Evaluating code complexity of SPL variability management:

Emergence of Code Unpluggable Decorators-Based Annotations

Wrapper from pure::variants:

```
1  //PV:IFCOND(pv:hasFeature(HazardWarning))
2  static int warning_lights_value; [REMAINING CODE OF HazardWarning ...]
3  //PV:ENDCOND
```

Adapted to code

```
import { PuzzleManagerService } from "src/app/services/puzzleGenerator/puzzle-manager.service";
var EXPRESSION_START91 = { "zoomCoordinates": "true" };
import { SetZoomComponent } from "./set-zoom/set-zoom.component";
var EXPRESSION_END91 = { "EXPRESSION_END": "------------------------" };
[ ... OTHER IMPORTS ...]
@Component({
    selector: "app-zoom-management", templateUrl: "./zoom-management.component.html",
    styleUrls: ["./zoom-management.component.scss"]})
export class ZoomManagementComponent implements ZoomManagementInterface, AfterViewInit {
    centerX = 25;
    [ ... OTHER CLASS VARIABLES ...]
    constructor(puzzleManagerService: PuzzleManagerService,
    @DecoratorTypesService.skipLineParameter({ "OR": { "zoomCoordinates": "true", "zoomValue"
      componentFactoryService: ComponentFactoryService) {
            this.zoomManagerService = puzzleManagerService.getZoomManagerService();
            this.zoomManagerService.initForComponent(this);
    }
    ngAfterViewInit(): void { this.getComponentElement(this); }
    EXPRESSION_START97 = { "zoomCoordinates": "true" };
    public addZoomCoordinates(zoomHTML: Element | null): void {
        const positionAfterHeading = function <T>(domLocation: HTMLElement, componentRef: Compone
            domLocation.insertBefore(componentRef.location.nativeElement, domLocation.children.item(1)
        this.instantiateZoomCoordinatesComponentAndEvents(zoomHTML, this, positionAfterHeading);
    }
    EXPRESSION_END97 = { "EXPRESSION_END": "------------------------" };
    public getComponentElement(self: ZoomManagementComponent): Element | null | undefined {
        const zoomHTML = document.getElementsByClassName("zoom-management-part")?.item(0);
        var EXPRESSION_START93 = { "zoomValue": "true" };
        this.addZoomValue(zoomHTML);
        var EXPRESSION_END93 = { "EXPRESSION_END": "------------------------" };
        [ ... OTHER CALLS ...]
        return zoomHTML;
    }
    [ ... OTHER METHODS ...]
}
[ ... OTHER CONTENT ...]
```

Our decorator:

```
3  //@{"computerOpponent": "true"}
4  public class ComputerPlayer extends AbstractPlayer{
```

Adapted to code

```
import { PuzzleManagerService } from "src/app/services/puzzleGenerator/puzzle-manager.se
var EXPRESSION_START101 = { "zoomCoordinates": "true" };
import { SetZoomComponent } from "./set-zoom/set-zoom.component";
var EXPRESSION_END101 = { "EXPRESSION_END": "------------------------" };
[ ... OTHER IMPORTS ...]
@Component({
    selector: "app-zoom-management", templateUrl: "./zoom-management.component.html",
    styleUrls: ["./zoom-management.component.scss"]})
export class ZoomManagementComponent implements ZoomManagementInterface, AfterVie
    centerX = 25;
    [ ... OTHER CLASS VARIABLES ...]
    constructor(puzzleManagerService: PuzzleManagerService,
    @DecoratorTypesService.skipLineParameter({ "OR": { "zoomCoordinates": "true", "zo
      componentFactoryService: ComponentFactoryService) {
            this.zoomManagerService = puzzleManagerService.getZoomManagerService();
            this.zoomManagerService.initForComponent(this);
    }
    ngAfterViewInit(): void { this.getComponentElement(this); }
    @DecoratorTypesService.wholeBlockMethod({ "zoomValue": "true" })
    public addZoomValue(zoomHTML: Element | null): void {
        const positionAfterHeading = function <T>(domLocation: HTMLElement, componentRef
            domLocation.insertBefore(componentRef.location.nativeElement, domLocation.children
        this.instantiateZoomValueComponentAndEvents(zoomHTML, this, positionAfterHeading);
    }
    public getComponentElement(self: ZoomManagementComponent): Element | null | undefi
        const zoomHTML = document.getElementsByClassName("zoom-management-part")?.ite
        var EXPRESSION_START103 = { "zoomValue": "true" };
        this.addZoomValue(zoomHTML);
        var EXPRESSION_END103 = { "EXPRESSION_END": "------------------------" };
        [ ... OTHER CALLS ...]
        return zoomHTML;
    } [ ... OTHER METHODS ...]
}
[ ... OTHER CONTENT ...]
```

