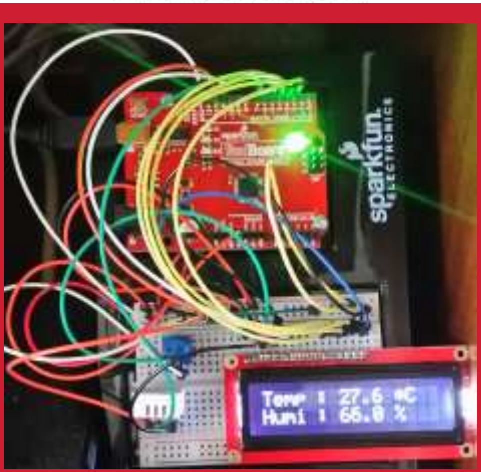
Arduino-IOT

[wk08]

Data Visualization II

- plotly.js + node



Visualization of Signals using Arduino, Node.js & storing signals in MongoDB & mining data using Python

Drone-IoT-Comsi, INJE University

2nd semester, 2021

Email : chaos21c@gmail.com

My ID

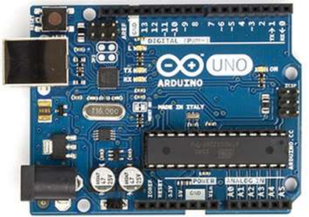
ID를 확인하고 github에 repo 만들기

AA01	김준수	AA13	조재윤
AA02	김현서	AA14	고태승
AA03	박영훈	AA15	이한글
AA04	박윤호	AA16	장세진
AA05	성은지	AA17	장태호
AA06	손윤우	AA18	정지원
AA07	오세윤	AA19	진우태
AA08	우승철	AA20	황혁준
AA09	윤현석	AA21	장이제
AA10	이예주	AA22	박상현
AA11	강지환	AA23	정은성
AA12	성인제	AA24	김경영

위의 id를 이용해서 github에 repo를 만드시오.

Option: 아두이노응용 실습 과제 – AAnn

Public, README.md check



[Review]

◆ [wk07]

- charts by plotly
- Complete your project
- Upload folder: aann-rpt07
- Use repo “aann” in github

wk07 : Practice : aann-rpt07

[Target of this week]

- Complete your works
- **Save your outcomes and upload outputs in github**

제출폴더명 : aann-rpt07

- 압축할 파일들

① AAnn_Chart_Layout.png

② AAnn_Axis_Title.png

③ AAnn_Line_Dash_Dot.png

④ AAnn_lux_Time_Series.png

⑤ AAnn_lux_Rangeslider.png

⑥ All *.html in data_charts folder

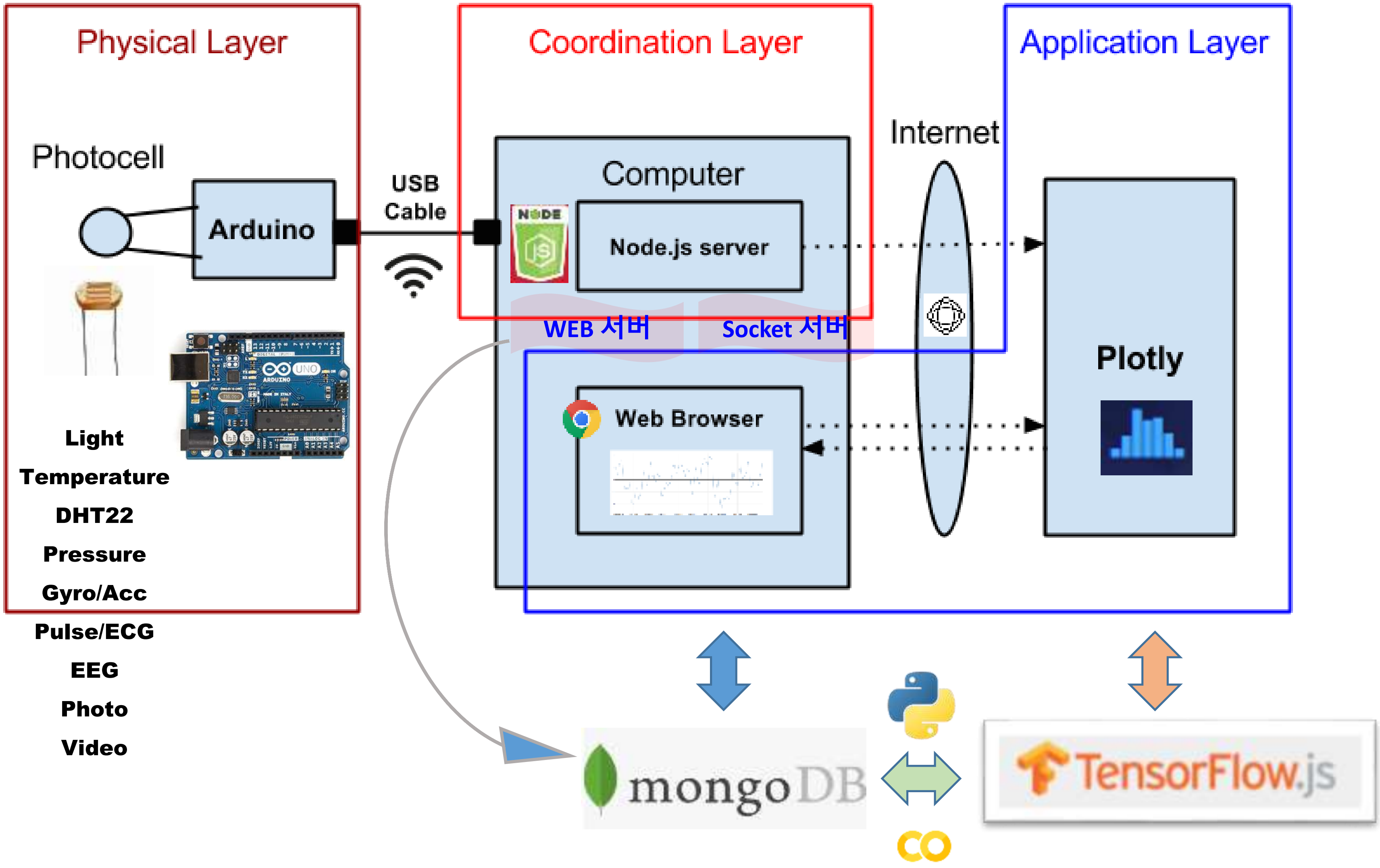
Purpose of AA

주요 수업 목표는 다음과 같다.

1. Node.js를 이용한 아두이노 센서 신호 처리
2. Plotly.js를 이용한 아두이노 센서 신호 시각화
3. MongoDB에 아두이노 센서 데이터 저장 및 처리

4. 저장된 IoT 데이터의 마이닝 (파이썬 코딩)

Layout [H S C]



Physical Layer

Photocell

Arduino

Light

Temperature

DHT22

Pressure

Gyro/Acc

Pulse/ECG

EEG

Photo

Video

USB Cable

Coordination Layer

Computer

Node.js server

WEB 서버

Socket 서버

Web Browser

Internet

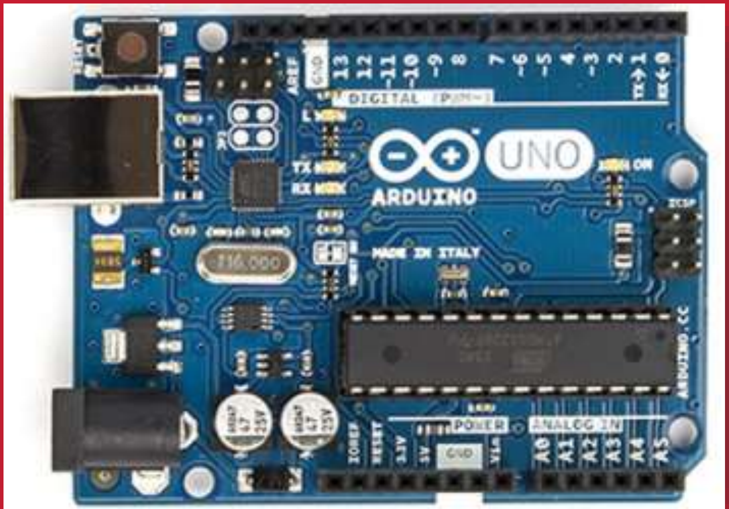
Application Layer

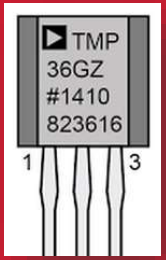
Plotly

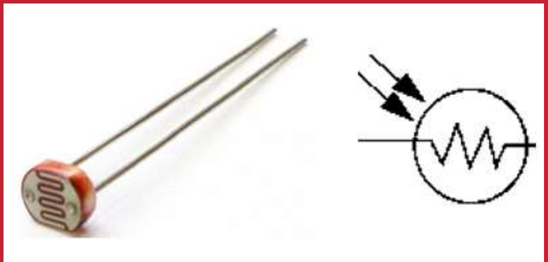
Arduino

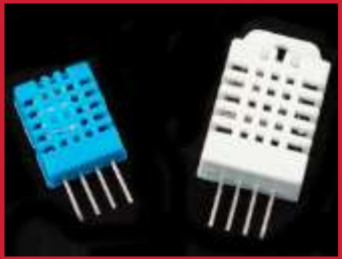
Sensors

+ Node.js

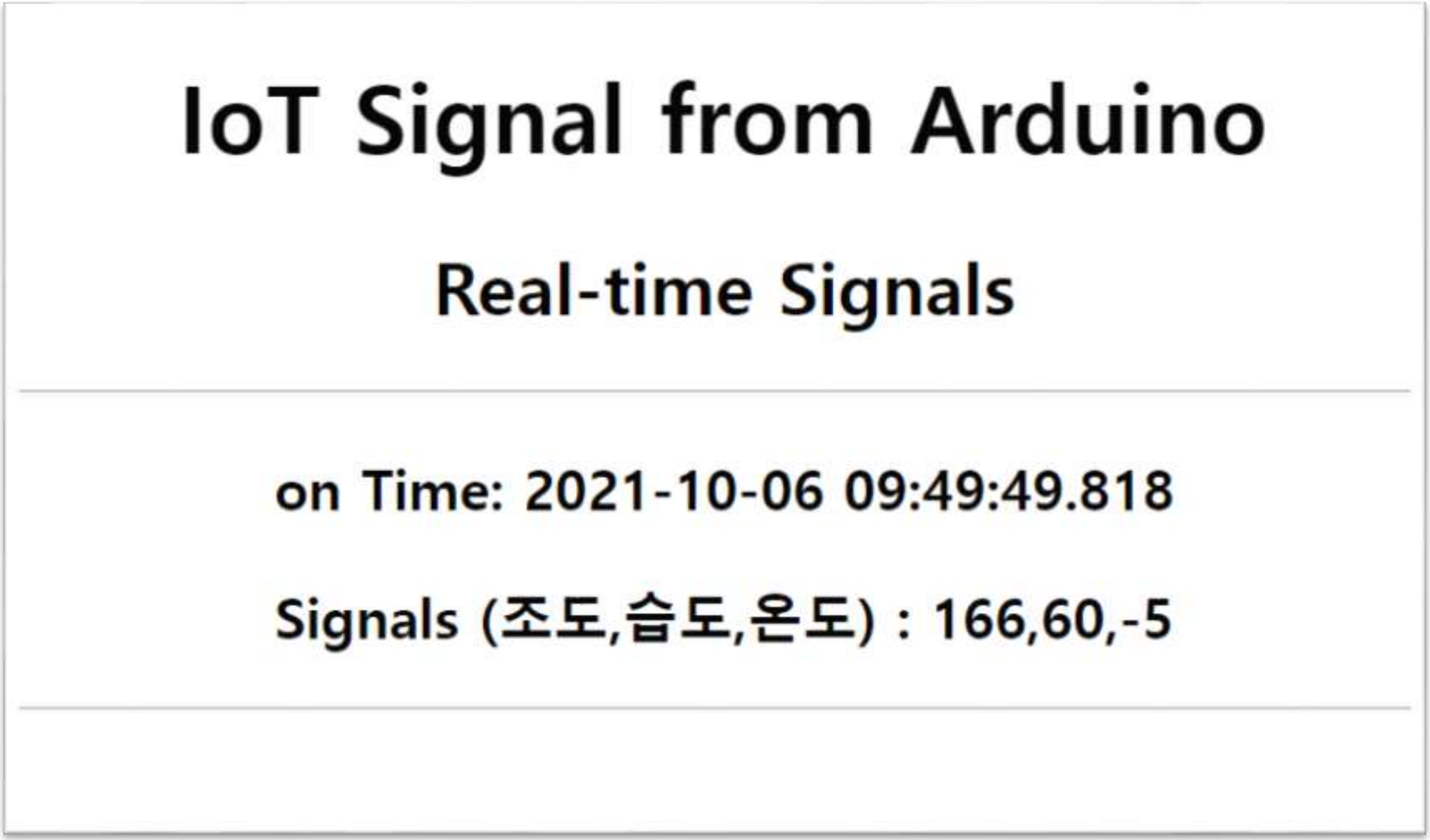








on WEB monitoring Arduino data



IoT Signal from Arduino

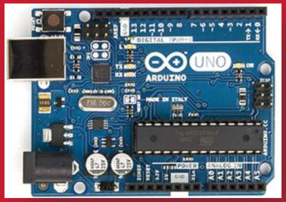
Real-time Signals

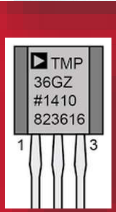
on Time: 2021-10-06 09:49:49.818

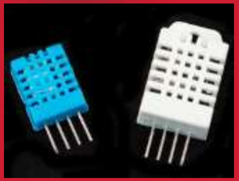
Signals (조도,습도,온도) : 166,60,-5

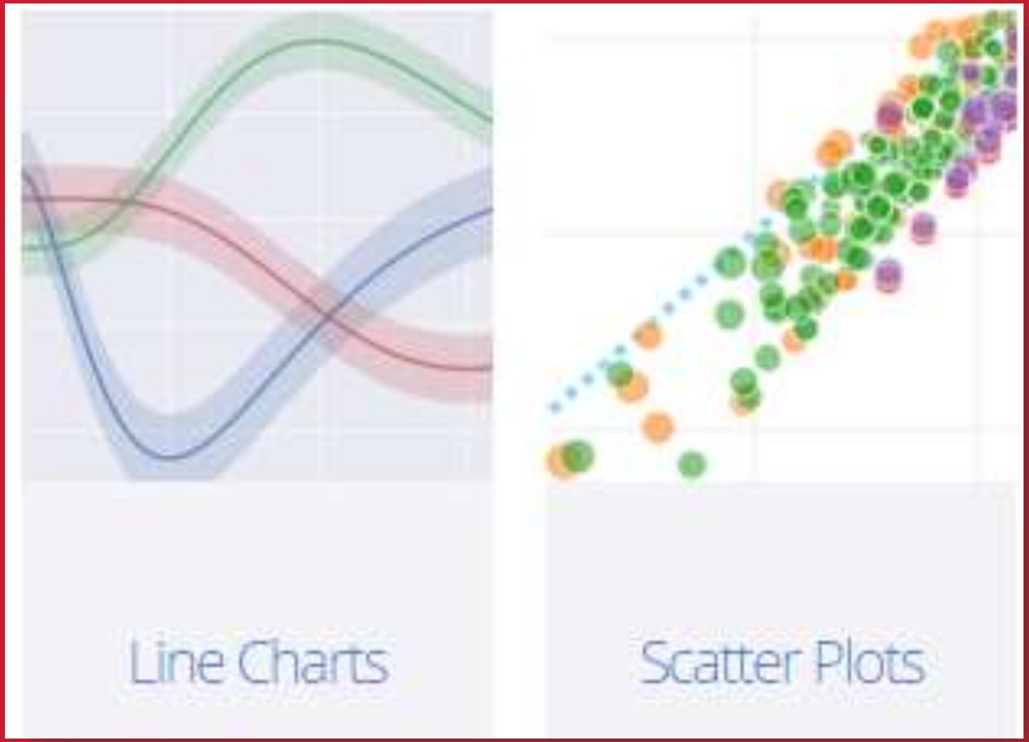
http://chaos.inje.ac.kr:3030/iot_multi.html

Data charts using **plotly.js**



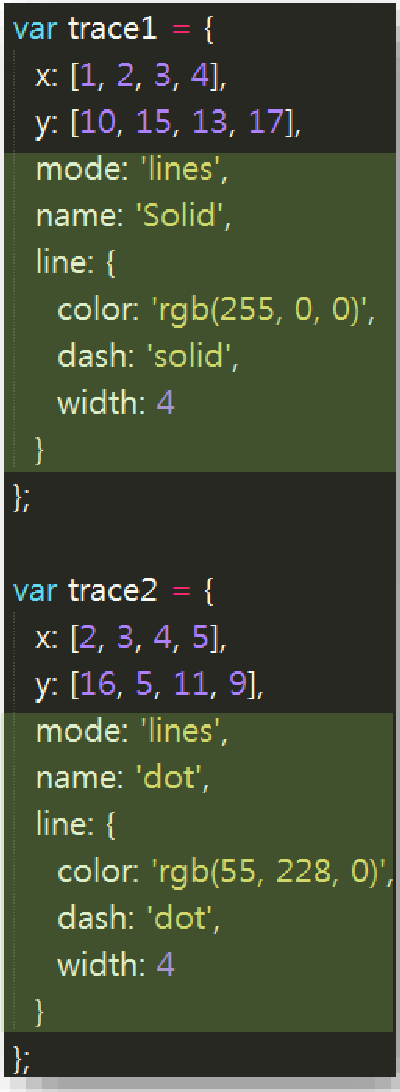




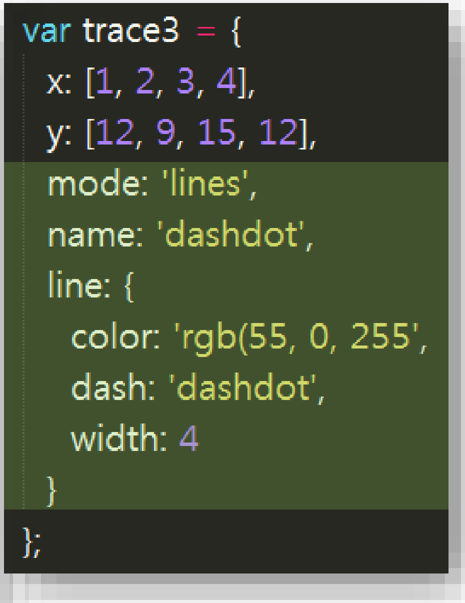


A5.2.6.6 plotly.js: Line & Scatter plot

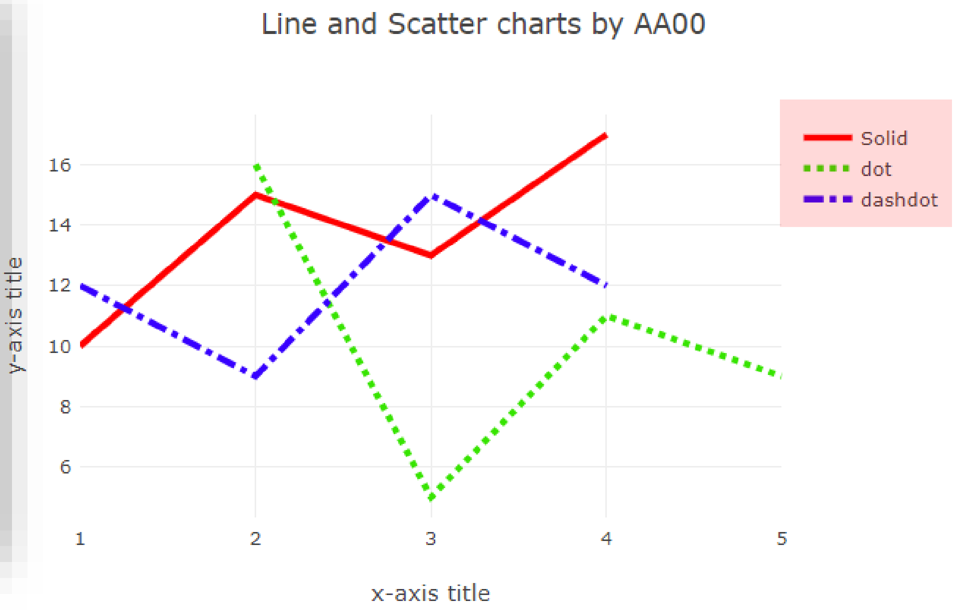
[3.5] Line & scatter plot with dash and dot



```
var trace1 = {
  x: [1, 2, 3, 4],
  y: [10, 15, 13, 17],
  mode: 'lines',
  name: 'Solid',
  line: {
    color: 'rgb(255, 0, 0)',
    dash: 'solid',
    width: 4
  }
};

var trace2 = {
  x: [2, 3, 4, 5],
  y: [16, 5, 11, 9],
  mode: 'lines',
  name: 'dot',
  line: {
    color: 'rgb(55, 228, 0)',
    dash: 'dot',
    width: 4
  }
};
```

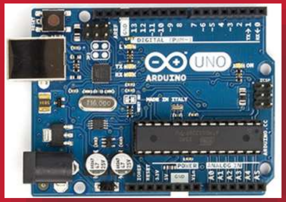


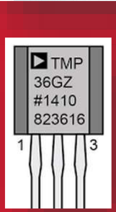
```
var trace3 = {
  x: [1, 2, 3, 4],
  y: [12, 9, 15, 12],
  mode: 'lines',
  name: 'dashdot',
  line: {
    color: 'rgb(55, 0, 255',
    dash: 'dashdot',
    width: 4
  }
};
```

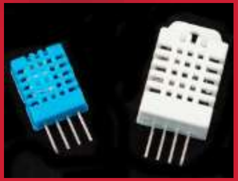


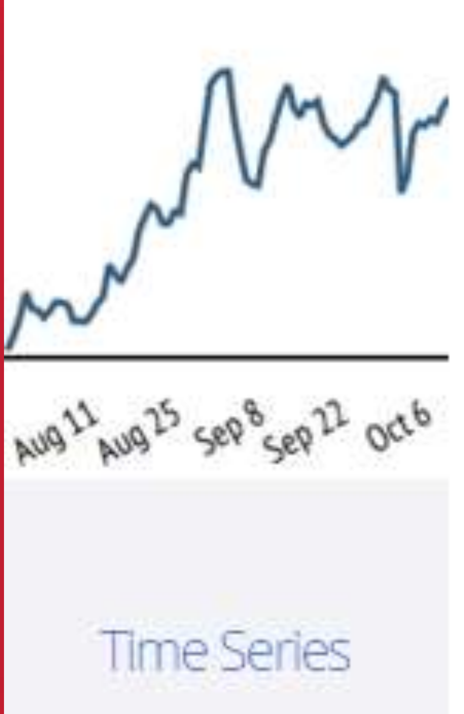
AAnn_Line_Dash_Dot.png

Data visualization using plotly.js



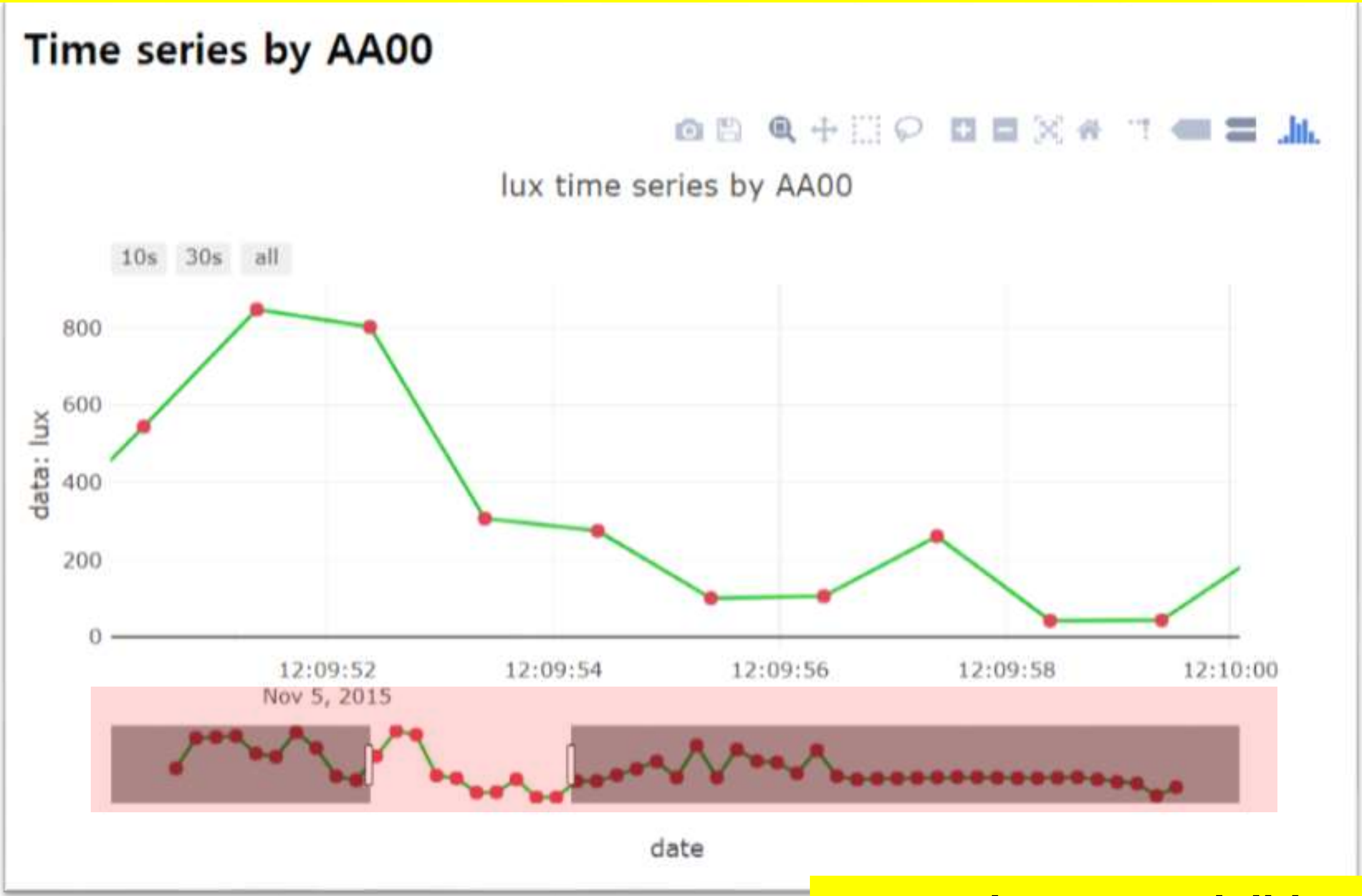






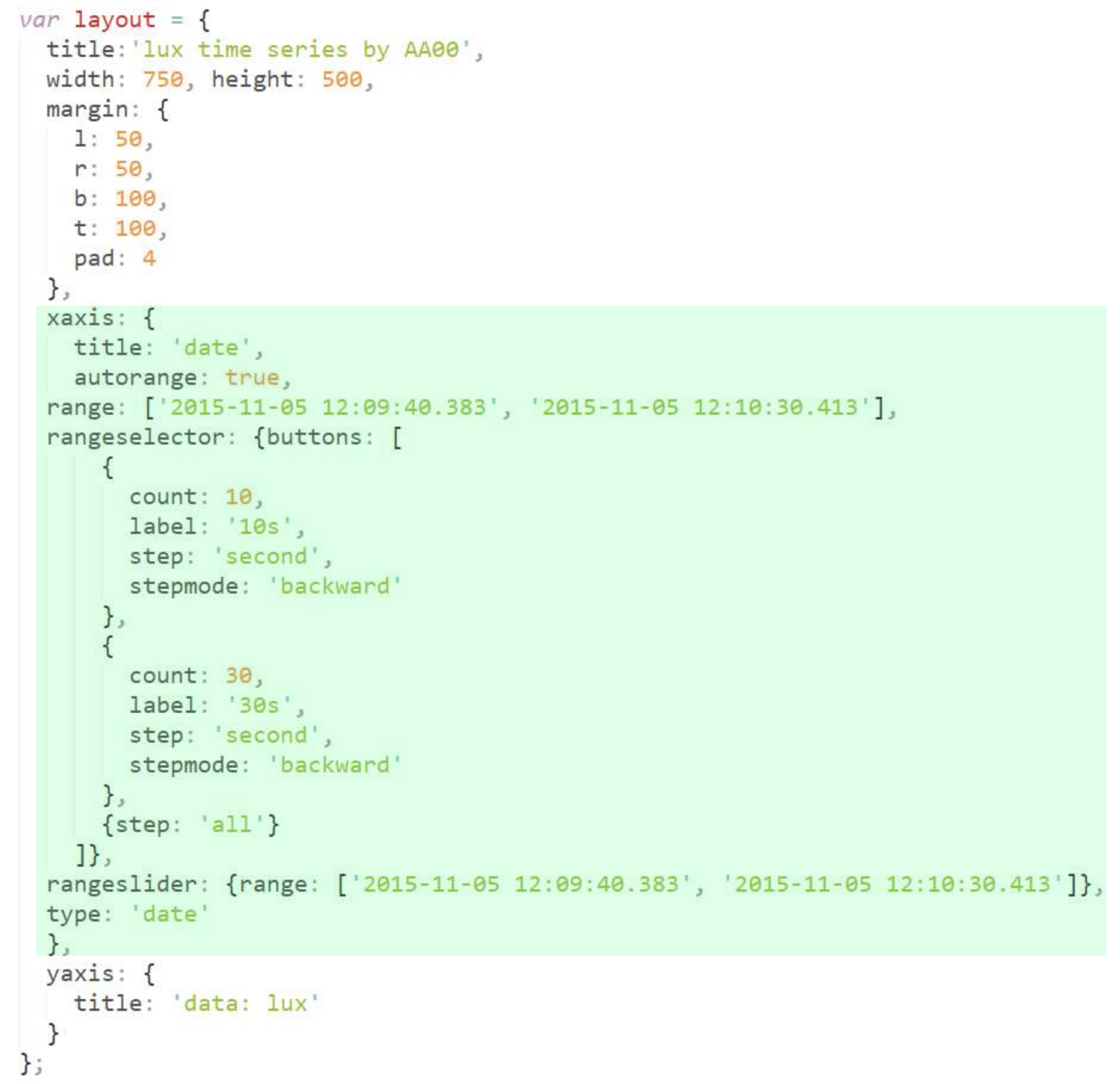
Project: Time series with Rangeslider

[Project-DIY] AAnn_lux_Rangelslider.html


Time series by AA00

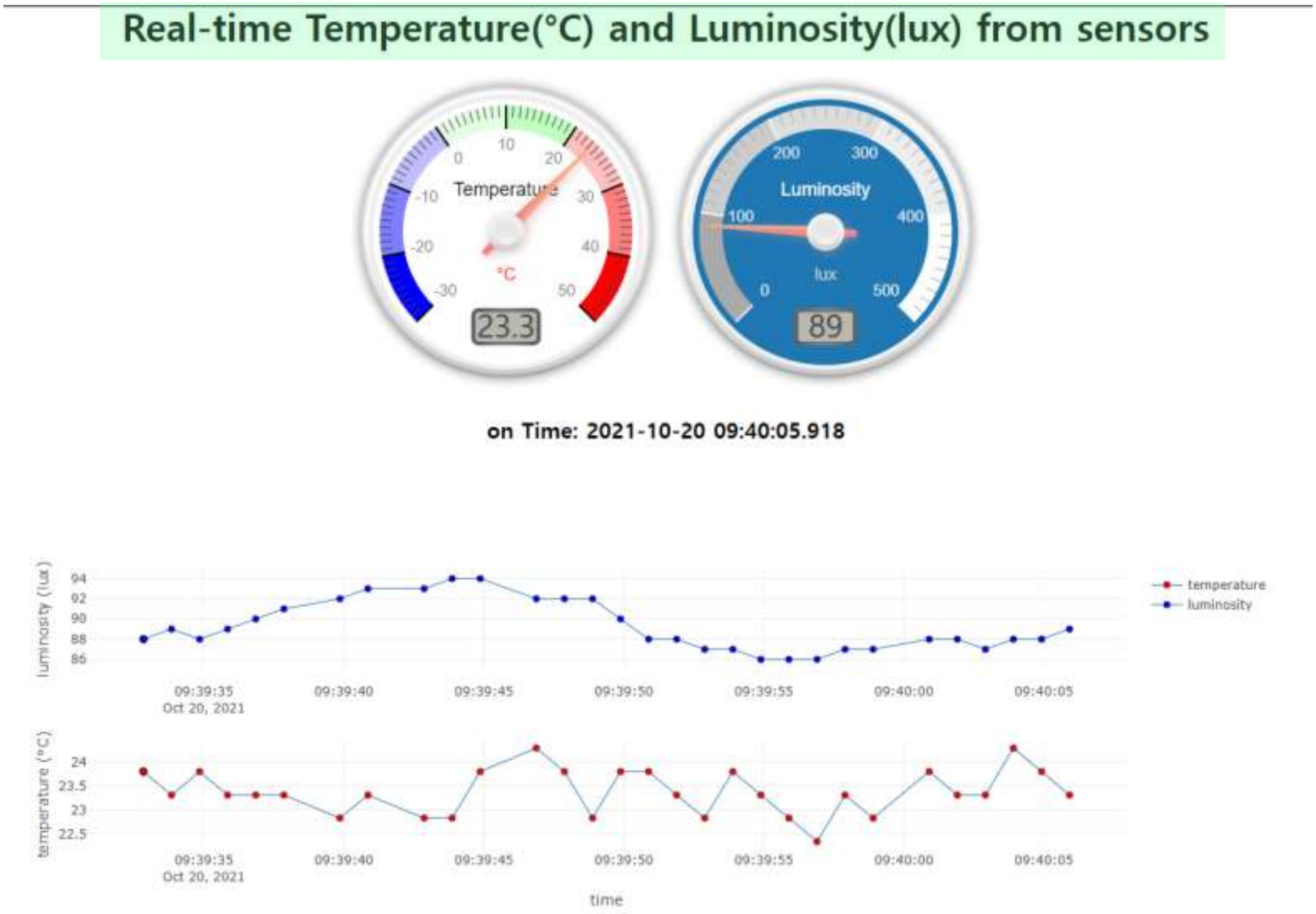
AAnn_lux_Rangelslider.png

Time series with Rangeslider



```
var layout = {
  title:'lux time series by AA00',
  width: 750, height: 500,
  margin: {
    l: 50,
    r: 50,
    b: 100,
    t: 100,
    pad: 4
  },
  xaxis: {
    title: 'date',
    autorange: true,
  range: ['2015-11-05 12:09:40.383', '2015-11-05 12:10:30.413'],
  rangeselector: {buttons: [
      {
        count: 10,
        label: '10s',
        step: 'second',
        stepmode: 'backward'
      },
      {
        count: 30,
        label: '30s',
        step: 'second',
        stepmode: 'backward'
      },
      {step: 'all'}
    ]},
  rangeslider: {range: ['2015-11-05 12:09:40.383', '2015-11-05 12:10:30.413']},
  type: 'date'
  },
  yaxis: {
    title: 'data: lux'
  }
};
```

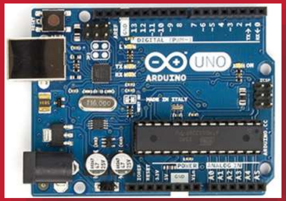
Arduino data + plotly + gauge.js

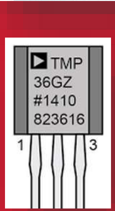


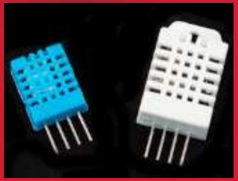
Real-time Temperature(°C) and Luminosity(lux) from sensors

