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과제#2 WebUI 계산기 구현

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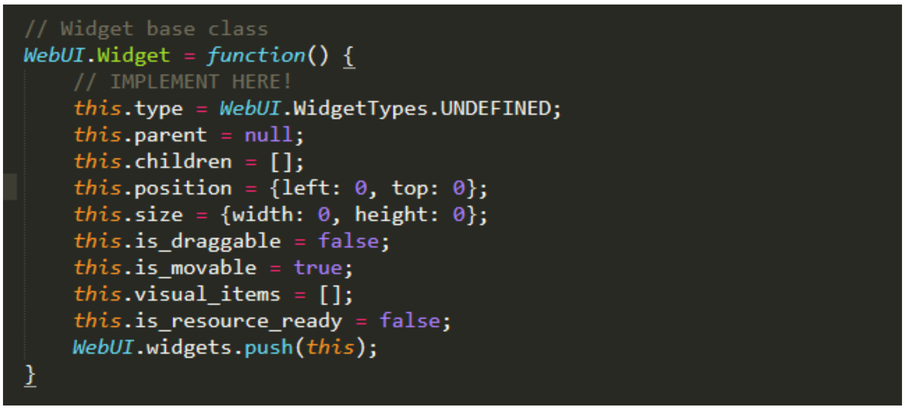
조현민

요약표

0단계	1단계	2단계	3단계
위젯 기능 구현o	레이아웃 기능 구현o	CalcButton 클래스o	GridView생성o
로그인 페이지 구성o	로그인 페이지 재구성o	initWidgets() 함수 재정의o	calcSave생성o

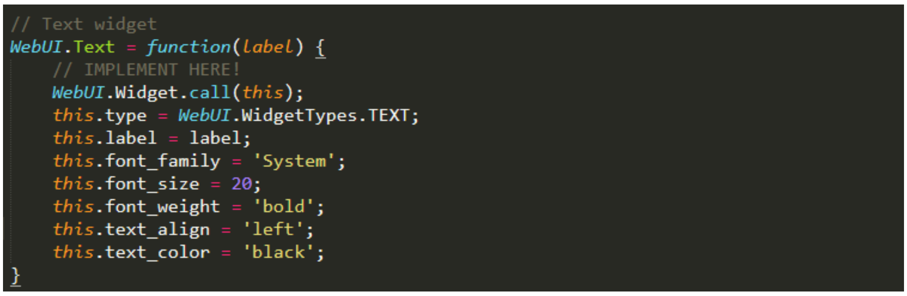
1. 0단계

Widget 구현(강의자료)



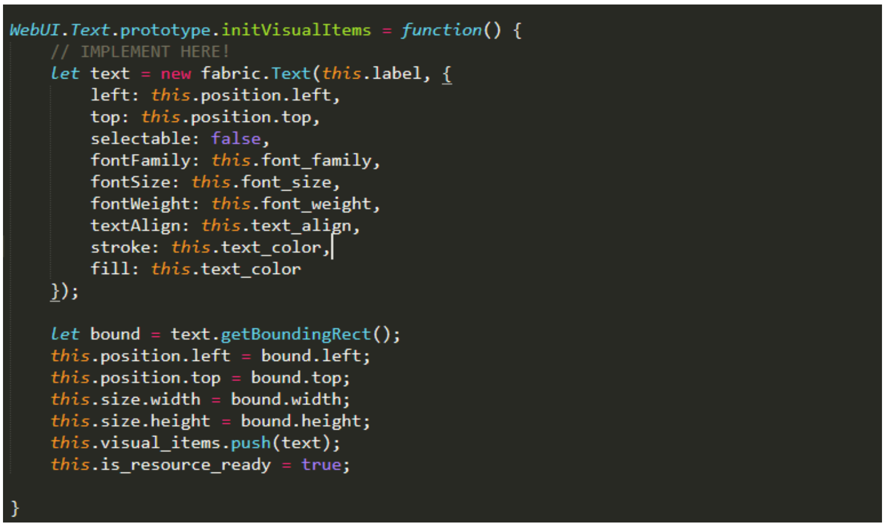
```
// Widget base class
WebUI.Widget = function() {
    // IMPLEMENT HERE!
    this.type = WebUI.WidgetTypes.UNDEFINED;
    this.parent = null;
    this.children = [];
    this.position = {left: 0, top: 0};
    this.size = {width: 0, height: 0};
    this.is_draggable = false;
    this.is_movable = true;
    this.visual_items = [];
    this.is_resource_ready = false;
    WebUI.widgets.push(this);
}
```

Text 구현(강의자료)



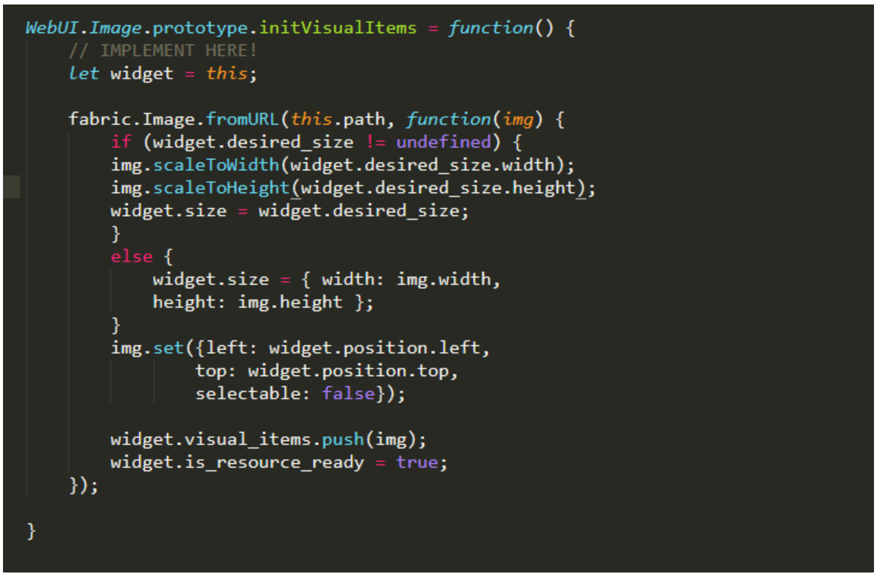
```
// Text widget
WebUI.Text = function(label) {
    // IMPLEMENT HERE!
    WebUI.Widget.call(this);
    this.type = WebUI.WidgetTypes.TEXT;
    this.label = label;
    this.font_family = 'System';
    this.font_size = 20;
    this.font_weight = 'bold';
    this.text_align = 'left';
    this.text_color = 'black';
}
```

Text initVisualItems 구현(강의자료)



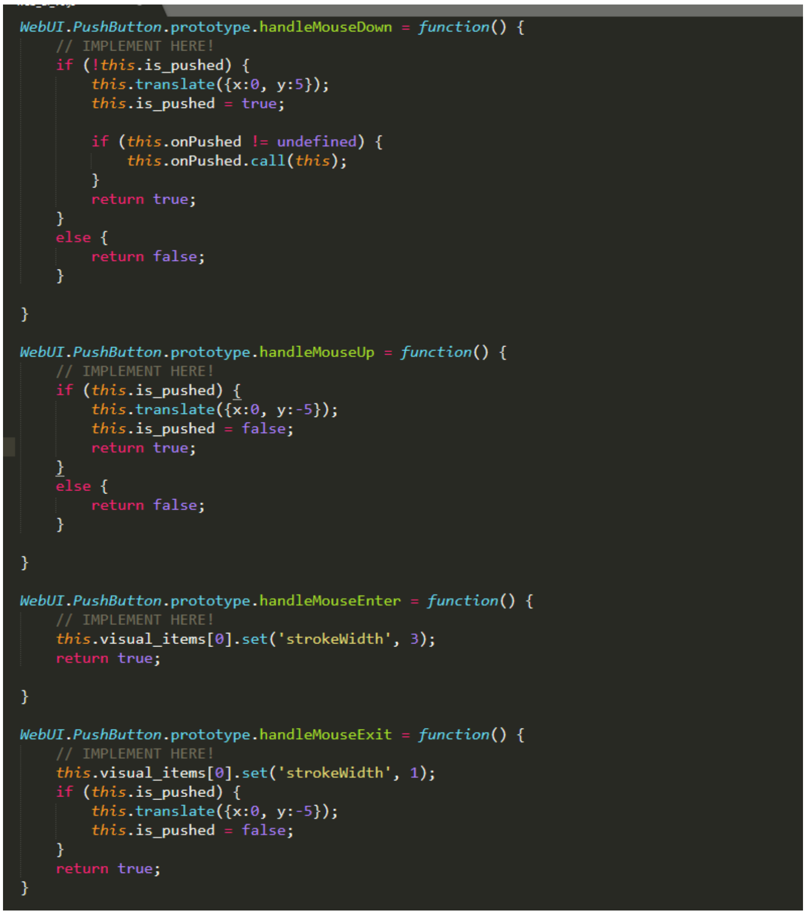
```
WebUI.Text.prototype.initVisualItems = function() {
    // IMPLEMENT HERE!
    let text = new fabric.Text(this.label, {
        left: this.position.left,
        top: this.position.top,
        selectable: false,
        fontFamily: this.font_family,
        fontSize: this.font_size,
        fontWeight: this.font_weight,
        textAlign: this.text_align,
        stroke: this.text_color,
        fill: this.text_color
    });

    let bound = text.getBoundingRect();
    this.position.left = bound.left;
    this.position.top = bound.top;
    this.size.width = bound.width;
    this.size.height = bound.height;
    this.visual_items.push(text);
    this.is_resource_ready = true;

}
```

