

## Weather station on Arduino

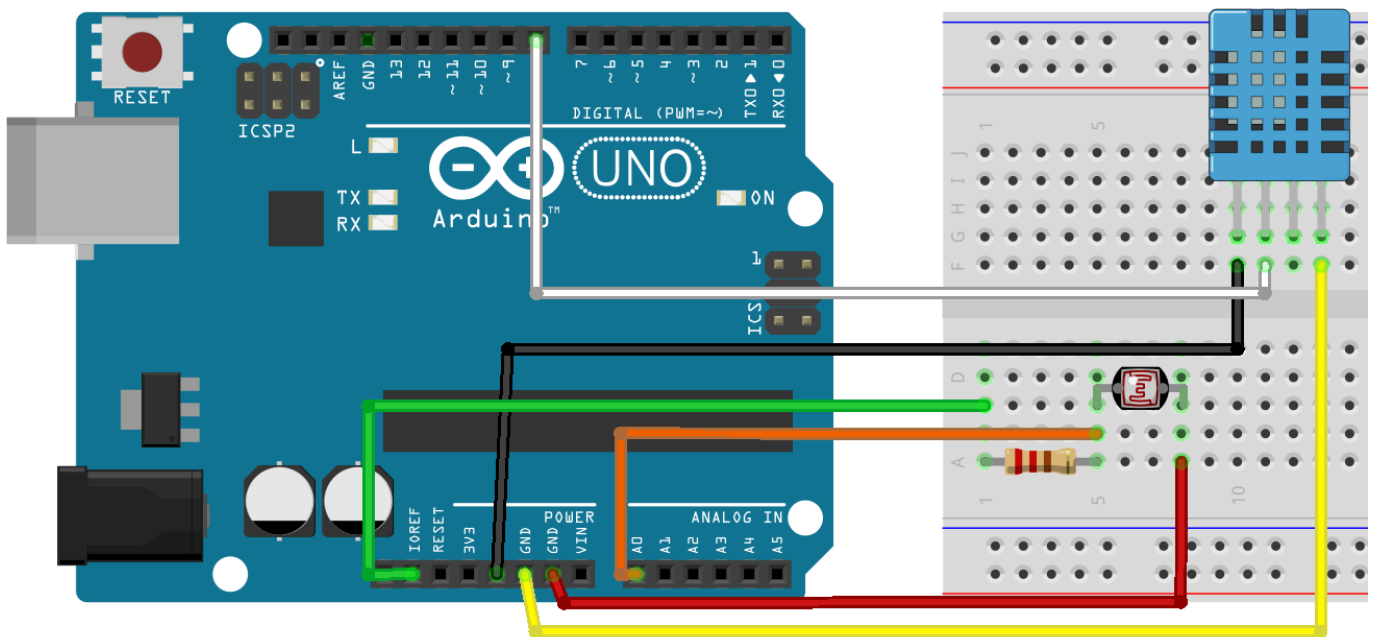
Article

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## Weather station on Arduino

It was [InterSystems hackathon](#) time and our team, consisting of Artem Viznyuk and me had [Arduino](#) board (one) and various parts of it (in overabundance). And so like that our course of action was set - like all other Arduino beginners, we decided to build a weather station. But with data persistent storage in Caché and visualization in DeepSee!



## Work with devices

InterSystems Caché can work [directly](#) with many types of physical and logical devices

- Terminal
- TCP
- The Spooler
- Printers
- Magnetic Tape
- **COM ports**
- and many others

As Arduino uses COM port for communication, we were all set. Generally, work with devices could be divided into 5 steps:

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1. [OPEN](#) command to register device with current process and access it
2. [USE](#) command to make it primary
3. Do some actual work. [READ](#) to receive data from a device, and [WRITE](#) to send data
4. USE again to switch primary device
5. [CLOSE](#) command to free the device

So, that's theory, what's in practice?