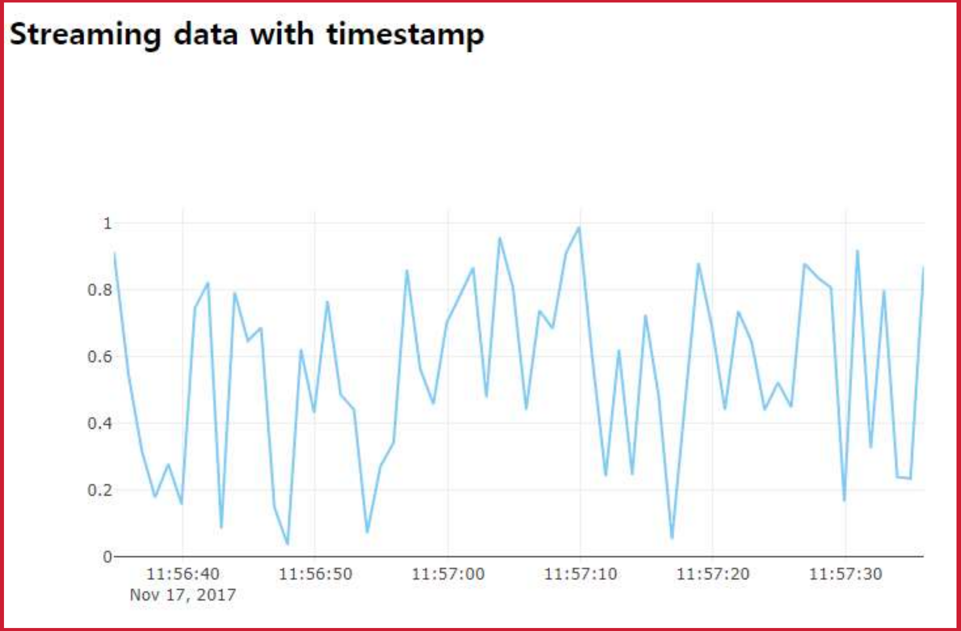
on Time: 2021-10-20 09:40:05.918

Data Streaming using plotly.js



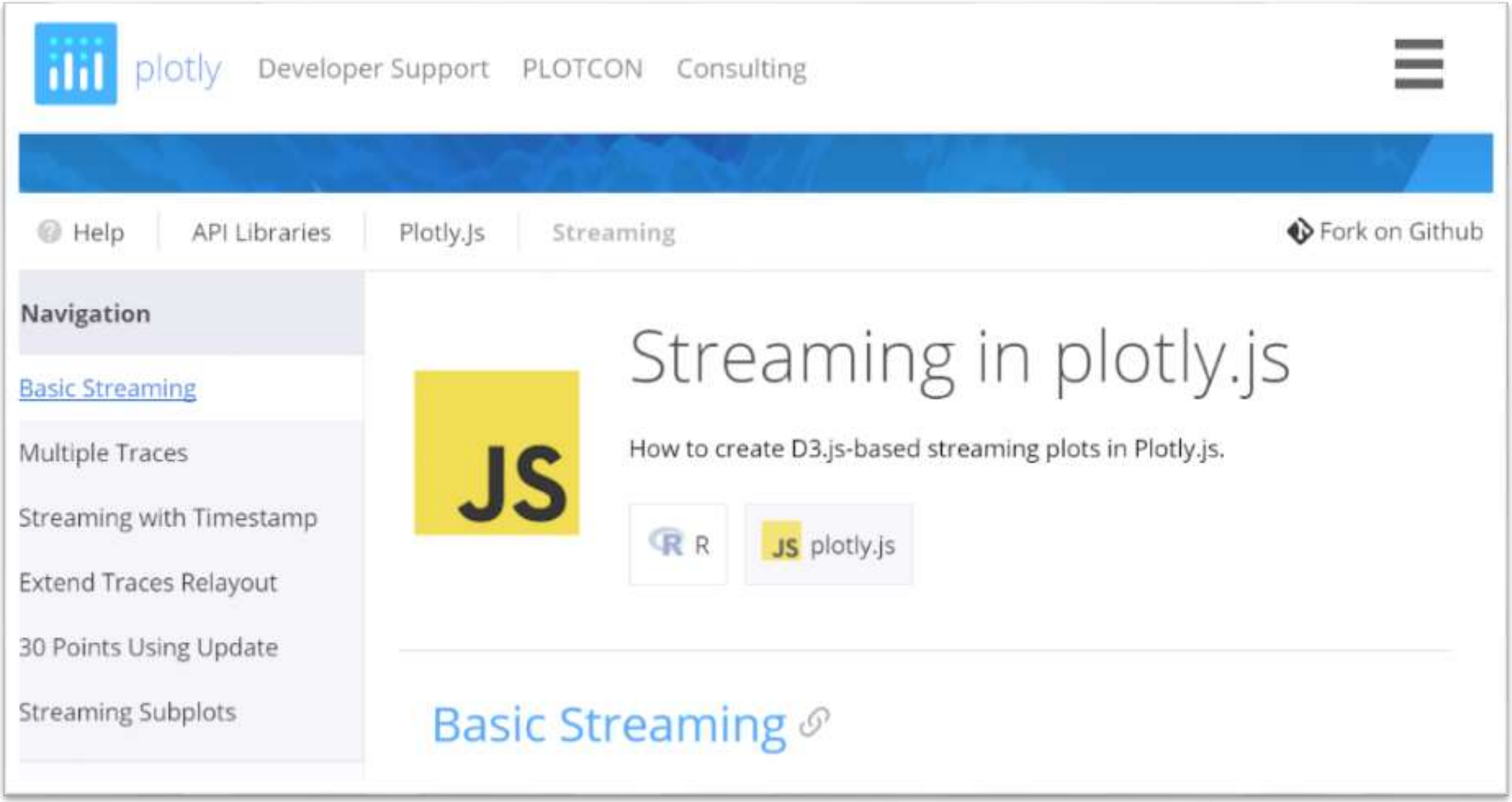






A5.4 plotly.js: Streaming data

Plot.ly > Streaming



plotly Developer Support PLOTCON Consulting

Help | API Libraries | Plotly.Js | Streaming | Fork on Github

Navigation

- Basic Streaming
- Multiple Traces
- Streaming with Timestamp
- Extend Traces Relayout
- 30 Points Using Update
- Streaming Subplots

Streaming in plotly.js

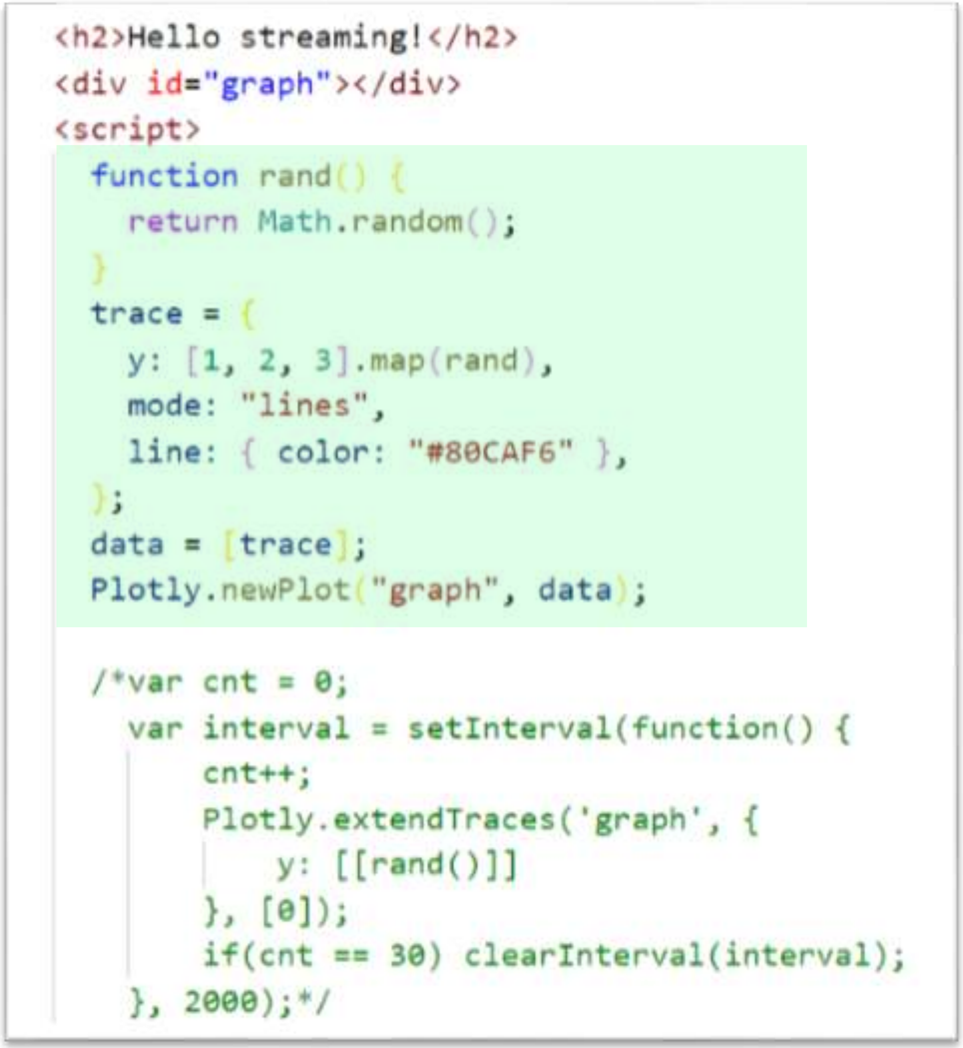
How to create D3.js-based streaming plots in Plotly.js.

R | plotly.js

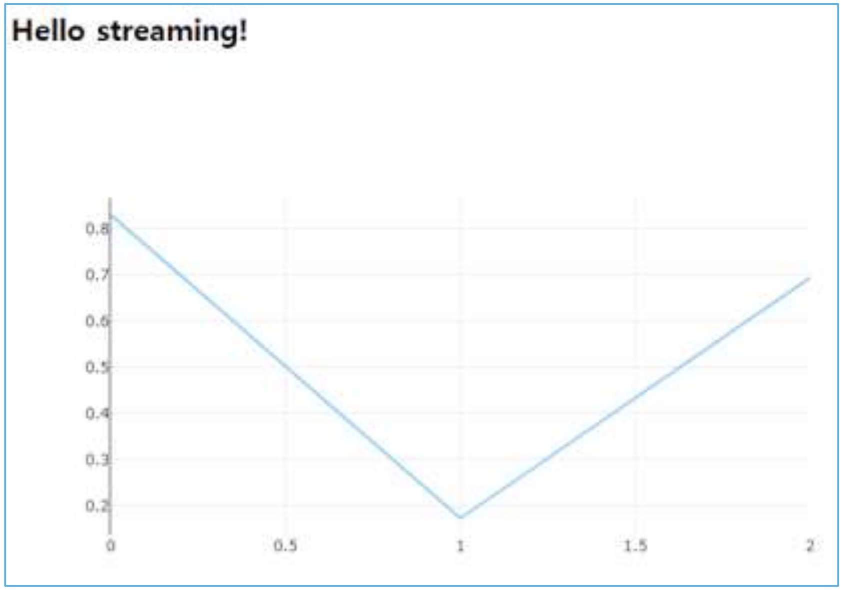
Basic Streaming

A5.4.1 plotly.js: Streaming data

[1.0] Starting chart



```
<h2>Hello streaming!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }
  trace = {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#80CAF6" },
  };
  data = [trace];
  Plotly.newPlot("graph", data);

  /*var cnt = 0;
    var interval = setInterval(function() {
        cnt++;
        Plotly.extendTraces('graph', {
            y: [[rand()]]
        }, [0]);
        if(cnt == 30) clearInterval(interval);
    }, 2000);*/
```

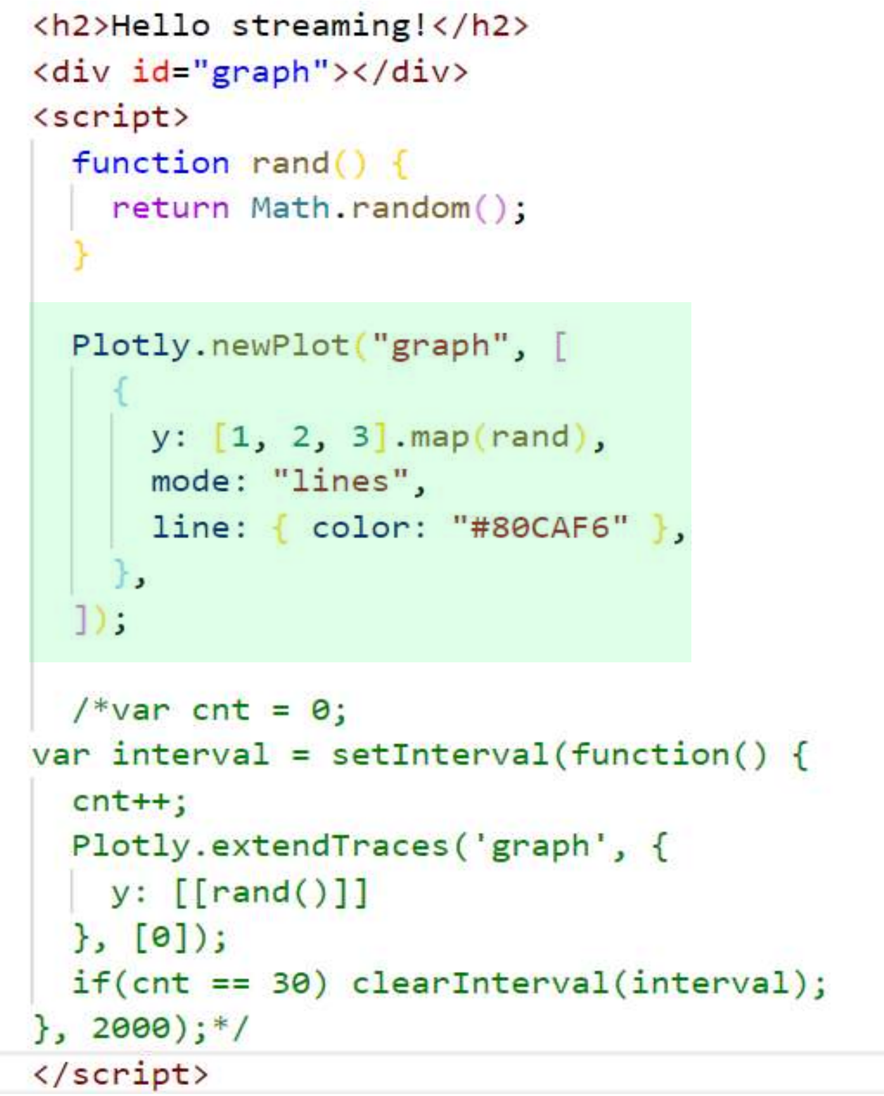


Hello streaming!

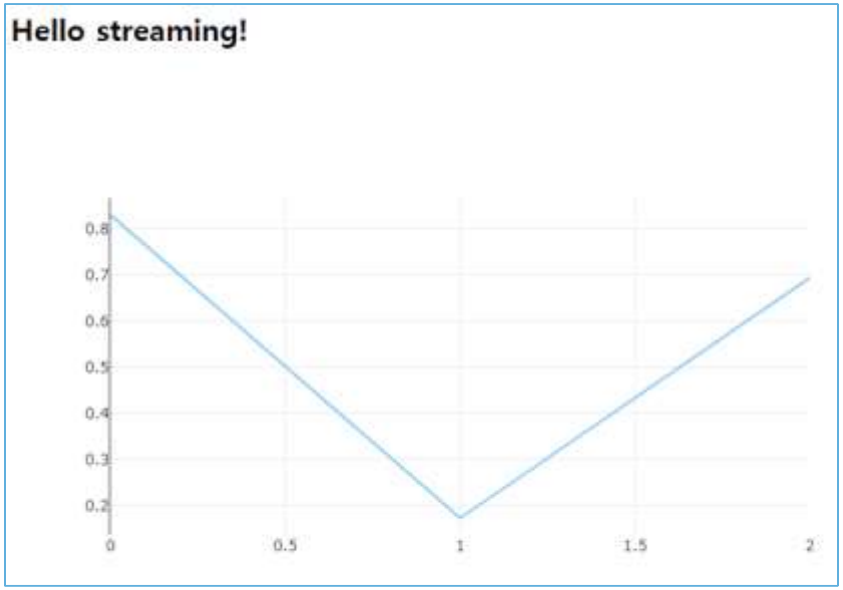
https://developer.mozilla.org/ko/docs/Web/JavaScript/Reference/Global_Objects/Array/map

A5.4.2.1 plotly.js: Streaming data

[1.1] Starting chart (new) DV_streaming01.html



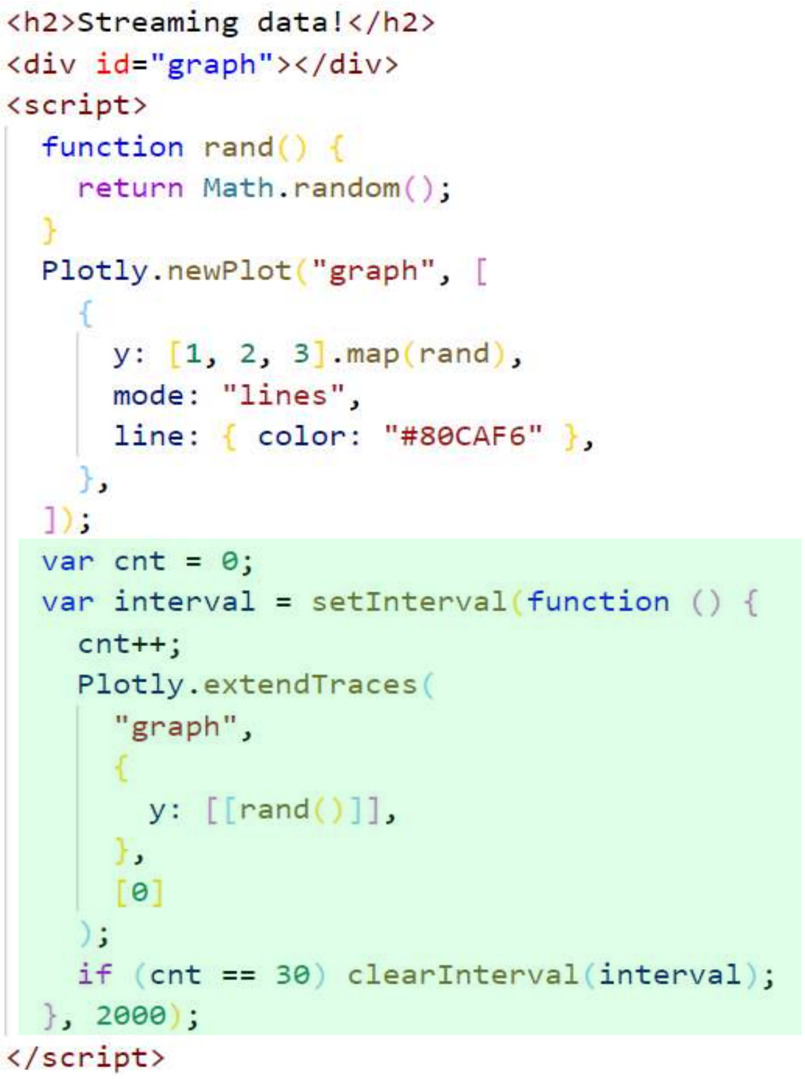
```
<h2>Hello streaming!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }

  Plotly.newPlot("graph", [
    {
      y: [1, 2, 3].map(rand),
      mode: "lines",
      line: { color: "#80CAF6" },
    },
  ]);

  /*var cnt = 0;
var interval = setInterval(function() {
  cnt++;
  Plotly.extendTraces('graph', {
    y: [[rand()]]
  }, [0]);
  if(cnt == 30) clearInterval(interval);
}, 2000);*/
</script>
```



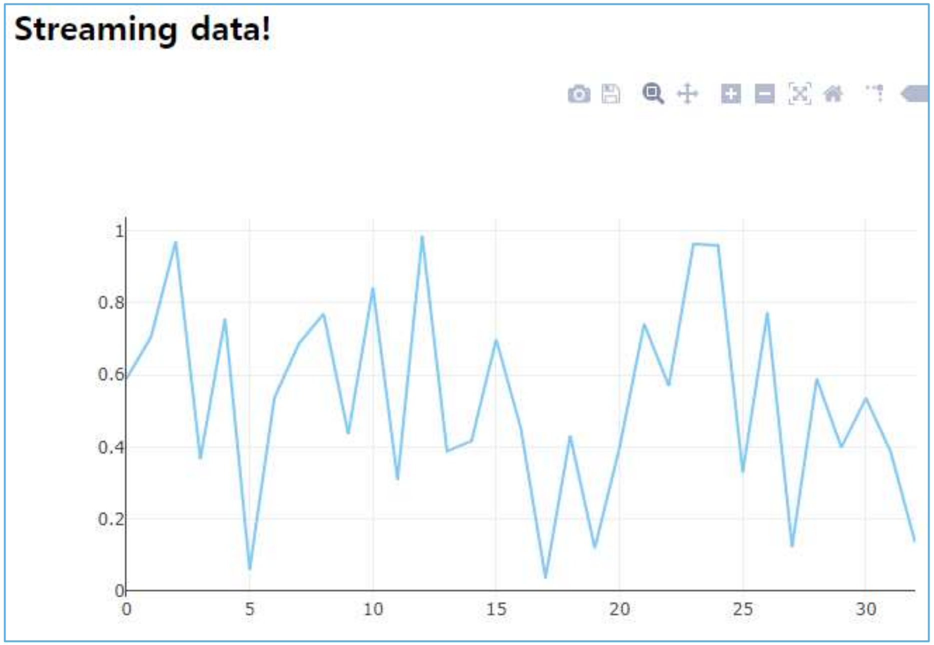
Hello streaming!

A5.4.2.2 plotly.js: Streaming data

[1.2] Basic streaming DV_streaming01S.html



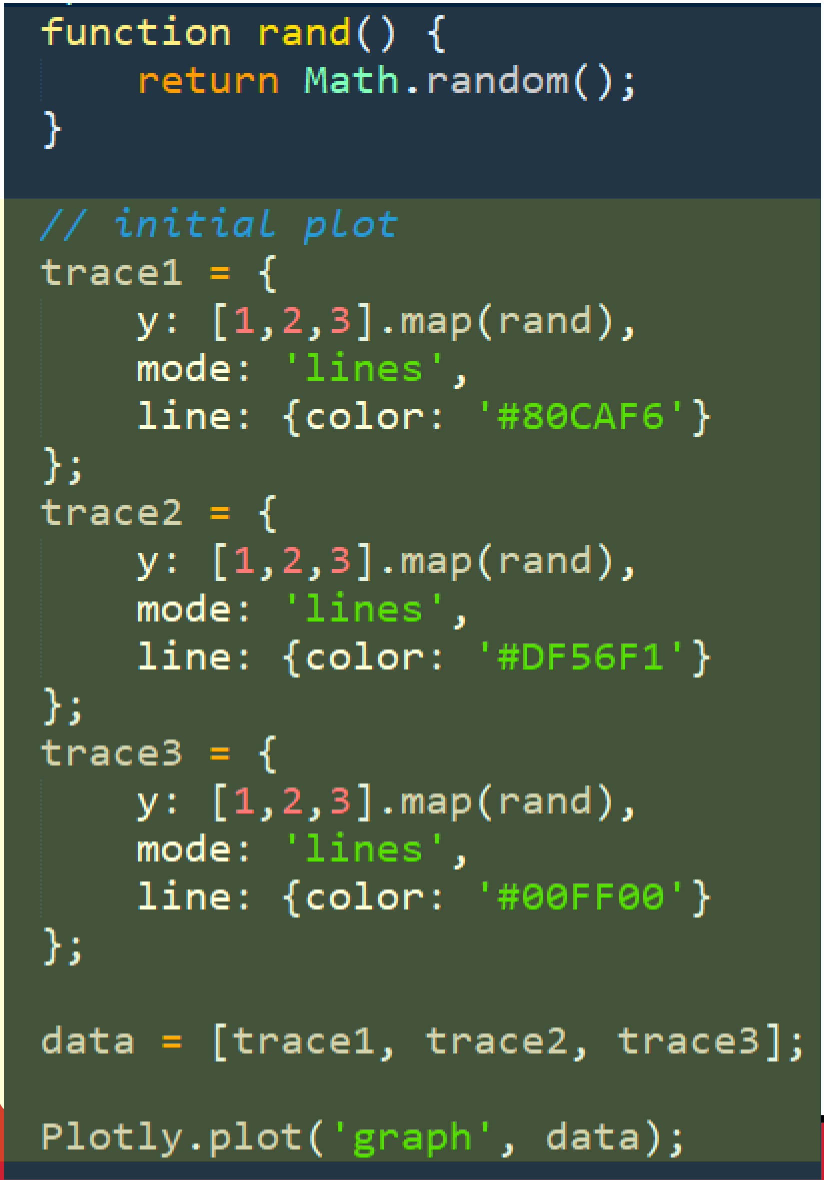
```
<h2>Streaming data!</h2>
<div id="graph"></div>
<script>
  function rand() {
    return Math.random();
  }
  Plotly.newPlot("graph", [
    {
      y: [1, 2, 3].map(rand),
      mode: "lines",
      line: { color: "#80CAF6" },
    },
  ]);
  var cnt = 0;
  var interval = setInterval(function () {
    cnt++;
    Plotly.extendTraces(
      "graph",
      {
        y: [[rand()]],
      },
      [0]
    );
    if (cnt == 30) clearInterval(interval);
  }, 2000);
</script>
```



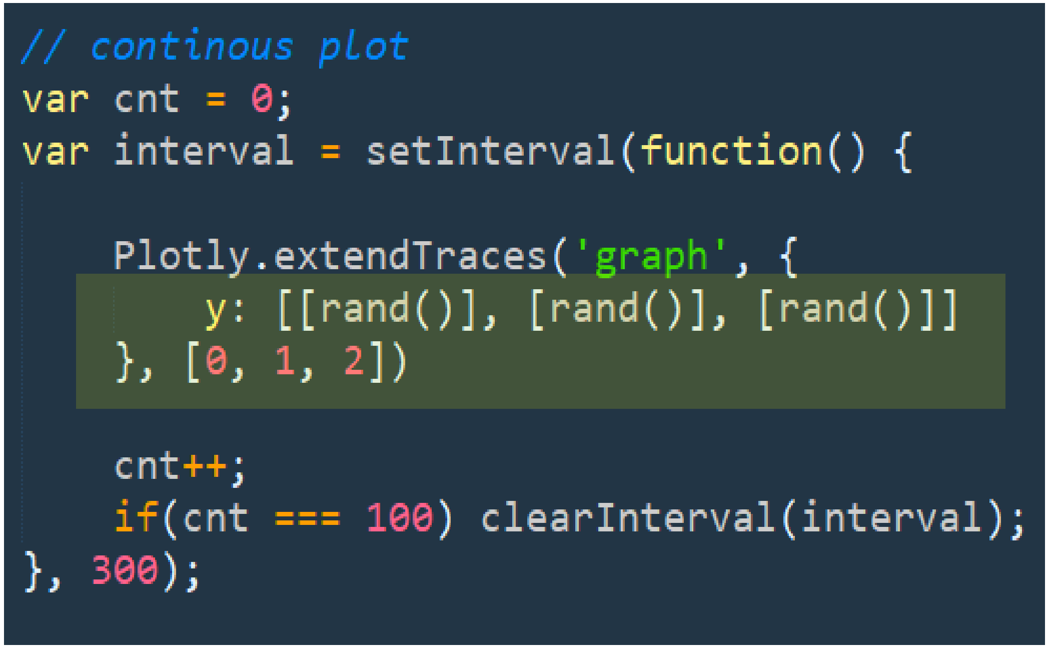
Streaming data!

A5.4.3.1 plotly.js: Streaming data

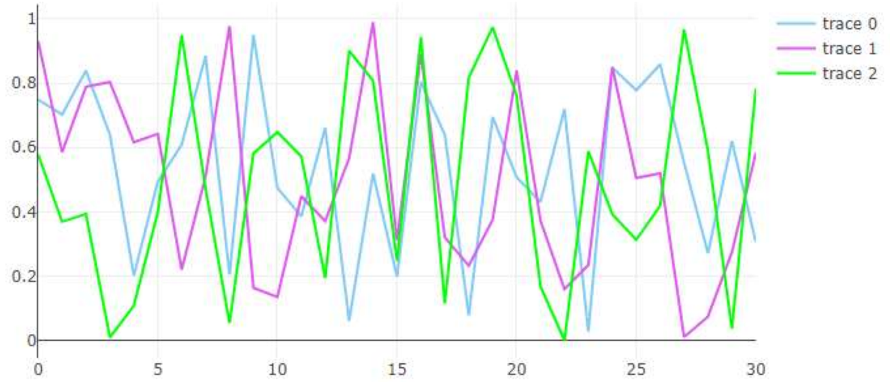
[2.1] Streaming multiple traces



```
function rand() {
    return Math.random();
}

// initial plot
trace1 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#80CAF6'}
};
trace2 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#DF56F1'}
};
trace3 = {
    y: [1,2,3].map(rand),
    mode: 'lines',
    line: {color: '#00FF00'}
};

data = [trace1, trace2, trace3];

Plotly.plot('graph', data);
```

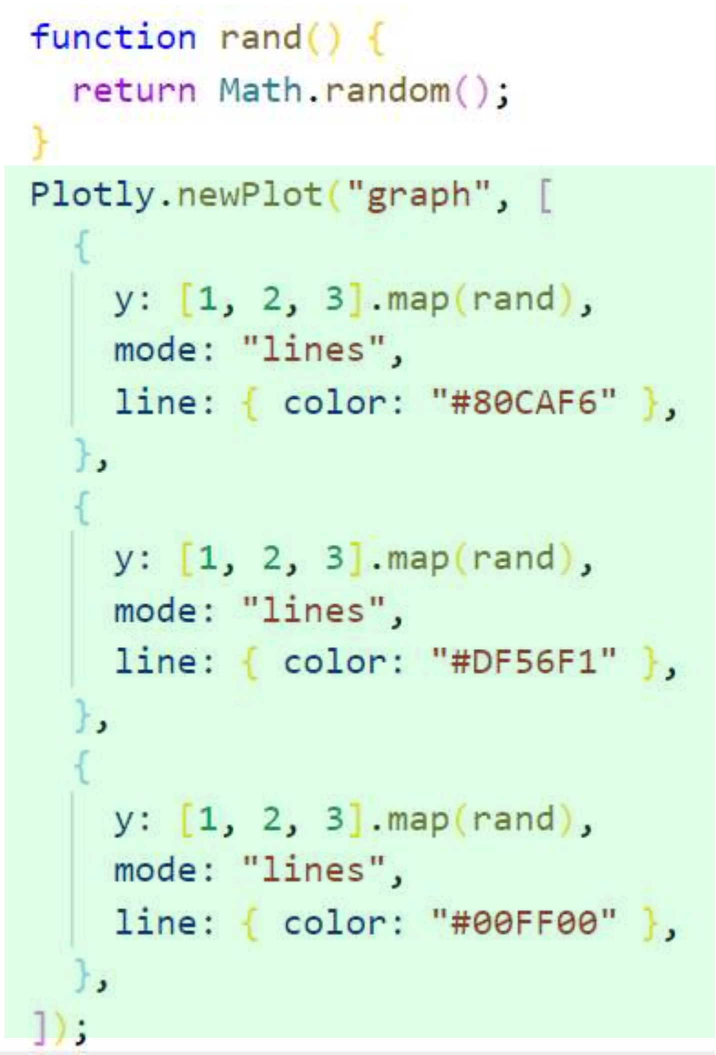


```
// continous plot
var cnt = 0;
var interval = setInterval(function() {

    Plotly.extendTraces('graph', {
        y: [[rand()], [rand()], [rand()]]
    }, [0, 1, 2])

    cnt++;
    if(cnt === 100) clearInterval(interval);
}, 300);
```

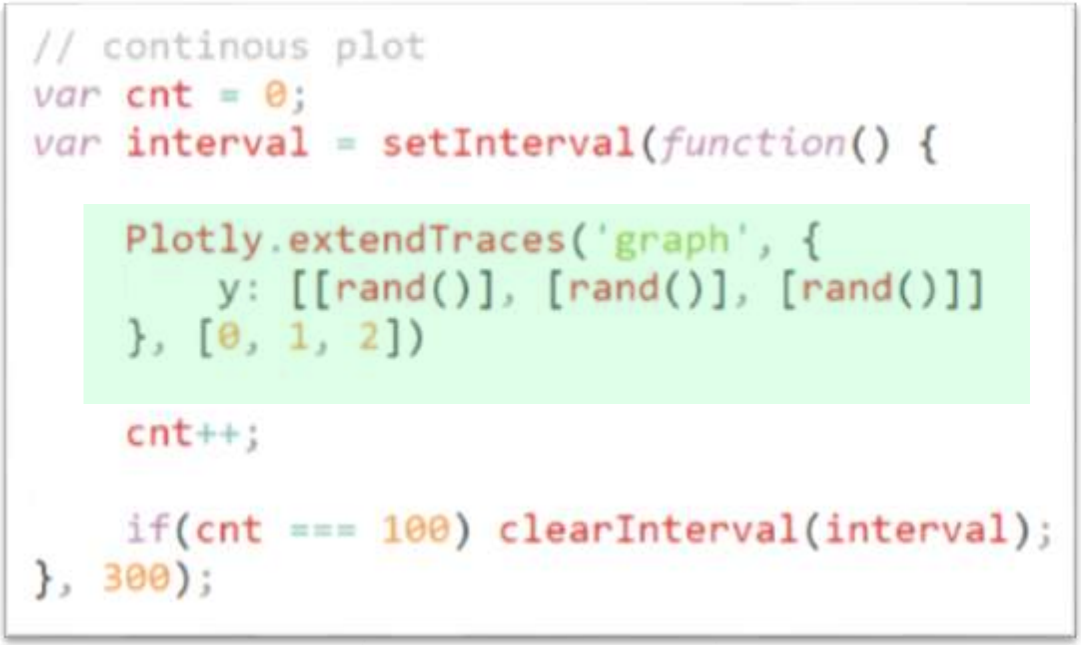


A5.4.3.2 plotly.js: Streaming data

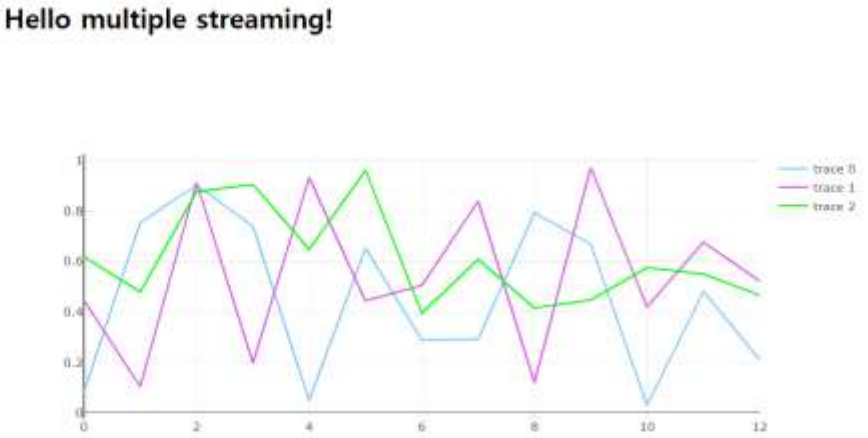
[2.2] Streaming multiple traces (new code) **DV_streaming02.html**



```
function rand() {
  return Math.random();
}
Plotly.newPlot("graph", [
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#80CAF6" },
  },
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#DF56F1" },
  },
  {
    y: [1, 2, 3].map(rand),
    mode: "lines",
    line: { color: "#00FF00" },
  },
]);
```



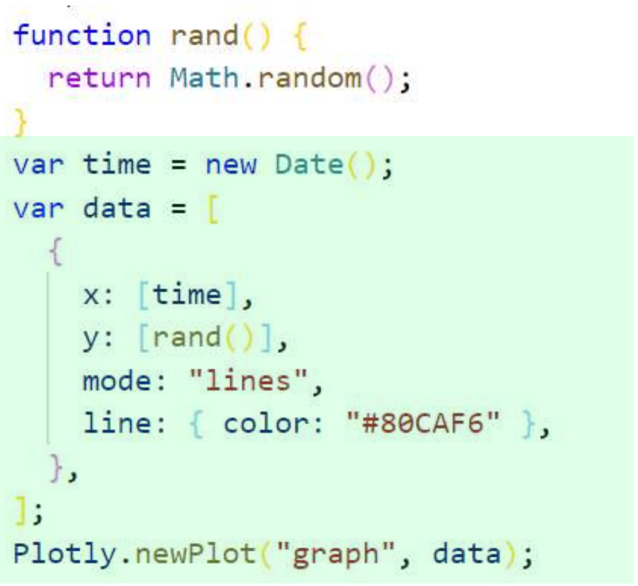
```
// continous plot
var cnt = 0;
var interval = setInterval(function() {

    Plotly.extendTraces('graph', {
        y: [[rand()], [rand()], [rand()]]
    }, [0, 1, 2])

    cnt++;

    if(cnt === 100) clearInterval(interval);
}, 300);
```



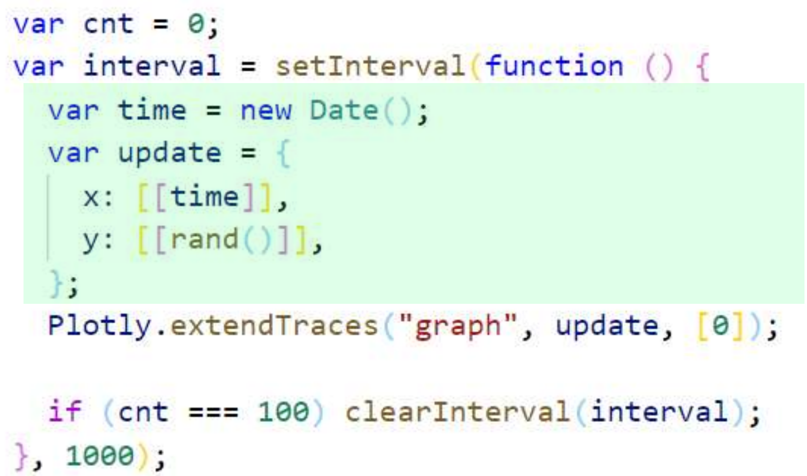
Hello multiple streaming!