Image initVisualItems 구현(강의자료)



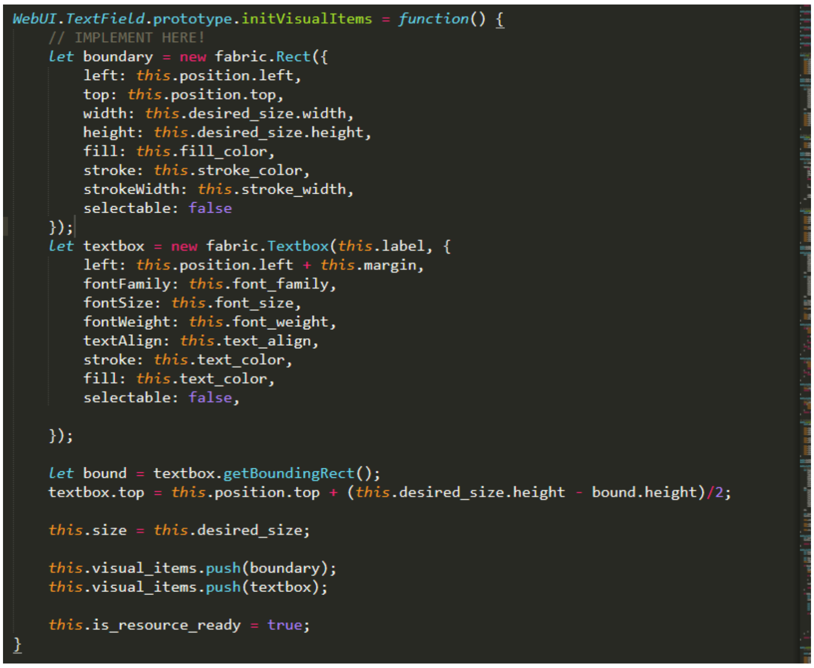
```
WebUI.Image.prototype.initVisualItems = function() {
    // IMPLEMENT HERE!
    let widget = this;

    fabric.Image.fromURL(this.path, function(img) {
        if (widget.desired_size != undefined) {
        img.scaleToWidth(widget.desired_size.width);
        img.scaleToHeight(widget.desired_size.height);
        widget.size = widget.desired_size;
        }
        else {
            widget.size = { width: img.width,
            height: img.height };
        }
        img.set({left: widget.position.left,
                top: widget.position.top,
                selectable: false});

        widget.visual_items.push(img);
        widget.is_resource_ready = true;
    });

}
```

PushButton 마우스조작 구현(강의자료)



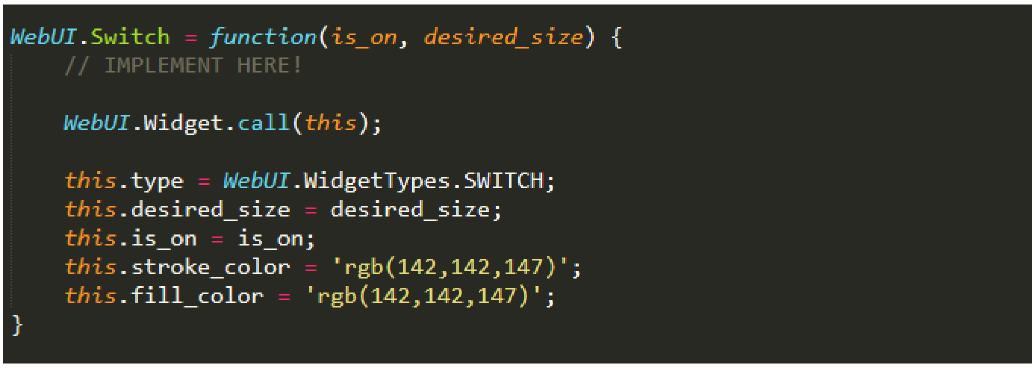
```
WebUI.PushButton.prototype.handleMouseDown = function() {
    // IMPLEMENT HERE!
    if (!this.is_pushed) {
        this.translate({x:0, y:5});
        this.is_pushed = true;

        if (this.onPushed != undefined) {
            this.onPushed.call(this);
        }
        return true;
    }
    else {
        return false;
    }

}

WebUI.PushButton.prototype.handleMouseUp = function() {
    // IMPLEMENT HERE!
    if (this.is_pushed) {
        this.translate({x:0, y:-5});
        this.is_pushed = false;
        return true;
    }
    else {
        return false;
    }

}

WebUI.PushButton.prototype.handleMouseEnter = function() {
    // IMPLEMENT HERE!
    this.visual_items[0].set('strokeWidth', 3);
    return true;

}

WebUI.PushButton.prototype.handleMouseExit = function() {
    // IMPLEMENT HERE!
    this.visual_items[0].set('strokeWidth', 1);
    if (this.is_pushed) {
        this.translate({x:0, y:-5});
        this.is_pushed = false;
    }
    return true;
}
```

TextField initVisualItems 구현(강의자료)



```
WebUI.TextField.prototype.initVisualItems = function() {
    // IMPLEMENT HERE!
    let boundary = new fabric.Rect({
        left: this.position.left,
        top: this.position.top,
        width: this.desired_size.width,
        height: this.desired_size.height,
        fill: this.fill_color,
        stroke: this.stroke_color,
        strokeWidth: this.stroke_width,
        selectable: false
    });
    let textbox = new fabric.Textbox(this.label, {
        left: this.position.left + this.margin,
        fontFamily: this.font_family,
        fontSize: this.font_size,
        fontWeight: this.font_weight,
        textAlign: this.text_align,
        stroke: this.text_color,
        fill: this.text_color,
        selectable: false,

    });

    let bound = textbox.getBoundingRect();
    textbox.top = this.position.top + (this.desired_size.height - bound.height)/2;

    this.size = this.desired_size;

    this.visual_items.push(boundary);
    this.visual_items.push(textbox);

    this.is_resource_ready = true;
}
```

Switch 정의

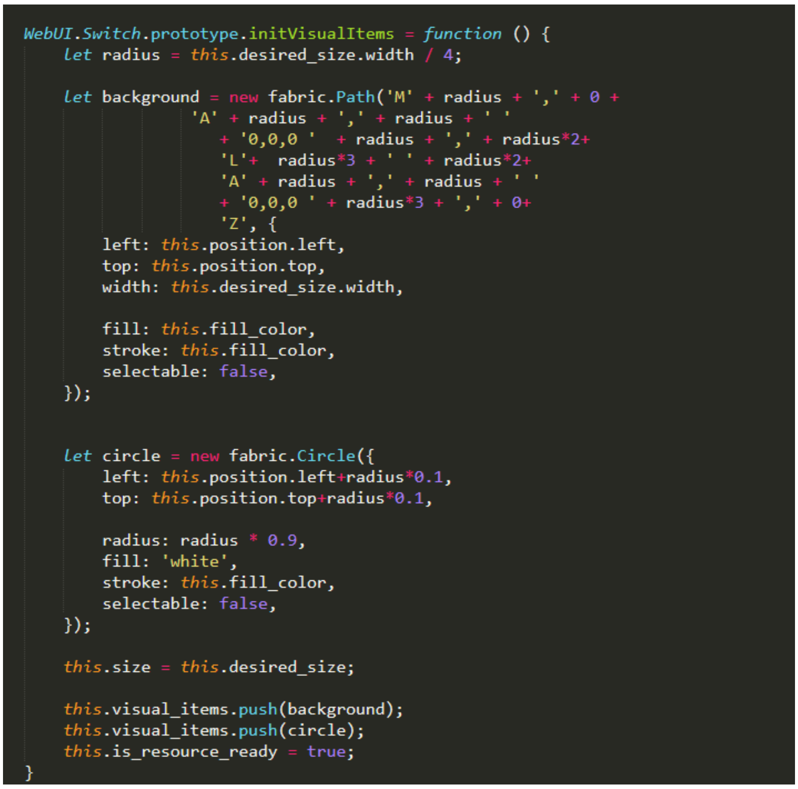


```
WebUI.Switch = function(is_on, desired_size) {
    // IMPLEMENT HERE!

    WebUI.Widget.call(this);

    this.type = WebUI.WidgetTypes.SWITCH;
    this.desired_size = desired_size;
    this.is_on = is_on;
    this.stroke_color = 'rgb(142,142,147)';
    this.fill_color = 'rgb(142,142,147)';
}
```

Switch initVisualItems 구현

스위치의 배경을 그리기 위해 fabric.Path를 이용하였다(사이트 참고).

스위치의 원은 배경보다 작게 제작하였다.

