
**External Services | RESTful API**

**WorkSheet 4**

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# 1. Investigating About Web Services

### (a) Define Web Services

Web services are software systems designed to support interoperable machine-to-machine interaction over a network. According to the W3C Web Services Architecture, a web service is defined as:

> "A software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format (specifically WSDL). Other systems interact with the web service in a manner prescribed by its description using SOAP messages, typically conveyed using HTTP with an XML serialization."

In simpler terms, **web services allow different applications and devices to communicate with each other over the internet or a private network using standardized protocols like HTTP, XML, JSON, SOAP, or REST.**

### (b) Describe What Are Application Programming Interfaces (APIs)

An **Application Programming Interface (API)** is a set of rules, protocols, and tools that allow different software applications to communicate with one another.

APIs define how requests should be made, what data formats to use, and the conventions to follow. Developers use APIs to integrate third-party services, access hardware features, or connect with web-based platforms such as weather data providers, social media, or payment services.

For example, using an API, an IoT device can fetch live weather data from a government server and display it on a screen, or trigger alerts based on specific conditions.

### c) What is a RESTful API?

A **RESTful API** (Representational State Transfer API) is a type of web API that follows the principles of REST architecture. It allows systems to interact over HTTP by using standard HTTP methods like:

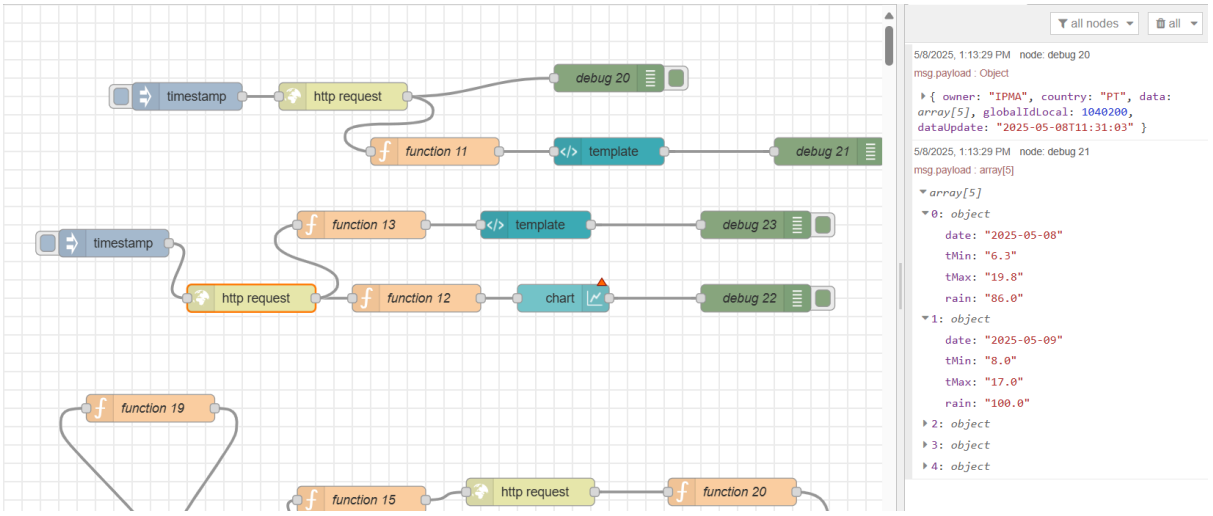
- **GET** (read data)
- **POST** (create data)
- **PUT** (update data)
- **DELETE** (remove data)

RESTful APIs are stateless, meaning each request from a client contains all the information

needed for the server to fulfill it. They often use **JSON or XML** as data formats.

RESTful APIs are widely used in web and IoT applications because they are **lightweight, scalable, and easy to integrate**, especially with cloud-based and real-time services like IPMA (weather data API).