A5.4.4 plotly.js: Streaming data

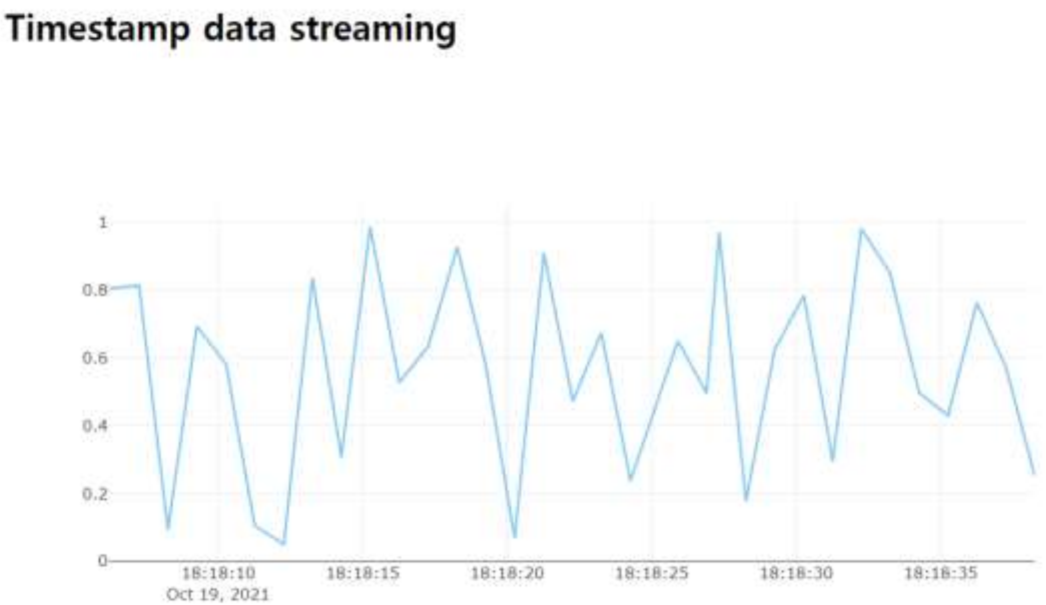
[3] Streaming data with timestamp DV_streaming03_timestamp.html



```
function rand() {
  return Math.random();
}
var time = new Date();
var data = [
  {
    x: [time],
    y: [rand()],
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```

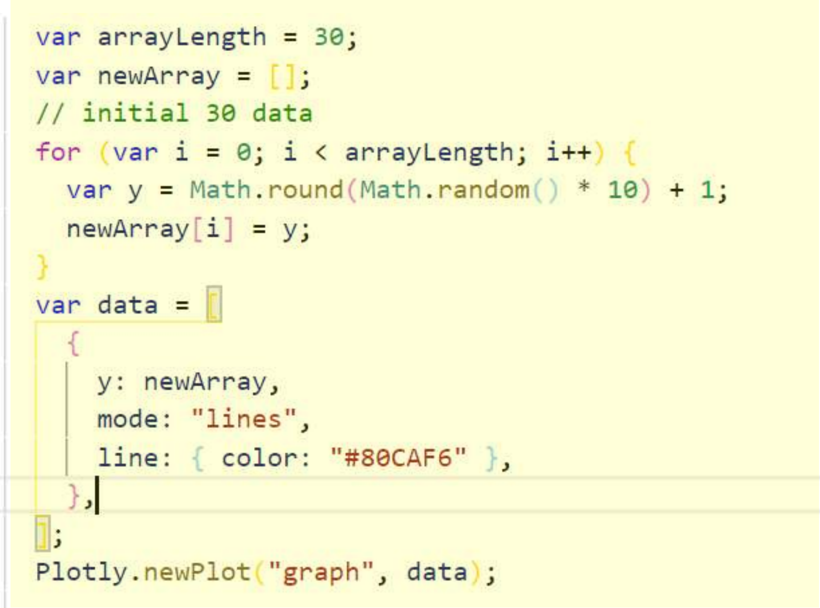


```
var cnt = 0;
var interval = setInterval(function () {
  var time = new Date();
  var update = {
    x: [[time]],
    y: [[rand()]],
  };
  Plotly.extendTraces("graph", update, [0]);

  if (cnt === 100) clearInterval(interval);
}, 1000);
```

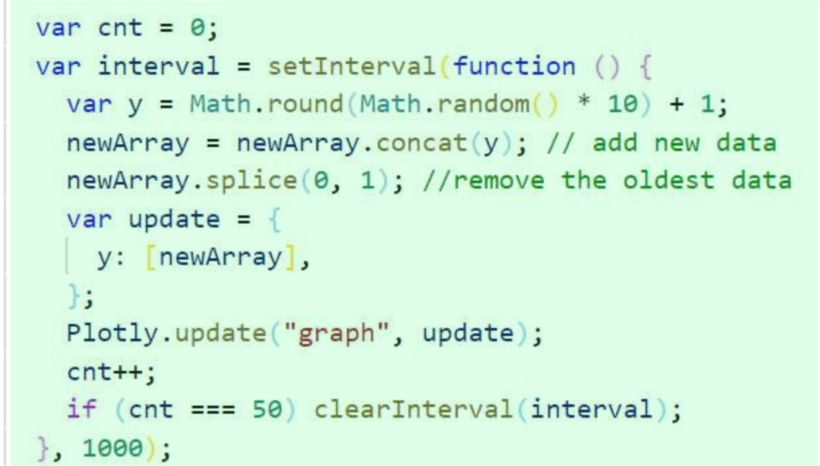


A5.4.5 plotly.js: Streaming data

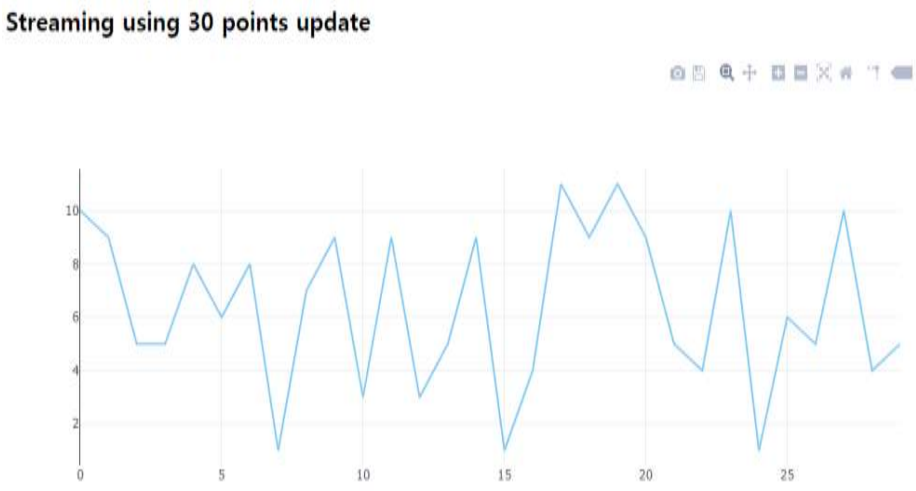
[4] Streaming data using 30 points update



```
var arrayLength = 30;
var newArray = [];
// initial 30 data
for (var i = 0; i < arrayLength; i++) {
  var y = Math.round(Math.random() * 10) + 1;
  newArray[i] = y;
}
var data = [
  {
    y: newArray,
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```

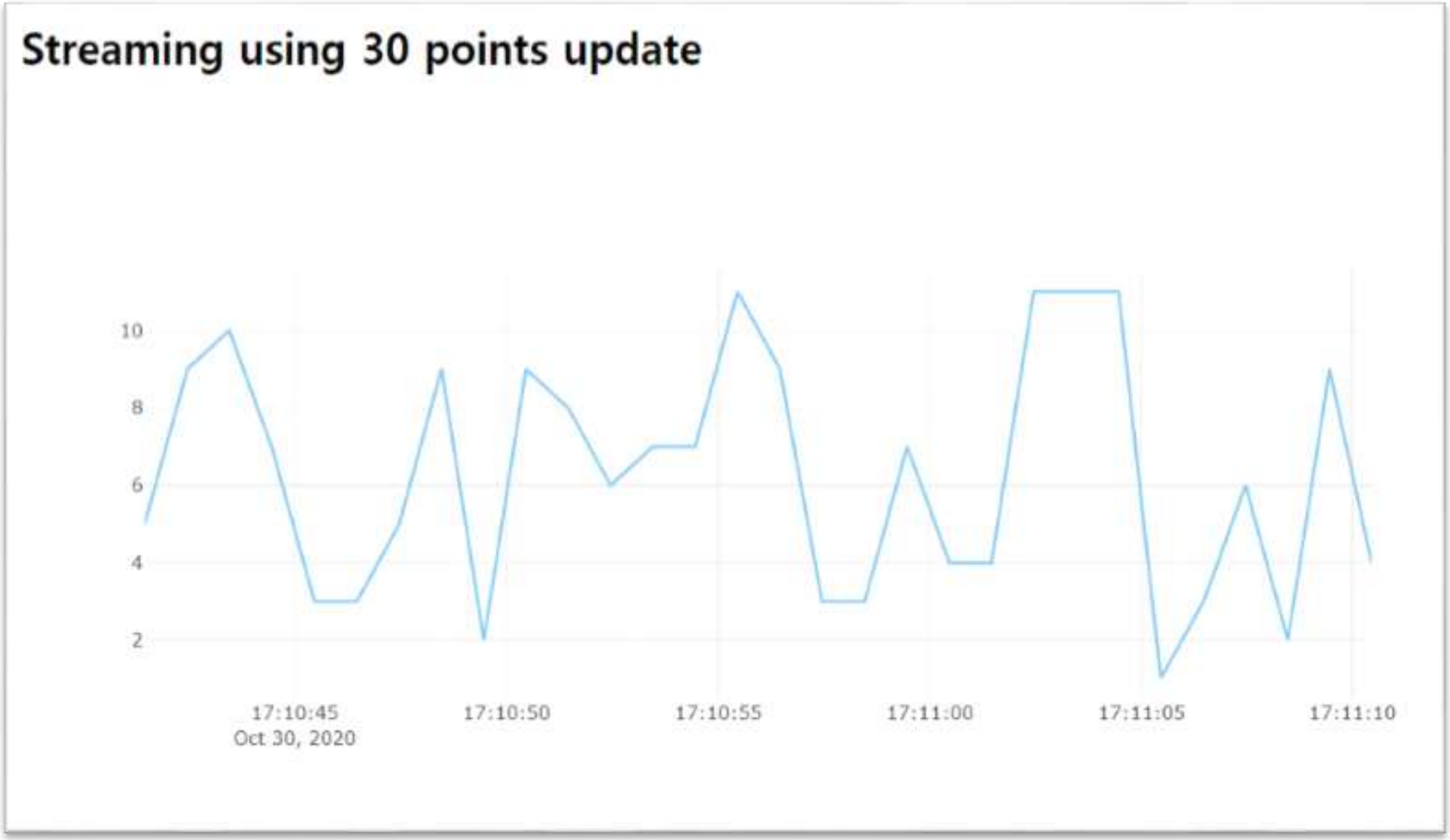


```
var cnt = 0;
var interval = setInterval(function () {
  var y = Math.round(Math.random() * 10) + 1;
  newArray = newArray.concat(y); // add new data
  newArray.splice(0, 1); //remove the oldest data
  var update = {
    y: [newArray],
  };
  Plotly.update("graph", update);
  cnt++;
  if (cnt === 50) clearInterval(interval);
}, 1000);
```


Streaming using 30 points update

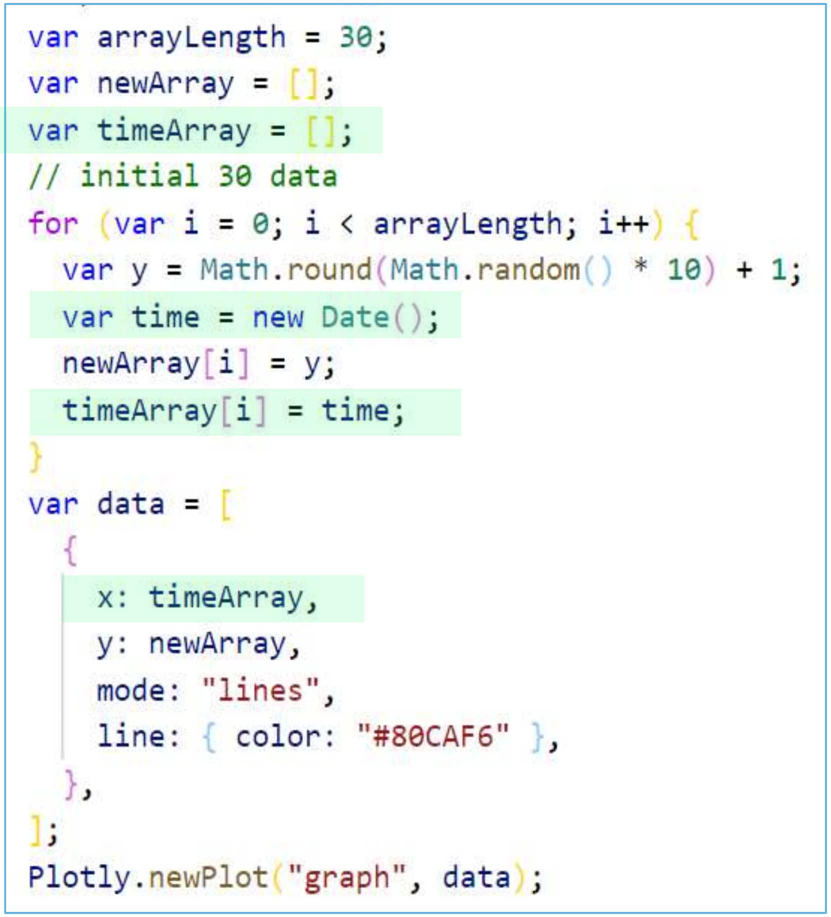
A5.4.5.1 plotly.js: Streaming data

[4.1] Streaming data using 30 points update (with timestamp)

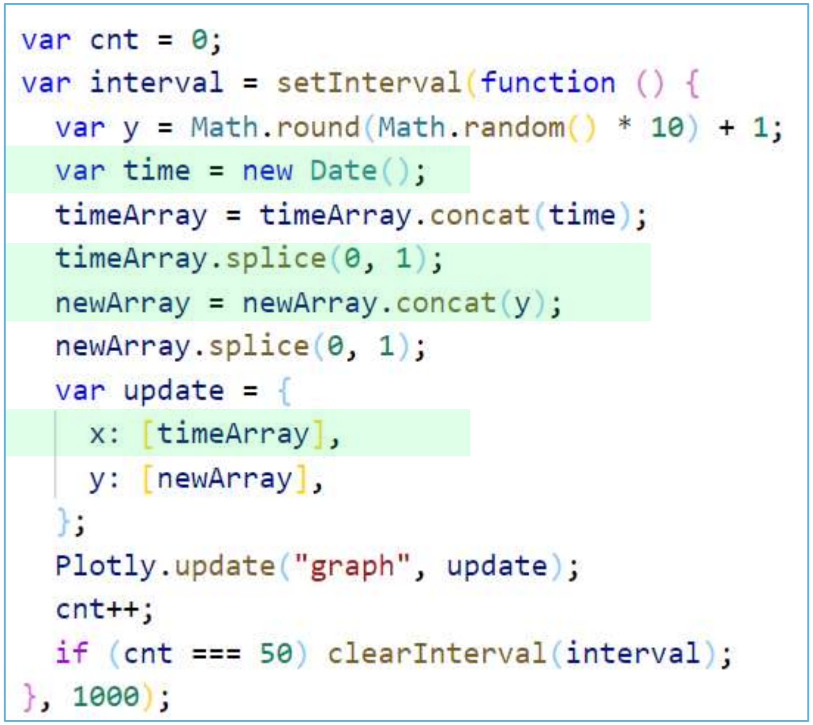


A5.4.5.2 plotly.js: Streaming data

[4.2] Streaming data using 30 points update **DV_streaming04_range.html**



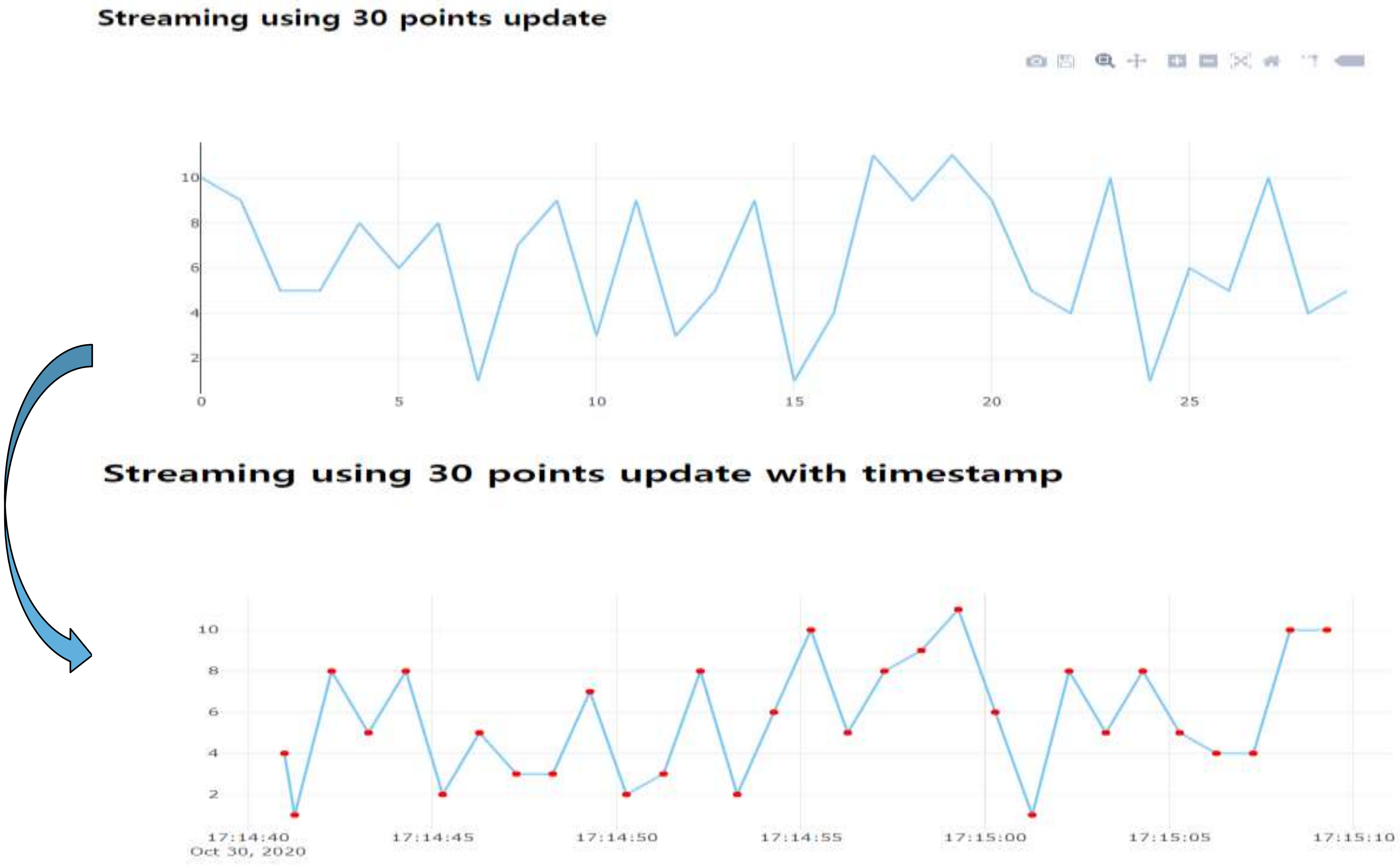
```
var arrayLength = 30;
var newArray = [];
var timeArray = [];
// initial 30 data
for (var i = 0; i < arrayLength; i++) {
  var y = Math.round(Math.random() * 10) + 1;
  var time = new Date();
  newArray[i] = y;
  timeArray[i] = time;
}
var data = [
  {
    x: timeArray,
    y: newArray,
    mode: "lines",
    line: { color: "#80CAF6" },
  },
];
Plotly.newPlot("graph", data);
```



```
var cnt = 0;
var interval = setInterval(function () {
  var y = Math.round(Math.random() * 10) + 1;
  var time = new Date();
  timeArray = timeArray.concat(time);
  timeArray.splice(0, 1);
  newArray = newArray.concat(y);
  newArray.splice(0, 1);
  var update = {
    x: [timeArray],
    y: [newArray],
  };
  Plotly.update("graph", update);
  cnt++;
  if (cnt === 50) clearInterval(interval);
}, 1000);
```

A5.4.5.3 plotly.js: Streaming data

[DIY] Streaming time series using 30 points update



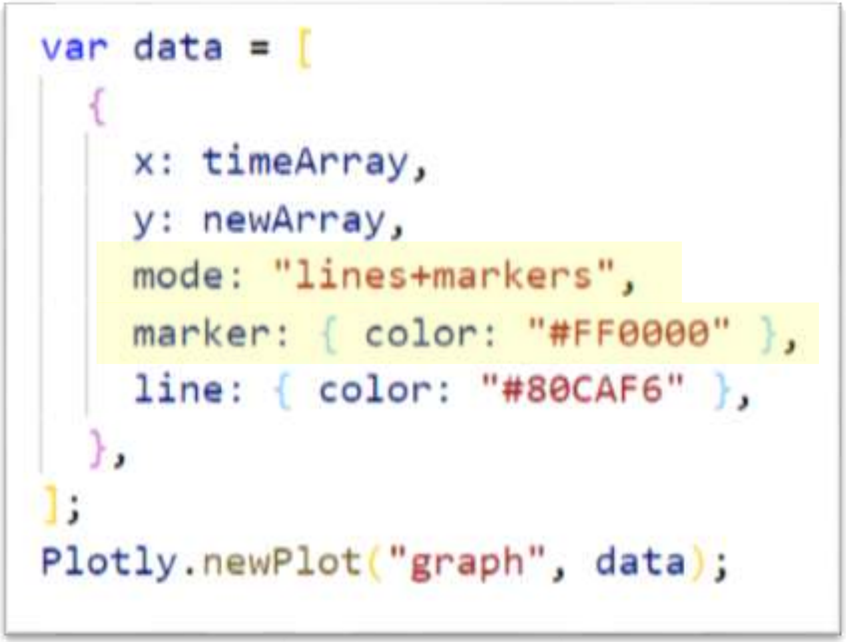
Streaming using 30 points update

Streaming using 30 points update with timestamp

AAnn_DS_30timestamps.png 로 캡처 저장.

A5.4.5.4 plotly.js: Streaming data

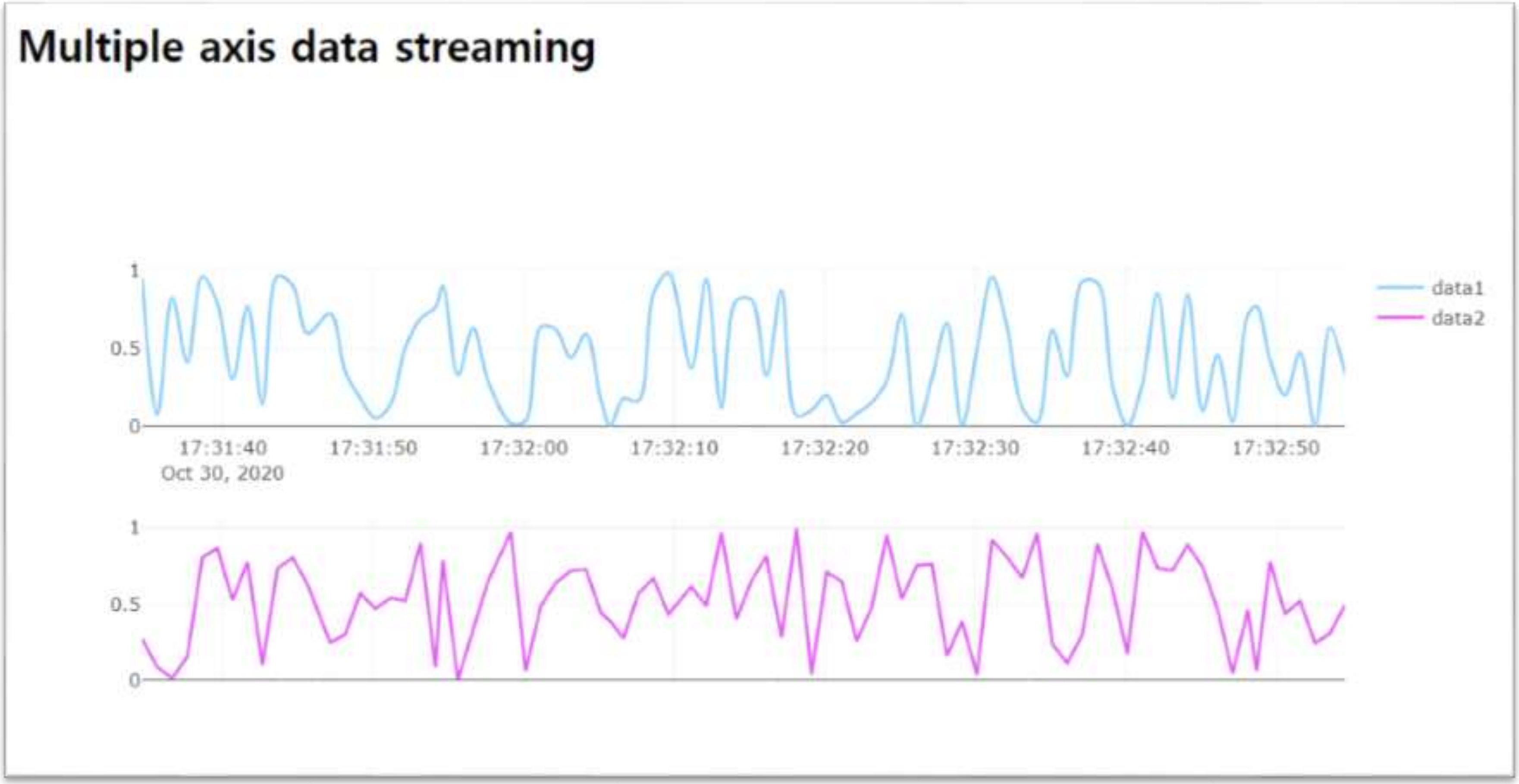
[DIY-hint] Streaming time series using 30 points update



```
var data = [
    {
        x: timeArray,
        y: newArray,
        mode: "lines+markers",
        marker: { color: "#FF0000" },
        line: { color: "#80CAF6" },
    },
];
Plotly.newPlot("graph", data);
```

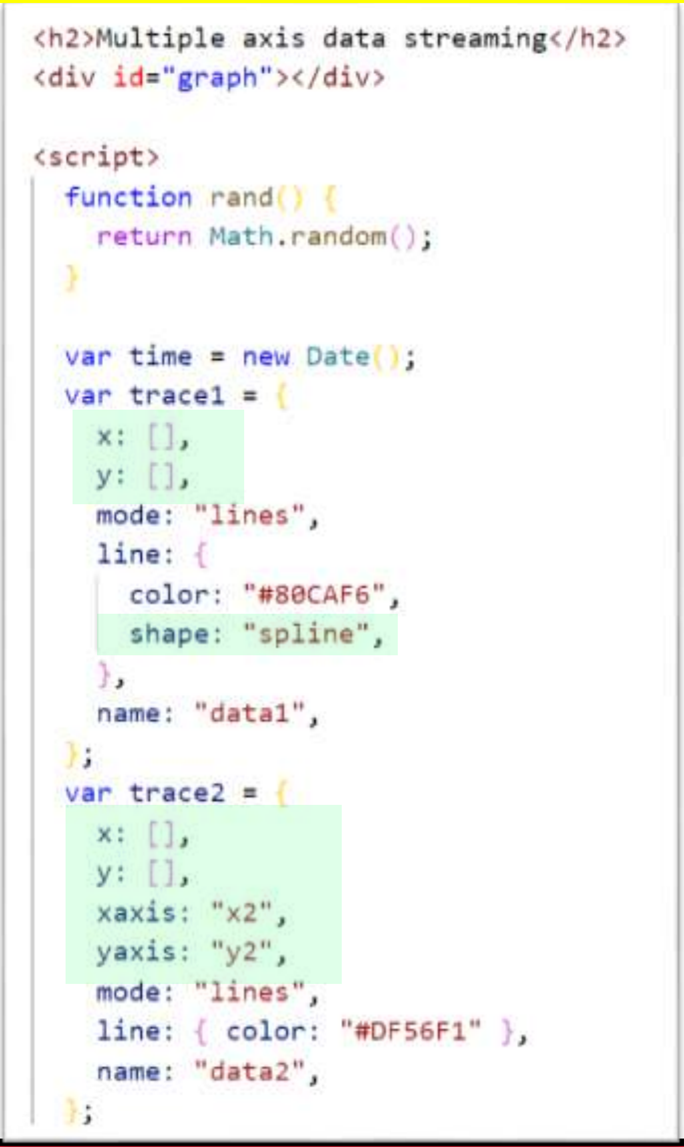
A5.4.6 plotly.js: Streaming data

[5] Streaming data using multiple axis

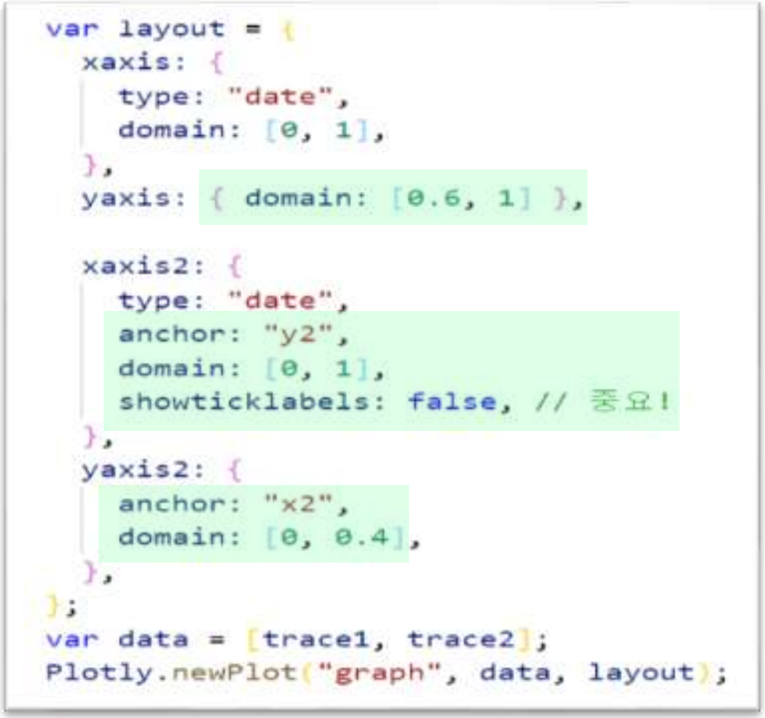


A5.4.6.1 plotly.js: Streaming data

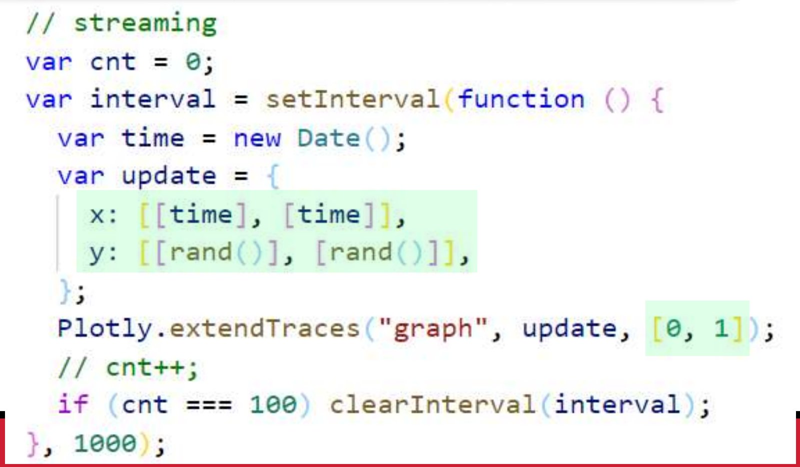
[5.1] Streaming data using multiple axis   DV_streaming05_multiple_axis.html



```
<h2>Multiple axis data streaming</h2>
<div id="graph"></div>

<script>
  function rand() {
    return Math.random();
  }

  var time = new Date();
  var trace1 = {
    x: [],
    y: [],
    mode: "lines",
    line: {
      color: "#80CAF6",
      shape: "spline",
    },
    name: "data1",
  };
  var trace2 = {
    x: [],
    y: [],
    xaxis: "x2",
    yaxis: "y2",
    mode: "lines",
    line: { color: "#DF56F1" },
    name: "data2",
  };
```



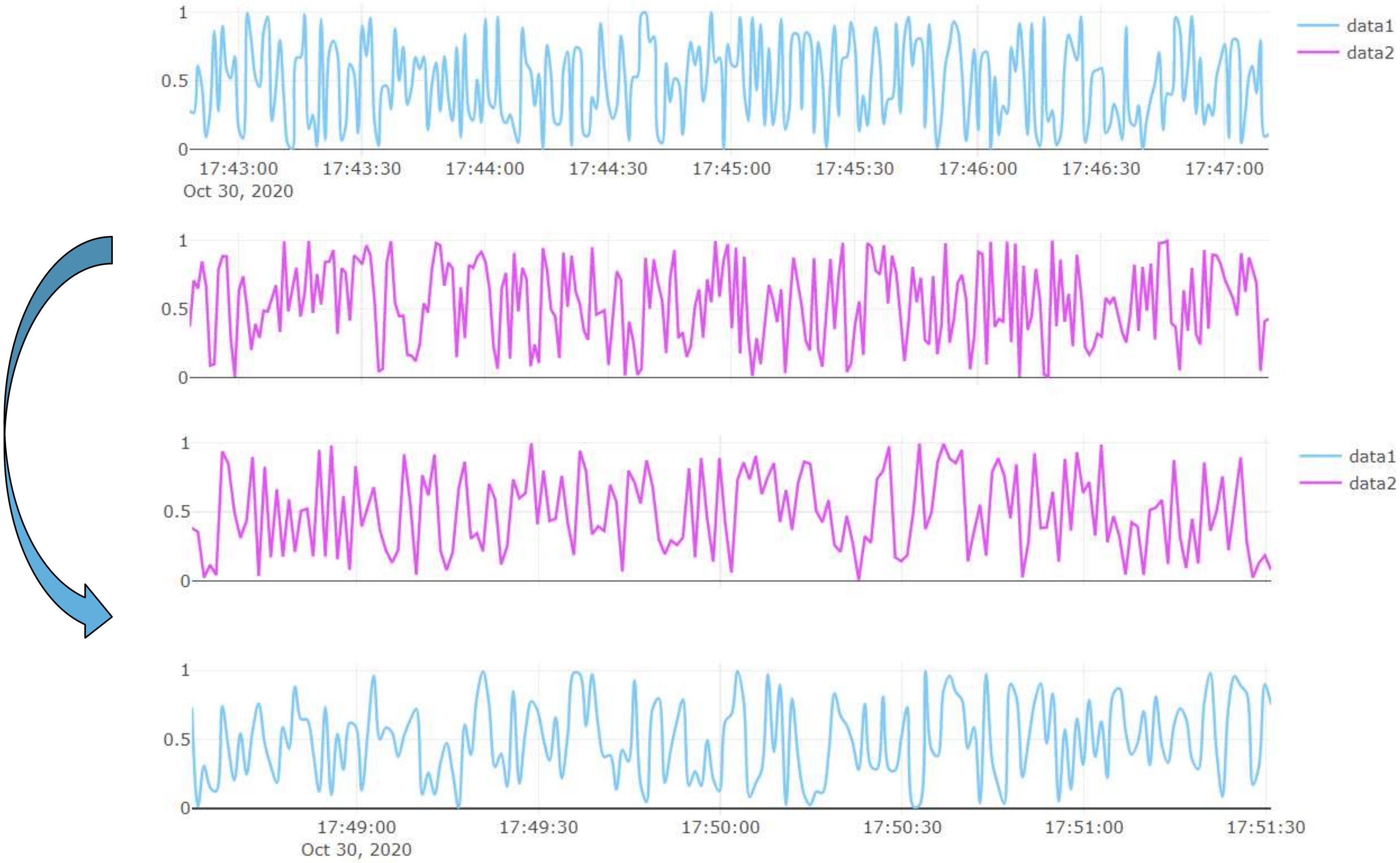
```
  var layout = {
    xaxis: {
      type: "date",
      domain: [0, 1],
    },
    yaxis: { domain: [0.6, 1] },

    xaxis2: {
      type: "date",
      anchor: "y2",
      domain: [0, 1],
      showticklabels: false, // 중요!
    },
    yaxis2: {
      anchor: "x2",
      domain: [0, 0.4],
    },
  };
  var data = [trace1, trace2];
  Plotly.newPlot("graph", data, layout);
```



```
  // streaming
  var cnt = 0;
  var interval = setInterval(function () {
    var time = new Date();
    var update = {
      x: [[time], [time]],
      y: [[rand()], [rand()]],
    };
    Plotly.extendTraces("graph", update, [0, 1]);
    // cnt++;
    if (cnt === 100) clearInterval(interval);
  }, 1000);
```

A5.4.6.2 plotly.js: Streaming data

[DIY] Streaming data using multiple axis → change axis

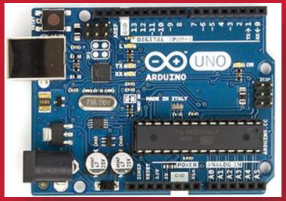


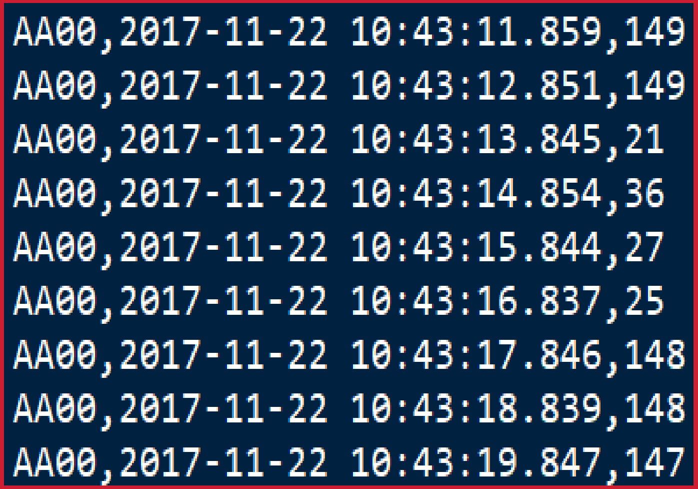
AAnn_DS_multiple_axis.png 로 캡처 저장.