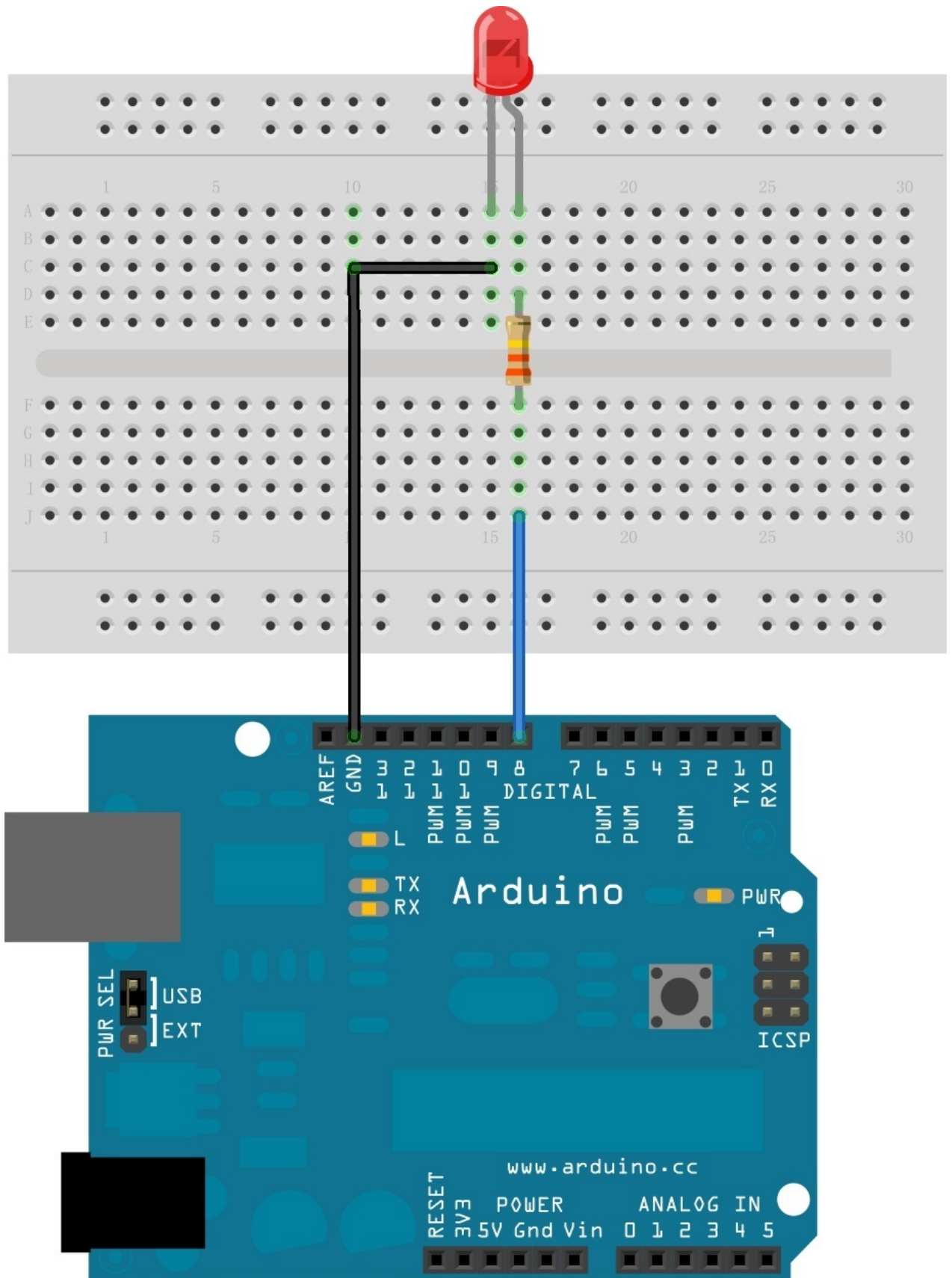
## Blink from Caché

Ferst, we built an Arduino device, which reads a number from COM port and powers the led for a specified number of milliseconds.

