enum as string (1 ms)
    ✗ Shouldn't quote boolean values (4 ms)

● JsonHelper › Shouldn't quote boolean values
```

Figura 12. Testes no red state. (Fonte: elaborado pelo autor, 2023)

#### Implementação do Código

#### json-helper.ts

```
1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3      const nonQuotable = ['number', 'boolean']
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5      undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += `"${key}":`;
9          if (!value || nonQuotable.indexOf(typeof value) !== -1)
10             jsonResponse += value
```

```

11         else
12             jsonResponse += `${value}`
13             if (entries.indexOf(entry) !== entries.length - 1)
14                 jsonResponse += ","
15         }
16         jsonResponse += "}"
17         return jsonResponse
    }
}

```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers
    ✓ Should parse enum as string
    ✓ Shouldn't quote boolean values

Test Suites: 1 passed, 1 total
Tests:       8 passed, 8 total
Snapshots:   0 total
Time:        3.467 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.

```

Figura 13. Teste no green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

Não foi identificada necessidade de refatoração nesse ciclo.

## 2.7 Sétimo Ciclo

Neste ciclo a conversão de objetos aninhados foi implementada. Para isso foi utilizado um objeto do tipo `FeedbackSessionLogEntry`, que contém um enum e um objeto aninhado.

### api-output.ts

```

1 export interface FeedbackSessionLogEntry {
2     studentData: Student;
3     feedbackSessionLogType: FeedbackSessionLogType;

```

```

4     timestamp: number;
5   }
6
7   export enum FeedbackSessionLogType {
8     ACCESS = "access",
9     SUBMISSION = "submission",
10    VIEW_RESULT = "view result",
11  }

```

## Teste - Red State

json-helper.spec.ts

1

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (4 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string (1 ms)
    ✓ Shouldn't quote boolean values (1 ms)
    ✗ Should parse nested objects (4 ms)

● JsonHelper › Should parse nested objects

expect(received).toEqual(expected) // deep equality

Expected: "{\\"studentData\\":{\\"name\\":\\"John Doe\\",\\"courseId\\":\\"TESTES\\",\\"email\\":\\"email@test.com.zt\\",\\"teamName\\":\\"PassaNada\\",\\"sectionName\\":\\"T01\\",\\"joinState\\":\\"JOINED\\"},\\"feedbackSessionLogType\\":\\"access\\",\\"timestamp\\":168825313}"
Received: "{\\"studentData\\":\\"[object Object]\\",\\"feedbackSessionLogType\\":\\"access\\",\\"timestamp\\":168825313}"

```

Figura 14. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

json-helper.ts

```

1   public static parseObjectToJSON(object: Object): string {
2     let jsonResponse = "{"
3     const nonQuotable = ['number', 'boolean']
4     const entries = Object.entries(object).filter(entry => entry[1] !==
5     undefined)
6     for (const entry of entries) {
7       const [key, value] = entry
8       jsonResponse += `"${key}":`;
9       if (!value || nonQuotable.indexOf(typeof value) !== -1)
10        jsonResponse += value
11       else if (typeof value === 'object')
12        jsonResponse += this.parseObjectToJSON(value)
13       else
14        jsonResponse += `"${value}"`

```



```

15         if (entries.indexOf(entry) !== entries.length - 1)
16             jsonResponse += ","
17     }
18     jsonResponse += "}"
19     return jsonResponse
    }

```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
Another process, with id 44646, is currently running ngcc.
Waiting up to 250s for it to finish.
(If you are sure no ngcc process is running then you should delete the lock-file at /home/
nicolas/Documents/unb/teammates/node_modules/.ngcc_lock_file.)
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (3 ms)
    ✓ Shouldn't contain undefined values
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string
    ✓ Shouldn't quote boolean values (1 ms)
    ✓ Should parse nested objects

Test Suites: 1 passed, 1 total
Tests:       9 passed, 9 total
Snapshots:   0 total
Time:        3.252 s
Ran all test suites related to changed files.

```

Figura 15. Teste no green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

Um novo teste foi adicionado, para identificar se há falhas na conversão de objetos com mais de um nível de aninhamento.

### json-helper.spec.ts

```

1  it("Should parse nested objects with more levels", () => {
2      const input: Object = {
3          name: "John Doe",
4          address: {
5              country: {
6                  code: "BR",
7                  name: "Brazil"
8              },
9              city: {
10                 state: "DF",
11                 name: "Brasília"
12             }
13         }
14     }

```

```

14     }
15
16
17     expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })

```

E a execução deste teste apontou que essa especificação também foi contemplada.