Arduino sensor data

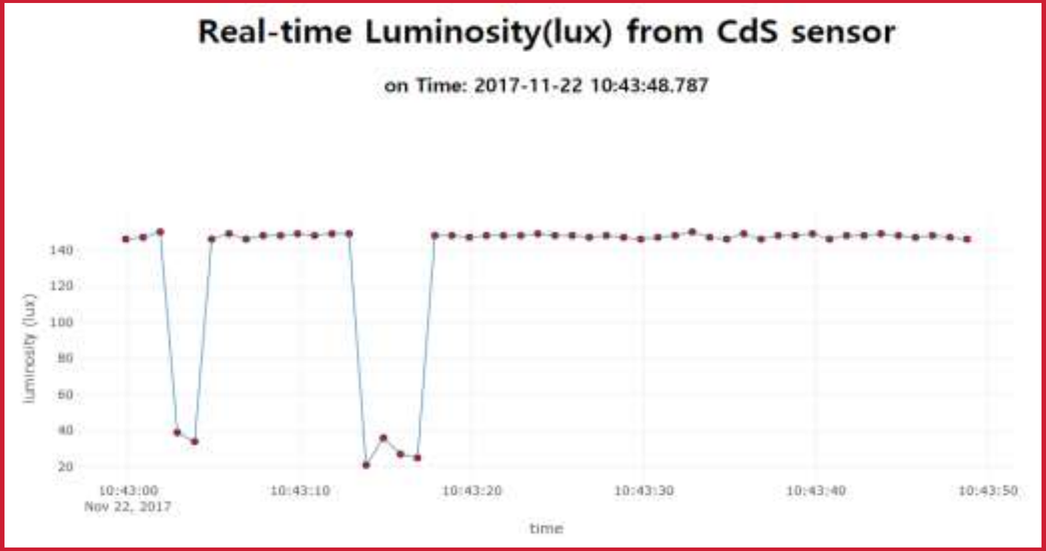
RT visualization

using plotly.js





```
AA00,2017-11-22 10:43:11.859,149
AA00,2017-11-22 10:43:12.851,149
AA00,2017-11-22 10:43:13.845,21
AA00,2017-11-22 10:43:14.854,36
AA00,2017-11-22 10:43:15.844,27
AA00,2017-11-22 10:43:16.837,25
AA00,2017-11-22 10:43:17.846,148
AA00,2017-11-22 10:43:18.839,148
AA00,2017-11-22 10:43:19.847,147
```

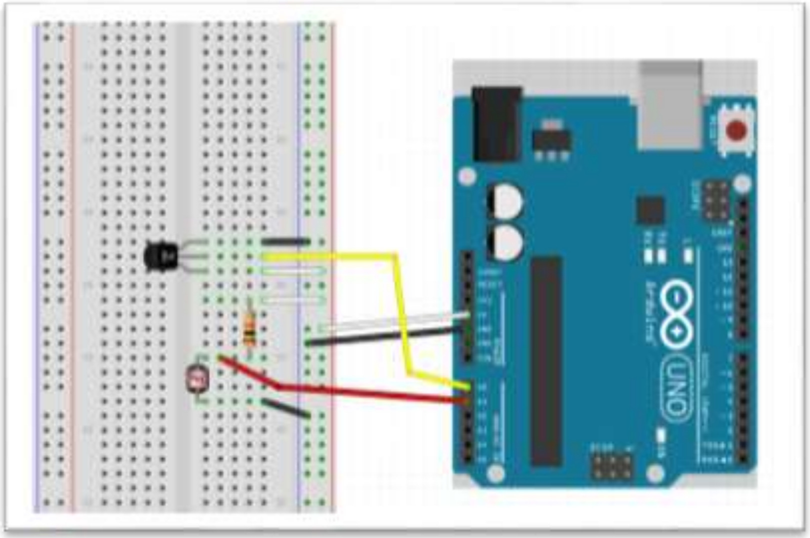


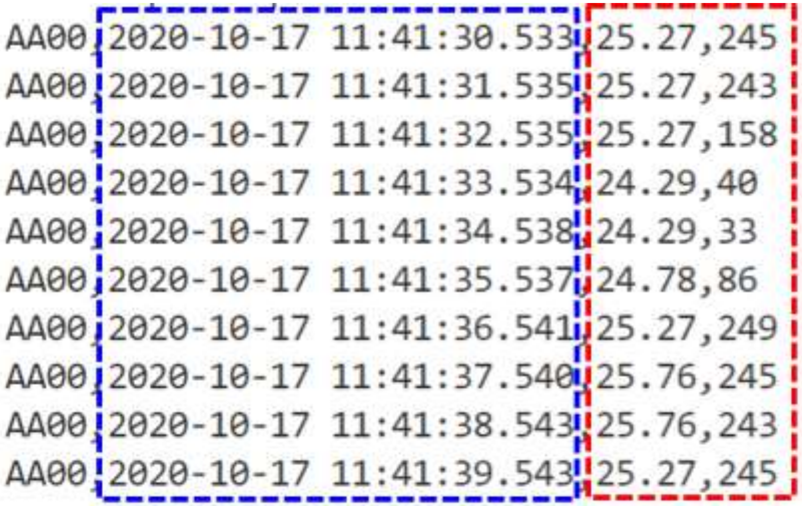
Real-time Luminosity(lux) from CdS sensor

on Time: 2017-11-22 10:43:48.787

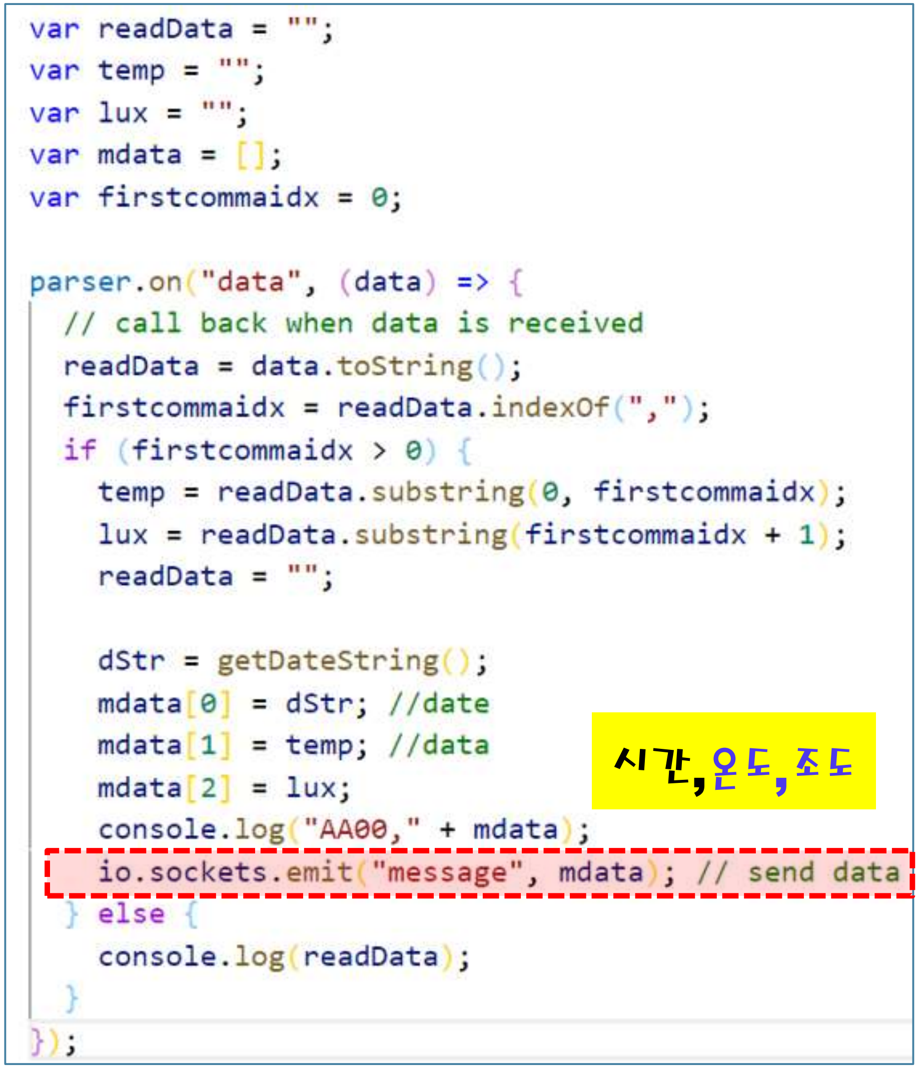
Network socket emitting data

tmp36 + CdS circuit





```
AA00,2020-10-17 11:41:30.533,25.27,245
AA00,2020-10-17 11:41:31.535,25.27,243
AA00,2020-10-17 11:41:32.535,25.27,158
AA00,2020-10-17 11:41:33.534,24.29,40
AA00,2020-10-17 11:41:34.538,24.29,33
AA00,2020-10-17 11:41:35.537,24.78,86
AA00,2020-10-17 11:41:36.541,25.27,249
AA00,2020-10-17 11:41:37.540,25.76,245
AA00,2020-10-17 11:41:38.543,25.76,243
AA00,2020-10-17 11:41:39.543,25.27,245
```



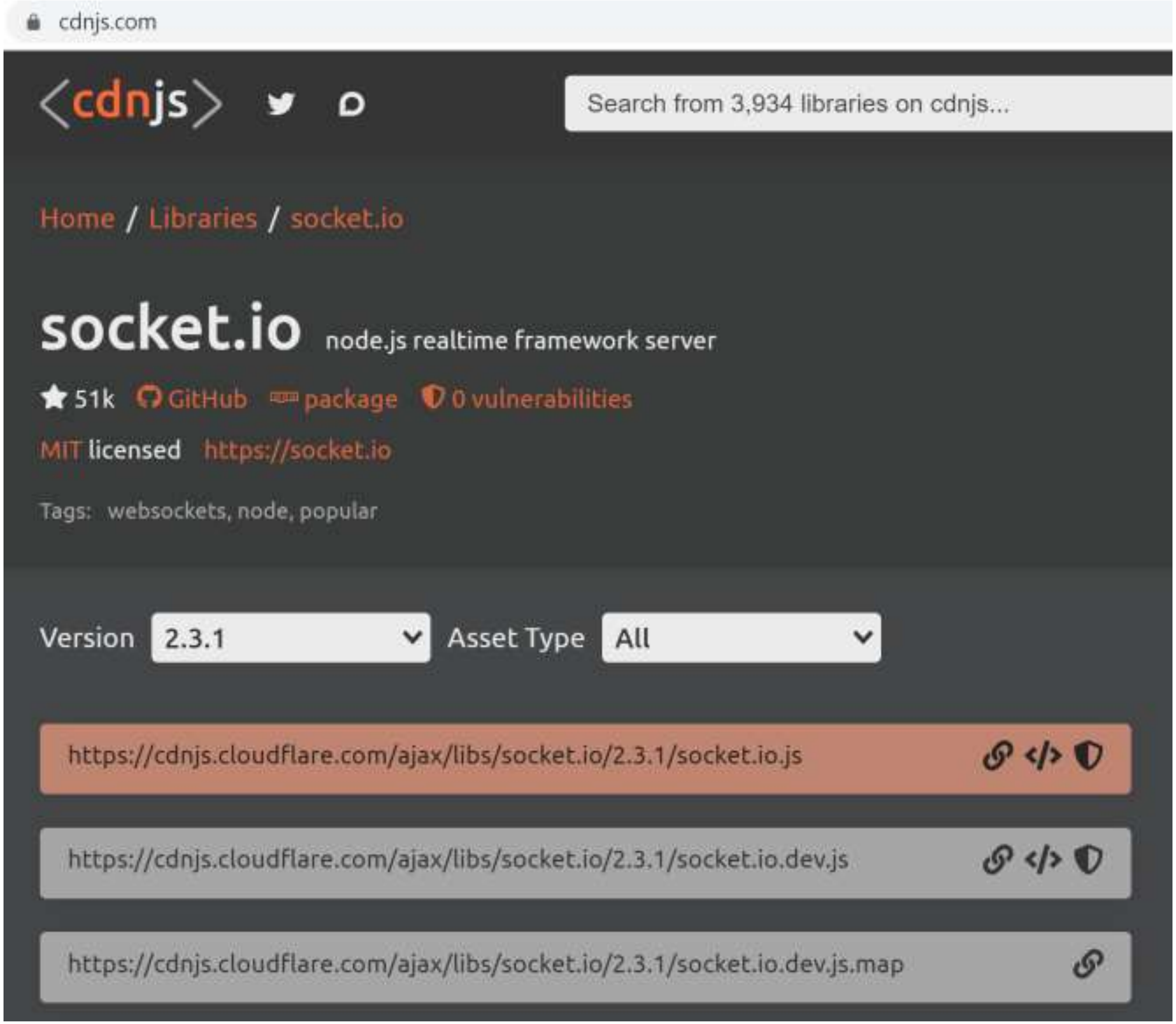
```
var readData = "";
var temp = "";
var lux = "";
var mdata = [];
var firstcommaidx = 0;

parser.on("data", (data) => {
  // call back when data is received
  readData = data.toString();
  firstcommaidx = readData.indexOf(",");
  if (firstcommaidx > 0) {
    temp = readData.substring(0, firstcommaidx);
    lux = readData.substring(firstcommaidx + 1);
    readData = "";

    dStr = getDateString();
    mdata[0] = dStr; //date
    mdata[1] = temp; //data
    mdata[2] = lux;
    console.log("AA00," + mdata);
    io.sockets.emit("message", mdata); // send data
  } else {
    console.log(readData);
  }
});
```

시간,온도,조도

Arduino data on network socket

Google search

socket.io.js cdn



cdnjs.com

Home / Libraries / socket.io

socket.io node.js realtime framework server

★ 51k GitHub package 0 vulnerabilities

MIT licensed https://socket.io

Tags: websockets, node, popular

Version 2.3.1 Asset Type All

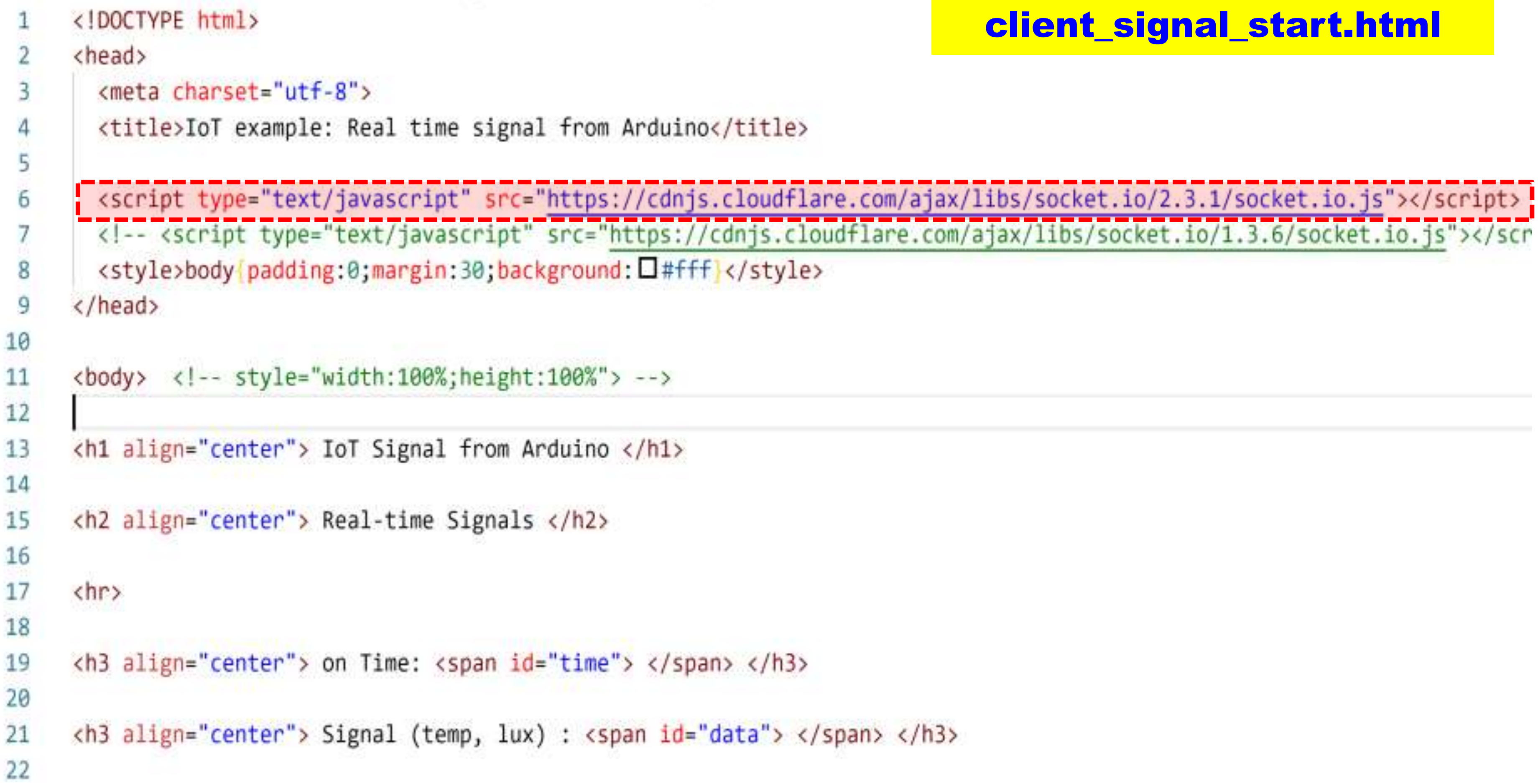
https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js

https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.dev.js

https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.dev.js.map

Arduino data on network socket

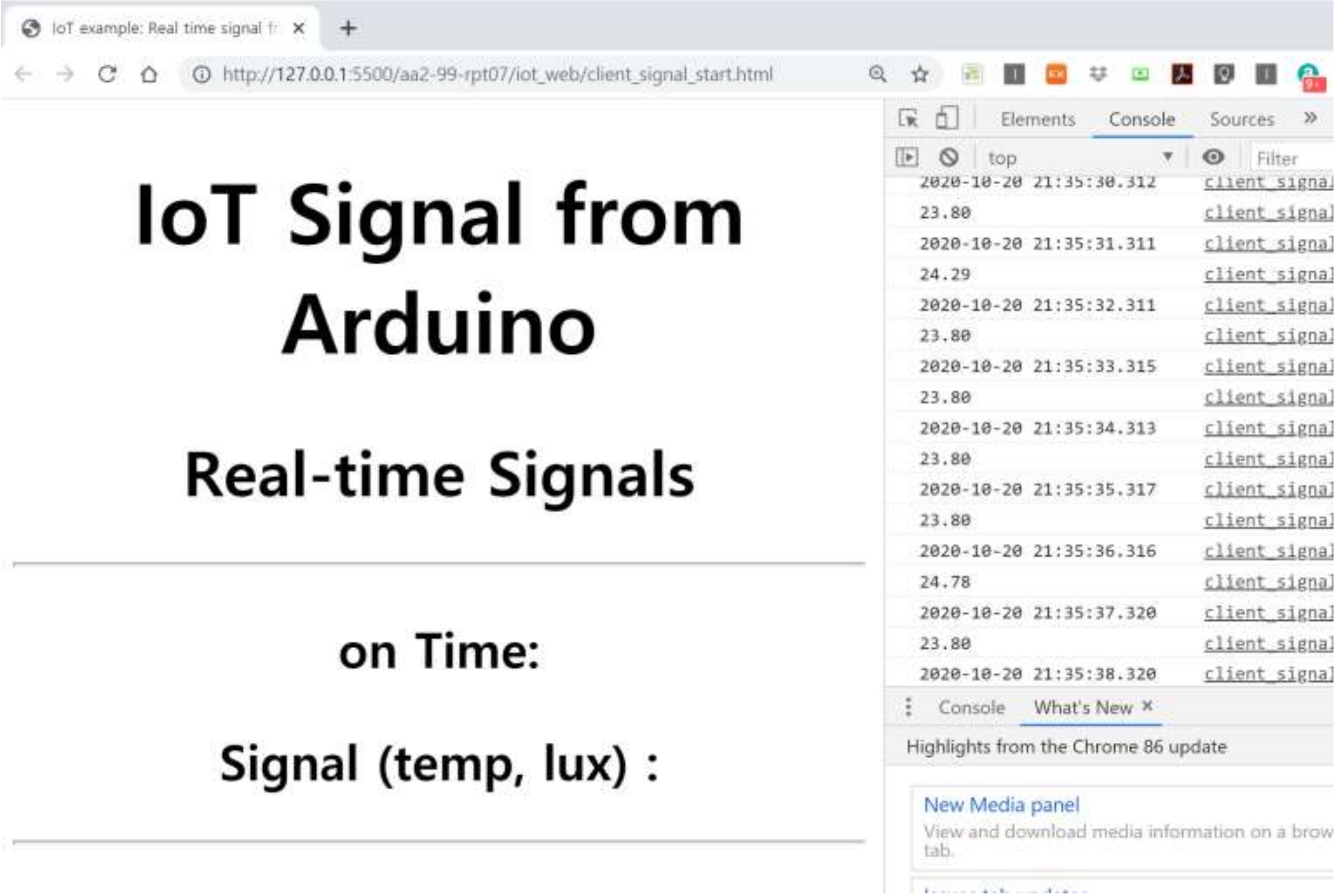
client_signal_start.html



```html
<!DOCTYPE html>
<head>
  <meta charset="utf-8">
  <title>IoT example: Real time signal from Arduino</title>

  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>
  <!-- <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/1.3.6/socket.io.js"></scr
  <style>body{padding:0;margin:30;background:#fff}</style>
</head>

<body>  <!-- style="width:100%;height:100%"> -->

<h1 align="center"> IoT Signal from Arduino </h1>

<h2 align="center"> Real-time Signals </h2>

<hr>

<h3 align="center"> on Time: <span id="time"> </span> </h3>

<h3 align="center"> Signal (temp, lux) : <span id="data"> </span> </h3>

```

Google search : socket.io.js cdn

Arduino data on network socket


IoT example: Real time signal fr
http://127.0.0.1:5500/aa2-99-rpt07/iot_web/client_signal_start.html
Elements
Console
Sources
top
Filter
Console
What's New

IoT Signal from Arduino

Real-time Signals

on Time:

Signal (temp, lux) :

```
2020-10-20 21:35:30.312     client_signal
23.80                       client_signal
2020-10-20 21:35:31.311     client_signal
24.29                       client_signal
2020-10-20 21:35:32.311     client_signal
23.80                       client_signal
2020-10-20 21:35:33.315     client_signal
23.80                       client_signal
2020-10-20 21:35:34.313     client_signal
23.80                       client_signal
2020-10-20 21:35:35.317     client_signal
23.80                       client_signal
2020-10-20 21:35:36.316     client_signal
24.78                       client_signal
2020-10-20 21:35:37.320     client_signal
23.80                       client_signal
2020-10-20 21:35:38.320     client_signal
```

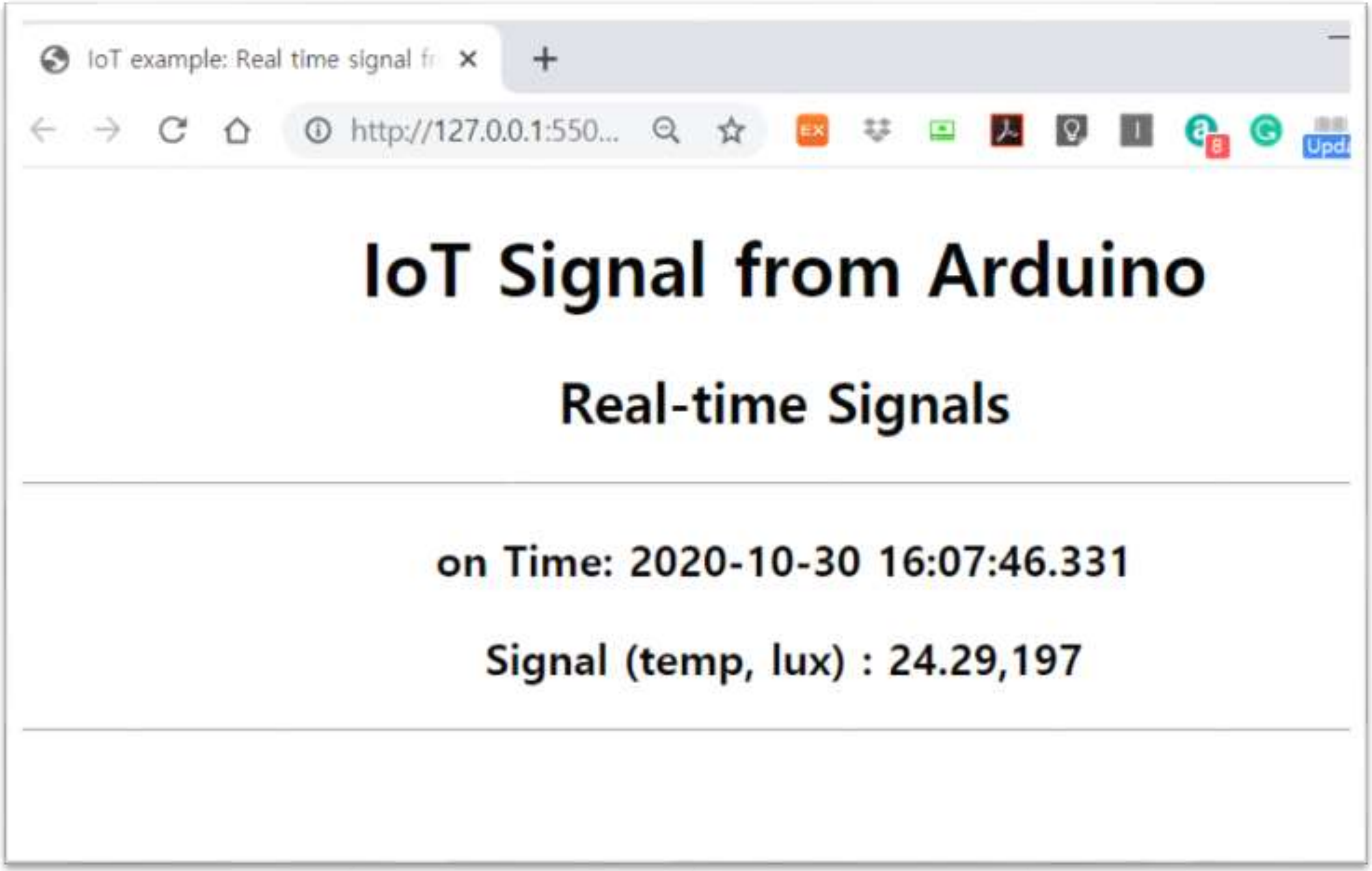
Highlights from the Chrome 86 update

New Media panel

View and download media information on a brow tab.

Real-time console showing a signal from Arduino in Chrome browser – F12

Arduino data on network socket



IoT Signal from Arduino

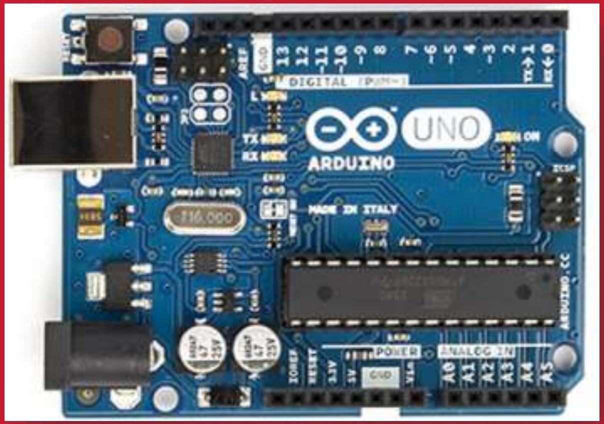
Real-time Signals

on Time: 2020-10-30 16:07:46.331

Signal (temp, lux) : 24.29,197

Real-time monitoring of a signal from Arduino
tmp36 + CdS circuit

Single sensor: CdS



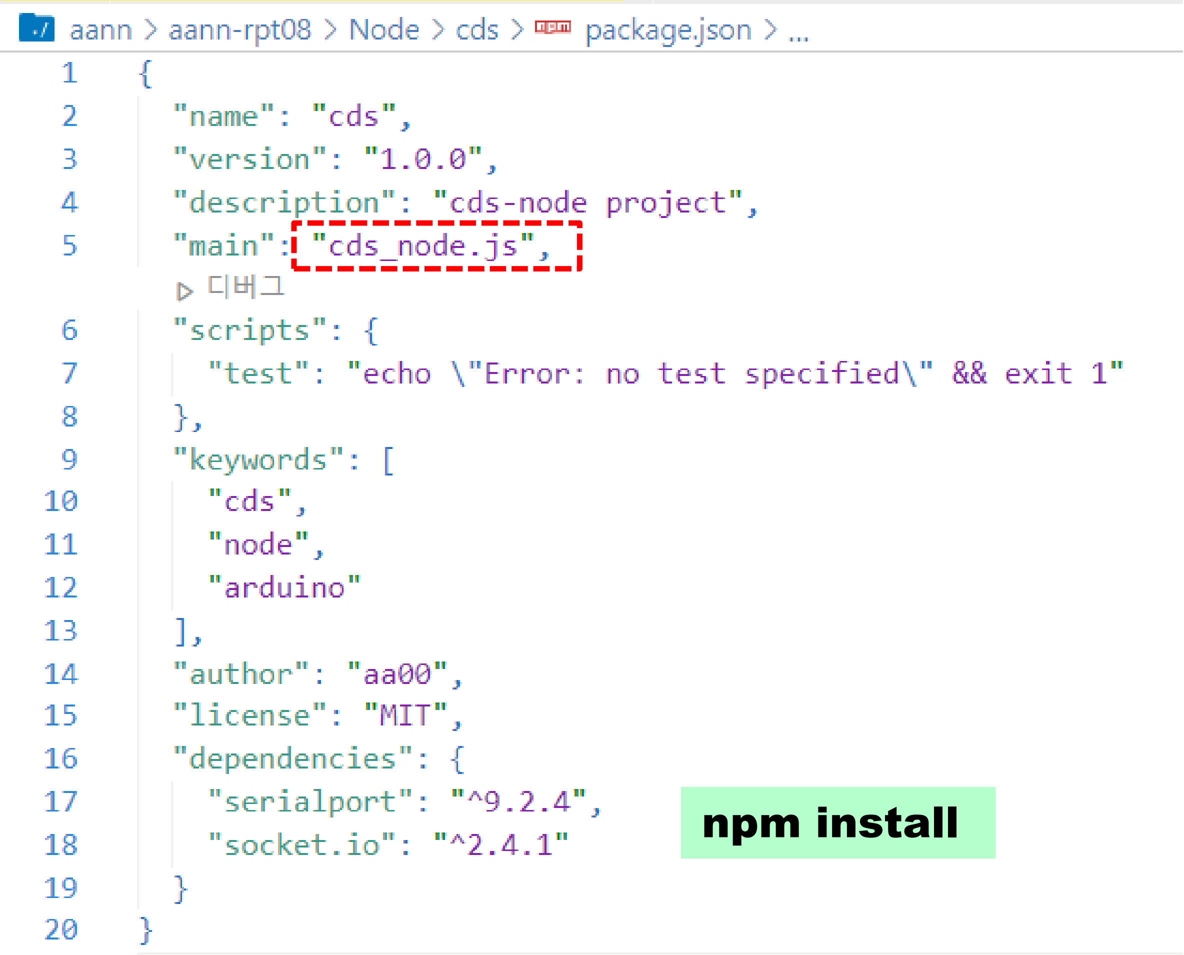
CdS (LDR)

Node project

A4.2.1 Luminosity sensor [Photocell LDR]

1. **Make cds node project**
   - **md cds**
   - **cd cds**
2. **Go to cds subfolder**
   - **npm init**
   - **npm install –save serialport**
   - **npm install –save socket.io**

Package.json

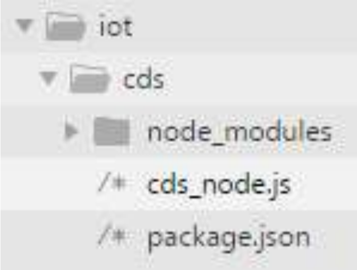


aann > aann-rpt08 > Node > cds > package.json > ...