**Circuit:**

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## C code (for Arduino)

```
/* Led.ino
 * Receive data on a COM port
 * Connect your led to ledPin
```

```
*/

// Pin, to connect your led
#define ledpin 8

// Received data buffer
String inString = "";

// Execute once at the beginning
void setup() {
  Serial.begin(9600);
  pinMode(ledpin, OUTPUT);
  digitalWrite(ledpin, LOW);
}

// Execute indefinetly
void loop() {
  // Get data from com
  while (Serial.available() > 0) {
    int inChar = Serial.read();
    if (isDigit(inChar)) {
      // one character at a time
      // and append it to data buffer
      inString += (char)inChar;
    }

    // Encounter new line
    if (inChar == '\n') {
      // Power on the led
      digitalWrite(ledpin, HIGH);
      int time = inString.toInt();
      delay(time);
      digitalWrite(ledpin, LOW);
      // Flush the buffer
      inString = "";
    }
  }
}
```

And finally a Caché method, which sends 1000\n string to a com port:

```
/// Send 1000\n to a com port
ClassMethod SendSerial()
{
  set port = "COM1"
  open port:(:::" 0801n0":/BAUD=9600) // Open device
  set old = $IO // Recorn current primary device
  use port // Switch to com port
  write $Char(10) // Send some test data
  hang 1
  write 1000 _ $Char(10) // Send 1000\n
  use old // Back to old terminal
  close port // Free the device
}
```

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«0801n0» is a string with parameters to access Com port, which is which is described in [documentation](#). And /BAUD=9600 — is, of course, the connection speed.

If we execute this method in a terminal:

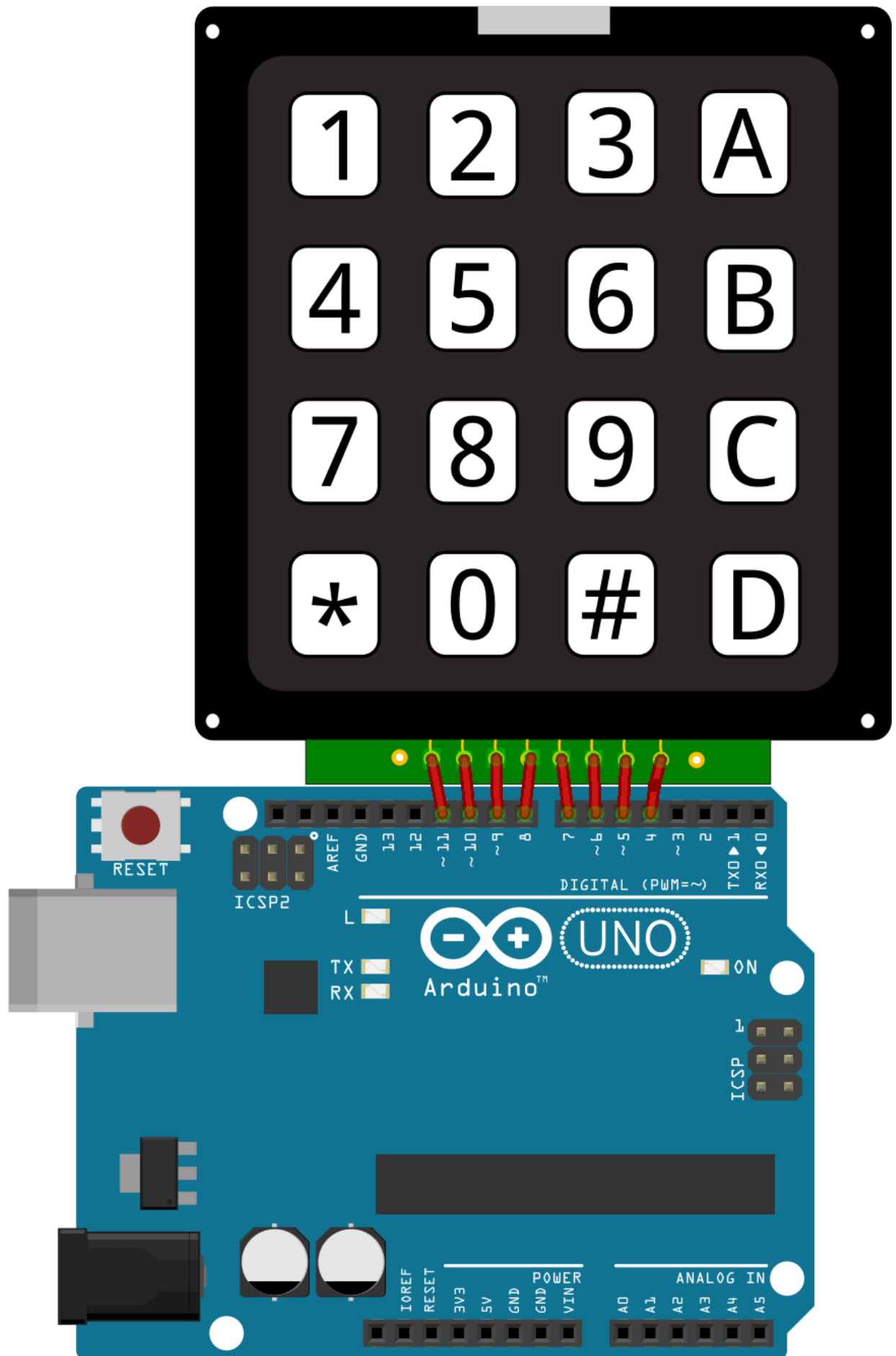
```
do ##class(Arduino.Habr).SendSerial()
```