2.b




*https://api.ipma.pt/open-data/forecast/meteorology/cities/daily/1040200.json*

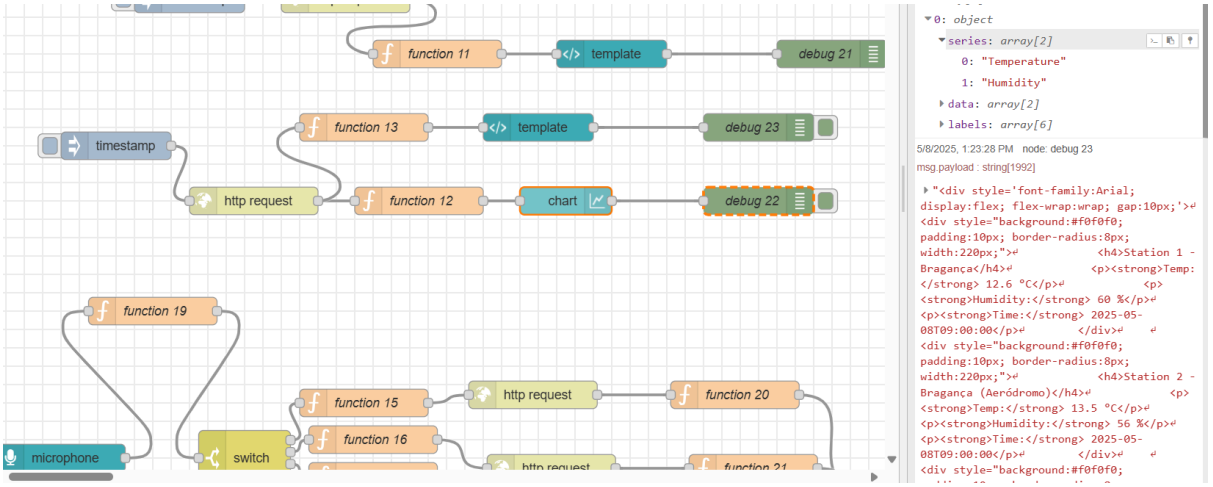
Using the "HTTP request

"[*https://api.ipma.pt/open-data/forecast/meteorology/cities/daily/1040200.json*]

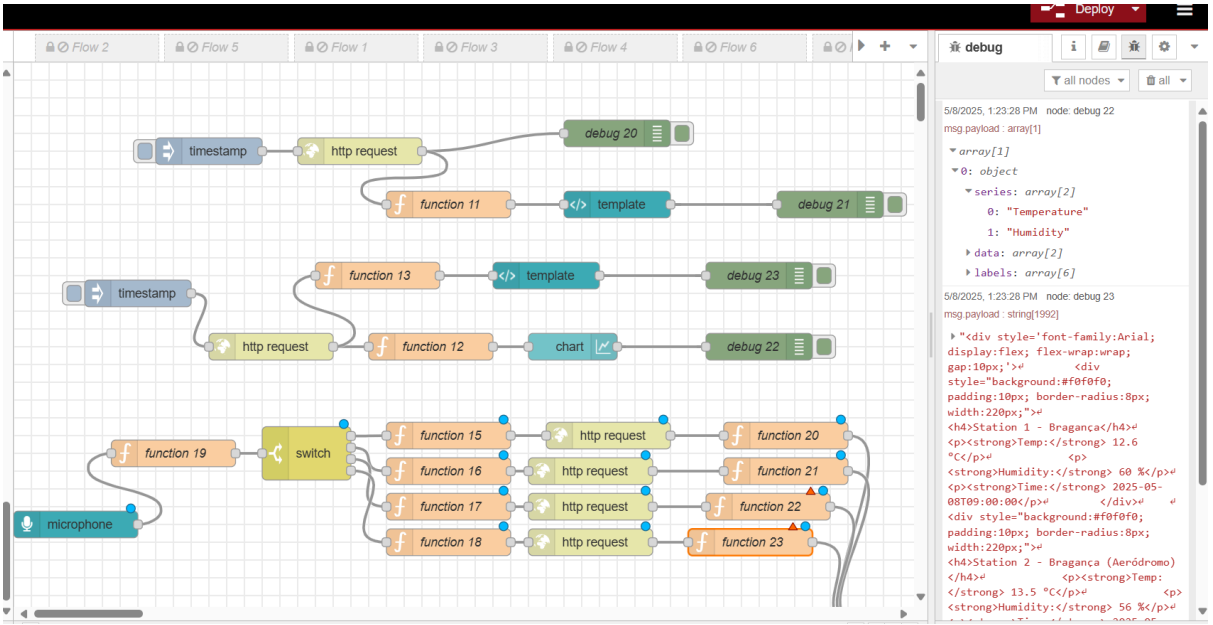
node in Node-RED to access the IPMA service "Daily Weather Forecast up to 5 days aggregated by Local" with the `globalIdLocal` parameter allows for the retrieval of detailed weather forecasts for a specific location in Portugal over a five-day period. The data includes maximum and minimum temperatures (`tMax` and `tMin`), wind direction and speed (`predWindDir` and `classWindSpeed`), probability of precipitation (`precipitaProb`), and a numerical code representing the expected weather type (`idWeatherType`). Each forecast entry also provides the corresponding date (`forecastDate`), facilitating a clear, day-by-day overview of anticipated weather conditions. A practical test in Node-RED confirmed the successful acquisition of structured JSON data, which can be further processed or visualized to develop informative dashboards or integrated into applications such as voice assistants or alert systems.