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
Another process, with id 45153, is currently running ngcc.
Waiting up to 250s for it to finish.
(If you are sure no ngcc process is running then you should delete the lock-file at /home/
nicolas/Documents/unb/teammates/node_modules/.ngcc_lock_file.)
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string
    ✓ Shouldn't quote boolean values (1 ms)
    ✓ Should parse nested objects
    ✓ Should parse nested objects with more levels (1 ms)

Test Suites: 1 passed, 1 total
Tests:       10 passed, 10 total
Snapshots:   0 total
Time:        3.162 s

```

Figura 16. Situação de Green State. (Fonte: elaborado pelo autor, 2023)

## 2.8 Oitavo Ciclo

Neste ciclo foi implementada a conversão de atributos do tipo. Para isso foi utilizado um objeto do tipo `Notifications`:

### api-output.ts

```

1  export interface Notification extends ApiOutput {
2    notificationId: string;
3    startTimestamp: number;
4    endTimestamp: number;
5    createdAt: number;
6    style: NotificationStyle;
7    targetUser: NotificationTargetUser;
8    title: string;
9    message: string;
10   shown: boolean;
11  }
12
13  export interface Notifications extends ApiOutput {
14    notifications: Notification[];

```

```

15   }
16
17
18   export enum NotificationStyle {
19       PRIMARY = "PRIMARY",
20       SECONDARY = "SECONDARY",
21       SUCCESS = "SUCCESS",
22       DANGER = "DANGER",
23       WARNING = "WARNING",
24       INFO = "INFO",
25       LIGHT = "LIGHT",
26       DARK = "DARK",
27   }
28
29
30   export enum NotificationTargetUser {
31       STUDENT = "STUDENT",
32       INSTRUCTOR = "INSTRUCTOR",
33       GENERAL = "GENERAL",
34   }

```

## Teste - Red State

### json-helper.spec.ts

```

1   it("Should parse array attribute", () => {
2       const input: Notifications = {
3           notifications: [
4               {
5                   notificationId: "41841",
6                   startTimestamp: 1688826966,
7                   endTimestamp: 1688827486,
8                   createdAt: 1688826999,
9                   style: NotificationStyle.WARNING,
10                  targetUser: NotificationTargetUser.STUDENT,
11                  title: "Activity wanting attention",
12                  message: "Don't forget to fill your feedback sessions.",
13                  shown: true,
14              },
15              {
16                  notificationId: "1894",
17                  startTimestamp: 1688812547,
18                  endTimestamp: 1688812458,
19                  createdAt: 1688812200,
20                  style: NotificationStyle.DANGER,
21                  targetUser: NotificationTargetUser.INSTRUCTOR,
22                  title: "Invalid Submission",
23                  message: "The data submitted for course was invalid.",
24                  shown: false,
25              }
26          ]
27      }

```

```
28
29 expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })
```

Figura 17. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

### json-helper.ts

```
1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3      const nonQuotable = ['number', 'boolean']
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5      undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += `${key}:"`;
9          if (!value || nonQuotable.indexOf(typeof value) !== -1)
10             jsonResponse += value
11             else if (value instanceof Array) {
12                 jsonResponse += '['
13                 jsonResponse += value.map(value =>
14                 this.parseObjectToJSON(value)).join(',')
15                 jsonResponse += ']'
16             }
17             else if (typeof value === 'object')
18                 jsonResponse += this.parseObjectToJSON(value)
19             else
20                 jsonResponse += `${value}`
21             if (entries.indexOf(entry) !== entries.length - 1)
22                 jsonResponse += ","
23         }
24         jsonResponse += "}"
25         return jsonResponse
26     }
```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string (1 ms)
    ✓ Shouldn't quote boolean values
    ✓ Should parse nested objects
    ✓ Should parse nested objects with more levels (1 ms)
    ✓ Should parse array attribute

Test Suites: 1 passed, 1 total
Tests:       11 passed, 11 total
Snapshots:   0 total
Time:        1.036 s
Ran all test suites matching /json/i.

```

Figura 18. Teste no green state. (Fonte: elaborado pelo autor, 2023)

## Refatoração

Após a refatoração, o código ficou da seguinte maneira:

### json-helper.ts

```

1  public static parseObjectToJSON(object: Object): string {
2      let jsonResponse = "{"
3      const nonQuotable = ['number', 'boolean']
4      const entries = Object.entries(object).filter(entry => entry[1] !==
5      undefined)
6      for (const entry of entries) {
7          const [key, value] = entry
8          jsonResponse += `"${key}":`;
9          if (!value || nonQuotable.indexOf(typeof value) !== -1)
10             jsonResponse += value
11          else if (value instanceof Array)
12             jsonResponse += `[${value.map(value =>
13             this.parseObjectToJSON(value)).join(',')}]`
14          else if (typeof value === 'object')
15             jsonResponse += this.parseObjectToJSON(value)
16          else
17             jsonResponse += `"${value}"`
18          if (entries.indexOf(entry) !== entries.length - 1)
19             jsonResponse += ","
20      }
21      jsonResponse += "}"

```

```
    return jsonResponse
  }
```

Validada pela execução correta dos testes.