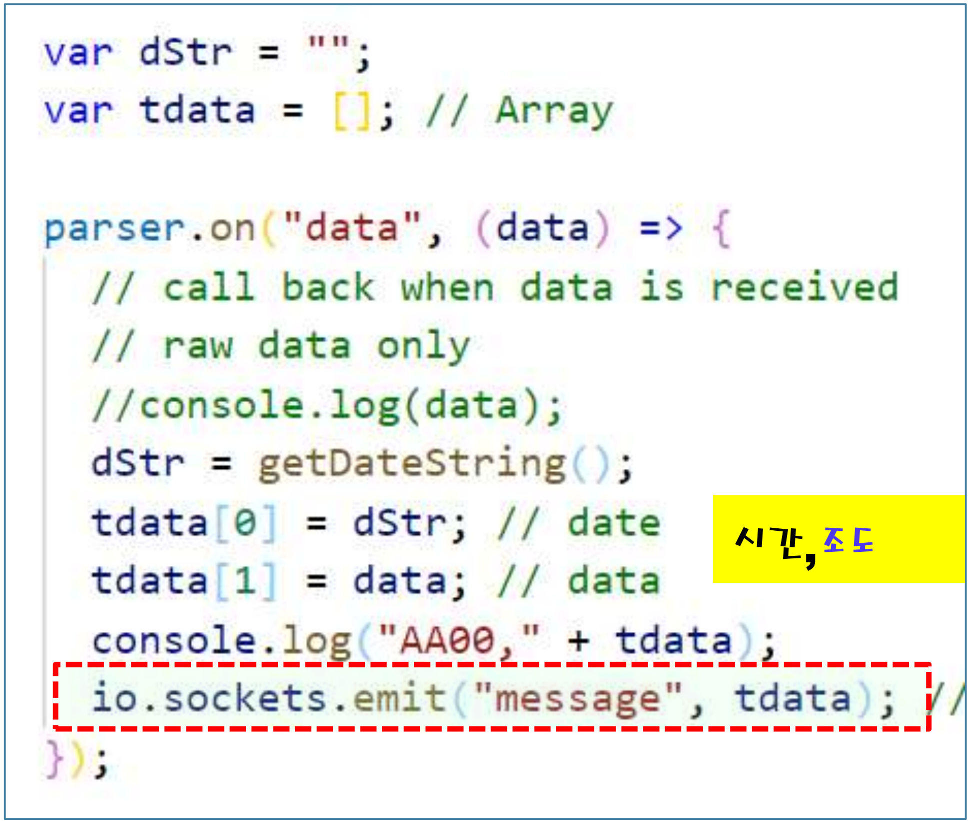
```
{
  "name": "cds",
  "version": "1.0.0",
  "description": "cds-node project",
  "main": "cds_node.js",
  ▷ 디버그
  "scripts": {
    "test": "echo \"Error: no test specified\" && exit 1"
  },
  "keywords": [
    "cds",
    "node",
    "arduino"
  ],
  "author": "aa00",
  "license": "MIT",
  "dependencies": {
    "serialport": "^9.2.4",
    "socket.io": "^2.4.1"
  }
}
```

npm install

A4.2.2 Luminosity sensor [Photocell LDR]



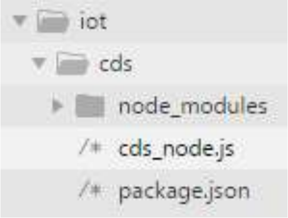
cds_node.js



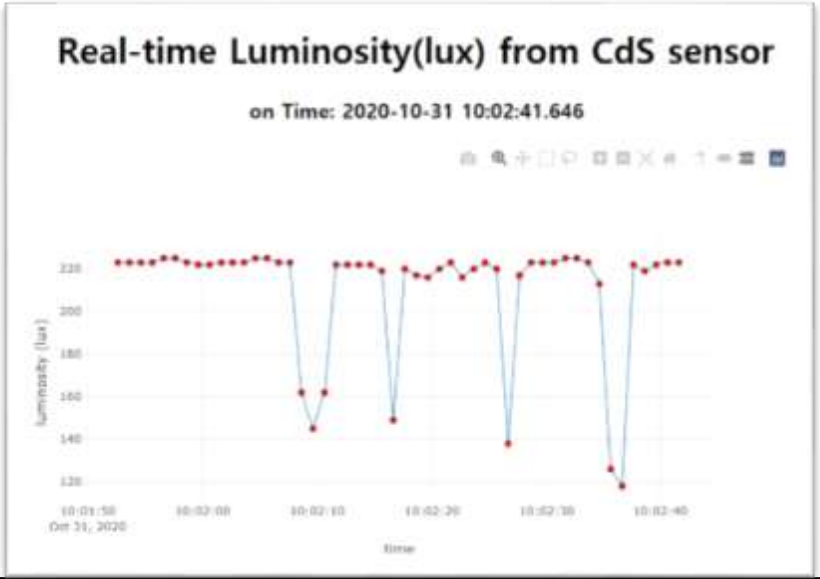
```
var dStr = "";
var tdata = []; // Array

parser.on("data", (data) => {
   // call back when data is received
   // raw data only
   //console.log(data);
   dStr = getDateString();
   tdata[0] = dStr; // date
   tdata[1] = data; // data
   console.log("AA00," + tdata);
   io.sockets.emit("message", tdata); //
});
```

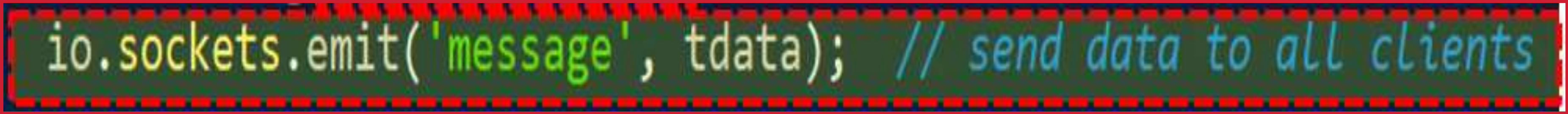
시간,조도

A4.2.3 cds_ node project (실행 결과)

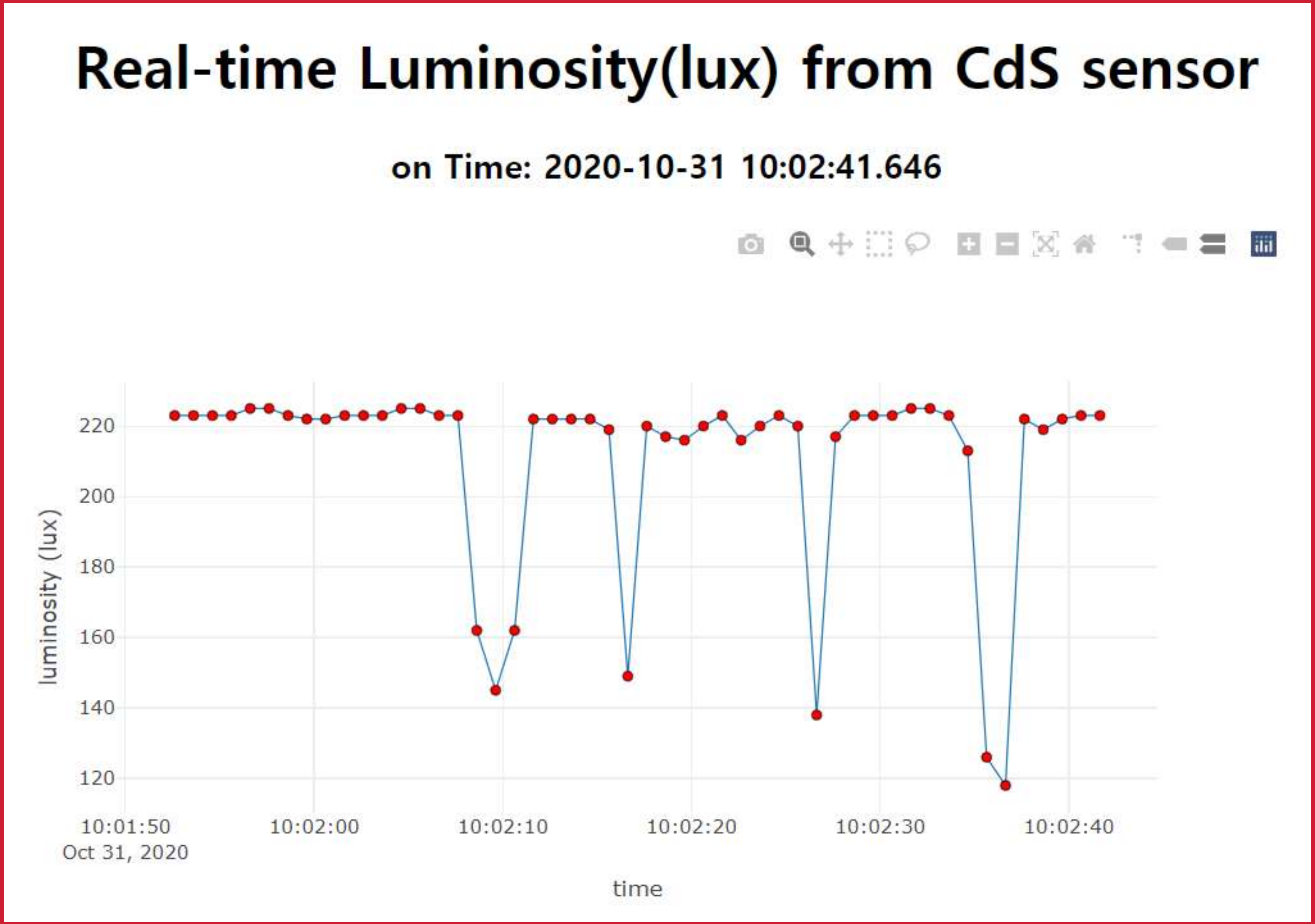


```
D:\Portable\vscode-portable\data\aa2-00\aa2-99-rpt08\wk11_src_start\Node\cds>node cds_node
serial port open
AA00,2020-10-31 09:40:24.912,220
AA00,2020-10-31 09:40:25.910,220
AA00,2020-10-31 09:40:26.914,220
AA00,2020-10-31 09:40:27.913,220
AA00,2020-10-31 09:40:28.912,222
AA00,2020-10-31 09:40:29.912,220
AA00,2020-10-31 09:40:30.915,220
AA00,2020-10-31 09:40:31.914,91
AA00,2020-10-31 09:40:32.914,217
AA00,2020-10-31 09:40:33.917,220
```





```
io.sockets.emit('message', tdata);  // send data to all clients
```

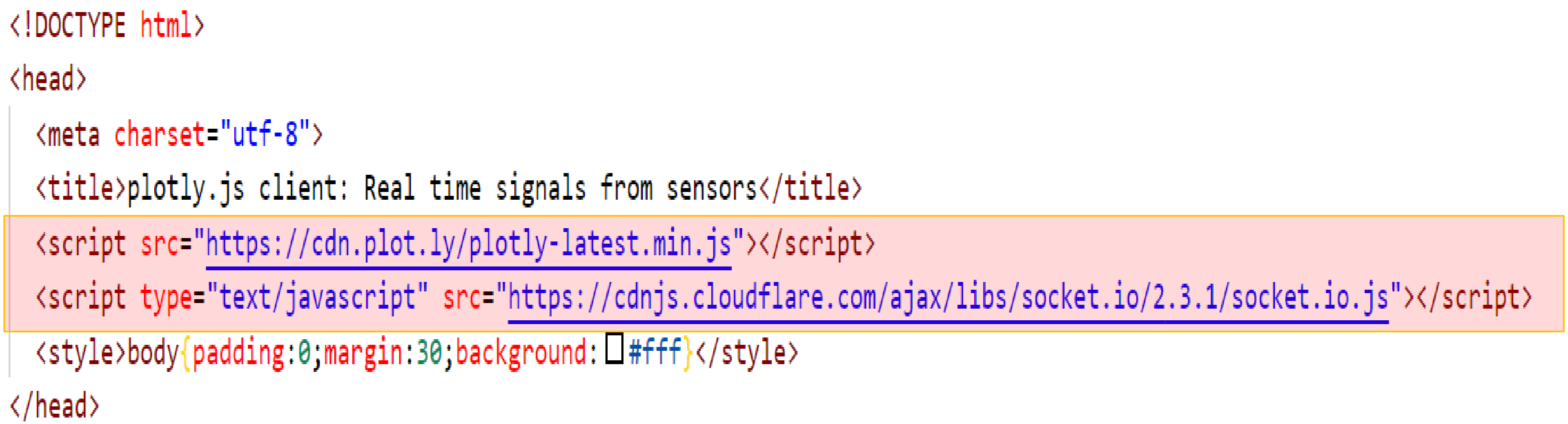


Real-time Luminosity(lux) from CdS sensor

on Time: 2020-10-31 10:02:41.646

A5.5.1 RT sensor-data streaming in Arduino

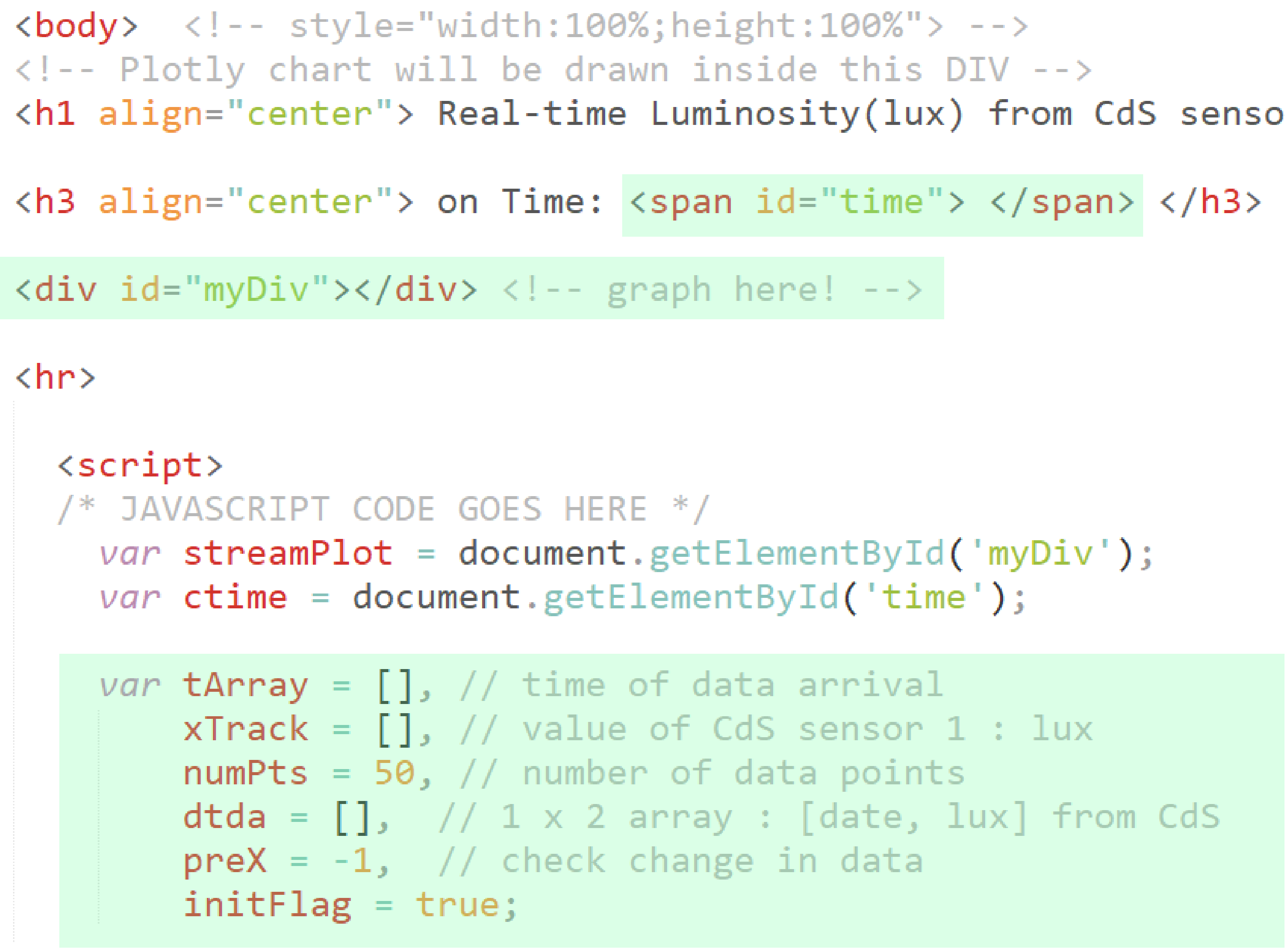
[1] Client html : client_cds.html (using socket.io.js & plotly.js)



```
<!DOCTYPE html>
<head>
  <meta charset="utf-8">
  <title>plotly.js client: Real time signals from sensors</title>
  <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>
  <style>body{padding:0;margin:30;background:□#fff}</style>
</head>
```

A5.5.2 RT sensor-data streaming in Arduino

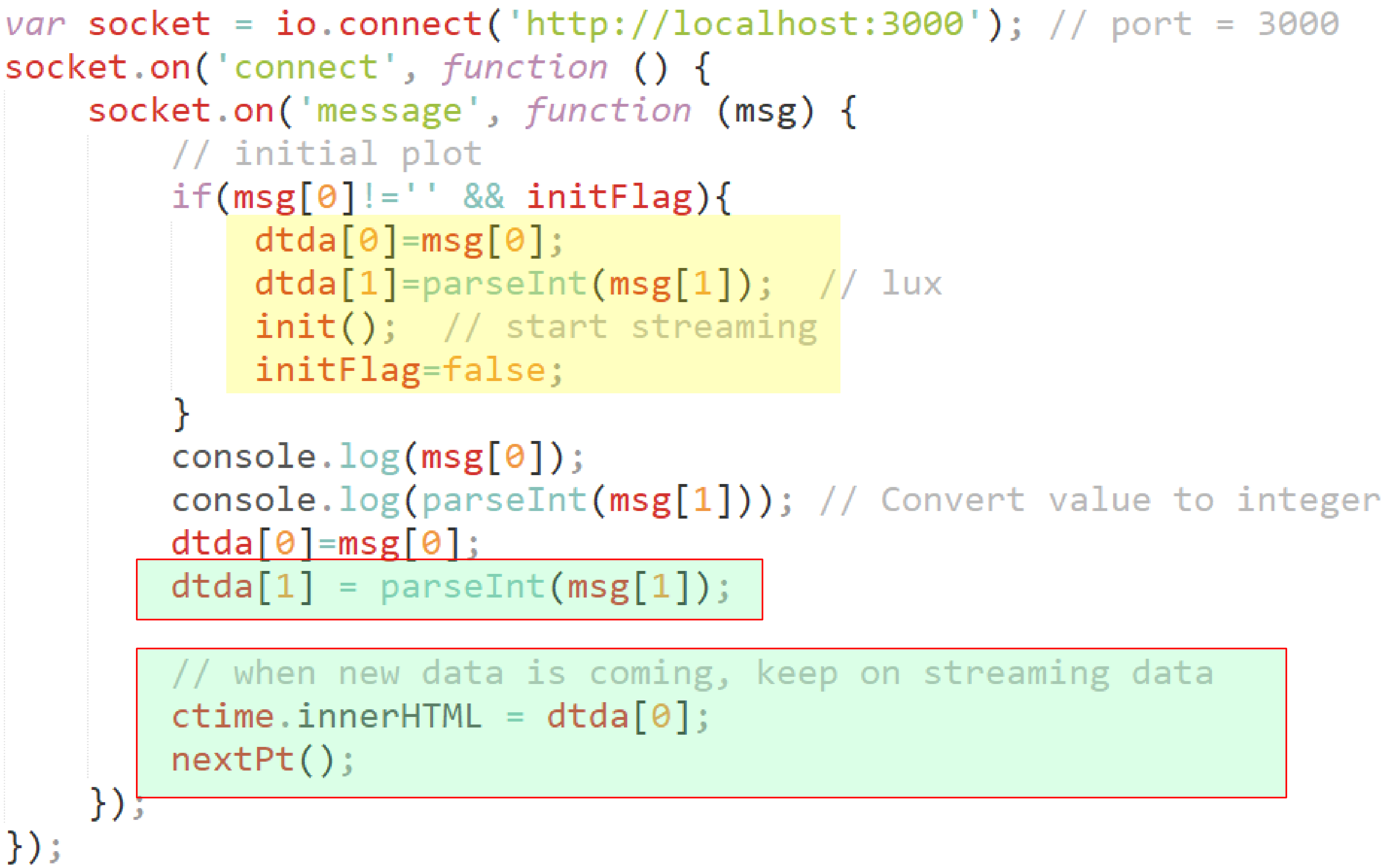
[2] Client html : client_cds.html (global variables)



```
<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center"> Real-time Luminosity(lux) from CdS sensor </h1>

<h3 align="center"> on Time: <span id="time"> </span> </h3>

<div id="myDiv"></div> <!-- graph here! -->

<hr>

  <script>
  /* JAVASCRIPT CODE GOES HERE */
    var streamPlot = document.getElementById('myDiv');
    var ctime = document.getElementById('time');

    var tArray = [], // time of data arrival
        xTrack = [], // value of CdS sensor 1 : lux
        numPts = 50, // number of data points
        dtda = [],  // 1 x 2 array : [date, lux] from CdS
        preX = -1,  // check change in data
        initFlag = true;
```

A5.5.3 RT sensor-data streaming in Arduino

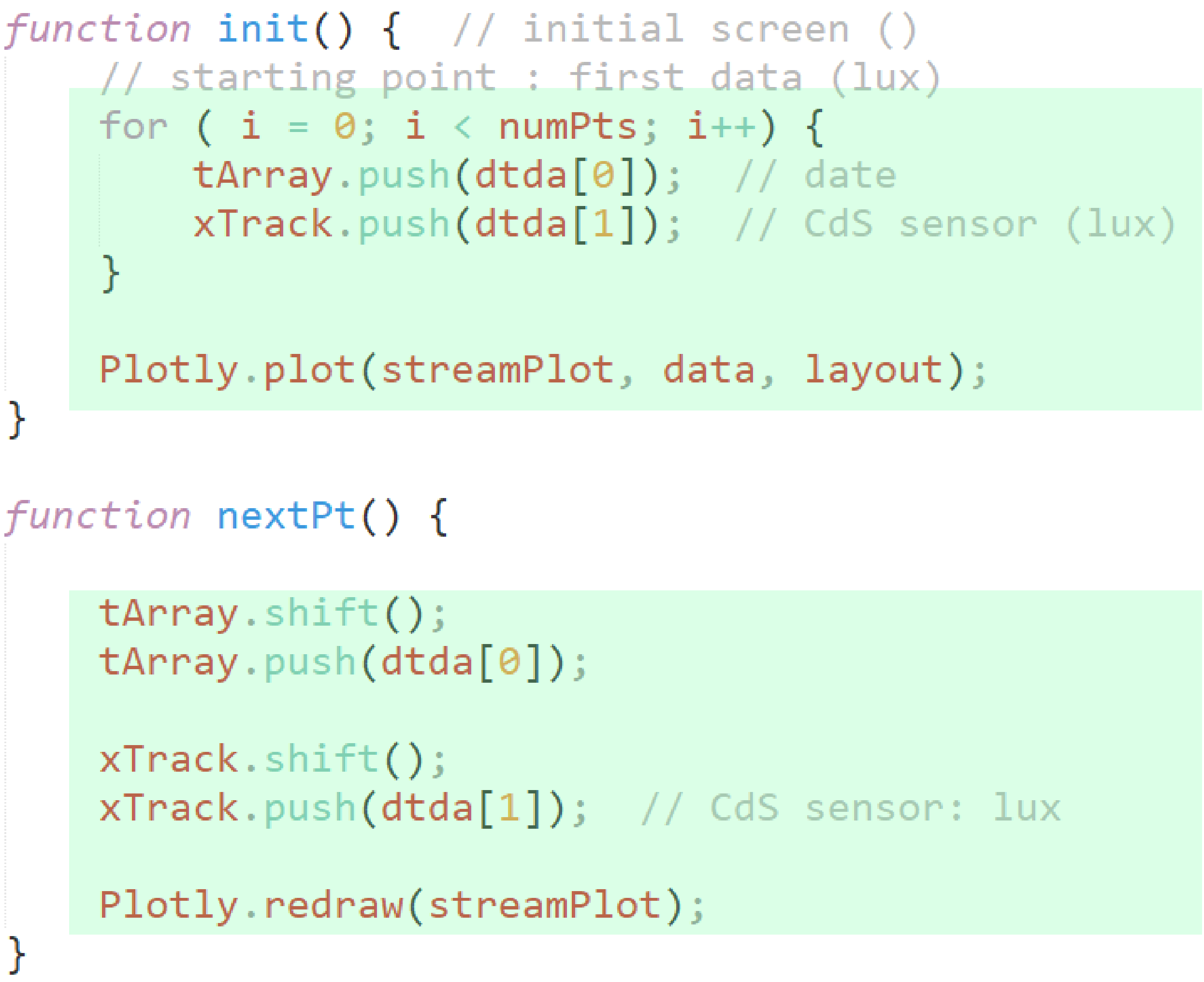
[3] Client html : client_cds.html (socket connection & handling message)



```
var socket = io.connect('http://localhost:3000'); // port = 3000
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Convert value to integer
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on streaming data
        ctime.innerHTML = dtda[0];
        nextPt();
    });
});
```

A5.5.4 RT sensor-data streaming in Arduino

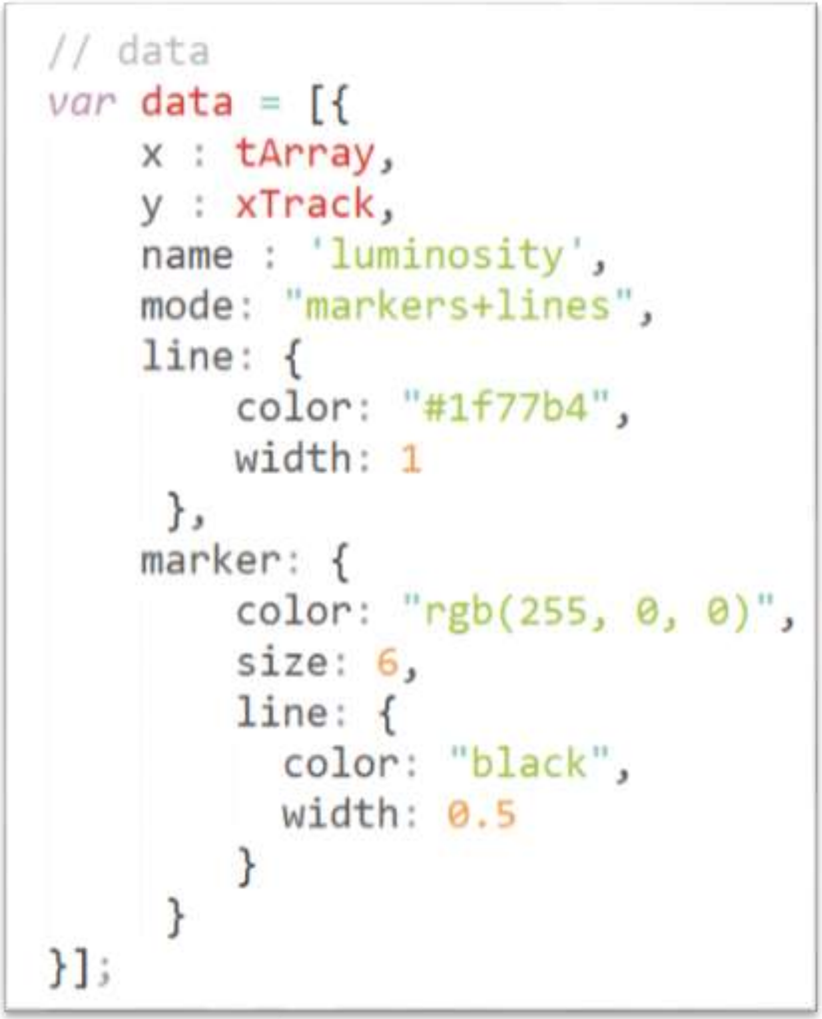
[4] Client html : client_cds.html (init() & nextPt())



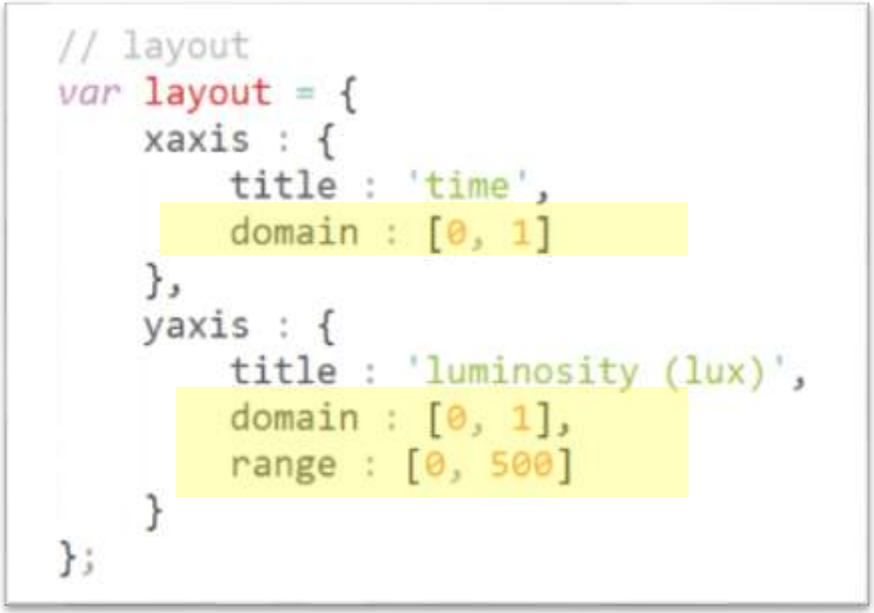
```
function init() {  // initial screen ()
    // starting point : first data (lux)
    for ( i = 0; i < numPts; i++) {
        tArray.push(dtda[0]);  // date
        xTrack.push(dtda[1]);  // CdS sensor (lux)
    }

    Plotly.plot(streamPlot, data, layout);
}

function nextPt() {

    tArray.shift();
    tArray.push(dtda[0]);

    xTrack.shift();
    xTrack.push(dtda[1]);  // CdS sensor: lux

    Plotly.redraw(streamPlot);
}
```

A5.5.5 RT sensor-data streaming in Arduino

[5] Client html : client_cds.html (data & layout)



```
// data
var data = [{
     x : tArray,
     y : xTrack,
     name : 'luminosity',
     mode: "markers+lines",
     line: {
          color: "#1f77b4",
          width: 1
      },
     marker: {
          color: "rgb(255, 0, 0)",
          size: 6,
          line: {
            color: "black",
            width: 0.5
          }
      }
}];
```



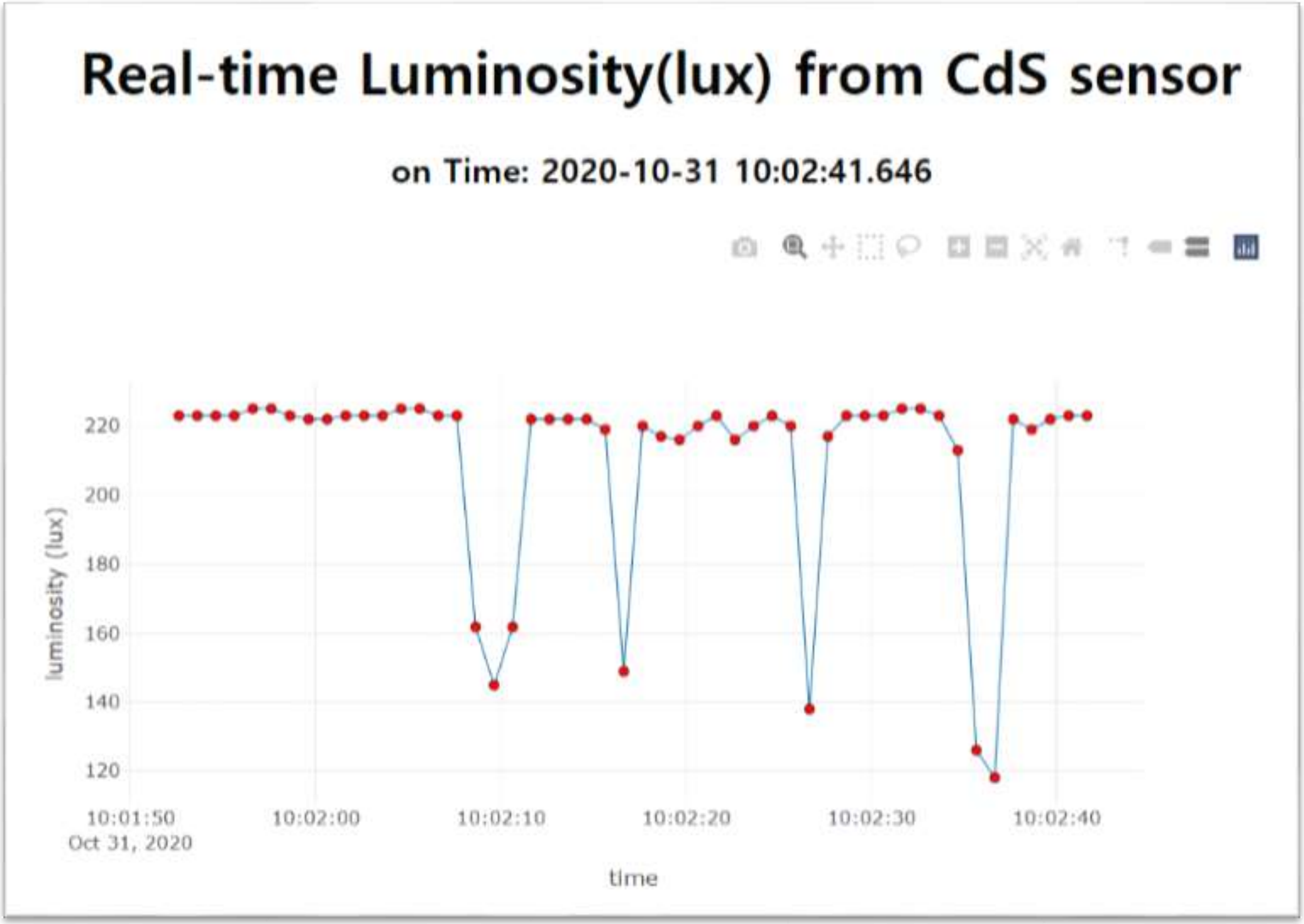
```
// layout
var layout = {
    xaxis : {
        title : 'time',
        domain : [0, 1]
    },
    yaxis : {
        title : 'luminosity (lux)',
        domain : [0, 1],
        range : [0, 500]
    }
};
```

domain: [0,1] → x 또는 y 축을 100% 사용

range: [0,500] → y 축의 범위를 0~500 설정

A5.5.6 RT sensor-data streaming in Arduino

[6] Client html : client_cds.html (real time monitoring of the luminosity)

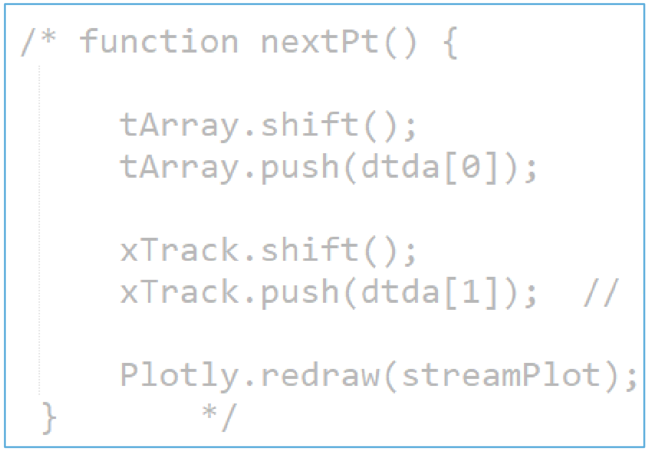


Real-time Luminosity(lux) from CdS sensor

on Time: 2020-10-31 10:02:41.646

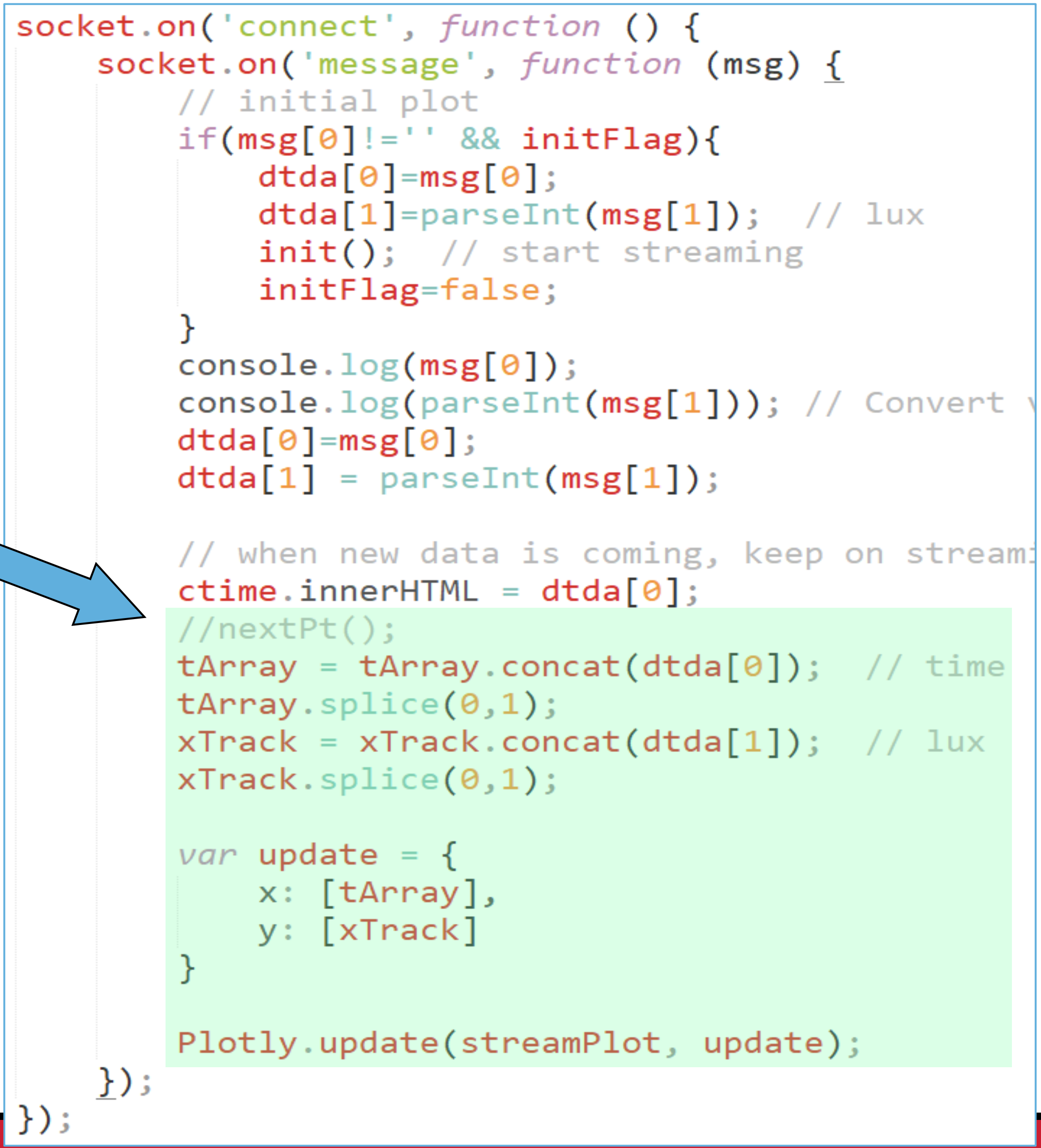
A5.5.7.1 RT sensor-data streaming in Arduino

[7.1] Client html : client_cds2.html (using plotly streaming without nextPt())



```
/* function nextPt() {

      tArray.shift();
      tArray.push(dtda[0]);

      xTrack.shift();
      xTrack.push(dtda[1]);  //

      Plotly.redraw(streamPlot);
 }       */
```

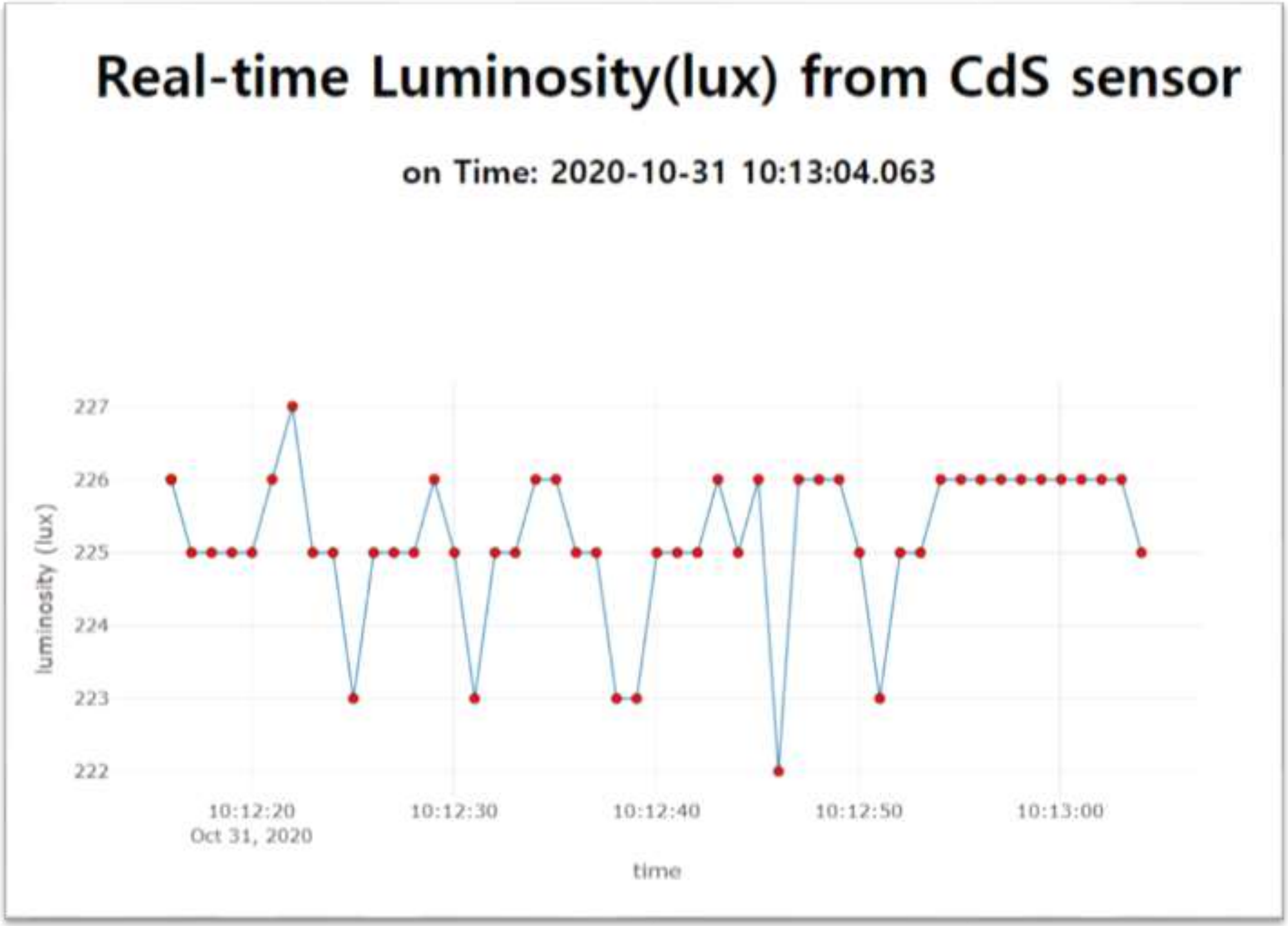
nextPt() 주석 처리



```
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Convert v
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on streami
        ctime.innerHTML = dtda[0];
        //nextPt();
        tArray = tArray.concat(dtda[0]);  // time
        tArray.splice(0,1);
        xTrack = xTrack.concat(dtda[1]);  // lux
        xTrack.splice(0,1);

        var update = {
            x: [tArray],
            y: [xTrack]
        }

        Plotly.update(streamPlot, update);
    });
});
```