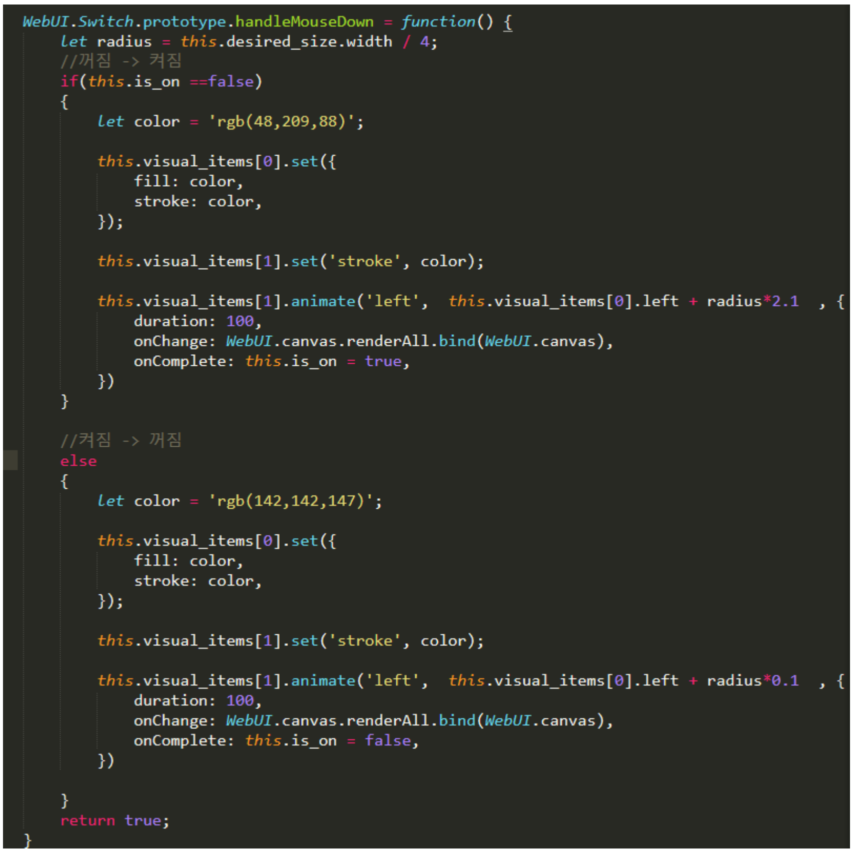


```
WebUI.Switch.prototype.initVisualItems = function () {
    let radius = this.desired_size.width / 4;

    let background = new fabric.Path('M' + radius + ',' + 0 +
                 'A' + radius + ',' + radius + ' '
                    + '0,0,0 '  + radius + ',' + radius*2+
                    'L'+  radius*3 + ' ' + radius*2+
                    'A' + radius + ',' + radius + ' '
                    + '0,0,0 ' + radius*3 + ',' + 0+
                    'Z', {
        left: this.position.left,
        top: this.position.top,
        width: this.desired_size.width,

        fill: this.fill_color,
        stroke: this.fill_color,
        selectable: false,
    });


    let circle = new fabric.Circle({
        left: this.position.left+radius*0.1,
        top: this.position.top+radius*0.1,

        radius: radius * 0.9,
        fill: 'white',
        stroke: this.fill_color,
        selectable: false,
    });

    this.size = this.desired_size;

    this.visual_items.push(background);
    this.visual_items.push(circle);
    this.is_resource_ready = true;
}
```

Switch 버튼 클릭 구현

켜져 있을 때와 꺼져있을 때, 각각에 맞는 작동을 구현하였다.

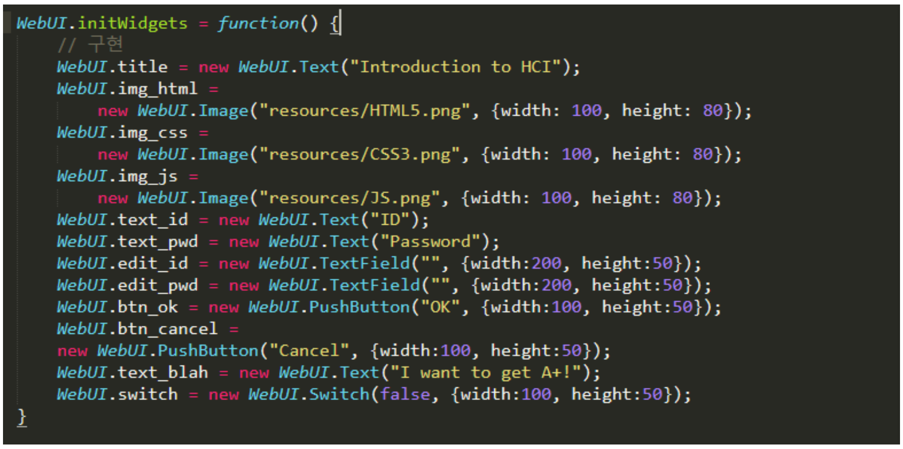
animate를 사용하여 부드럽게 움직이도록 구현하였다.



```
WebUI.Switch.prototype.handleMouseDown = function() {
    let radius = this.desired_size.width / 4;
    //꺼짐 -> 켜짐
    if(this.is_on ==false)
    {
        let color = 'rgb(48,209,88)';

        this.visual_items[0].set({
            fill: color,
            stroke: color,
        });

        this.visual_items[1].set('stroke', color);

        this.visual_items[1].animate('left',  this.visual_items[0].left + radius*2.1   , {
            duration: 100,
            onChange: WebUI.canvas.renderAll.bind(WebUI.canvas),
            onComplete: this.is_on = true,
        })
    }

    //켜짐 -> 꺼짐
    else
    {
        let color = 'rgb(142,142,147)';

        this.visual_items[0].set({
            fill: color,
            stroke: color,
        });

        this.visual_items[1].set('stroke', color);

        this.visual_items[1].animate('left',  this.visual_items[0].left + radius*0.1   , {
            duration: 100,
            onChange: WebUI.canvas.renderAll.bind(WebUI.canvas),
            onComplete: this.is_on = false,
        })

    }
    return true;
}
```

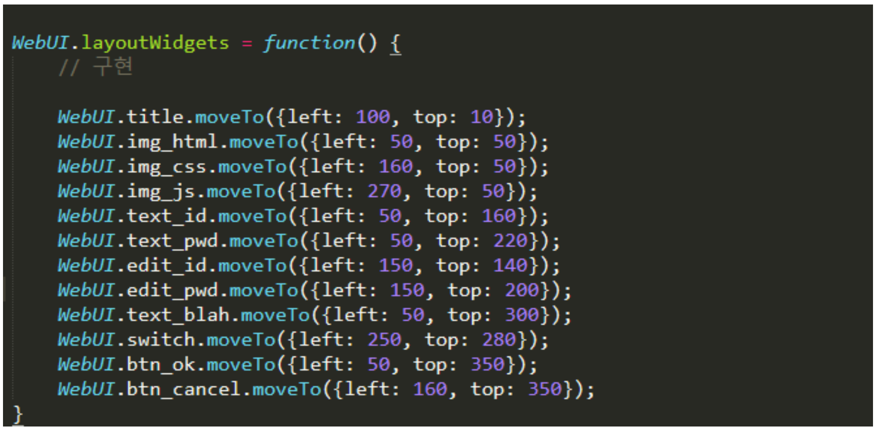
로그인 페이지 구성

initWidgets 구현(강의자료)



```
WebUI.initWidgets = function() {
    // 구현
    WebUI.title = new WebUI.Text("Introduction to HCI");
    WebUI.img_html =
        new WebUI.Image("resources/HTML5.png", {width: 100, height: 80});
    WebUI.img_css =
        new WebUI.Image("resources/CSS3.png", {width: 100, height: 80});
    WebUI.img_js =
        new WebUI.Image("resources/JS.png", {width: 100, height: 80});
    WebUI.text_id = new WebUI.Text("ID");
    WebUI.text_pwd = new WebUI.Text("Password");
    WebUI.edit_id = new WebUI.TextField("", {width:200, height:50});
    WebUI.edit_pwd = new WebUI.TextField("", {width:200, height:50});
    WebUI.btn_ok = new WebUI.PushButton("OK", {width:100, height:50});
    WebUI.btn_cancel =
    new WebUI.PushButton("Cancel", {width:100, height:50});
    WebUI.text_blah = new WebUI.Text("I want to get A+!");
    WebUI.switch = new WebUI.Switch(false, {width:100, height:50});
}
```

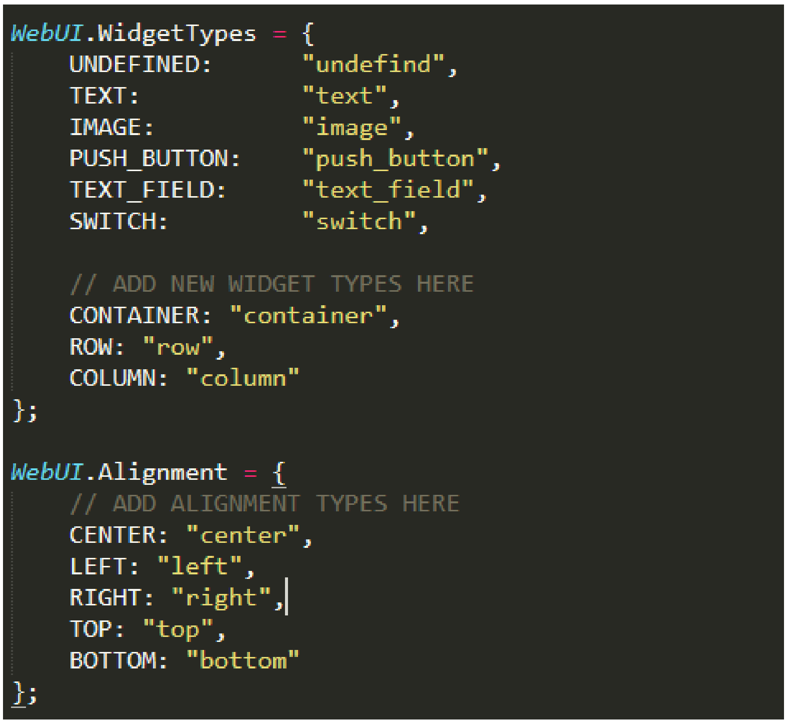
layoutWidgets 구현(강의자료)



```
WebUI.layoutWidgets = function() {
    // 구현

    WebUI.title.moveTo({left: 100, top: 10});
    WebUI.img_html.moveTo({left: 50, top: 50});
    WebUI.img_css.moveTo({left: 160, top: 50});
    WebUI.img_js.moveTo({left: 270, top: 50});
    WebUI.text_id.moveTo({left: 50, top: 160});
    WebUI.text_pwd.moveTo({left: 50, top: 220});
    WebUI.edit_id.moveTo({left: 150, top: 140});
    WebUI.edit_pwd.moveTo({left: 150, top: 200});
    WebUI.text_blah.moveTo({left: 50, top: 300});
    WebUI.switch.moveTo({left: 250, top: 280});
    WebUI.btn_ok.moveTo({left: 50, top: 350});
    WebUI.btn_cancel.moveTo({left: 160, top: 350});
}
```