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (5 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers
    ✓ Should parse enum as string (1 ms)
    ✓ Shouldn't quote boolean values
    ✓ Should parse nested objects (1 ms)
    ✓ Should parse nested objects with more levels (1 ms)
    ✓ Should parse array attribute

Test Suites: 1 passed, 1 total
Tests:       11 passed, 11 total
Snapshots:   0 total
Time:        4.22 s
Ran all test suites matching /json/i.

Watch Usage: Press w to show more.
```

Figura 19. Testes em green state. (Fonte: elaborado pelo autor, 2023)

## 2.9 Nono Ciclo

Neste ciclo foi implementada a conversão de um array de objetos.

### Teste - Red State

json-helper.spec.ts

```
1  it("Should parse array attribute", () => {imagin
2      const input: Notifications = {
3          notifications: [
4              {
5                  notificationId: "41841",
6                  startTimestamp: 1688826966,
7                  endTimestamp: 1688827486,
8                  createdAt: 1688826999,
9                  style: NotificationStyle.WARNING,
10                 targetUser: NotificationTargetUser.STUDENT,
11                 title: "Activity wanting attention",
```

```

12         message: "Don't forget to fill your feedback sessions.",
13         shown: true,
14     },
15     {
16         notificationId: "1894",
17         startTimestamp: 1688812547,
18         endTimestamp: 1688812458,
19         createdAt: 1688812200,
20         style: NotificationStyle.DANGER,
21         targetUser: NotificationTargetUser.INSTRUCTOR,
22         title: "Invalid Submission",
23         message: "The data submitted for course was invalid.",
24         shown: false,
25     }
26 ]
27 }
28
29 expect(JsonHelper.parseObjectToJSON(input)).toEqual(JSON.stringify(input))
    })

```

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
FAIL src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string
    ✓ Shouldn't quote boolean values (1 ms)
    ✓ Should parse nested objects (1 ms)
    ✓ Should parse nested objects with more levels
    ✓ Should parse array attribute (1 ms)
    ✗ Should parse an array of objects (3 ms)

● JsonHelper › Should parse an array of objects

  expect(received).toEqual(expected) // deep equality

  Expected: [{"courseId":"Testes-2023-1","courseName":"Testes de Software","timeZone":"America/Sao Paulo","institute":"UnB","creationTimestamp":1688827796,"deletionTimestamp":-1}]
  Received: [{"courseId":"Testes-2023-1","courseName":"Testes de Software","timeZone":"America/Sao Paulo","institute":"UnB","creationTimestamp":1688827796,"deletionTimestamp":-1}]

```

Figura 20. Testes no red state. (Fonte: elaborado pelo autor, 2023)

## Implementação do Código

### json-helper.ts

```

1  export class JsonHelper {
2
3      public static parseObjectToJSON(object: Object): string {
4          let jsonResponse: string;
5          if (object instanceof Array) {
6              jsonResponse = `[${object.map(obj =>
7  this.parseObjectToJSON(obj)).join(',')}]`
8
9          } else {
10             jsonResponse = `{`
11             const nonQuotable = ['number', 'boolean']
12             const entries = Object.entries(object).filter(entry => entry[1]
13  !== undefined)

```

```

14         for (const entry of entries) {
15             const [key, value] = entry
16             jsonResponse += `"${key}":`;
17             if (!value || nonQuotable.indexOf(typeof value) !== -1)
18                 jsonResponse += value
19             else if (value instanceof Array)
20                 jsonResponse += `[${value.map(value =>
21 this.parseObjectToJSON(value)).join(',')}]`
22             else if (typeof value === 'object')
23                 jsonResponse += this.parseObjectToJSON(value)
24             else
25                 jsonResponse += `"${value}"`
26             if (entries.indexOf(entry) !== entries.length - 1)
27                 jsonResponse += ","
28         }
29         jsonResponse += "}"
30     }
31     return jsonResponse
}

```

## Teste - Green State

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (4 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string (1 ms)
    ✓ Shouldn't quote boolean values (1 ms)
    ✓ Should parse nested objects (1 ms)
    ✓ Should parse nested objects with more levels (1 ms)
    ✓ Should parse array attribute (1 ms)
    ✓ Should parse an array of objects (1 ms)

Test Suites: 1 passed, 1 total
Tests:       12 passed, 12 total
Snapshots:   0 total
Time:        0.844 s, estimated 1 s
Ran all test suites matching /json/i with tests matching "json".