It would output nothing, but a led would flash for a second.

## Receive data

Now let's attach keypad to Cache and receive entered data. This could be used as a custom user authentication with [authentication delegation](#) and ZAUTHENTICATE.mac routine.

**Circuit:**



### C code

```
/* Keypadtest.ino *
 * Uses Keypad library,
 * Connect Keypad to Arduino pins
 * as specified in rowPins[] and colPins[].
 *
 */

// Repository:
// https://github.com/Chris--A/Keypad
#include <Keypad.h>

const byte ROWS = 4; // Four rows
const byte COLS = 4; // Three columns
// Map symbols to keys
char keys[ROWS][COLS] = {
  {'1','2','3','A'},
  {'4','5','6','B'},
  {'7','8','9','C'},
  {'*','0','#','D'}
};
// Connect keypad pins 1-8 (up-down) to Arduino pins 11-4: 1->11, 2->10, ... , 8->4
// Connect keypad ROW0, ROW1, ROW2 ? ROW3 to this Arduino pins
byte rowPins[ROWS] = { 7, 6, 5, 4 };

// Connect keypad COL0, COL1 and COL2 to this Arduino pins
byte colPins[COLS] = { 8, 9, 10, 11 };

// Keypad initialization
Keypad kpd = Keypad( makeKeymap(keys), rowPins, colPins, ROWS, COLS );

void setup() {
  Serial.begin(9600);
}

void loop() {
  char key = kpd.getKey(); // Receive key pressed
  if(key)
  {
    switch (key)
    {
      case '#':
        Serial.println();
      default:
        Serial.print(key);
    }
  }
}
```

And here is a Caché method used to get data from a com port, one line at a time:

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```
/// Receive one line till we encounter line terminator from COM1
ClassMethod ReceiveOneLine() As %String
{
  port = "COM1"
  set str=""
  try {
    open port:(:::" 0801n0":/BAUD=9600)
    set old = $io
    use port
    read str // Read till we encounter line terminator
    use old
    close port
  } catch ex {
    close port
  }
  return str
}
```

Execute in a terminal:

```
write ##class(Arduino.Habr).ReceiveOneLine()
```

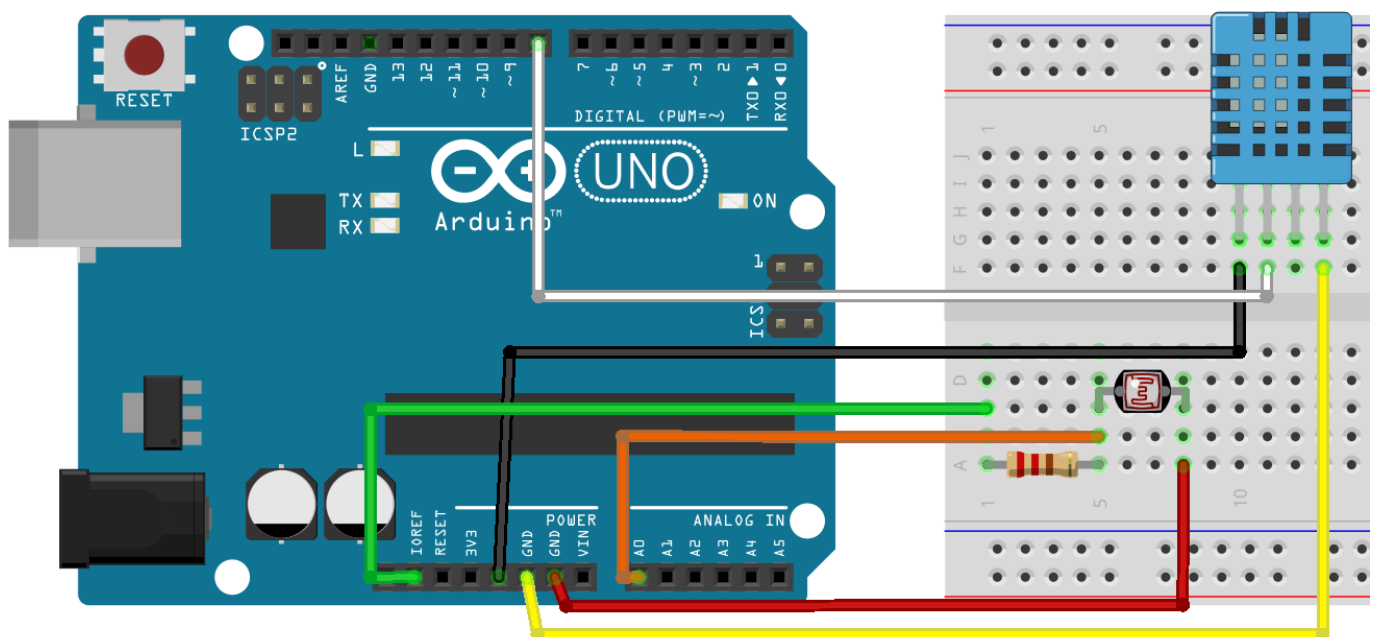
And it would start waiting for input till # is pressed (which would be sent as a line terminator), after which entered data would be displayed in a terminal.

That was Arduino-Caché I/O basics, and now we're ready to build our own weather station.

## Weather station

We're finally getting to the weather station! We used a photoresistor and a [DHT11](#) Humidity & Temperature Sensor to gather data.

**Circuit:**



**C code**



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```
/* Meteo.ino *
 * Register humidity, temperature and light level
 * And send them to a COM port
 * Output sample: H=1.0;T=1.0;LL=1;
 */

// Photoresistor pin (analog)
int lightPin = 0;

// DHT-11 pin (digital)
int DHpin = 8;

// Array to store DHT-11 temporary data
byte dat[5];

void setup() {
  Serial.begin(9600);
  pinMode(DHpin,OUTPUT);
}

void loop() {
  delay(1000); // measure everything once per second
  int lightLevel = analogRead(lightPin); //Get brightness level

  temp_hum(); // Get temperature and humidity into dat variable
  // And output the result
  Serial.print("H=");
  Serial.print(dat[0], DEC);
  Serial.print('.');
  Serial.print(dat[1],DEC);
  Serial.print(";T=");
  Serial.print(dat[2], DEC);
  Serial.print('.');
  Serial.print(dat[3],DEC);
  Serial.print(";LL=");
  Serial.print(lightLevel);
  Serial.println(";");
}

// Get DHT-11 data into dat
void temp_hum() {
  digitalWrite(DHpin,LOW);
  delay(30);
  digitalWrite(DHpin,HIGH);
  delayMicroseconds(40);
  pinMode(DHpin,INPUT);
  while(digitalRead(DHpin) == HIGH);
  delayMicroseconds(80);
  if(digitalRead(DHpin) == LOW);
  delayMicroseconds(80);
  for(int i=0;i<4;i++)
  {
    dat[i] = read_data();
  }
  pinMode(DHpin,OUTPUT);
  digitalWrite(DHpin,HIGH);
}

// Get a chunk of data from DHT-11
```

```
byte read_data() {
  byte data;
  for(int i=0; i<8; i++)
  {
    if(digitalRead(DHpin) == LOW)
    {
      while(digitalRead(DHpin) == LOW);
      delayMicroseconds(30);
      if(digitalRead(DHpin) == HIGH)
      {
        data |= (1<<(7-i));
      }
      while(digitalRead(DHpin) == HIGH);
    }
  }
  return data;
}
```

After we had loaded this code into Arduino, it started sending data from COM port in the following format:

```
H=34.0;T=24.0;LL=605;
```

Where:

- H — humidity (from 0 to 100 percent)
- T — temperature (degrees Celsius)
- LL — brightness (from 0 to 1023)