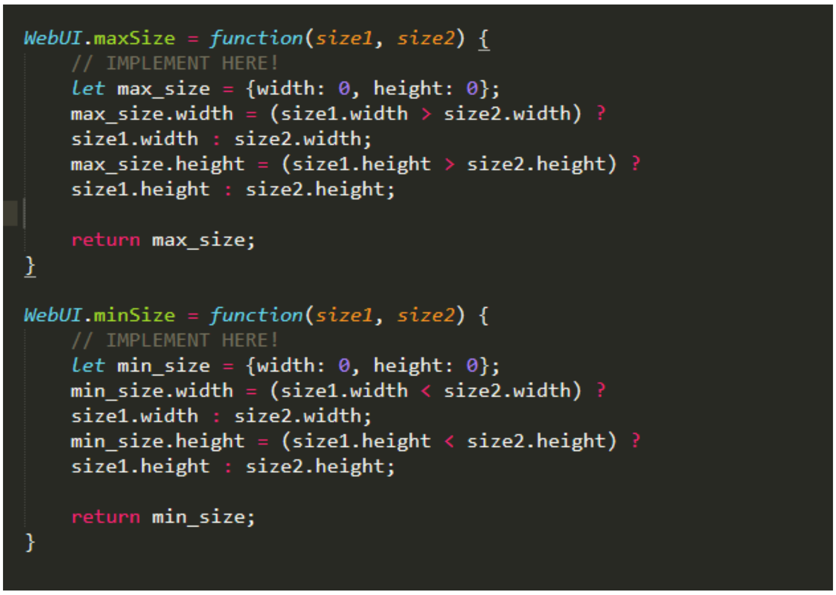
2. 1단계

WidgetTypes/Alignment 구현(강의자료)



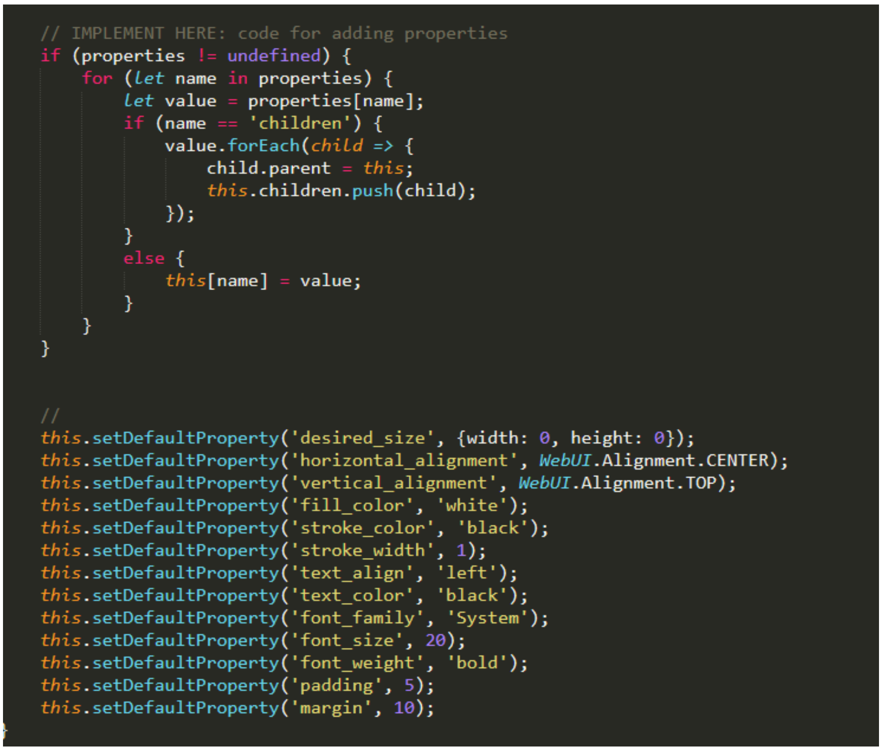
```
WebUI.WidgetTypes = {
    UNDEFINED:      "undefind",
    TEXT:           "text",
    IMAGE:          "image",
    PUSH_BUTTON:    "push_button",
    TEXT_FIELD:     "text_field",
    SWITCH:         "switch",

    // ADD NEW WIDGET TYPES HERE
    CONTAINER: "container",
    ROW: "row",
    COLUMN: "column"
};

WebUI.Alignment = {
    // ADD ALIGNMENT TYPES HERE
    CENTER: "center",
    LEFT: "left",
    RIGHT: "right",
    TOP: "top",
    BOTTOM: "bottom"
};
```

maxSize/minSize 구현(강의자료)



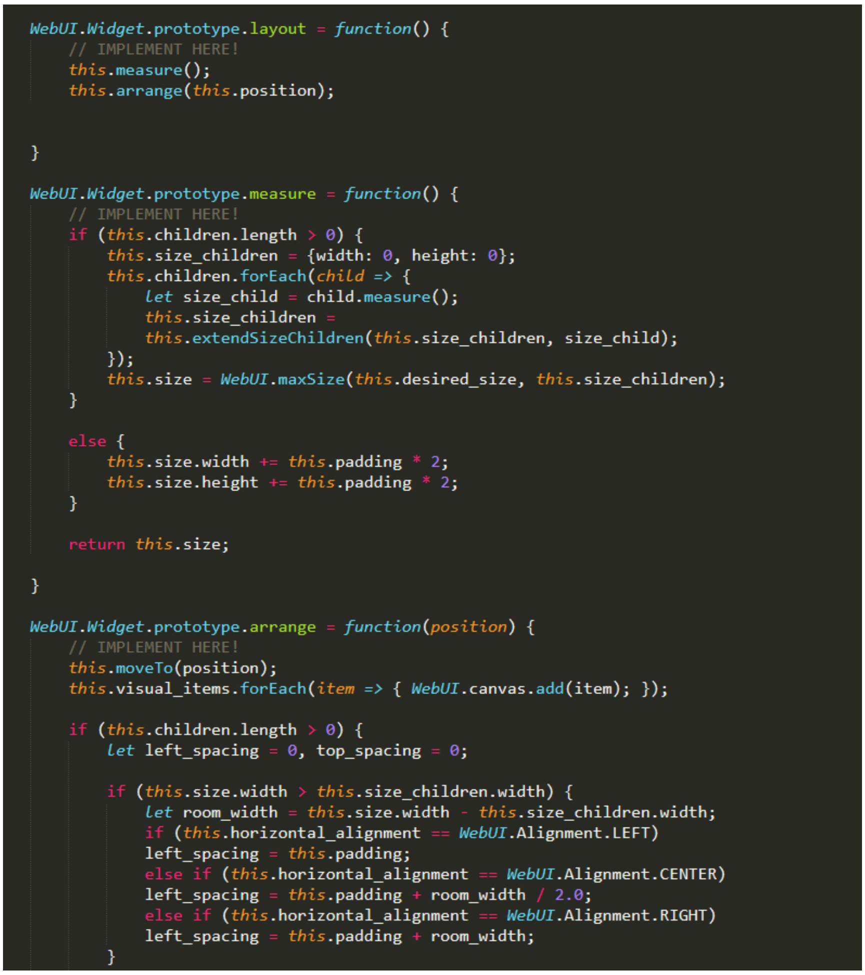
```
WebUI.maxSize = function(size1, size2) {
    // IMPLEMENT HERE!
    let max_size = {width: 0, height: 0};
    max_size.width = (size1.width > size2.width) ?
    size1.width : size2.width;
    max_size.height = (size1.height > size2.height) ?
    size1.height : size2.height;

    return max_size;
}

WebUI.minSize = function(size1, size2) {
    // IMPLEMENT HERE!
    let min_size = {width: 0, height: 0};
    min_size.width = (size1.width < size2.width) ?
    size1.width : size2.width;
    min_size.height = (size1.height < size2.height) ?
    size1.height : size2.height;

    return min_size;
}
```

Widget 구현(강의자료)