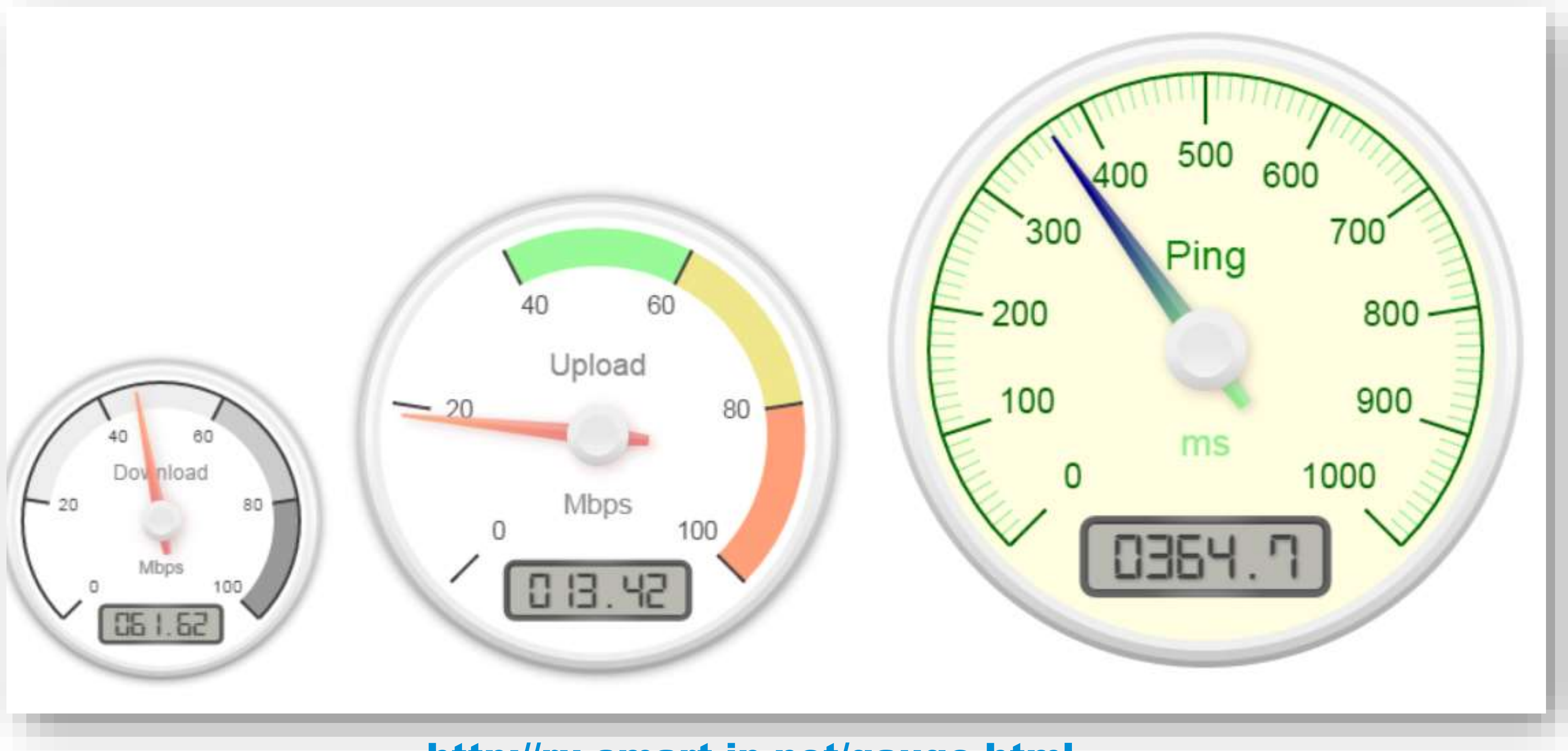
A5.5.7.2 RT sensor-data streaming in Arduino

[7.2] Client html : client_cds2.html (using plotly streaming without nextPt())



Canvas Gauge

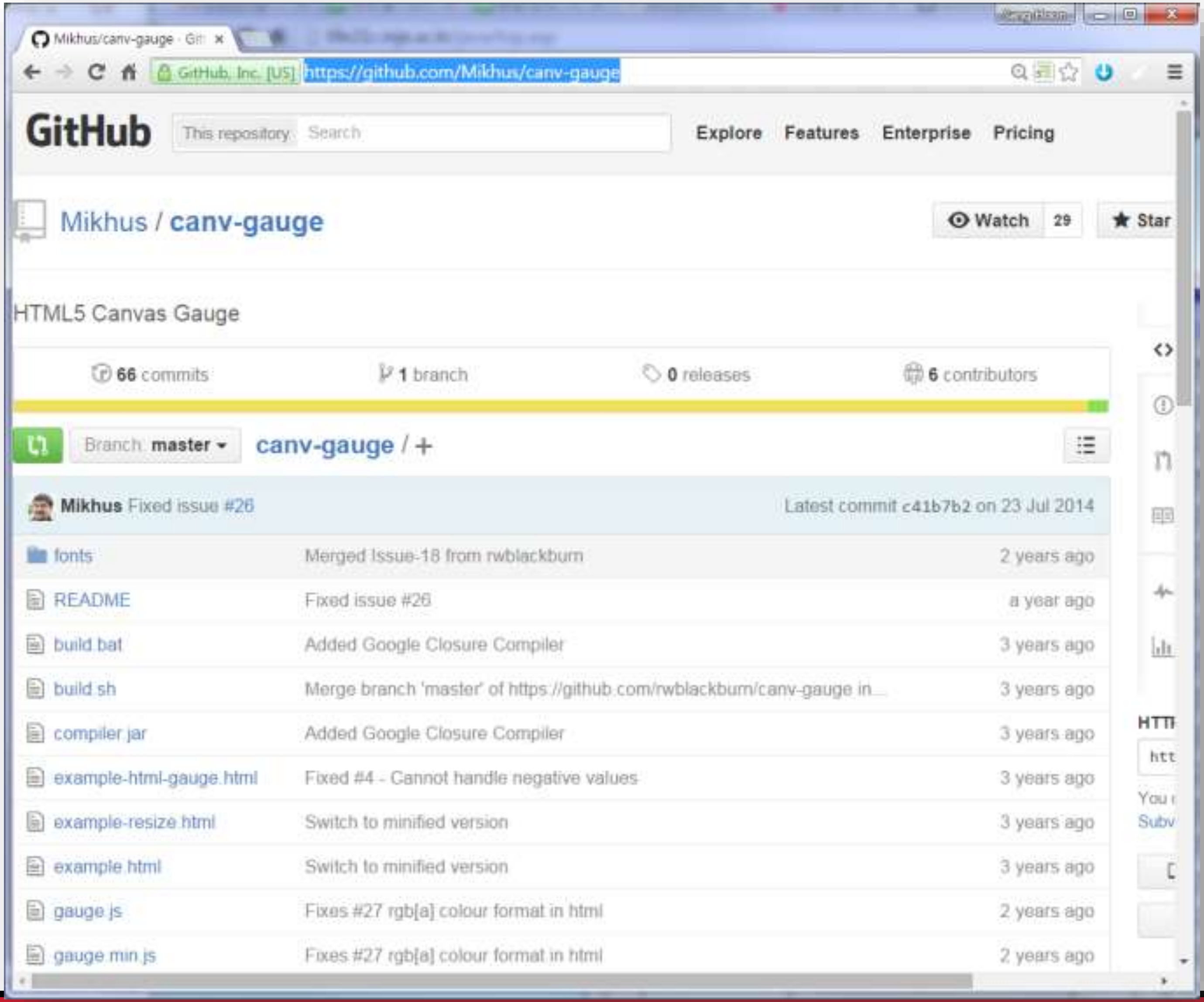
[1] Canvas gauge javascript library : example



http://ru.smart-ip.net/gauge.html

Canvas Gauge

[2] Canvas gauge javascript library : gauge.js



Mikhus / canv-gauge

HTML5 Canvas Gauge

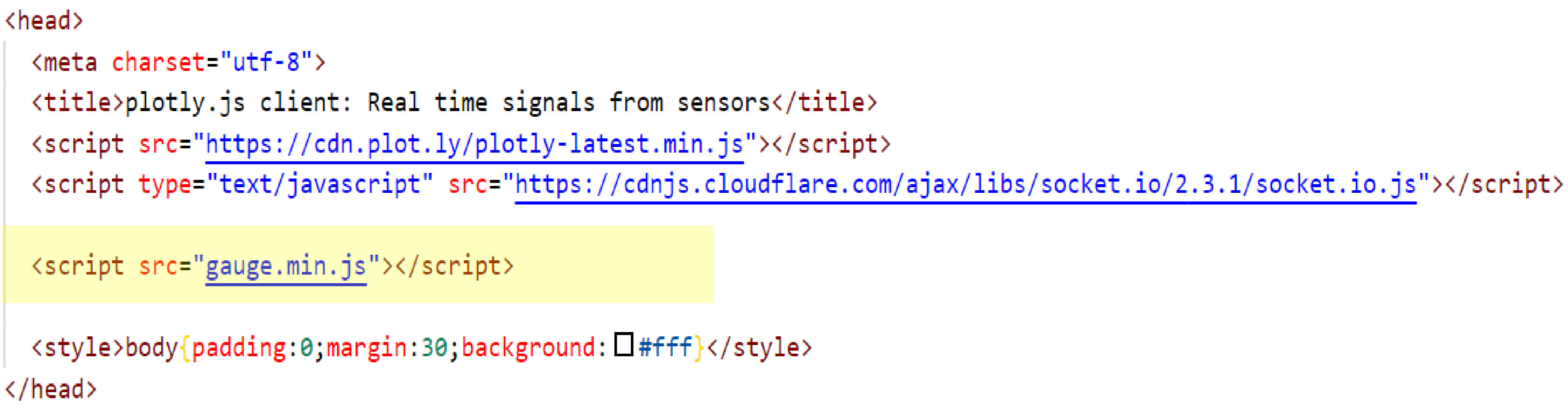
66 commits · 1 branch · 0 releases · 6 contributors

Mikhus Fixed issue #26 — Latest commit c41b7b2 on 23 Jul 2014

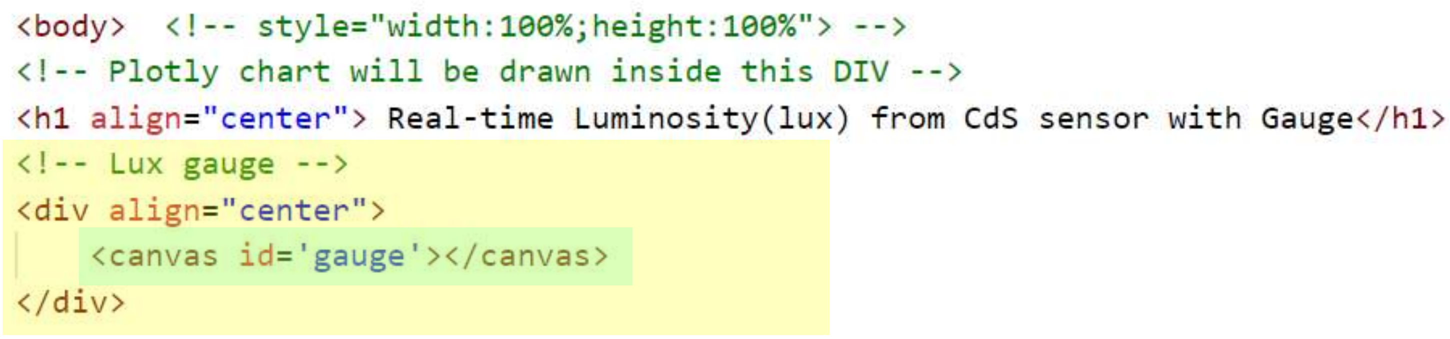
fonts	Merged Issue-18 from rwblackburn	2 years ago
README	Fixed issue #26	a year ago
build.bat	Added Google Closure Compiler	3 years ago
build.sh	Merge branch 'master' of https://github.com/rwblackburn/canv-gauge in...	3 years ago
compiler.jar	Added Google Closure Compiler	3 years ago
example-html-gauge.html	Fixed #4 - Cannot handle negative values	3 years ago
example-resize.html	Switch to minified version	3 years ago
example.html	Switch to minified version	3 years ago
gauge.js	Fixes #27 rgb[a] colour format in html	2 years ago
gauge.min.js	Fixes #27 rgb[a] colour format in html	2 years ago

A5.5.8.1 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_gauge.html (add Gauge)



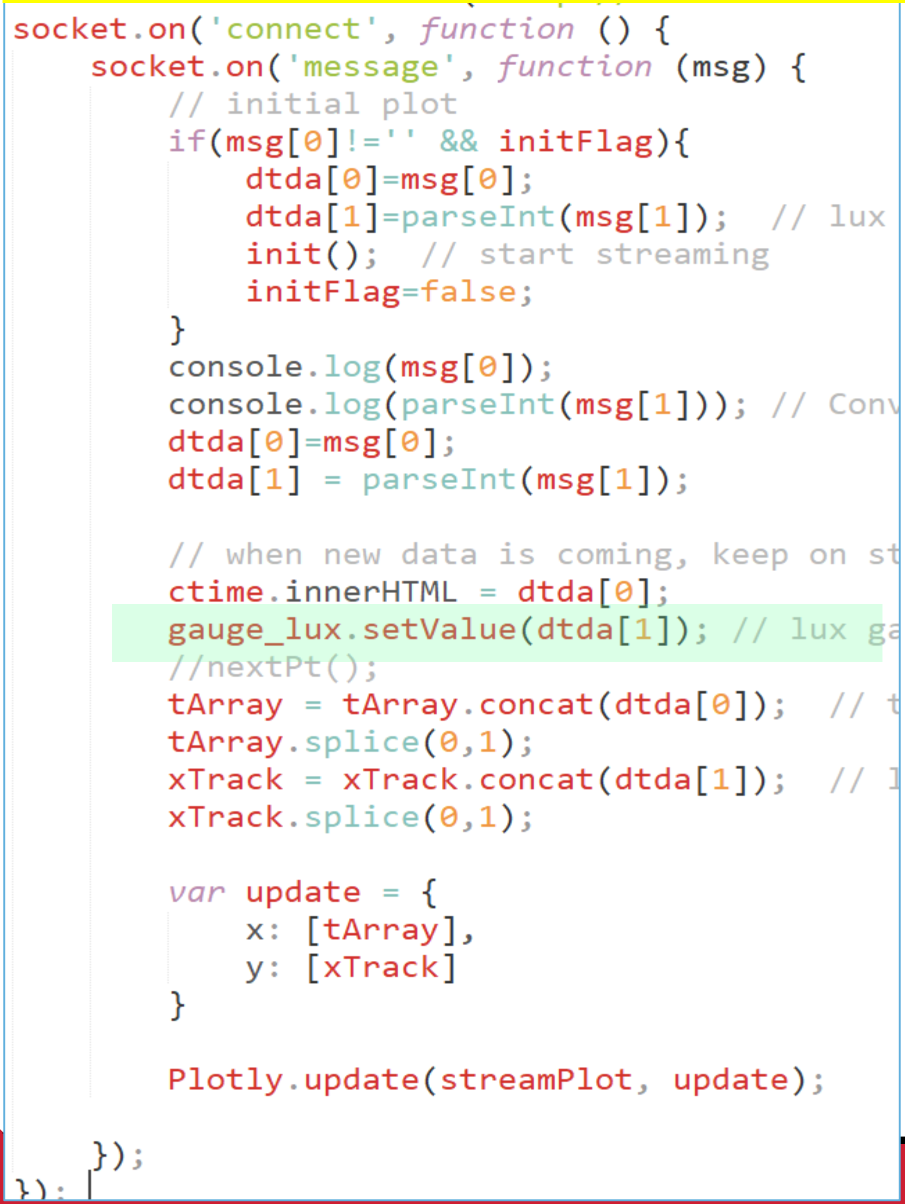
```
<head>
  <meta charset="utf-8">
  <title>plotly.js client: Real time signals from sensors</title>
  <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
  <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>

  <script src="gauge.min.js"></script>

  <style>body{padding:0;margin:30;background:□#fff}</style>
</head>
```



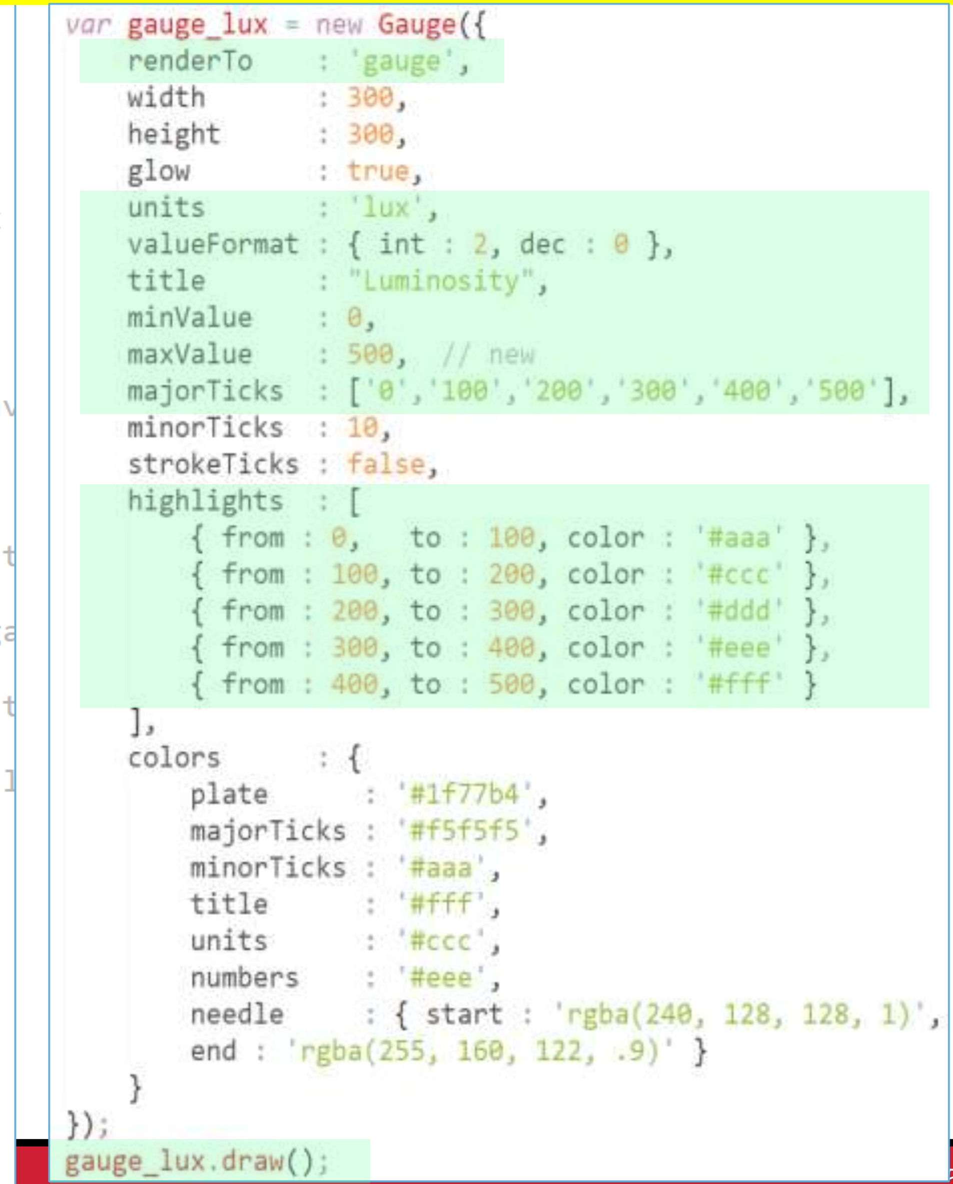
```
<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center"> Real-time Luminosity(lux) from CdS sensor with Gauge</h1>
<!-- Lux gauge -->
<div align="center">
    <canvas id='gauge'></canvas>
</div>
```

A5.5.8.2 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_gauge.html (add Gauge)



```
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseInt(msg[1]);  // lux
            init();  // start streaming
            initFlag=false;
        }
        console.log(msg[0]);
        console.log(parseInt(msg[1])); // Conv
        dtda[0]=msg[0];
        dtda[1] = parseInt(msg[1]);

        // when new data is coming, keep on st
        ctime.innerHTML = dtda[0];
        gauge_lux.setValue(dtda[1]); // lux ga
        //nextPt();
        tArray = tArray.concat(dtda[0]);  // t
        tArray.splice(0,1);
        xTrack = xTrack.concat(dtda[1]);  // l
        xTrack.splice(0,1);

        var update = {
            x: [tArray],
            y: [xTrack]
        }

        Plotly.update(streamPlot, update);

    });
});
```

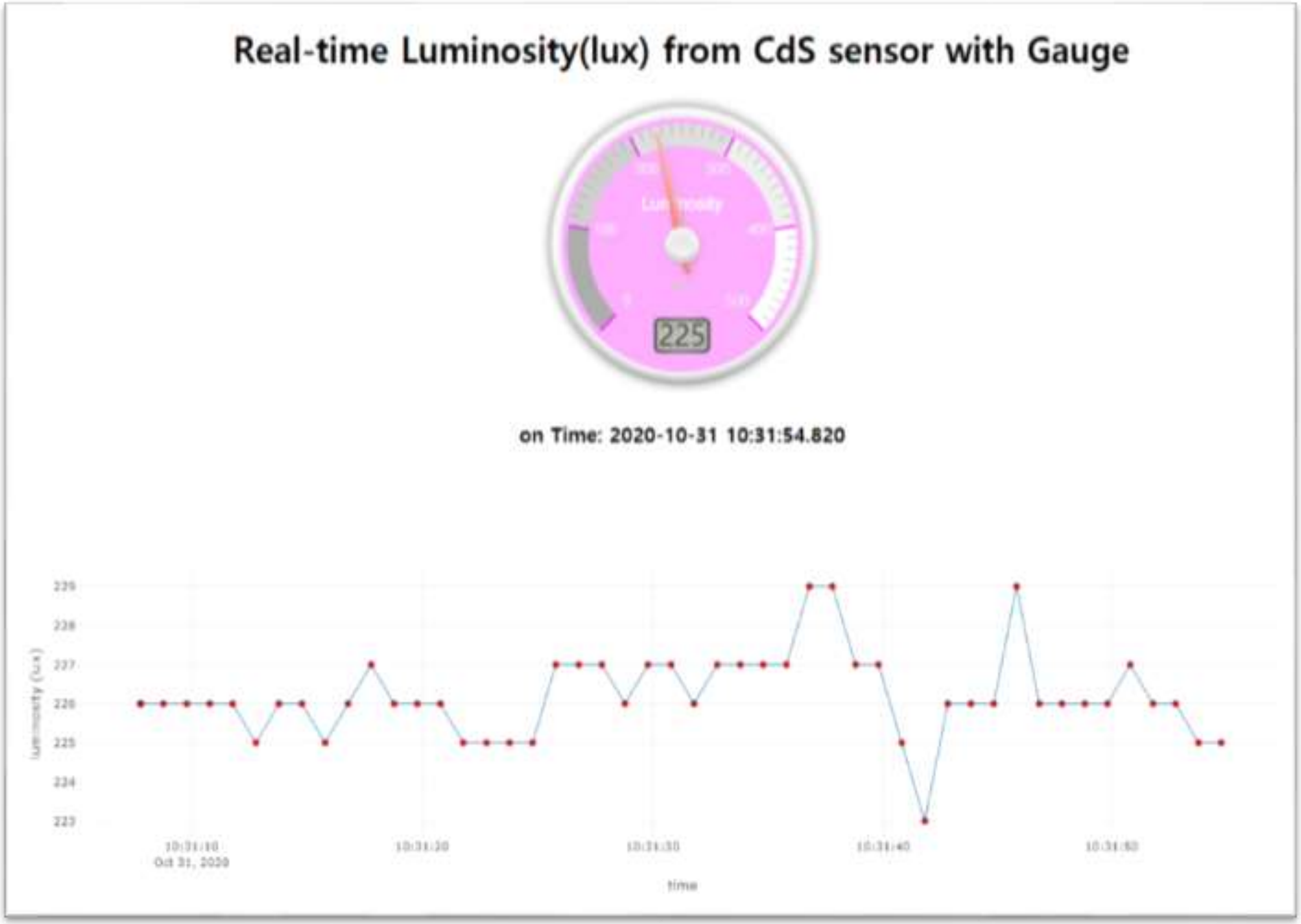


```
var gauge_lux = new Gauge({
    renderTo    : 'gauge',
    width       : 300,
    height      : 300,
    glow        : true,
    units       : 'lux',
    valueFormat : { int : 2, dec : 0 },
    title       : "Luminosity",
    minValue    : 0,
    maxValue    : 500,  // new
    majorTicks  : ['0','100','200','300','400','500'],
    minorTicks  : 10,
    strokeTicks : false,
    highlights  : [
        { from : 0,   to : 100, color : '#aaa' },
        { from : 100, to : 200, color : '#ccc' },
        { from : 200, to : 300, color : '#ddd' },
        { from : 300, to : 400, color : '#eee' },
        { from : 400, to : 500, color : '#fff' }
    ],
    colors      : {
        plate      : '#1f77b4',
        majorTicks : '#f5f5f5',
        minorTicks : '#aaa',
        title      : '#fff',
        units      : '#ccc',
        numbers    : '#eee',
        needle     : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_lux.draw();
```

A5.5.8.3 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_gauge.html (change design of Gauge)

변경된 디자인으로 된 그래프를 캡처하여 AAnn_cds_gauge.png 로 저장

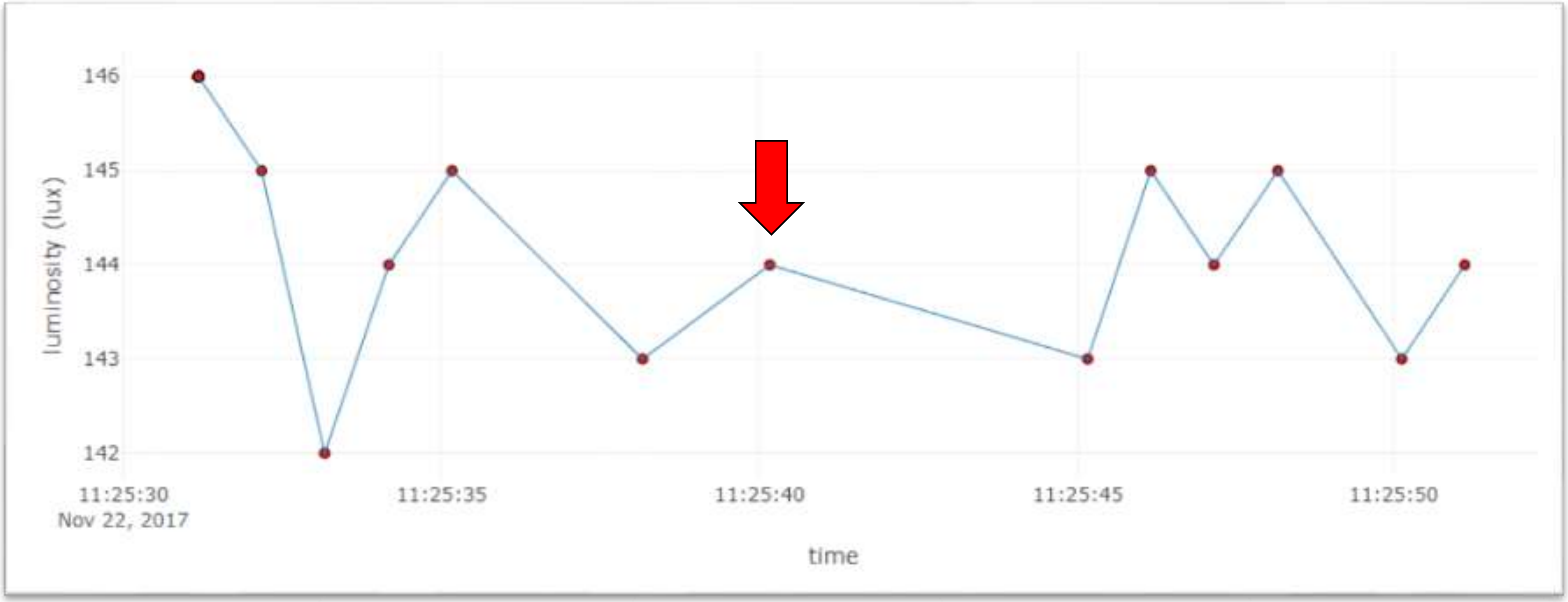


Real-time Luminosity(lux) from CdS sensor with Gauge

on Time: 2020-10-31 10:31:54.820

A5.5.9.1 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_change.html (detecting change)



이상 감지 (anomaly detection)

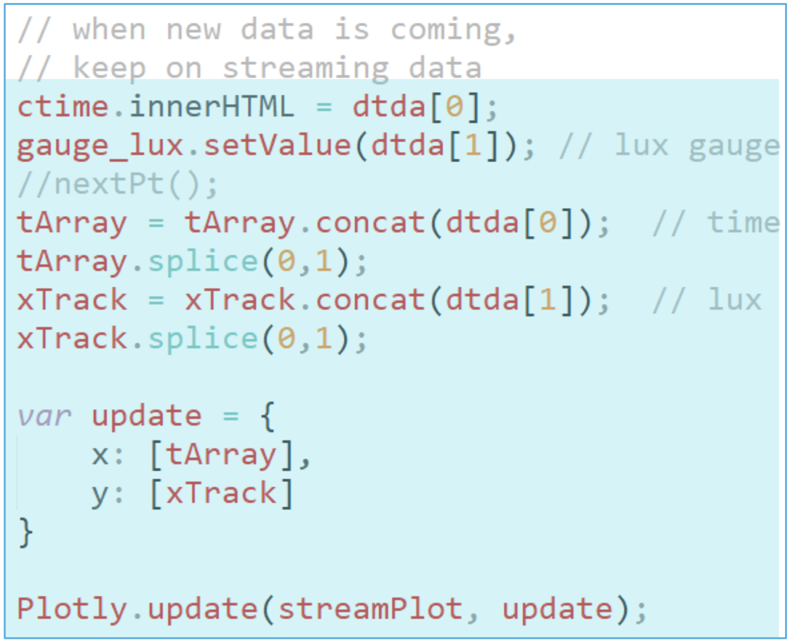
입력되는 lux 값이 변하는 경우에만 그래프를 그림.

실시간 모니터링에서 이상 감지 기능이 필요함.