Let's store this data in Caché, for that we wrote a new `Arduino.Info` class:

```
Class Arduino.Info Extends %Persistent
{
  Parameter SerialPort As %String = "com1";
  Property DateTime As %DateTime;
  Property Temperature As %Double;
  Property Humidity As %Double(MAXVAL = 100, MINVAL = 0);
  Property Brightness As %Double(MAXVAL = 100, MINVAL = 0);
  Property Volume As %Double(MAXVAL = 100, MINVAL = 0);

  ClassMethod AddNew(Temperature = 0, Humidity = 0, Brightness = 0, Volume = 0)
  {
    set obj = ..%New()
    set obj.DateTime=$ZDT($H,3,1)
    set obj.Temperature=Temperature
    set obj.Humidity=Humidity
    set obj.Brightness=Brightness/1023*100
    set obj.Volume=Volume
  }
}
```

```
write $SYSTEM.Status.DisplayError(obj.%Save())
}
```

After that then we wrote a method which would receive data from Arduino and transform them into Arduino.Info class objects

```
/// Receive a RAW data in this format: H=34.0;T=24.0;LL=605;\n
/// Convert into Arduino.Info objects
ClassMethod ReceiveSerial(port = {..#SerialPort})
{
  try {
    open port:(:::" 0801n0"/BAUD=9600)
    set old = $IO
    use port
    for {
      read x //read one line
      if (x '= "") {
        set Humidity = $Piece($Piece(x,";",1),"=",2)
        set Temperature = $Piece($Piece(x,";",2),"=",2)
        set Brightness = $Piece($Piece(x,";",3),"=",2)
        do ..AddNew(Temperature,Humidity,Brightness) // Add data
      }
    }
  } catch anyError {
    close port
  }
}
```

And finally we connected Arduino and executed ReceiveSerial method:

```
write ##class(Arduino.Info).ReceiveSerial()
```

This method would receive and store data from Arduino indefinitely

## Data visualisation

After we built our device we set it outside to collect data for a night:

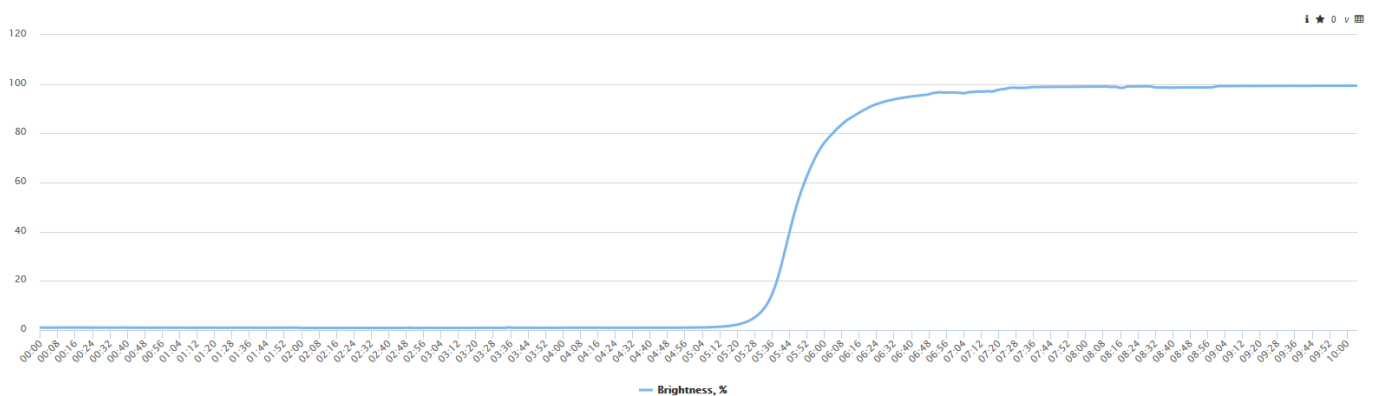
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Come morning we got some 36000+ records and we decided to visualize them in [DeepSee](#) with [MDX2JSON](#) server-side REST API and [DeepSeeWeb](#) dashboard renderer, here are the results:

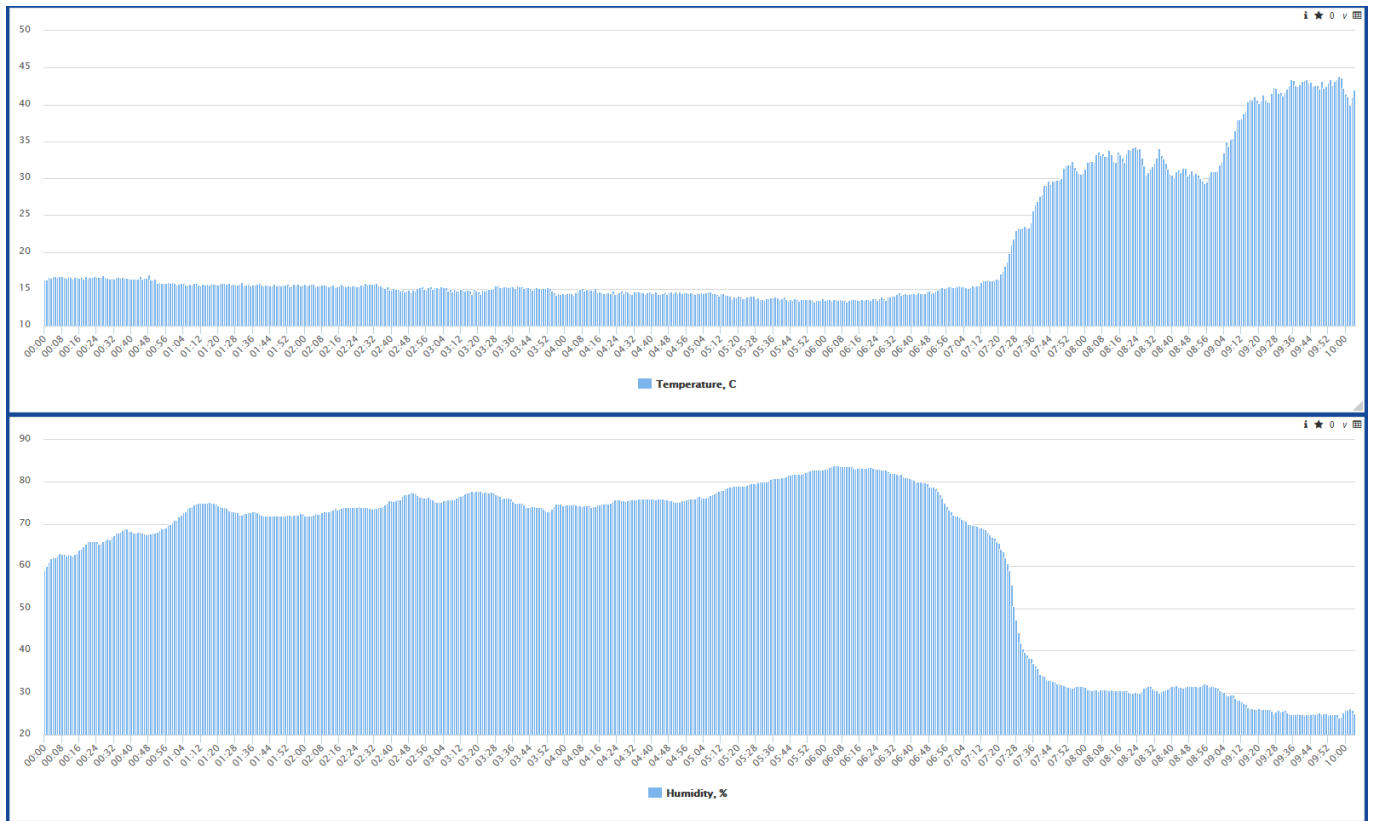
Brightness levels. Sunrise is clearly visible around 5:50:



Temperature and humidity graphs:

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Negative correlation between humidity and temperature is clearly visible.

## Demo

Available [here](#).

## Conclusion

With InterSystems Caché you can communicate with a large number of different devices directly. You can develop your solutions for data processing and visualization rapidly - it took our team around 4 hours to build our own weather station connect it to Caché and visualize the results and we mainly spend them designing the circuit and writing C code.

## Links

- » [Documentation](#)
- » [GitHub repository](#)

[#Best Practices](#) [#Caché](#) [#IRIS Analytics \(DeepSee\)](#) [#Terminal](#) [#InterSystems Data Platform Blog](#)

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