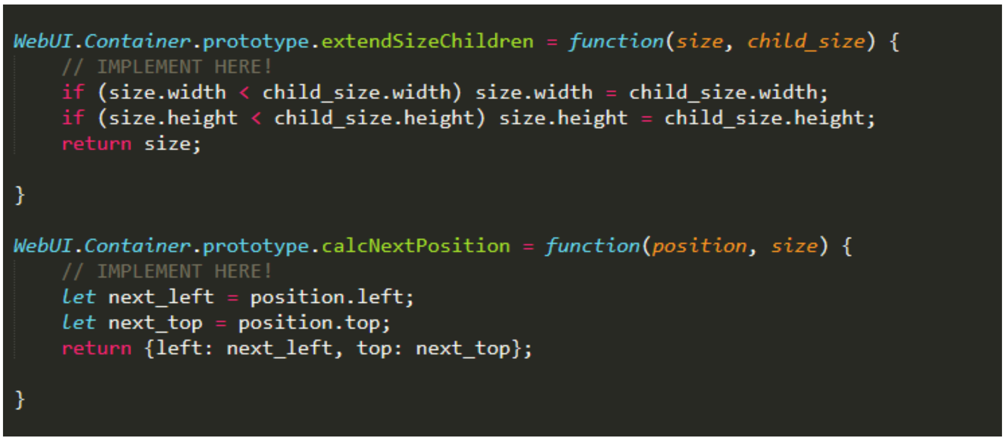
```
    // IMPLEMENT HERE: code for adding properties
    if (properties != undefined) {
        for (let name in properties) {
            let value = properties[name];
            if (name == 'children') {
                value.forEach(child => {
                    child.parent = this;
                    this.children.push(child);
                });
            }
            else {
                this[name] = value;
            }
        }
    }


    //
    this.setDefaultProperty('desired_size', {width: 0, height: 0});
    this.setDefaultProperty('horizontal_alignment', WebUI.Alignment.CENTER);
    this.setDefaultProperty('vertical_alignment', WebUI.Alignment.TOP);
    this.setDefaultProperty('fill_color', 'white');
    this.setDefaultProperty('stroke_color', 'black');
    this.setDefaultProperty('stroke_width', 1);
    this.setDefaultProperty('text_align', 'left');
    this.setDefaultProperty('text_color', 'black');
    this.setDefaultProperty('font_family', 'System');
    this.setDefaultProperty('font_size', 20);
    this.setDefaultProperty('font_weight', 'bold');
    this.setDefaultProperty('padding', 5);
    this.setDefaultProperty('margin', 10);
}
```

Layout/measure/arrange 구현(강의자료)



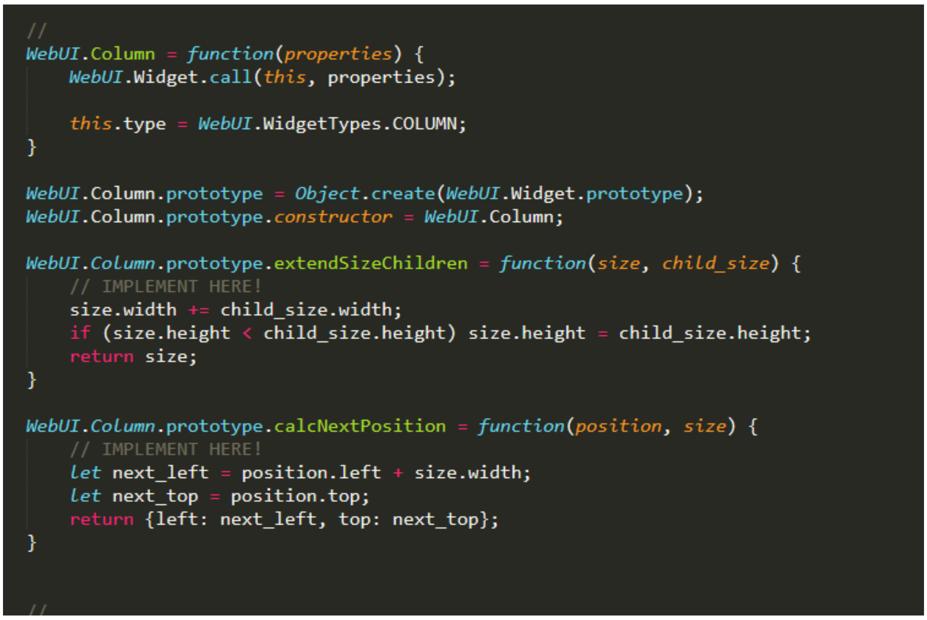
```
WebUI.Widget.prototype.layout = function() {
    // IMPLEMENT HERE!
    this.measure();
    this.arrange(this.position);


}

WebUI.Widget.prototype.measure = function() {
    // IMPLEMENT HERE!
    if (this.children.length > 0) {
        this.size_children = {width: 0, height: 0};
        this.children.forEach(child => {
            let size_child = child.measure();
            this.size_children =
            this.extendSizeChildren(this.size_children, size_child);
        });
        this.size = WebUI.maxSize(this.desired_size, this.size_children);
    }

    else {
        this.size.width += this.padding * 2;
        this.size.height += this.padding * 2;
    }

    return this.size;

}

WebUI.Widget.prototype.arrange = function(position) {
    // IMPLEMENT HERE!
    this.moveTo(position);
    this.visual_items.forEach(item => { WebUI.canvas.add(item); });

    if (this.children.length > 0) {
        let left_spacing = 0, top_spacing = 0;

        if (this.size.width > this.size_children.width) {
            let room_width = this.size.width - this.size_children.width;
            if (this.horizontal_alignment == WebUI.Alignment.LEFT)
            left_spacing = this.padding;
            else if (this.horizontal_alignment == WebUI.Alignment.CENTER)
            left_spacing = this.padding + room_width / 2.0;
            else if (this.horizontal_alignment == WebUI.Alignment.RIGHT)
            left_spacing = this.padding + room_width;
        }
```

Container 속성 구현(강의자료)



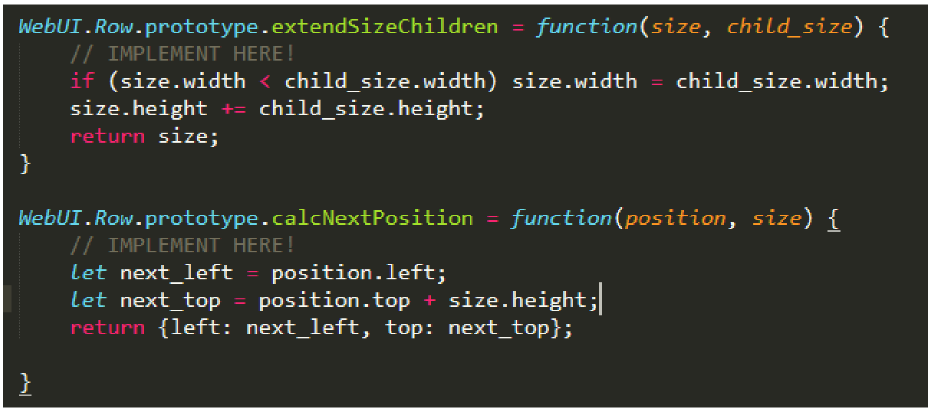
```
WebUI.Container.prototype.extendSizeChildren = function(size, child_size) {
    // IMPLEMENT HERE!
    if (size.width < child_size.width) size.width = child_size.width;
    if (size.height < child_size.height) size.height = child_size.height;
    return size;

}

WebUI.Container.prototype.calcNextPosition = function(position, size) {
    // IMPLEMENT HERE!
    let next_left = position.left;
    let next_top = position.top;
    return {left: next_left, top: next_top};

}
```

Column 속성 구현(강의자료)



```
//
WebUI.Column = function(properties) {
    WebUI.Widget.call(this, properties);

    this.type = WebUI.WidgetTypes.COLUMN;
}

WebUI.Column.prototype = Object.create(WebUI.Widget.prototype);
WebUI.Column.prototype.constructor = WebUI.Column;

WebUI.Column.prototype.extendSizeChildren = function(size, child_size) {
    // IMPLEMENT HERE!
    size.width += child_size.width;
    if (size.height < child_size.height) size.height = child_size.height;
    return size;
}

WebUI.Column.prototype.calcNextPosition = function(position, size) {
    // IMPLEMENT HERE!
    let next_left = position.left + size.width;
    let next_top = position.top;
    return {left: next_left, top: next_top};
}


//
```

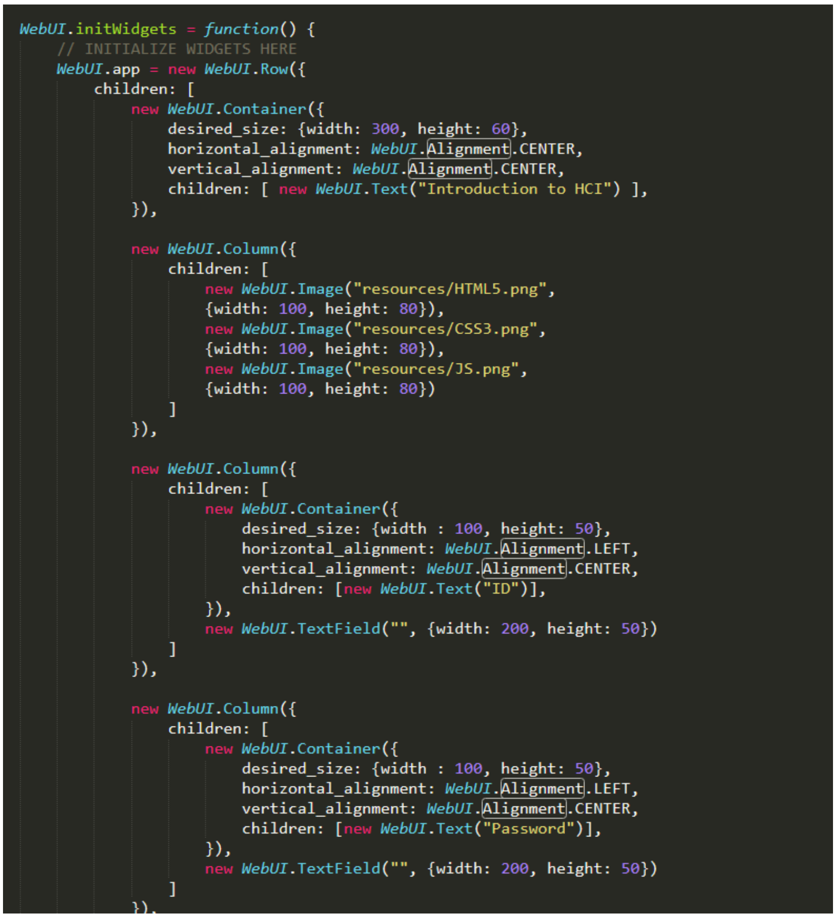
Row 속성 구현(강의자료)



```
WebUI.Row.prototype.extendSizeChildren = function(size, child_size) {
    // IMPLEMENT HERE!
    if (size.width < child_size.width) size.width = child_size.width;
    size.height += child_size.height;
    return size;
}

WebUI.Row.prototype.calcNextPosition = function(position, size) {
    // IMPLEMENT HERE!
    let next_left = position.left;
    let next_top = position.top + size.height;
    return {left: next_left, top: next_top};

}
```