Watch Usage: Press w to show more.

```

Figura 21. Teste no green state. (Fonte: elaborado pelo autor, 2023)



## Refatoração

Após a refatoração, o código ficou da seguinte maneira:

json-helper.ts

```
1  export class JsonHelper {
2
3      public static parseObjectToJSON(object: Object): string {
4
5          if (object instanceof Array)
6              return `[${object.map(obj =>
7  this.parseObjectToJSON(obj)).join(',')}]`
8
9          const entries = Object.entries(object).filter(entry => entry[1] !==
10 undefined).map(entry => {
11              return `"${entry[0]}":${this.parseAttributeToJson(entry[1])}`;
12          })
13          return `{${entries.join(",")}}`
14      }
15
16      private static parseAttributeToJson(value: Object) {
17          const nonQuotable = ['number', 'boolean']
18          if (!value || nonQuotable.indexOf(typeof value) !== -1)
19              return value
20          else if (value instanceof Array)
21              return `[${value.map(value =>
22  this.parseObjectToJSON(value)).join(',')}]`
23          else if (typeof value === 'object')
24              return this.parseObjectToJSON(value)
25          return `"${value}"`
26      }
27  }
```

Validada pela execução correta dos testes.

```

Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (3 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers
    ✓ Should parse enum as string
    ✓ Shouldn't quote boolean values (1 ms)
    ✓ Should parse nested objects (1 ms)
    ✓ Should parse nested objects with more levels (1 ms)
    ✓ Should parse array attribute (1 ms)
    ✓ Should parse an array of objects (1 ms)

Test Suites: 1 passed, 1 total
Tests:       12 passed, 12 total
Snapshots:   0 total
Time:        0.779 s, estimated 1 s
Ran all test suites matching /json/i with tests matching "json".

Watch Usage: Press w to show more.

```

Figura 22. Testes em green state. (Fonte: elaborado pelo autor, 2023)

### 3. Código Fonte

| Descrição                | Link  |
|--------------------------|---|
| Código de teste          | <a href="#">json-helper.spec.ts</a>                           |
| Código da funcionalidade | <a href="#">json-helper.ts</a>                                |
| Commits                  | <a href="#">Commit #cda69</a> e <a href="#">Commit #a039a</a> |

### 4. Resultado Final da Execução dos Testes

```
Determining test suites to run...
ngcc-jest-processor: running ngcc
PASS src/web/services/json-helper.spec.ts
  JsonHelper
    ✓ Should parse student to JSON (4 ms)
    ✓ Should parse null values as null (1 ms)
    ✓ Shouldn't contain undefined values (1 ms)
    ✓ Shouldn't quote numeric values (1 ms)
    ✓ Shouldn't quote float values (1 ms)
    ✓ Should quote string numbers (1 ms)
    ✓ Should parse enum as string (1 ms)
    ✓ Shouldn't quote boolean values
    ✓ Should parse nested objects
    ✓ Should parse nested objects with more levels
    ✓ Should parse array attribute (1 ms)
    ✓ Should parse an array of objects (1 ms)

Test Suites: 1 passed, 1 total
Tests:       12 passed, 12 total
Snapshots:   0 total
Time:        2.788 s
Ran all test suites matching /json/i with tests matching "json".

Watch Usage: Press w to show more.█
```

Figura 23. Resultado Final (Fonte: elaborado pelo autor, 2023)

## 5. Conclusão

A realização de um método utilitário com a metodologia Test-Driven Development foi essencial para a fixação das etapas de desenvolvimento e documentação do requisito elaborado. A escolha da função teve maior influência pelo fator didático, uma vez que o próprio javascript faz essa conversão automaticamente com o método que foi utilizado para testar. Foram encontradas dificuldades em aplicar TDD em funcionalidades propostas em issues abertas, por envolverem mais conhecimento de código e do projeto em si. Além disso, durante o período do trabalho, não foi possível encontrar outros projetos com boas issues iniciais e propícias para o TDD, uma vez que muitas issues são referentes à problemas em interfaces, bugs visuais e problemas correlatos, que envolvem uma configuração maior dos testes, escapando do escopo do TDD. Como citado anteriormente, esse método, embora adequado para o aprendizado, não agrega valor ao produto `teammates`, por este motivo não foi realizado um `Pull Request`.

Este documento explicita como os testes podem fornecer uma documentação detalhada acerca da funcionalidade, uma vez que pelos nomes dos testes realizados é possível extrair todos os critérios de aceitação do requisito especificado inicialmente, em um nível entre baixo e alto nível, isto é, esses requisitos estão em um nível de compreensão compatível com um analista de requisitos e um desenvolvedor.