Cf1: SOURCE CODE IN FORM 1

G	H	I	J
Halstead Difficulty	Halstead Effort	Halstead Length	Halstead Time
8.13	3060.883	74	170.049
5.893	2149.082	69	119.393
14.211	19460.57	216	1081.143
8.069	3717.772	86	206.543
14.737	18517.35	203	1028.[illegible]
4.857	758.103	35	42.117
4.75	903.429	40	50.19
14.537	33312.59	348	1850.7
5.125	2448.68	87	136.038
11.217	15945.04	247	885.836
3.5	239.863	18	13.326
12	20255.46	267	1125.303
11.684	15559		
2.5	340.		
2.708	232.		
2.679	261.		
2.5	148.		
2.667	276.		
2.5			
2.5	161.		
4	903.		
21.309	37671		

Cf2: SOURCE CODE IN FORM 2

AA	AB	AC	AD
Halstead Difficulty	Halstead Effort	Halstead Length	Halstea Time
7.619	2528.999	67	14
4.846	1541.152	62	85
13.548	17797.83	209	988.7
6.852	2819.858	79	156.6
14.045	16873.36	196	937.4
3.75	437.842	28	24.3
3.719	555.126	33	30
13.3	24866.39	288	1381.4
5.162	2240.728	80	124.4
12.989	17855.49	240	991.9
3	114.161	11	6.3
10.935	14531.32	214	807.2
10.353	10210.6	165	567.2
1.5	147.161	22	8.1
65	85.48	14	4.7
25	101.579	16	5.6
.5	42.794	9	2.3
15	109.846	17	6.1

TRANSFORMATION

METRICS OF Cf1

METRICS OF Cf2

TESTING SIGNIFICANCE OF DIFFERENCE

Name of compared metric	Corr.	W	p-value	95% CI	Est.	p>0.05
Cyclomatic Complexity	1.0000	0	1.0000E+00	NaN, NaN	NaN	TRUE
Cyclomatic Density	0.8226	0	3.5776E-13	-4.1959, -2.28	-3.02	FALSE
Halstead's Bugs	0.9997	2556	2.4526E-13	0.01, 0.02	0.0141	FALSE
Halstead's Difficulty	0.9971	2237	5.9298E-09	0.60, 0.80	0.7390	FALSE
Halstead's Effort	0.9988	2386	2.2106E-10	503.04, 1493.10	841.6983	FALSE
Halstead's Length	0.9997	2556	9.3382E-17	6.00, 6.00	6.0000	FALSE
Halstead's Time	0.9988	2386	2.2106E-10	27.95, 82.95	46.7609	FALSE
Halstead's Vocabulary	0.9994	2484	4.2116E-14	3.00, 3.45	3.0000	FALSE
Halstead's Volume	0.9997	2556	2.4761E-13	39.32, 45.96	42.2363	FALSE
Halstead's Id Dist. Operands	0.9996	2415	2.5713E-16	2.00, 2.00	2.0000	FALSE
Halstead's Id Ttl Operands	0.9999	2556	9.3382E-17	2.00, 2.00	2.0000	FALSE
Halstead's Id Dist. Operators	0.9886	2030	2.1410E-12	1.00, 1.50	1.0000	FALSE
Halstead's Id Ttl Operators	0.9999	2485	9.8502E-17	4.00, 4.00	4.0000	FALSE
LOC Physical	0.9998	2556	2.1563E-16	1.00, 1.00	1.0000	FALSE
LOC Logical	0.9999	2485	9.8502E-17	2.00, 2.00	2.0000	FALSE

DIFFERENCES BETWEEN Cf1 AND Cf2 METRICS

AG	AH	AI	AJ
Halstead Difficulty	Halstead Effort	Halstead Length	Halstead Time
0.511	494.137	6	27.452
1.047	583.072	6	32.392
1.217	862.22	6	47.901
1.107	304.624	6	16.924
0	0	0	0
-1.772	-1984.85	6	-110.269
0	89.295	6	4.961
1.082	434.855		
0.553	498.503		

Used metrics

Comparative analysis of:

Visualization

HALSTEAD'S TIME

HALSTEAD'S VOCABULARY

CYCLOMATIC DENSITY

HALSTEAD'S BUGS

HALSTEAD'S VOLUME

Link Code: https://github.com/jperdek/variabilityMgmtCodeConstructsComplexity

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