initWidgets 구현

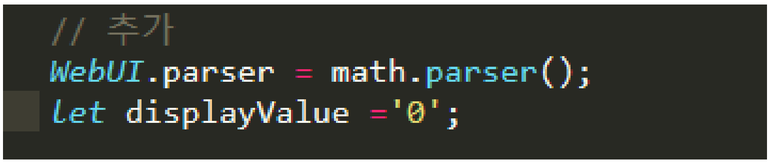
Row/Column/Container를 이용하여 initWidgets을 구현하였다.



```
WebUI.initWidgets = function() {
    // INITIALIZE WIDGETS HERE
    WebUI.app = new WebUI.Row({
        children: [
            new WebUI.Container({
                desired_size: {width: 300, height: 60},
                horizontal_alignment: WebUI.Alignment.CENTER,
                vertical_alignment: WebUI.Alignment.CENTER,
                children: [ new WebUI.Text("Introduction to HCI") ],
            }),

            new WebUI.Column({
                children: [
                    new WebUI.Image("resources/HTML5.png",
                    {width: 100, height: 80}),
                    new WebUI.Image("resources/CSS3.png",
                    {width: 100, height: 80}),
                    new WebUI.Image("resources/JS.png",
                    {width: 100, height: 80})
                ]
            }),

            new WebUI.Column({
                children: [
                    new WebUI.Container({
                        desired_size: {width : 100, height: 50},
                        horizontal_alignment: WebUI.Alignment.LEFT,
                        vertical_alignment: WebUI.Alignment.CENTER,
                        children: [new WebUI.Text("ID")],
                    }),
                    new WebUI.TextField("", {width: 200, height: 50})
                ]
            }),

            new WebUI.Column({
                children: [
                    new WebUI.Container({
                        desired_size: {width : 100, height: 50},
                        horizontal_alignment: WebUI.Alignment.LEFT,
                        vertical_alignment: WebUI.Alignment.CENTER,
                        children: [new WebUI.Text("Password")],
                    }),
                    new WebUI.TextField("", {width: 200, height: 50})
                ]
            }),
```

3. 2단계

수식 계산을 위한 객체 정의

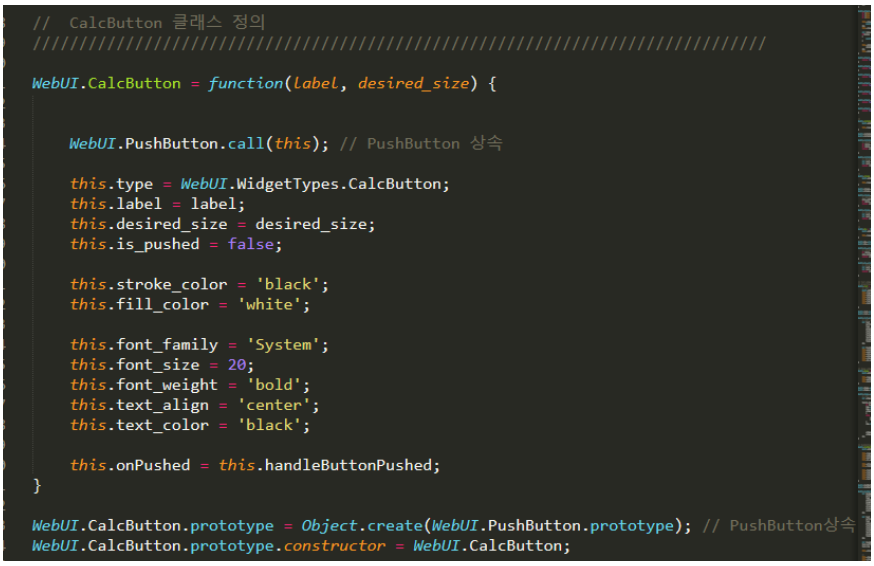


```
// 추가
WebUI.parser = math.parser();
let displayValue ='0';
```

CalcButton 클래스 정의

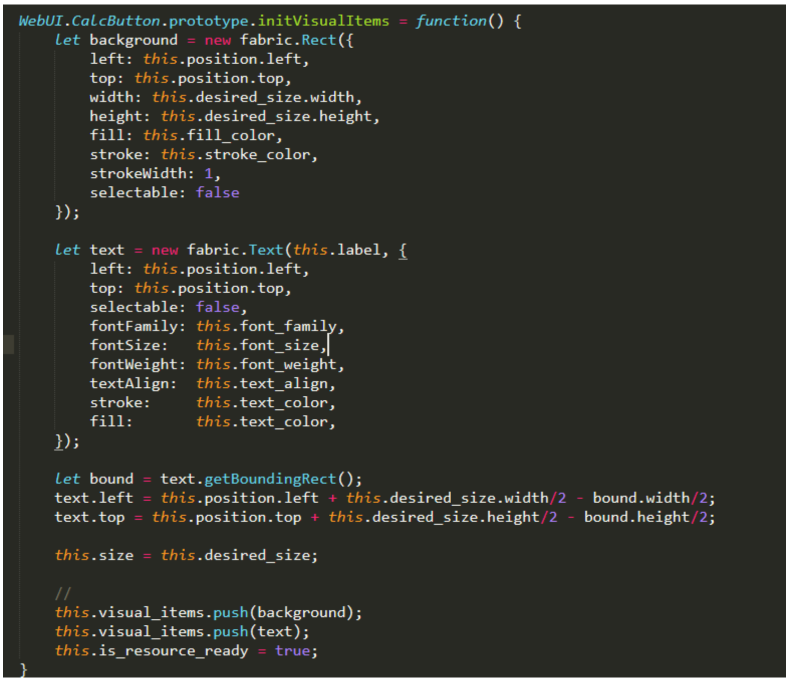
this.onPushed = this.handleButtonPushed 추가

PushButton 상속



```
//  CalcButton 클래스 정의
///////////////////////////////////////////////////////////////////////////////

WebUI.CalcButton = function(label, desired_size) {


    WebUI.PushButton.call(this); // PushButton 상속

    this.type = WebUI.WidgetTypes.CalcButton;
    this.label = label;
    this.desired_size = desired_size;
    this.is_pushed = false;

    this.stroke_color = 'black';
    this.fill_color = 'white';

    this.font_family = 'System';
    this.font_size = 20;
    this.font_weight = 'bold';
    this.text_align = 'center';
    this.text_color = 'black';

    this.onPushed = this.handleButtonPushed;
}

WebUI.CalcButton.prototype = Object.create(WebUI.PushButton.prototype); // PushButton상속
WebUI.CalcButton.prototype.constructor = WebUI.CalcButton;
```

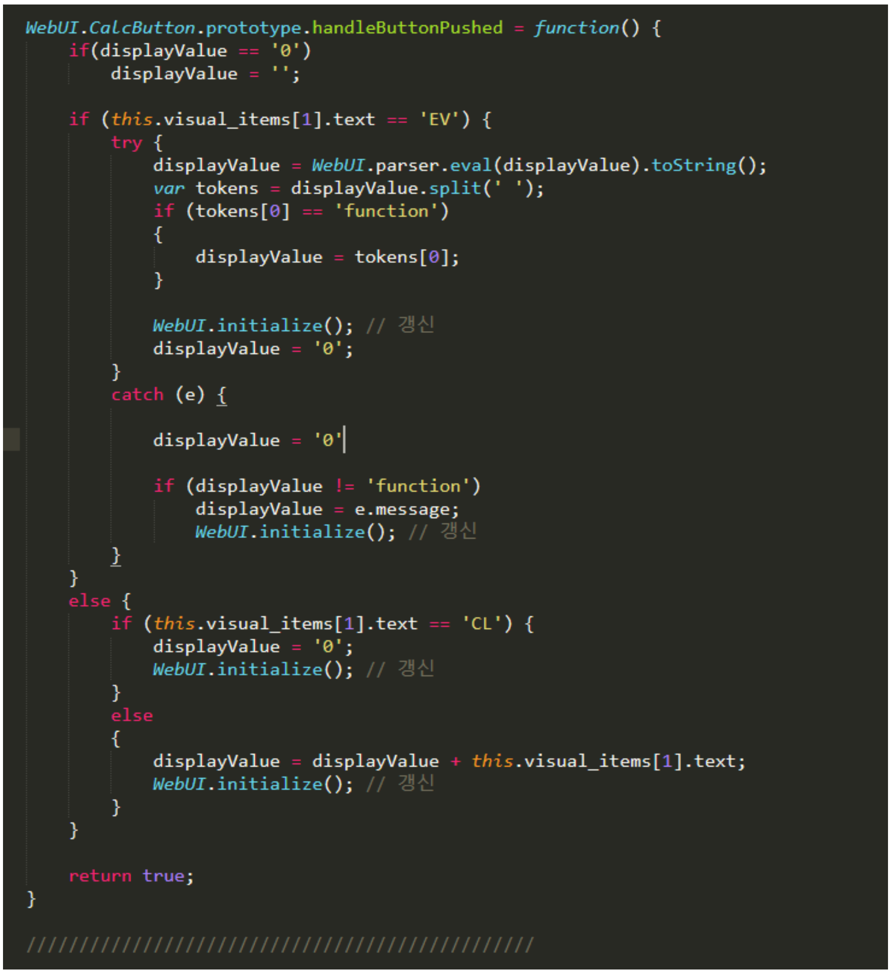
CalcButton initVisualItems 구현



```
WebUI.CalcButton.prototype.initVisualItems = function() {
    let background = new fabric.Rect({
        left: this.position.left,
        top: this.position.top,
        width: this.desired_size.width,
        height: this.desired_size.height,
        fill: this.fill_color,
        stroke: this.stroke_color,
        strokeWidth: 1,
        selectable: false
    });

    let text = new fabric.Text(this.label, {
        left: this.position.left,
        top: this.position.top,
        selectable: false,
        fontFamily: this.font_family,
        fontSize:   this.font_size,
        fontWeight: this.font_weight,
        textAlign:  this.text_align,
        stroke:     this.text_color,
        fill:       this.text_color,
    });

    let bound = text.getBoundingRect();
    text.left = this.position.left + this.desired_size.width/2 - bound.width/2;
    text.top = this.position.top + this.desired_size.height/2 - bound.height/2;

    this.size = this.desired_size;

    //
    this.visual_items.push(background);
    this.visual_items.push(text);
    this.is_resource_ready = true;
}
```