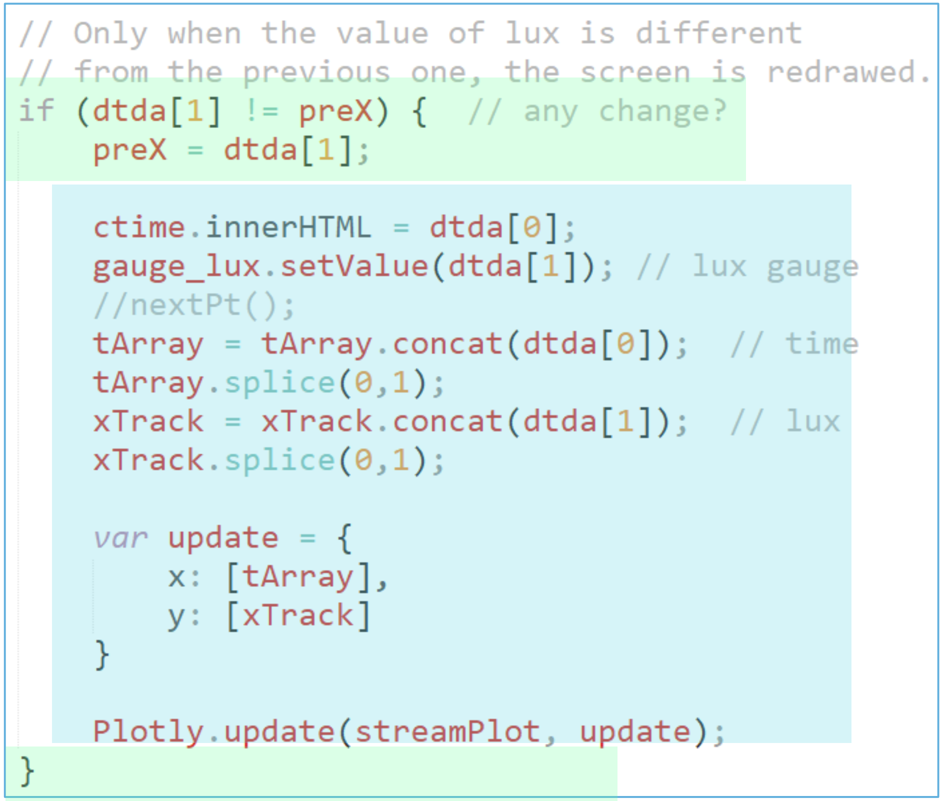
밝기 값 변화의 문턱값을 설정해서 이상 감지 기능 구현

A5.5.9.2 RT sensor-data streaming in Arduino

[DIY. hint] Client html : client_cds_change.html (detecting change)



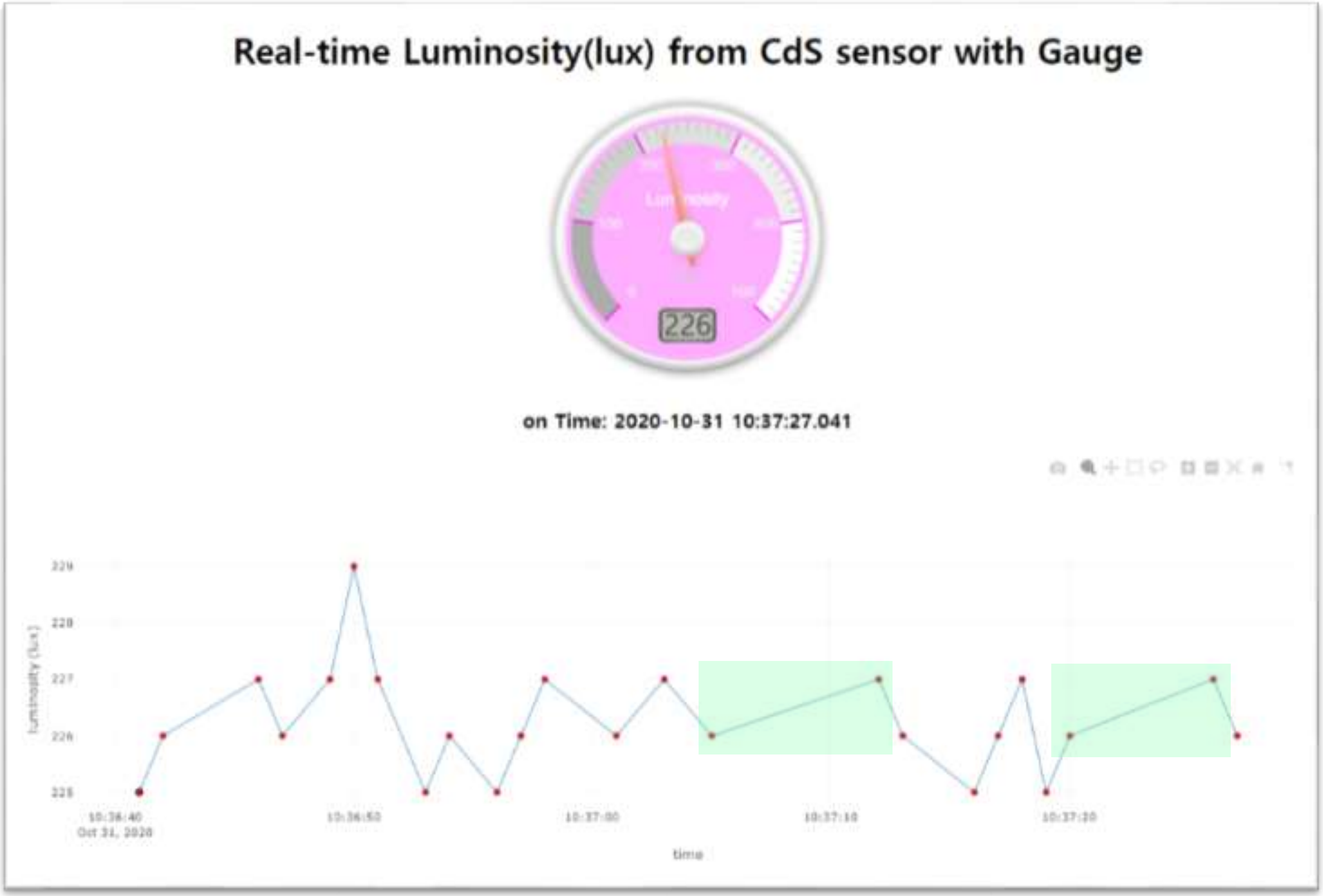
```
// when new data is coming,
// keep on streaming data
ctime.innerHTML = dtda[0];
gauge_lux.setValue(dtda[1]); // lux gauge
//nextPt();
tArray = tArray.concat(dtda[0]);  // time
tArray.splice(0,1);
xTrack = xTrack.concat(dtda[1]);  // lux
xTrack.splice(0,1);

var update = {
    x: [tArray],
    y: [xTrack]
}

Plotly.update(streamPlot, update);
```



```
// Only when the value of lux is different
// from the previous one, the screen is redrawed.
if (dtda[1] != preX) {  // any change?
    preX = dtda[1];

    ctime.innerHTML = dtda[0];
    gauge_lux.setValue(dtda[1]); // lux gauge
    //nextPt();
    tArray = tArray.concat(dtda[0]);  // time
    tArray.splice(0,1);
    xTrack = xTrack.concat(dtda[1]);  // lux
    xTrack.splice(0,1);

    var update = {
        x: [tArray],
        y: [xTrack]
    }

    Plotly.update(streamPlot, update);
}
```

A5.5.9.3 RT sensor-data streaming in Arduino

[DIY] Client html : client_cds_change.html (detecting change)

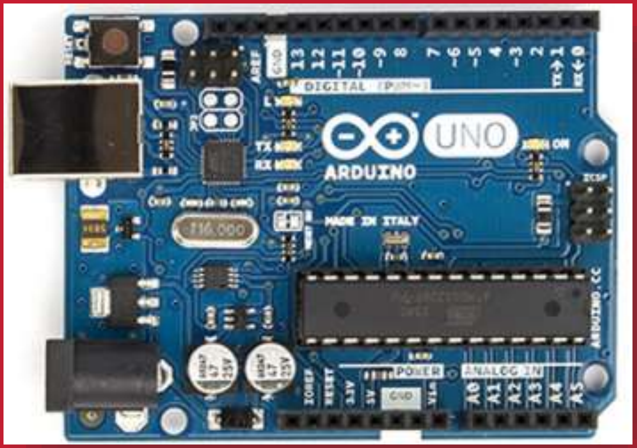


Real-time Luminosity(lux) from CdS sensor with Gauge

on Time: 2020-10-31 10:37:27.041

측정되는 주변광의 밝기가 일정 시간 유지되다가 변하는 그래프를 캡처하여 AAnn_cds_change.png 로 저장

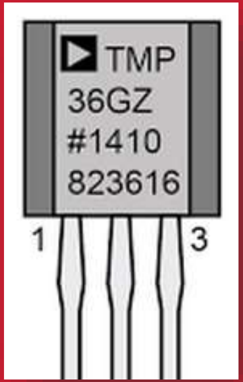
Multiple sensors



CdS + TMP36

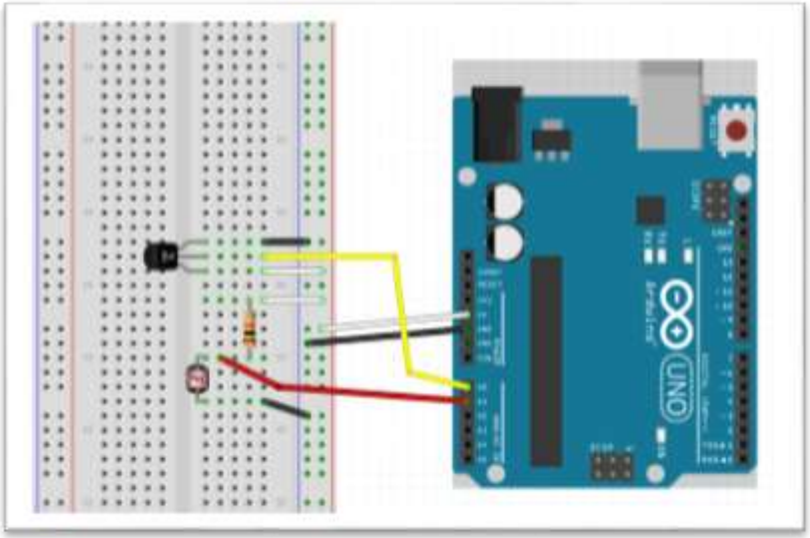
+ plotly.js

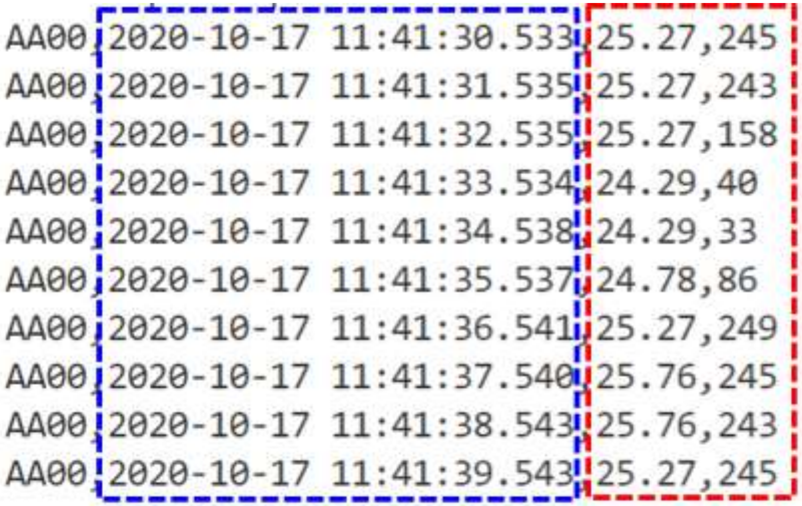
Node project



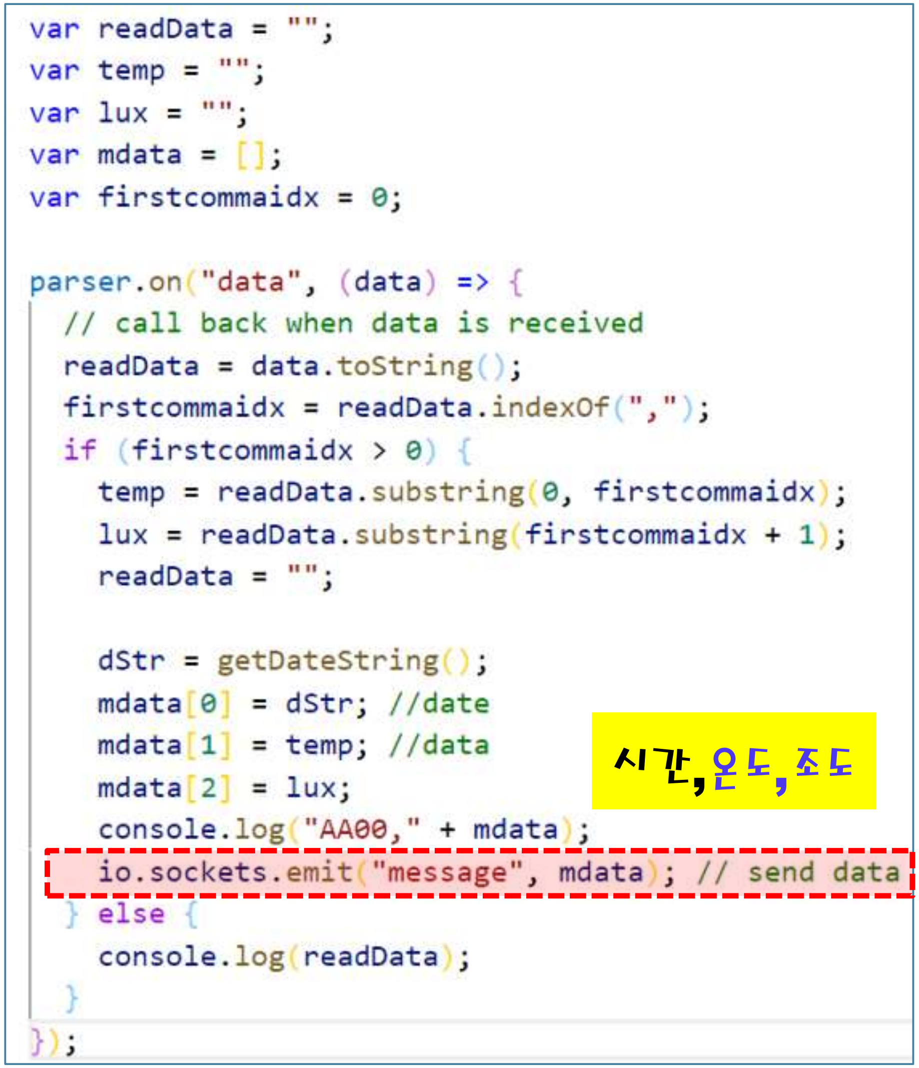
CdS + TMP36 + Node.js + Plotly

tmp36 + CdS circuit





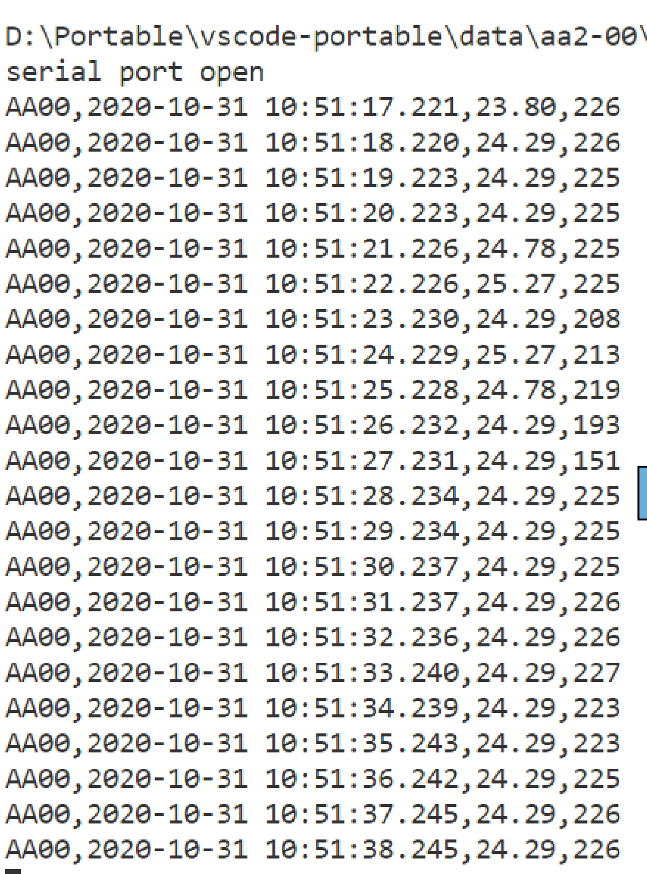
```
AA00,2020-10-17 11:41:30.533,25.27,245
AA00,2020-10-17 11:41:31.535,25.27,243
AA00,2020-10-17 11:41:32.535,25.27,158
AA00,2020-10-17 11:41:33.534,24.29,40
AA00,2020-10-17 11:41:34.538,24.29,33
AA00,2020-10-17 11:41:35.537,24.78,86
AA00,2020-10-17 11:41:36.541,25.27,249
AA00,2020-10-17 11:41:37.540,25.76,245
AA00,2020-10-17 11:41:38.543,25.76,243
AA00,2020-10-17 11:41:39.543,25.27,245
```



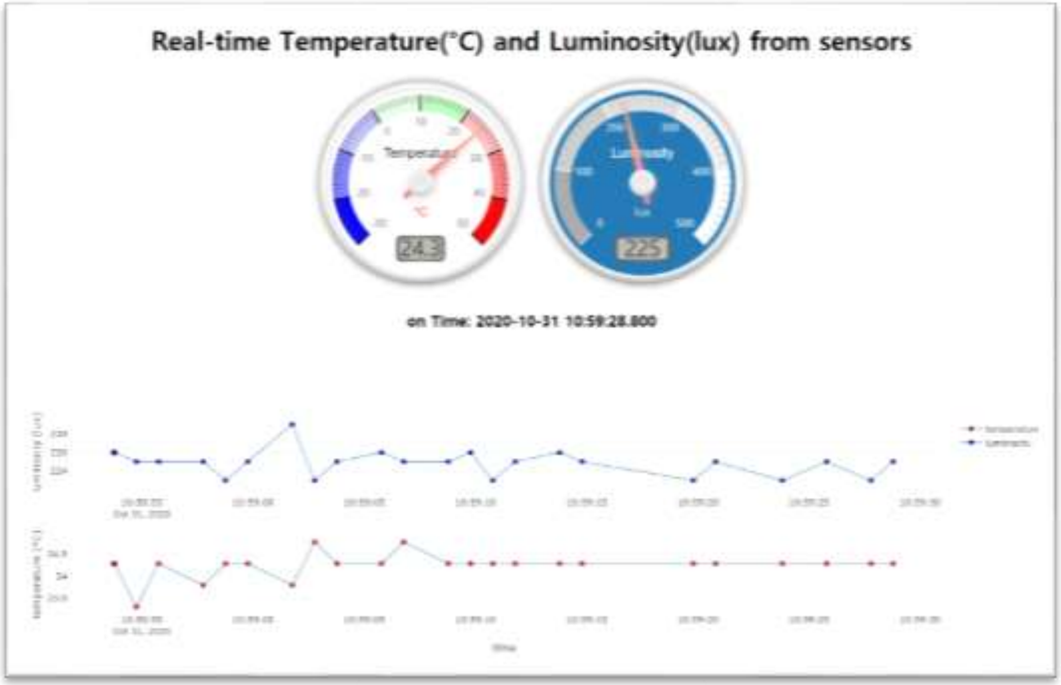
```
var readData = "";
var temp = "";
var lux = "";
var mdata = [];
var firstcommaidx = 0;

parser.on("data", (data) => {
  // call back when data is received
  readData = data.toString();
  firstcommaidx = readData.indexOf(",");
  if (firstcommaidx > 0) {
    temp = readData.substring(0, firstcommaidx);
    lux = readData.substring(firstcommaidx + 1);
    readData = "";

    dStr = getDateString();
    mdata[0] = dStr; //date
    mdata[1] = temp; //data
    mdata[2] = lux;
    console.log("AA00," + mdata);
    io.sockets.emit("message", mdata); // send data
  } else {
    console.log(readData);
  }
});
```

시간,온도,조도

A5.6.1 cds_ tmp36_node project (실행 결과)



```
D:\Portable\vscode-portable\data\aa2-00\aa2-99-rpt08\wk11_src_start\Node\cds_tmp36>node cds_tmp36_node
serial port open
AA00,2020-10-31 10:51:17.221,23.80,226
AA00,2020-10-31 10:51:18.220,24.29,226
AA00,2020-10-31 10:51:19.223,24.29,225
AA00,2020-10-31 10:51:20.223,24.29,225
AA00,2020-10-31 10:51:21.226,24.78,225
AA00,2020-10-31 10:51:22.226,25.27,225
AA00,2020-10-31 10:51:23.230,24.29,208
AA00,2020-10-31 10:51:24.229,25.27,213
AA00,2020-10-31 10:51:25.228,24.78,219
AA00,2020-10-31 10:51:26.232,24.29,193
AA00,2020-10-31 10:51:27.231,24.29,151
AA00,2020-10-31 10:51:28.234,24.29,225
AA00,2020-10-31 10:51:29.234,24.29,225
AA00,2020-10-31 10:51:30.237,24.29,225
AA00,2020-10-31 10:51:31.237,24.29,226
AA00,2020-10-31 10:51:32.236,24.29,226
AA00,2020-10-31 10:51:33.240,24.29,227
AA00,2020-10-31 10:51:34.239,24.29,223
AA00,2020-10-31 10:51:35.243,24.29,223
AA00,2020-10-31 10:51:36.242,24.29,225
AA00,2020-10-31 10:51:37.245,24.29,226
AA00,2020-10-31 10:51:38.245,24.29,226
█
```

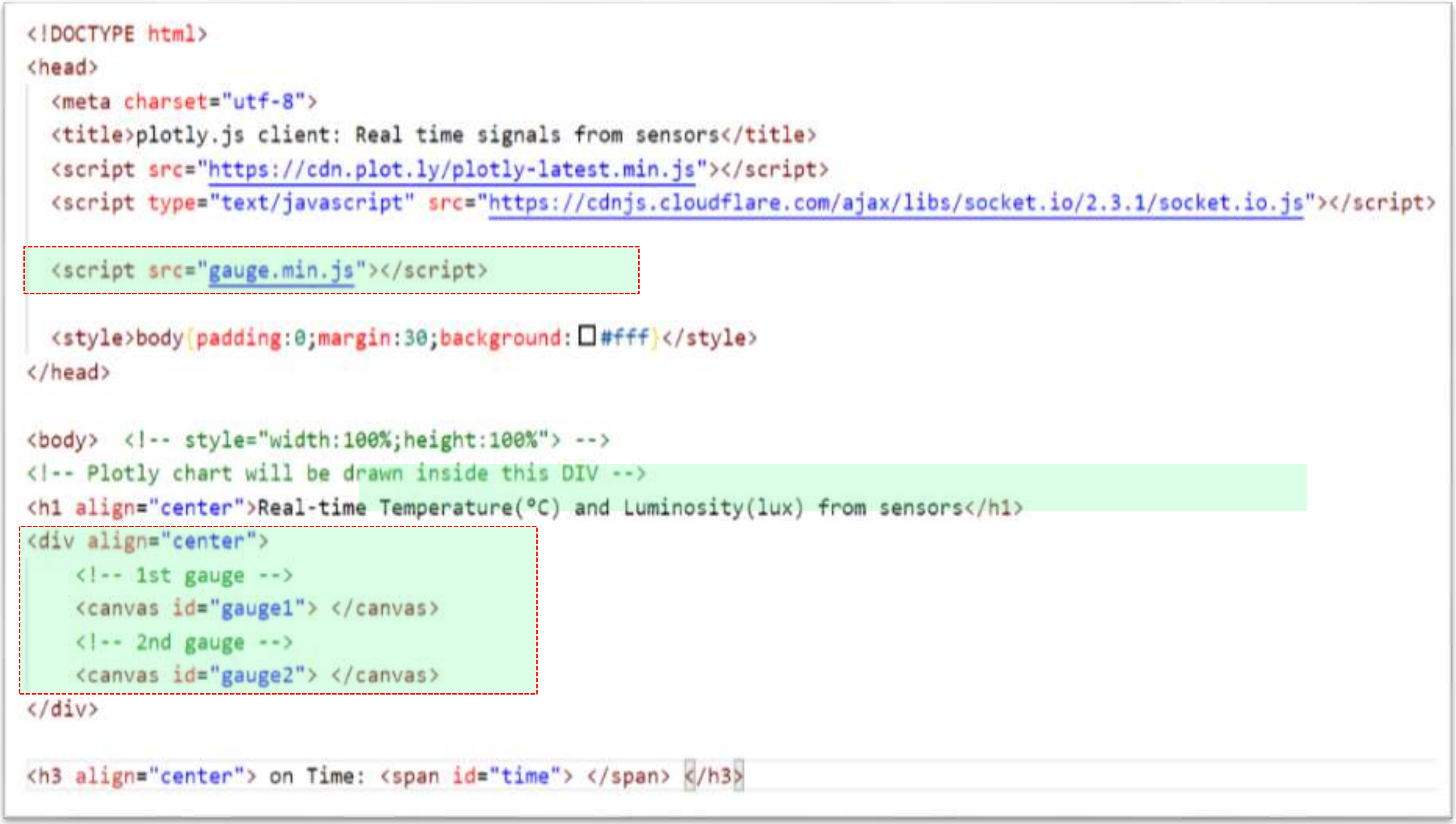

Real-time Temperature(°C) and Luminosity(lux) from sensors
Temperature
°C
24.3
Luminosity
lux
225
on Time: 2020-10-31 10:59:28.800
Time

IOT data format

시간, 온도,조도

A5.6.1 TMP36 + CdS streaming project

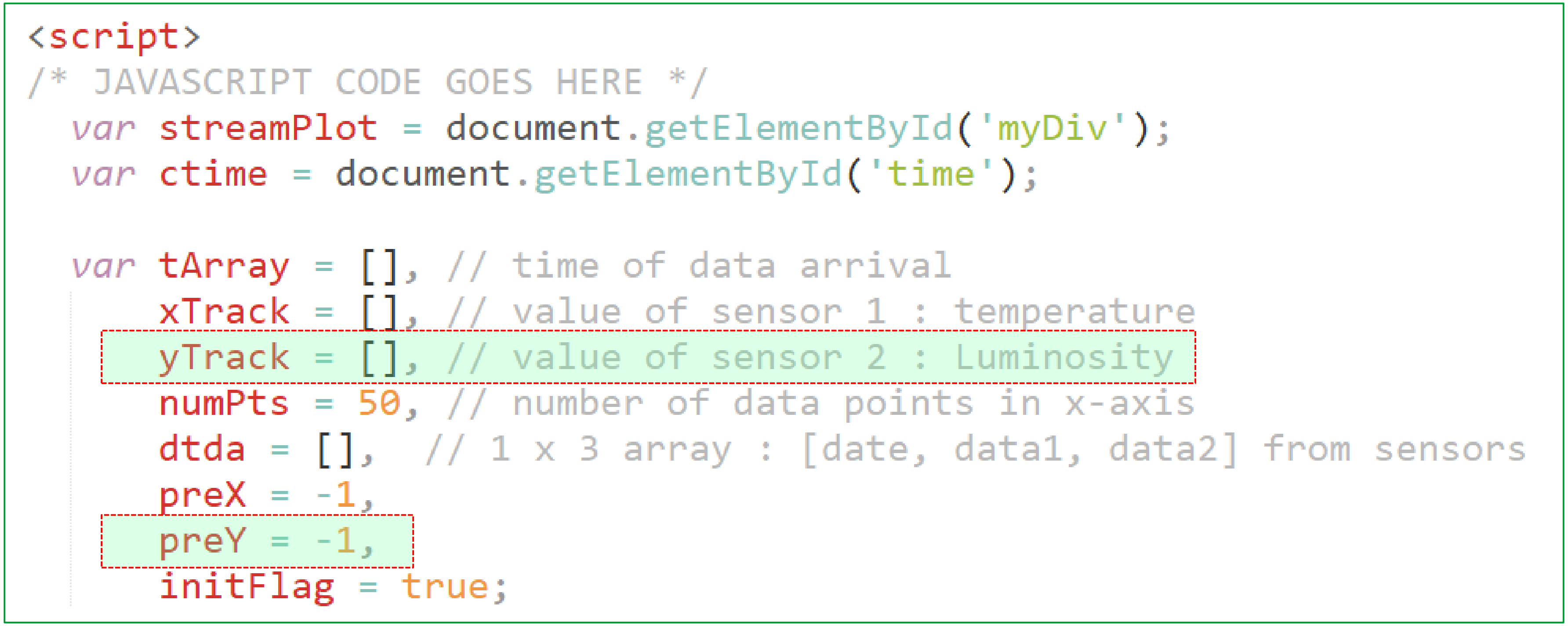
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



```html
<!DOCTYPE html>
<head>
    <meta charset="utf-8">
    <title>plotly.js client: Real time signals from sensors</title>
    <script src="https://cdn.plot.ly/plotly-latest.min.js"></script>
    <script type="text/javascript" src="https://cdnjs.cloudflare.com/ajax/libs/socket.io/2.3.1/socket.io.js"></script>

    <script src="gauge.min.js"></script>

    <style>body{padding:0;margin:30;background:□#fff}</style>
</head>

<body>  <!-- style="width:100%;height:100%"> -->
<!-- Plotly chart will be drawn inside this DIV -->
<h1 align="center">Real-time Temperature(°C) and Luminosity(lux) from sensors</h1>
<div align="center">
    <!-- 1st gauge -->
    <canvas id="gauge1"> </canvas>
    <!-- 2nd gauge -->
    <canvas id="gauge2"> </canvas>
</div>

<h3 align="center"> on Time: <span id="time"> </span> </h3>
```

A5.6.2 TMP36 + CdS streaming project

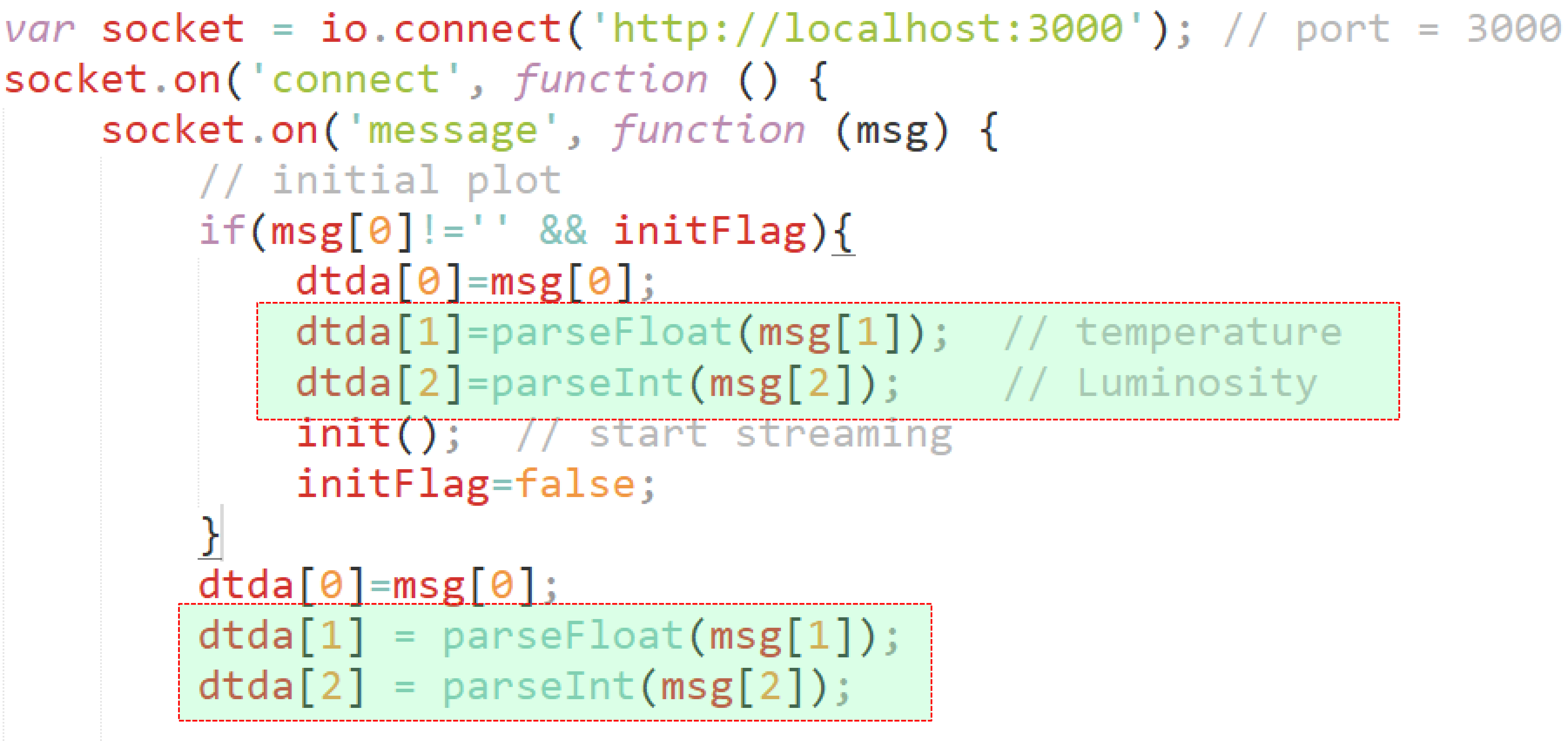
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



```
<script>
/* JAVASCRIPT CODE GOES HERE */
  var streamPlot = document.getElementById('myDiv');
  var ctime = document.getElementById('time');

  var tArray = [], // time of data arrival
      xTrack = [], // value of sensor 1 : temperature
      yTrack = [], // value of sensor 2 : Luminosity
      numPts = 50, // number of data points in x-axis
      dtda = [],  // 1 x 3 array : [date, data1, data2] from sensors
      preX = -1,
      preY = -1,
      initFlag = true;
```

A5.6.3 TMP36 + CdS streaming project

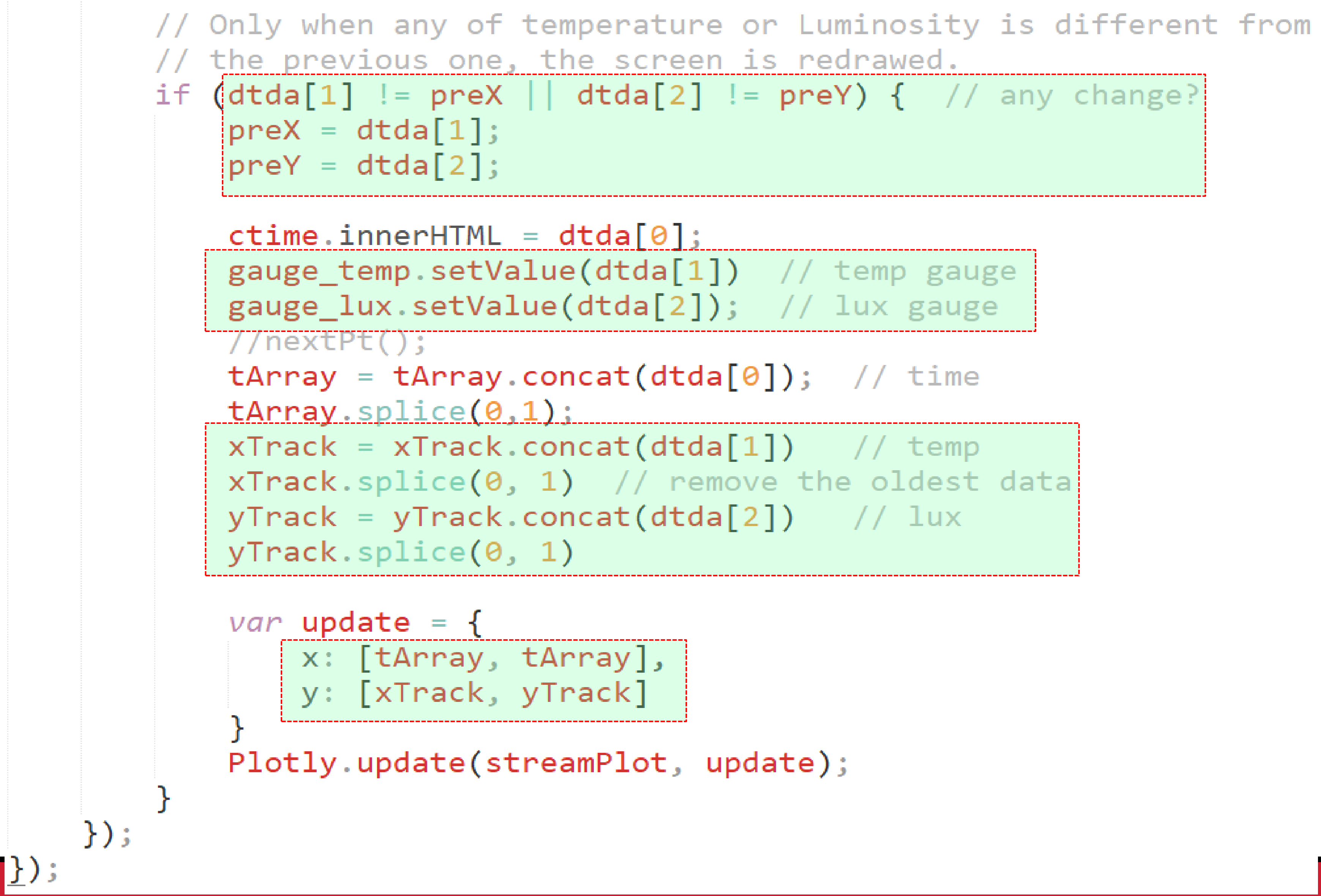
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



```
var socket = io.connect('http://localhost:3000'); // port = 3000
socket.on('connect', function () {
    socket.on('message', function (msg) {
        // initial plot
        if(msg[0]!='' && initFlag){
            dtda[0]=msg[0];
            dtda[1]=parseFloat(msg[1]);  // temperature
            dtda[2]=parseInt(msg[2]);    // Luminosity
            init();  // start streaming
            initFlag=false;
        }
        dtda[0]=msg[0];
        dtda[1] = parseFloat(msg[1]);
        dtda[2] = parseInt(msg[2]);
```

A5.6.4 TMP36 + CdS streaming project

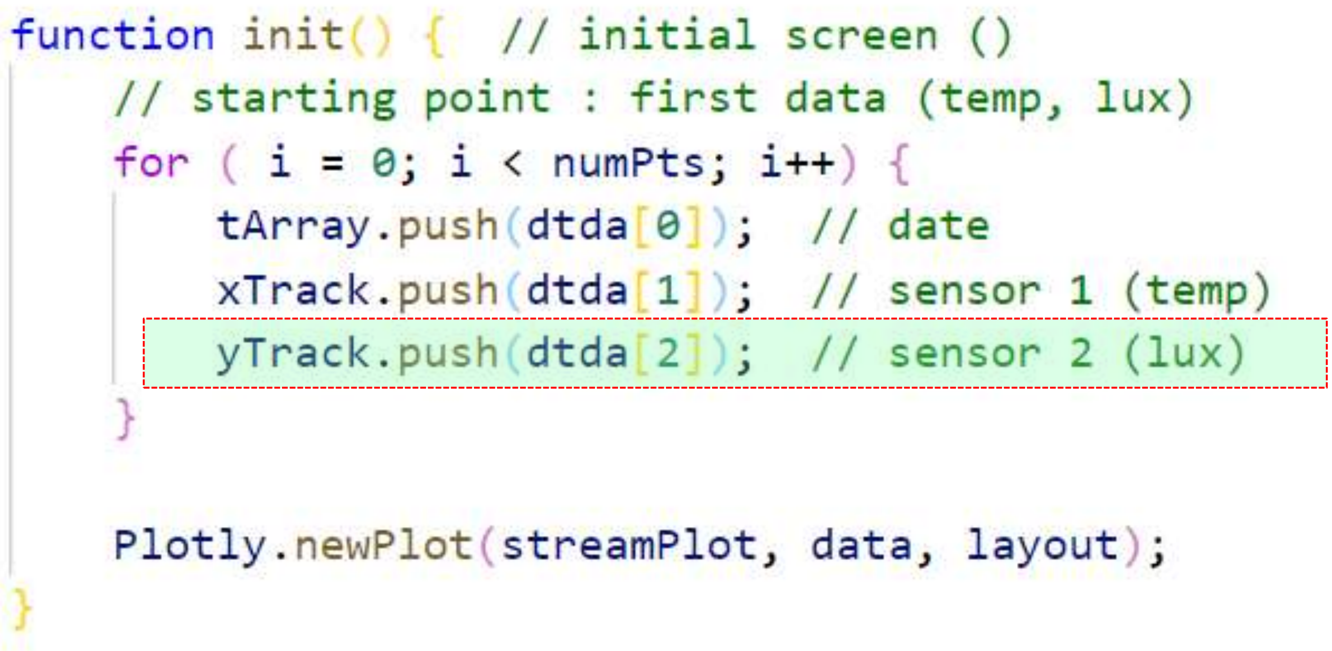
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



```
        // Only when any of temperature or Luminosity is different from
        // the previous one, the screen is redrawed.
        if (dtda[1] != preX || dtda[2] != preY) {  // any change?
            preX = dtda[1];
            preY = dtda[2];

            ctime.innerHTML = dtda[0];
            gauge_temp.setValue(dtda[1])  // temp gauge
            gauge_lux.setValue(dtda[2]);  // lux gauge
            //nextPt();
            tArray = tArray.concat(dtda[0]);  // time
            tArray.splice(0,1);
            xTrack = xTrack.concat(dtda[1])   // temp
            xTrack.splice(0, 1)  // remove the oldest data
            yTrack = yTrack.concat(dtda[2])   // lux
            yTrack.splice(0, 1)

            var update = {
                x: [tArray, tArray],
                y: [xTrack, yTrack]
            }
            Plotly.update(streamPlot, update);
        }
    });
});
```