CalcButton handleButtonPushed 구현(강의자료)

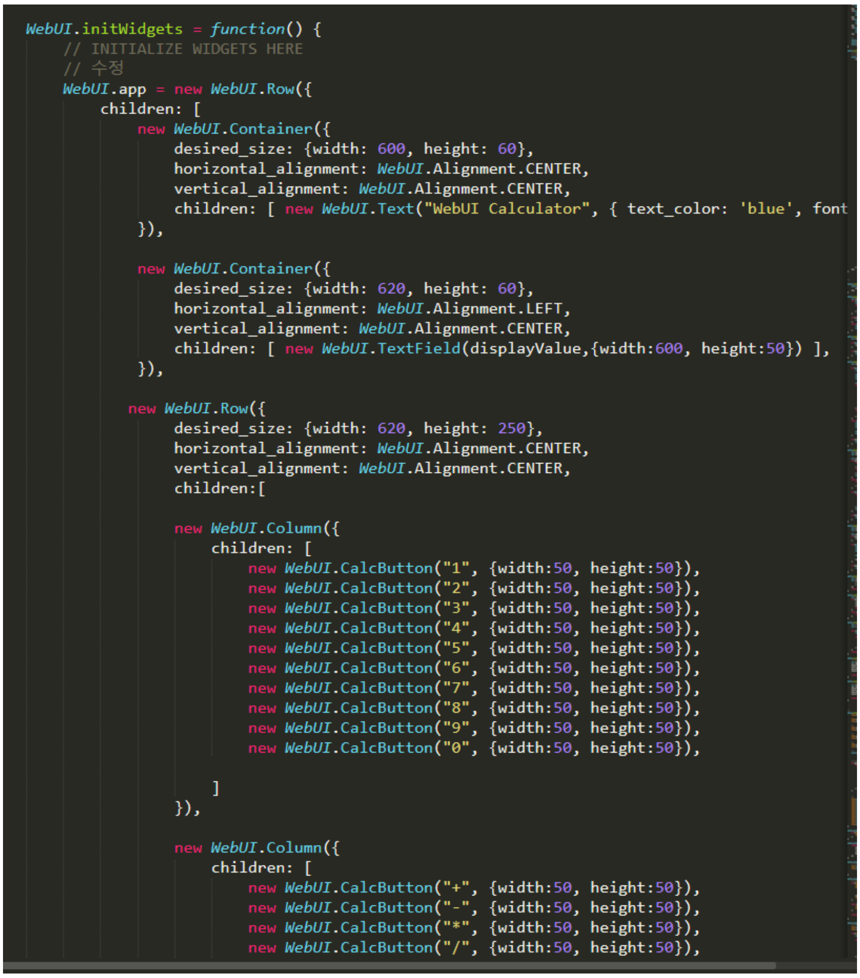
갱신을 위해 WebUI.initialize() 구문을 추가하였다.



```
WebUI.CalcButton.prototype.handleButtonPushed = function() {
    if(displayValue == '0')
        displayValue = '';

    if (this.visual_items[1].text == 'EV') {
        try {
            displayValue = WebUI.parser.eval(displayValue).toString();
            var tokens = displayValue.split(' ');
            if (tokens[0] == 'function')
            {
                displayValue = tokens[0];
            }

            WebUI.initialize(); // 갱신
            displayValue = '0';
        }
        catch (e) {

            displayValue = '0'

            if (displayValue != 'function')
                displayValue = e.message;
                WebUI.initialize(); // 갱신
        }
    }
    else {
        if (this.visual_items[1].text == 'CL') {
            displayValue = '0';
            WebUI.initialize(); // 갱신
        }
        else
        {
            displayValue = displayValue + this.visual_items[1].text;
            WebUI.initialize(); // 갱신
        }
    }

    return true;
}

////////////////////////////////////////////////
```

initWidgets 재정의

레이아웃에 맞춰 initWidgets을 수정하였다.

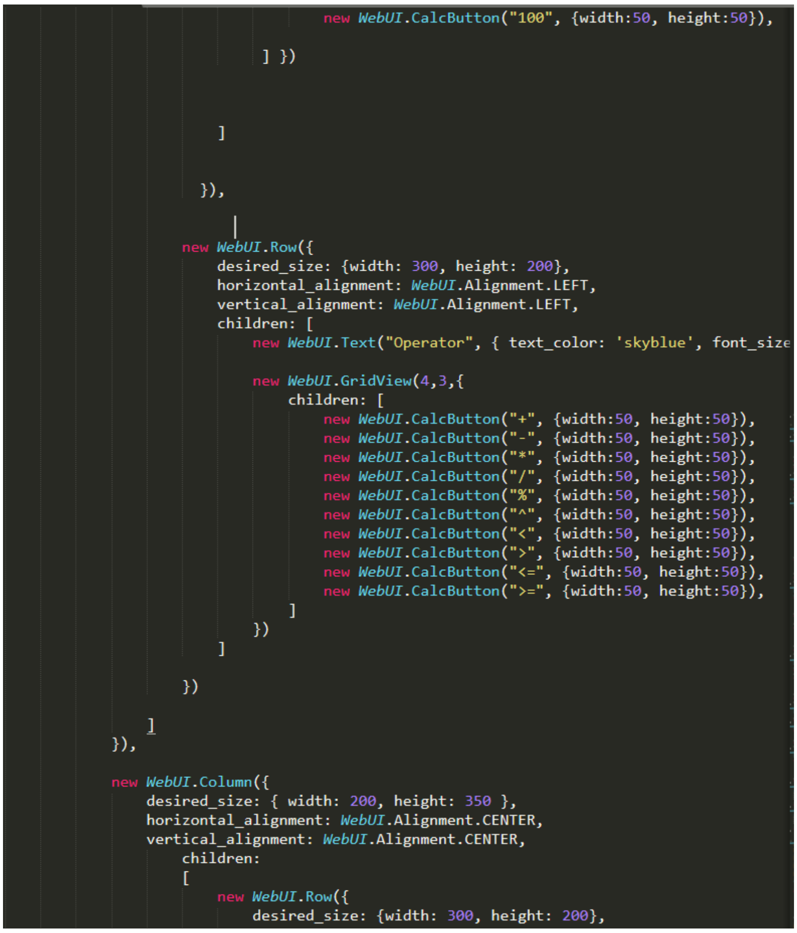


```
WebUI.initWidgets = function() {
    // INITIALIZE WIDGETS HERE
    // 수정
    WebUI.app = new WebUI.Row({
        children: [
            new WebUI.Container({
                desired_size: {width: 600, height: 60},
                horizontal_alignment: WebUI.Alignment.CENTER,
                vertical_alignment: WebUI.Alignment.CENTER,
                children: [ new WebUI.Text("WebUI Calculator", { text_color: 'blue', font
            }),

            new WebUI.Container({
                desired_size: {width: 620, height: 60},
                horizontal_alignment: WebUI.Alignment.LEFT,
                vertical_alignment: WebUI.Alignment.CENTER,
                children: [ new WebUI.TextField(displayValue,{width:600, height:50}) ],
            }),

           new WebUI.Row({
                desired_size: {width: 620, height: 250},
                horizontal_alignment: WebUI.Alignment.CENTER,
                vertical_alignment: WebUI.Alignment.CENTER,
                children:[

                new WebUI.Column({
                    children: [
                        new WebUI.CalcButton("1", {width:50, height:50}),
                        new WebUI.CalcButton("2", {width:50, height:50}),
                        new WebUI.CalcButton("3", {width:50, height:50}),
                        new WebUI.CalcButton("4", {width:50, height:50}),
                        new WebUI.CalcButton("5", {width:50, height:50}),
                        new WebUI.CalcButton("6", {width:50, height:50}),
                        new WebUI.CalcButton("7", {width:50, height:50}),
                        new WebUI.CalcButton("8", {width:50, height:50}),
                        new WebUI.CalcButton("9", {width:50, height:50}),
                        new WebUI.CalcButton("0", {width:50, height:50}),

                    ]
                }),

                new WebUI.Column({
                    children: [
                        new WebUI.CalcButton("+", {width:50, height:50}),
                        new WebUI.CalcButton("-", {width:50, height:50}),
                        new WebUI.CalcButton("*", {width:50, height:50}),
                        new WebUI.CalcButton("/", {width:50, height:50}),
```