A5.6.5 TMP36 + CdS streaming project

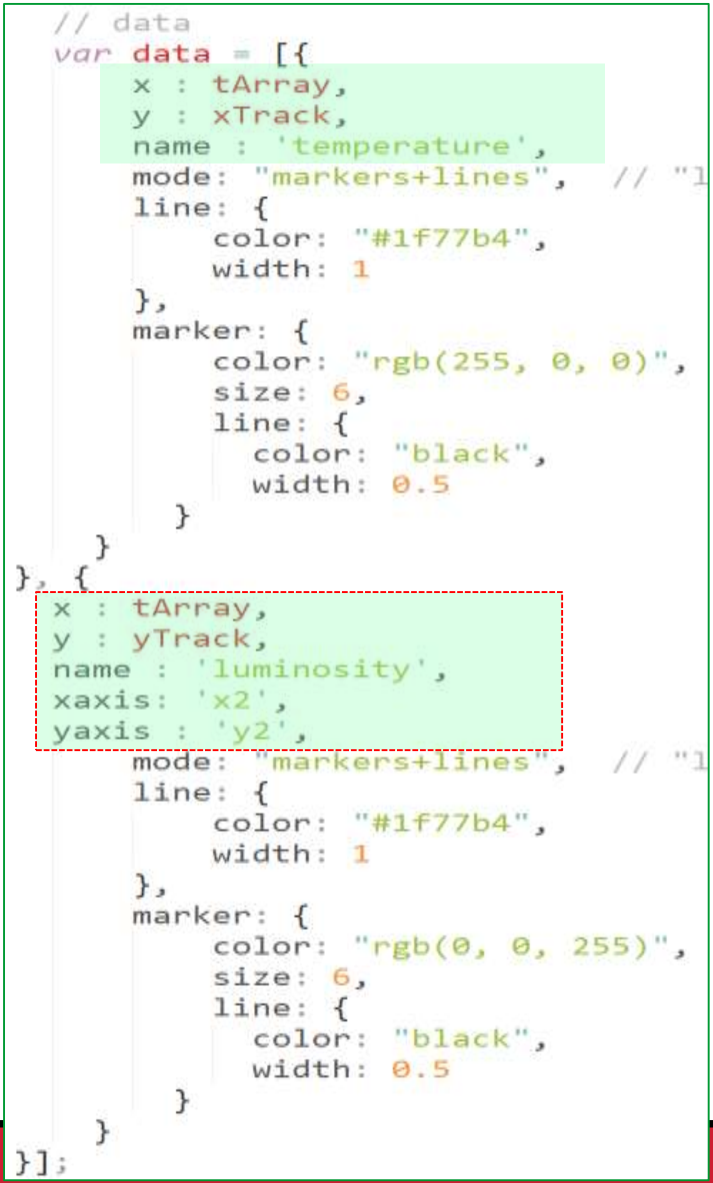
[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



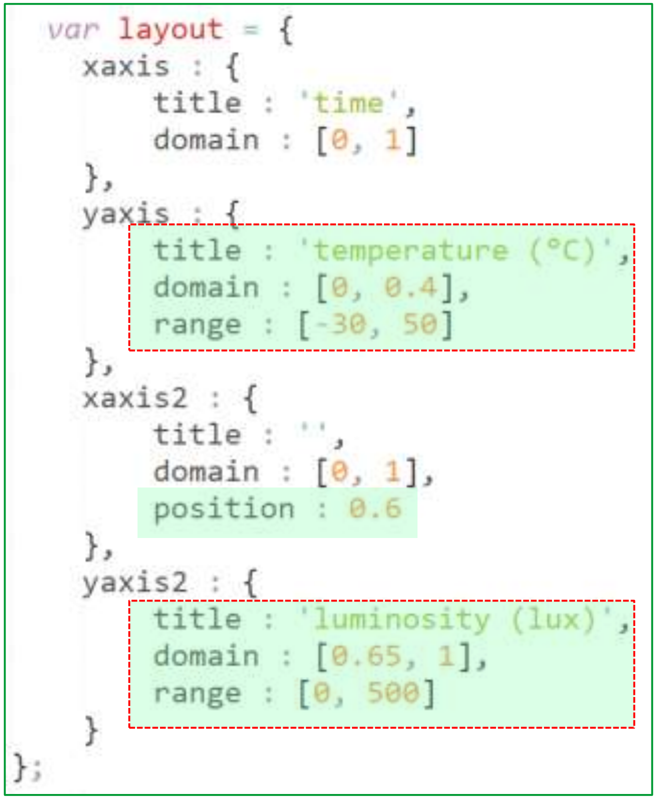
```
function init() {  // initial screen ()
    // starting point : first data (temp, lux)
    for ( i = 0; i < numPts; i++) {
        tArray.push(dtda[0]);  // date
        xTrack.push(dtda[1]);  // sensor 1 (temp)
        yTrack.push(dtda[2]);  // sensor 2 (lux)
    }

    Plotly.newPlot(streamPlot, data, layout);
}
```

A5.6.6 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



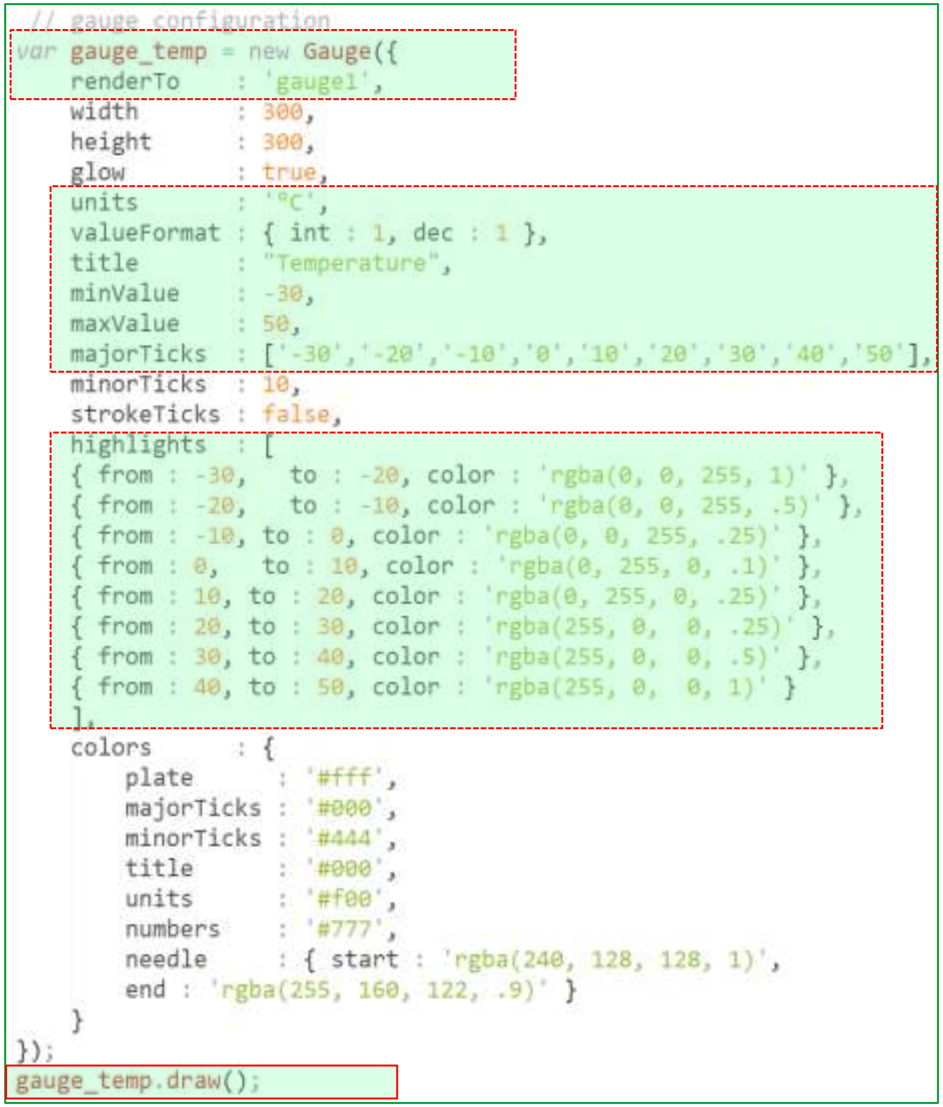
```
  // data
  var data = [{
      x : tArray,
      y : xTrack,
      name : 'temperature',
      mode: "markers+lines",    // "l
      line: {
          color: "#1f77b4",
          width: 1
      },
      marker: {
          color: "rgb(255, 0, 0)",
          size: 6,
          line: {
            color: "black",
            width: 0.5
          }
      }
}, {
  x : tArray,
  y : yTrack,
  name : 'luminosity',
  xaxis: 'x2',
  yaxis : 'y2',
      mode: "markers+lines",    // "l
      line: {
          color: "#1f77b4",
          width: 1
      },
      marker: {
          color: "rgb(0, 0, 255)",
          size: 6,
          line: {
            color: "black",
            width: 0.5
          }
      }
}];
```



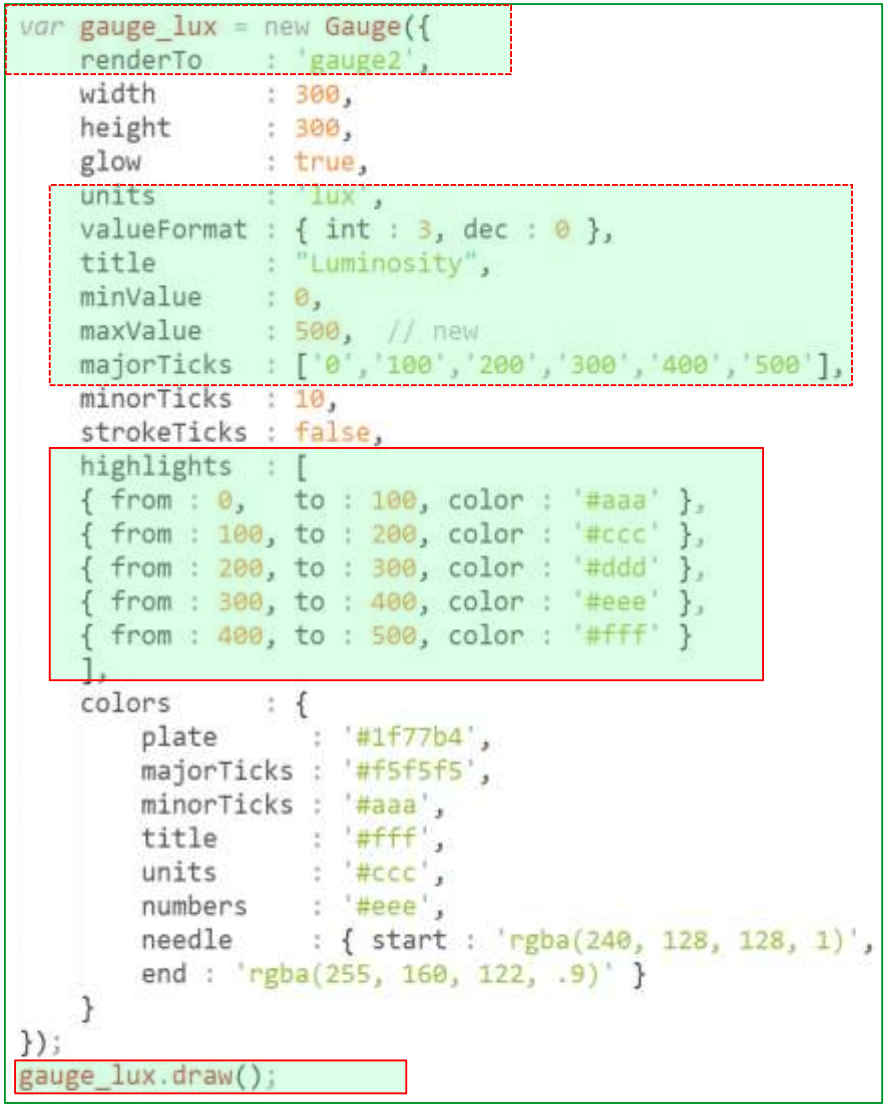
```
  var layout = {
    xaxis : {
        title : 'time',
        domain : [0, 1]
    },
    yaxis : {
        title : 'temperature (°C)',
        domain : [0, 0.4],
        range : [-30, 50]
    },
    xaxis2 : {
        title : '',
        domain : [0, 1],
        position : 0.6
    },
    yaxis2 : {
        title : 'luminosity (lux)',
        domain : [0.65, 1],
        range : [0, 500]
    }
};
```

A5.6.7 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (data from multi sensors)



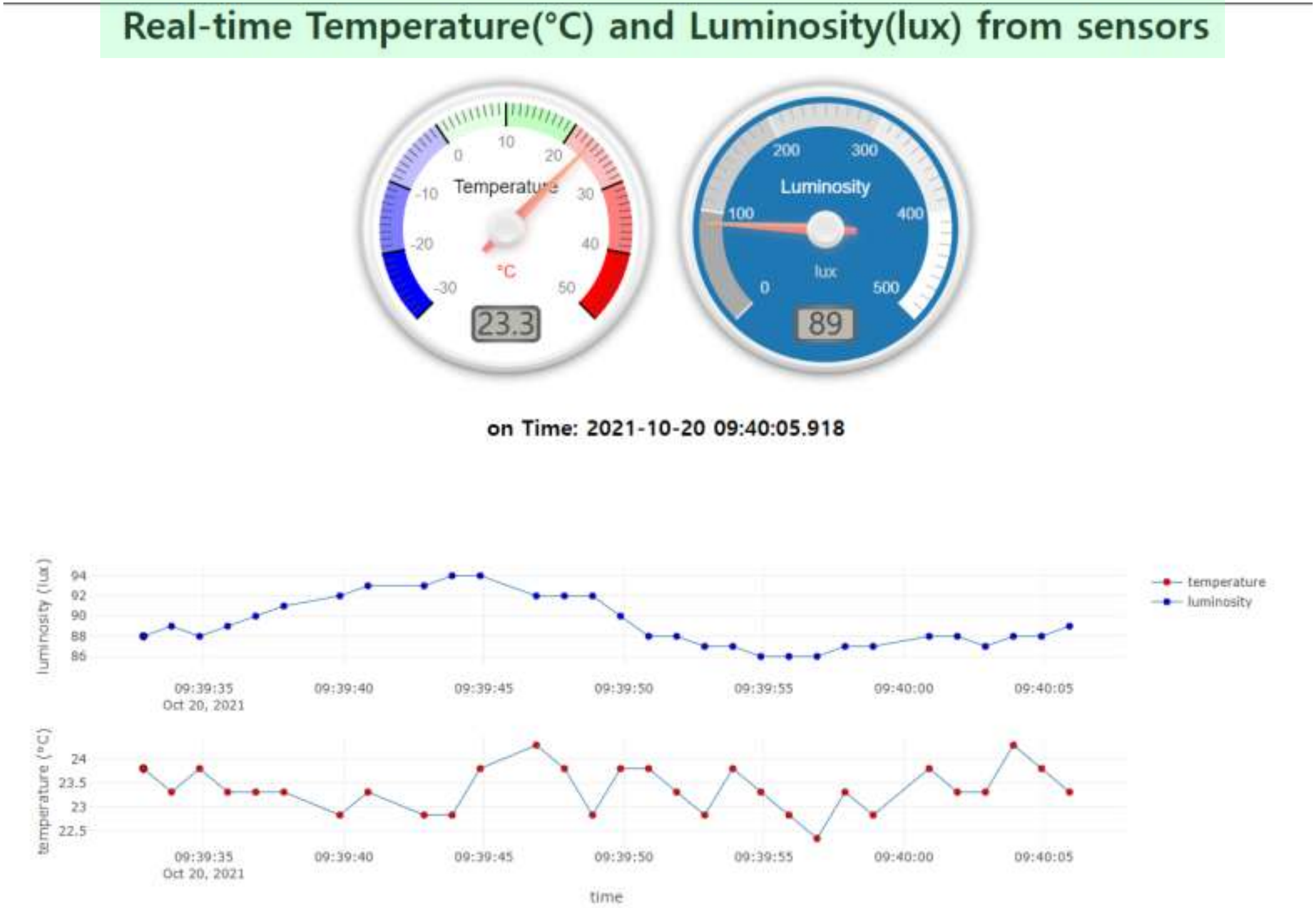
```
 // gauge configuration
var gauge_temp = new Gauge({
    renderTo     : 'gauge1',
    width        : 300,
    height       : 300,
    glow         : true,
    units        : '°C',
    valueFormat : { int : 1, dec : 1 },
    title        : "Temperature",
    minValue     : -30,
    maxValue     : 50,
    majorTicks   : ['-30','-20','-10','0','10','20','30','40','50'],
    minorTicks   : 10,
    strokeTicks : false,
    highlights   : [
    { from : -30,   to : -20, color : 'rgba(0, 0, 255, 1)' },
    { from : -20,   to : -10, color : 'rgba(0, 0, 255, .5)' },
    { from : -10, to : 0, color : 'rgba(0, 0, 255, .25)' },
    { from : 0,    to : 10, color : 'rgba(0, 255, 0, .1)' },
    { from : 10, to : 20, color : 'rgba(0, 255, 0, .25)' },
    { from : 20, to : 30, color : 'rgba(255, 0,  0, .25)' },
    { from : 30, to : 40, color : 'rgba(255, 0,  0, .5)' },
    { from : 40, to : 50, color : 'rgba(255, 0,  0, 1)' }
    ],
    colors       : {
        plate       : '#fff',
        majorTicks : '#000',
        minorTicks : '#444',
        title       : '#000',
        units       : '#f00',
        numbers     : '#777',
        needle      : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_temp.draw();
```



```
var gauge_lux = new Gauge({
    renderTo      : 'gauge2',
    width         : 300,
    height        : 300,
    glow          : true,
    units         : 'lux',
    valueFormat : { int : 3, dec : 0 },
    title         : "Luminosity",
    minValue      : 0,
    maxValue      : 500,   // new
    majorTicks    : ['0','100','200','300','400','500'],
    minorTicks    : 10,
    strokeTicks : false,
    highlights    : [
    { from : 0,    to : 100, color : '#aaa' },
    { from : 100, to : 200, color : '#ccc' },
    { from : 200, to : 300, color : '#ddd' },
    { from : 300, to : 400, color : '#eee' },
    { from : 400, to : 500, color : '#fff' }
    ],
    colors        : {
        plate        : '#1f77b4',
        majorTicks : '#f5f5f5',
        minorTicks : '#aaa',
        title        : '#fff',
        units        : '#ccc',
        numbers      : '#eee',
        needle       : { start : 'rgba(240, 128, 128, 1)',
        end : 'rgba(255, 160, 122, .9)' }
    }
});
gauge_lux.draw();
```

A5.6.8 TMP36 + CdS streaming project

[DIY] Client html : client_cds_tmp36.html (result)



Real-time Temperature(°C) and Luminosity(lux) from sensors

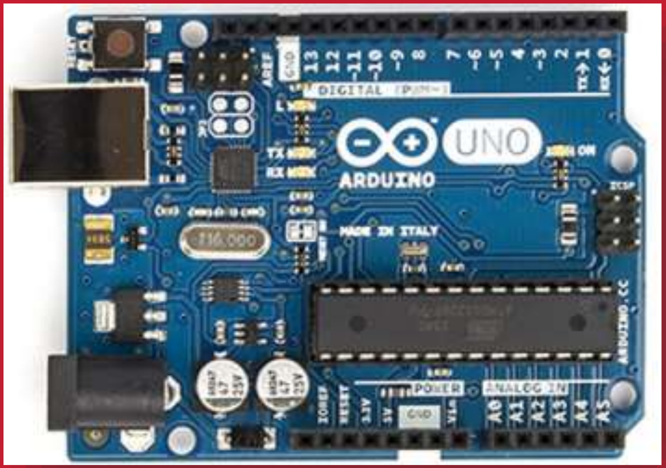
on Time: 2021-10-20 09:40:05.918

Gauge 디자인 변경한 후에, AAnn_DS_cds_tmp36.png 로 저장

CdS + DHT22

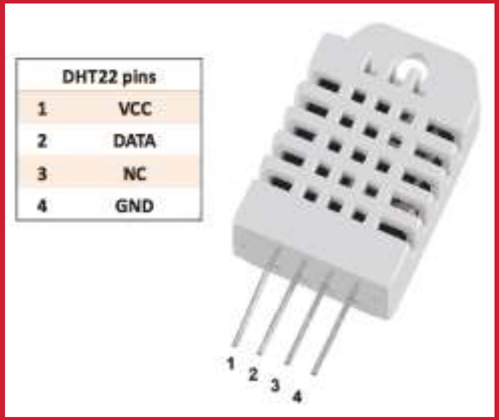
+ plotly.js

Node project

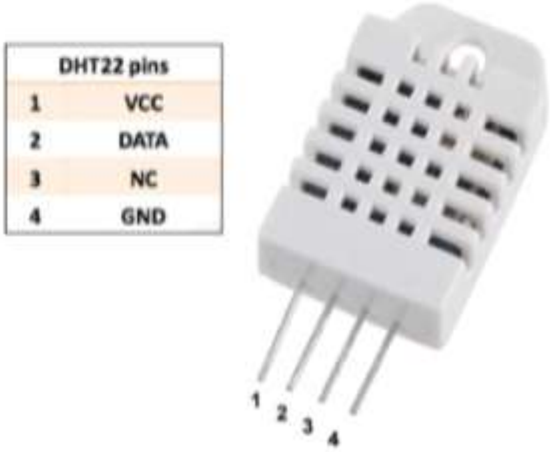


Multi-sensors

DHT22 + CdS



DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND



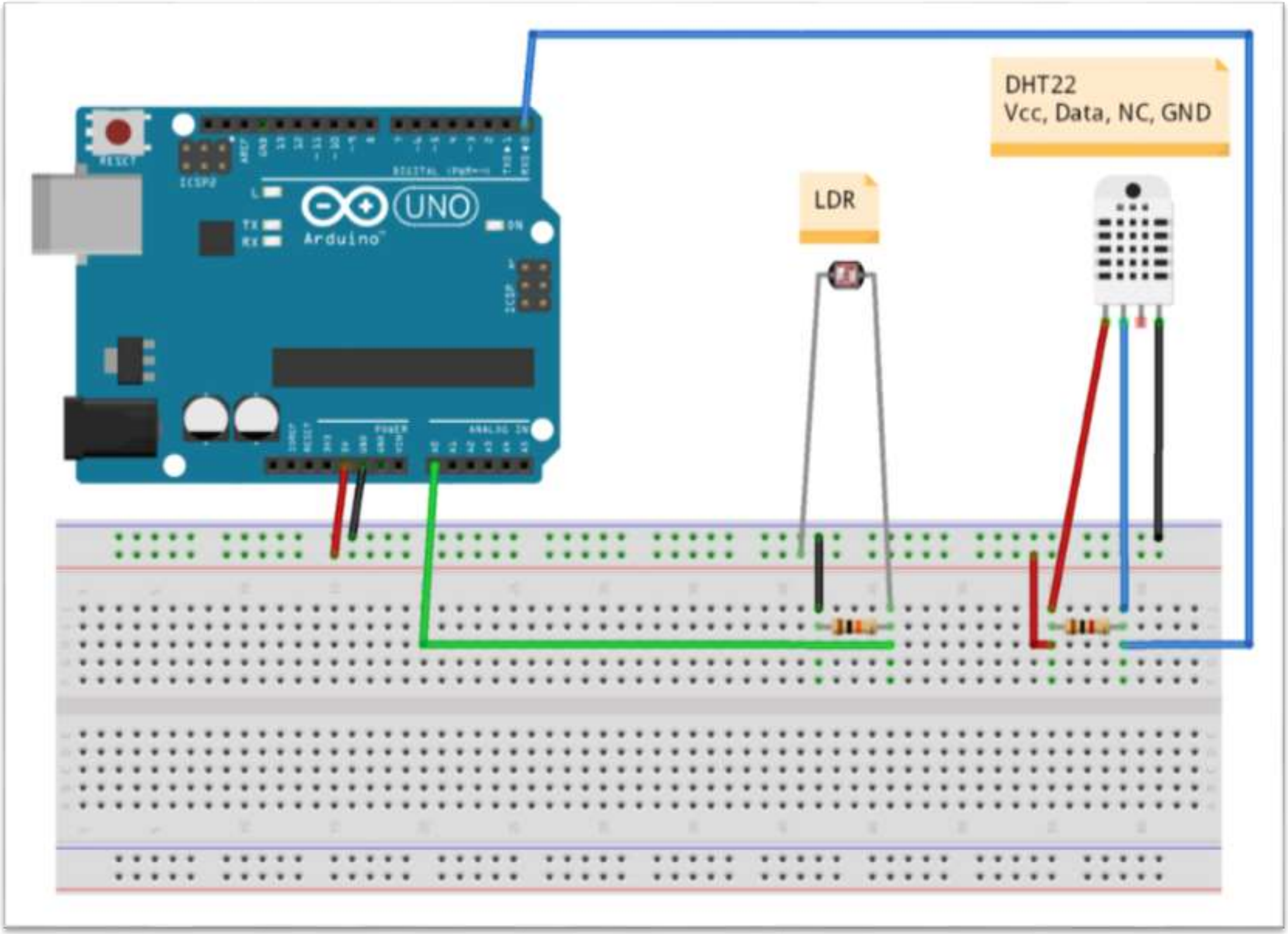
DHT22 pins	
1	VCC
2	DATA
3	NC
4	GND

그림 8−7 DHT22 pin 구조

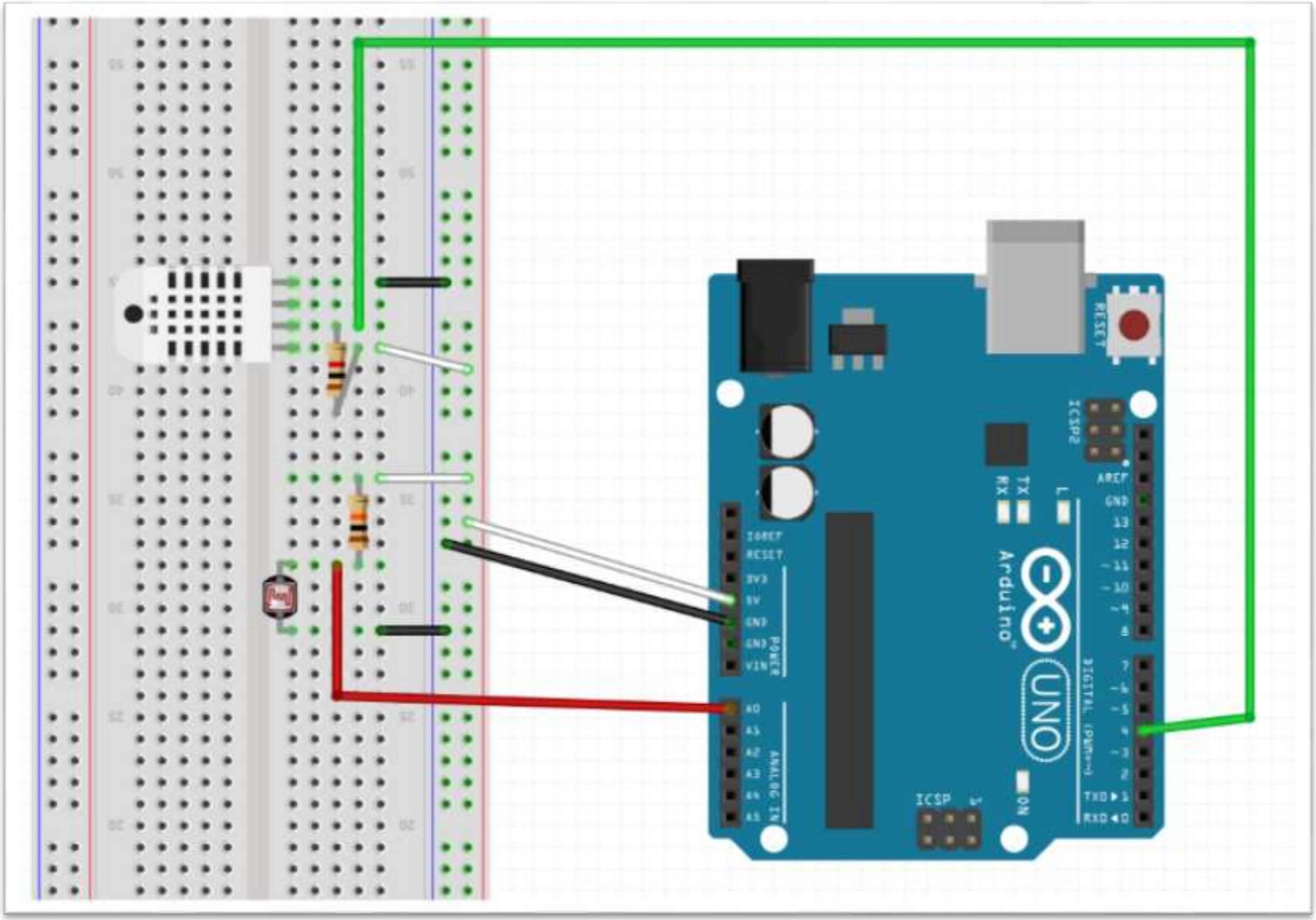
- 3 ~ 5V power and I/O
- 2.5mA max current
- [0-100%] humidity readings with 2-5% accuracy
- [-40 to 80°C] temperature readings ±0.5°C accuracy
- 0.5 Hz sampling rate

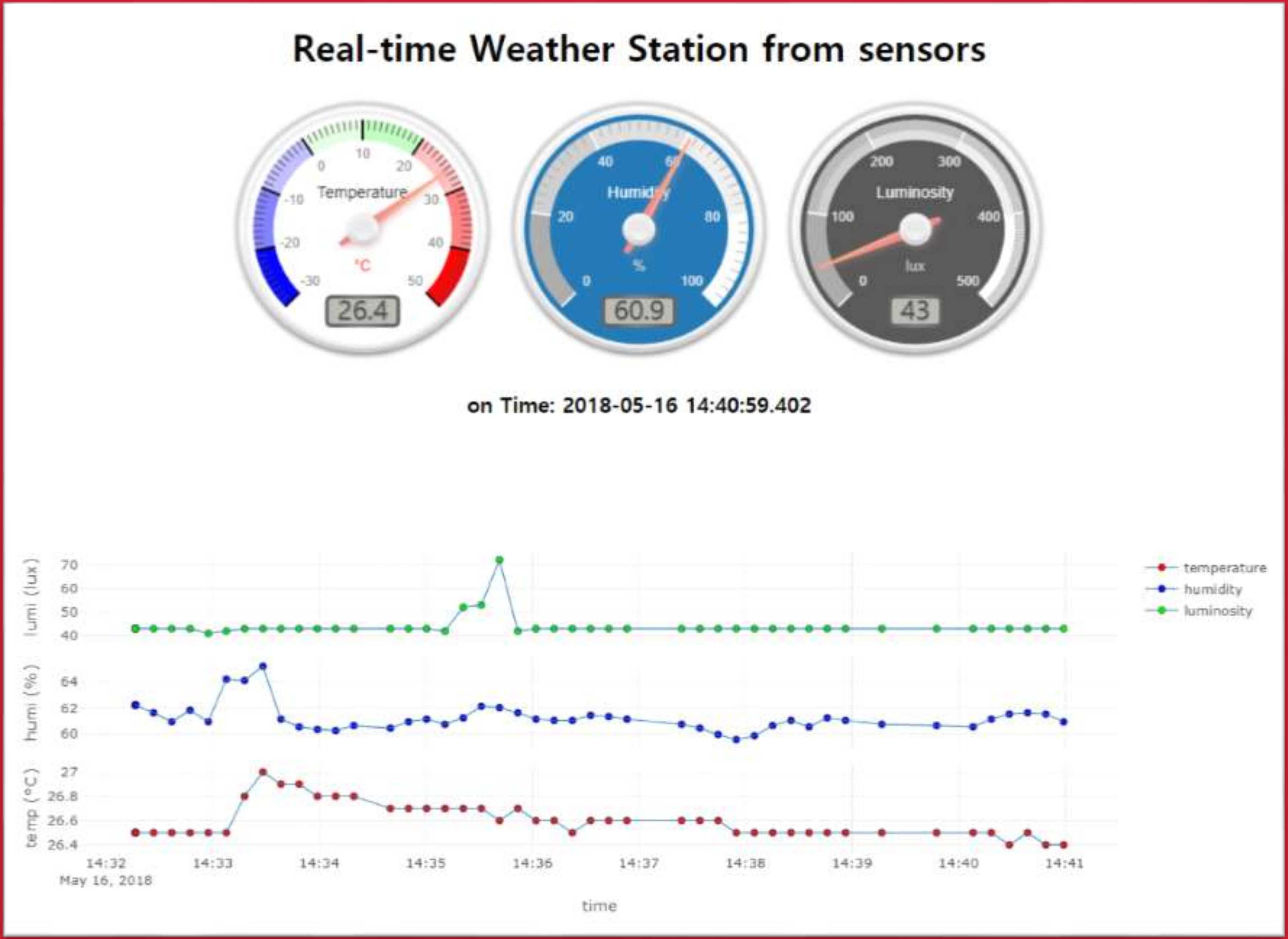
https://learn.adafruit.com/dht/overview

A5.7 DHT22 + CdS streaming project



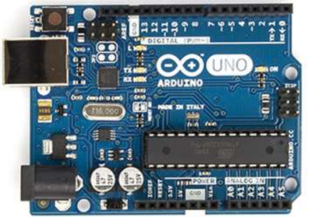
A5.7.1 DHT22 + CdS circuit





Real-time Weather Station from sensors

on Time: 2018-05-16 14:40:59.402



[Practice]

- [wk08]
  - RT Data Visualization with node.js
  - Usage of gauge.js
  - Complete your plotly-node project
  - Upload folder: aann-rpt08
  - Use repo “aann” in github

wk08 : Practice : aann-rpt08

◆ [Target of this week]

- Complete your works
- **Save your outcomes and upload outputs in github**

제출폴더명 : aann-rpt08

- 압축할 파일들

① AAnn_DS_30timestamps.png

② AAnn_DS_multiple_axis.png

③ AAnn_cds_gauge.png

④ AAnn_cds_change.png

⑤ AAnn_DS_cds_tmp36.png

⑥ All *.ino

⑦ All *.js

⑧ All *.html

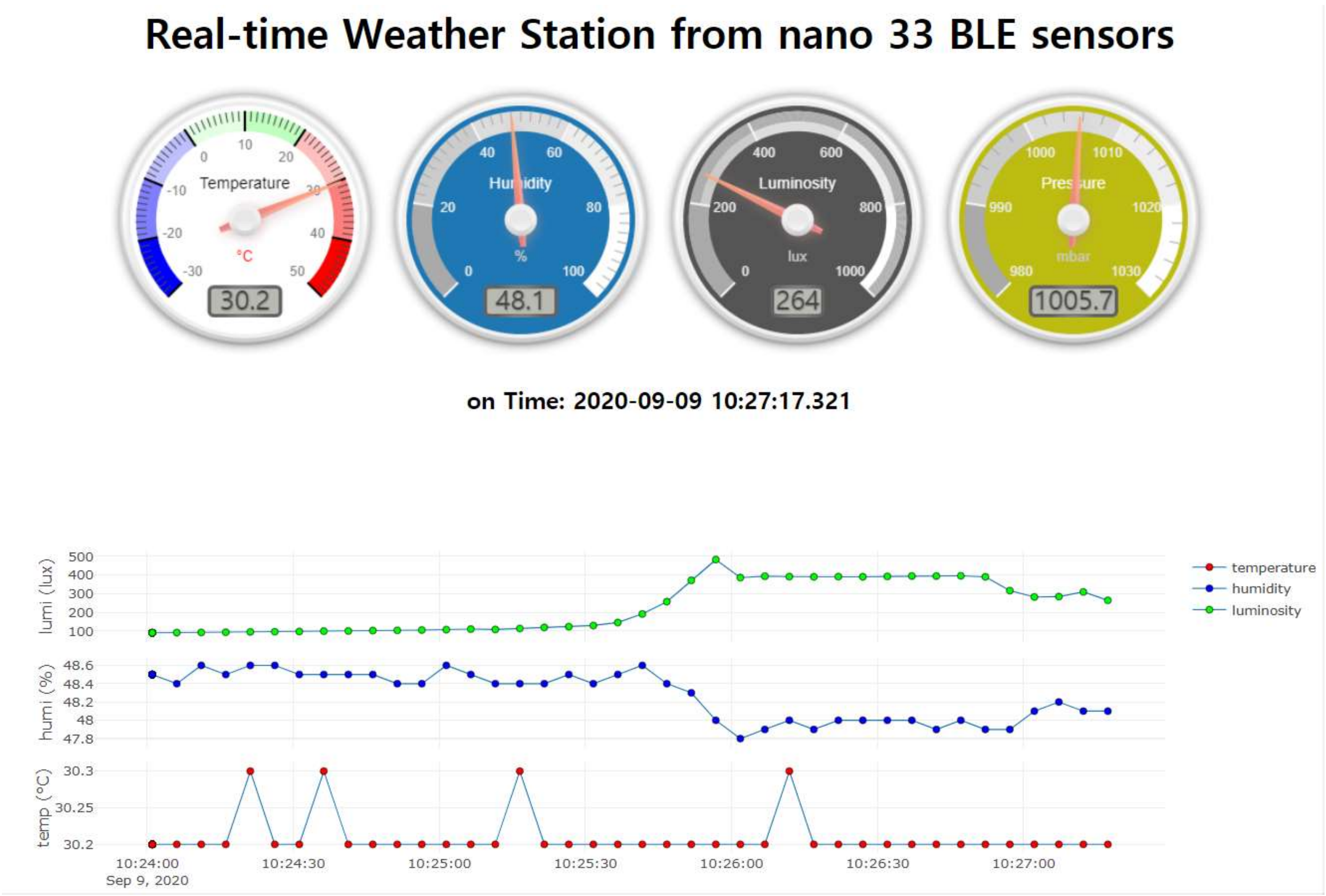
Email : chaos21c@gmail.com

Lecture materials

References & good sites

- ✓ http://www.arduino.cc Arduino Homepage
- ✓ http://www.nodejs.org/ko Node.js
- ✓ https://plot.ly/ plotly
- ✓ https://www.mongodb.com/ MongoDB
- ✓ http://www.w3schools.com By w3schools
- ✓ http://www.github.com GitHub

Target of this class



Real-time Weather Station from nano 33 BLE sensors

on Time: 2020-09-09 10:27:17.321