4. 3단계

initWidgets 재정의

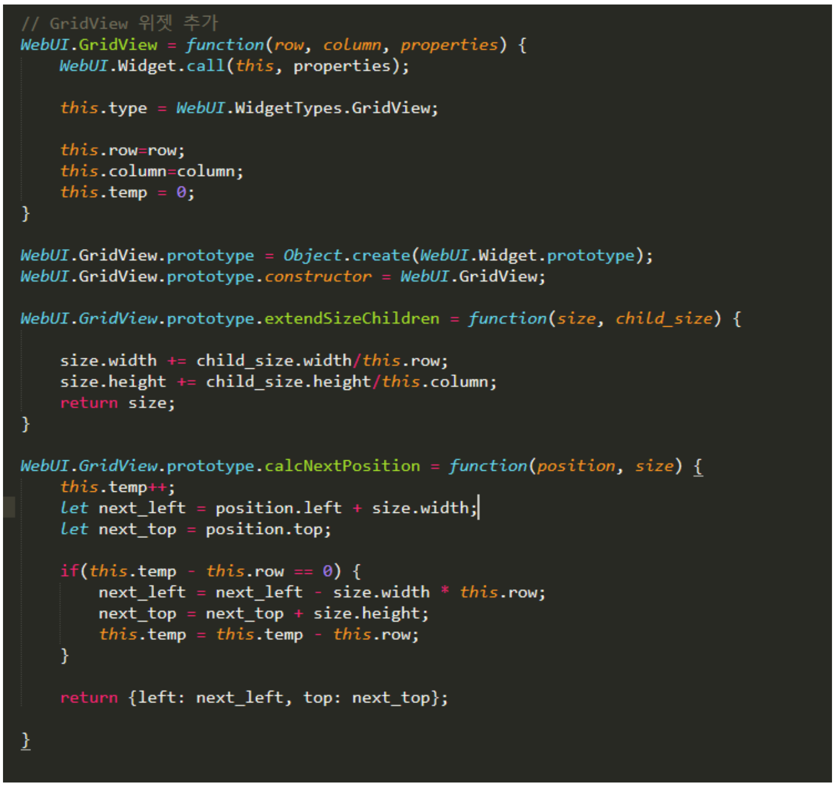
GridView를 사용하고 편의성을 위해서 initWidgets을 수정하였다.



```
                        new WebUI.CalcButton("100", {width:50, height:50}),

                 ] })



            ]


          }),

        new WebUI.Row({
            desired_size: {width: 300, height: 200},
            horizontal_alignment: WebUI.Alignment.LEFT,
            vertical_alignment: WebUI.Alignment.LEFT,
            children: [
                new WebUI.Text("Operator", { text_color: 'skyblue', font_size

                new WebUI.GridView(4,3,{
                    children: [
                        new WebUI.CalcButton("+", {width:50, height:50}),
                        new WebUI.CalcButton("-", {width:50, height:50}),
                        new WebUI.CalcButton("*", {width:50, height:50}),
                        new WebUI.CalcButton("/", {width:50, height:50}),
                        new WebUI.CalcButton("%", {width:50, height:50}),
                        new WebUI.CalcButton("^", {width:50, height:50}),
                        new WebUI.CalcButton("<", {width:50, height:50}),
                        new WebUI.CalcButton(">", {width:50, height:50}),
                        new WebUI.CalcButton("<=", {width:50, height:50}),
                        new WebUI.CalcButton(">=", {width:50, height:50}),
                    ]
                })
            ]

        })

    ]
}),

new WebUI.Column({
    desired_size: { width: 200, height: 350 },
    horizontal_alignment: WebUI.Alignment.CENTER,
    vertical_alignment: WebUI.Alignment.CENTER,
        children:
        [
            new WebUI.Row({
                desired_size: {width: 300, height: 200},
```

GridView 위젯 추가

열과 행에 맞춰서 위젯이 추가된다.

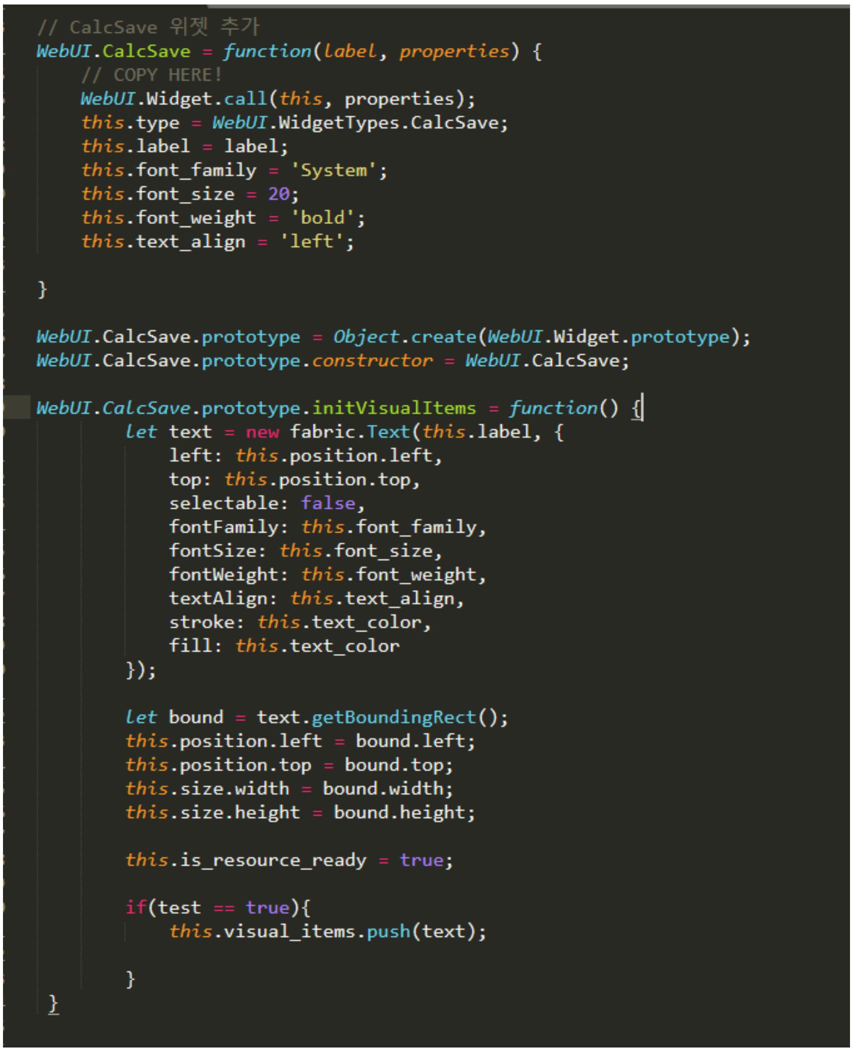


```
// GridView 위젯 추가
WebUI.GridView = function(row, column, properties) {
    WebUI.Widget.call(this, properties);

    this.type = WebUI.WidgetTypes.GridView;

    this.row=row;
    this.column=column;
    this.temp = 0;
}

WebUI.GridView.prototype = Object.create(WebUI.Widget.prototype);
WebUI.GridView.prototype.constructor = WebUI.GridView;

WebUI.GridView.prototype.extendSizeChildren = function(size, child_size) {

    size.width += child_size.width/this.row;
    size.height += child_size.height/this.column;
    return size;
}

WebUI.GridView.prototype.calcNextPosition = function(position, size) {
    this.temp++;
    let next_left = position.left + size.width;
    let next_top = position.top;

    if(this.temp - this.row == 0) {
        next_left = next_left - size.width * this.row;
        next_top = next_top + size.height;
        this.temp = this.temp - this.row;
    }

    return {left: next_left, top: next_top};

}
```

CalcSave 위젯 추가

EV 버튼을 누르면 Result에 계산된 값이 저장된다(CL버튼 누르기 전까지 값 저장).

CL 버튼을 누르면 Result에 저장된 값이 사라진다.



```
// CalcSave 위젯 추가
WebUI.CalcSave = function(label, properties) {
    // COPY HERE!
    WebUI.Widget.call(this, properties);
    this.type = WebUI.WidgetTypes.CalcSave;
    this.label = label;
    this.font_family = 'System';
    this.font_size = 20;
    this.font_weight = 'bold';
    this.text_align = 'left';

}

WebUI.CalcSave.prototype = Object.create(WebUI.Widget.prototype);
WebUI.CalcSave.prototype.constructor = WebUI.CalcSave;

WebUI.CalcSave.prototype.initVisualItems = function() {
        let text = new fabric.Text(this.label, {
            left: this.position.left,
            top: this.position.top,
            selectable: false,
            fontFamily: this.font_family,
            fontSize: this.font_size,
            fontWeight: this.font_weight,
            textAlign: this.text_align,
            stroke: this.text_color,
            fill: this.text_color
        });

        let bound = text.getBoundingRect();
        this.position.left = bound.left;
        this.position.top = bound.top;
        this.size.width = bound.width;
        this.size.height = bound.height;

        this.is_resource_ready = true;

        if(test == true){
            this.visual_items.push(text);

        }
 }
```

5. 논의

과제에서 요구하는 조건은 구현하였지만 3단계에서 GraphPlot을 이용하여 사용자 정의 함수를 시각화하지 못하였다.

WebUI를 이용하여 작동원리를 이해하는데 도움이 많이 되었고 나중에 이 코드를 다시 수정하고 개선하게 된다면 그래프 시각화를 꼭 추가해보고 싶다.