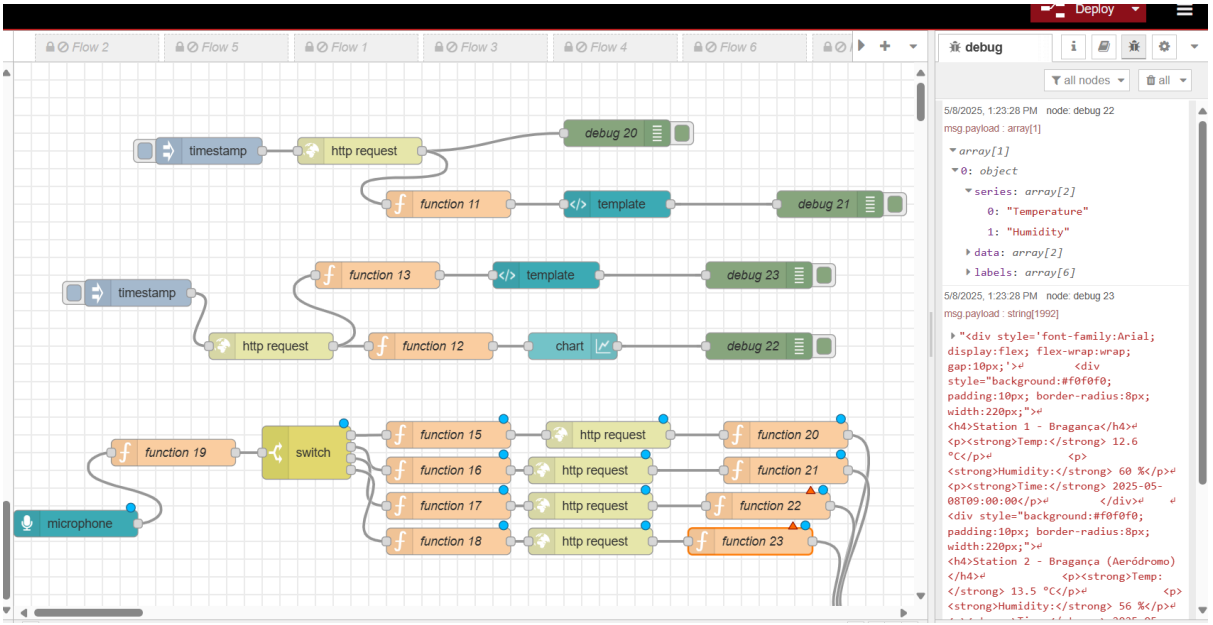
2.d

Using the IPMA API endpoint https://api.ipma.pt/open-data/observation/meteorology/stations/observations.json in Node-RED, along with the "HTTP request", "function", and "deploy" nodes, enables the retrieval and processing of real-time meteorological data from observation stations across Portugal. The "HTTP request" node fetches the raw JSON data, which includes multiple timestamps and weather parameters for various stations. The "function" node then filters and organizes the latest 24 hourly records for a specific station, extracting key information such as temperature, humidity, wind speed (in km/h and m/s), wind direction, precipitation, atmospheric pressure, and solar radiation. After deploying the flow, the resulting output is a clean, structured dataset that can be used for visualizations, monitoring dashboards, or further data processing in weather-related applications.



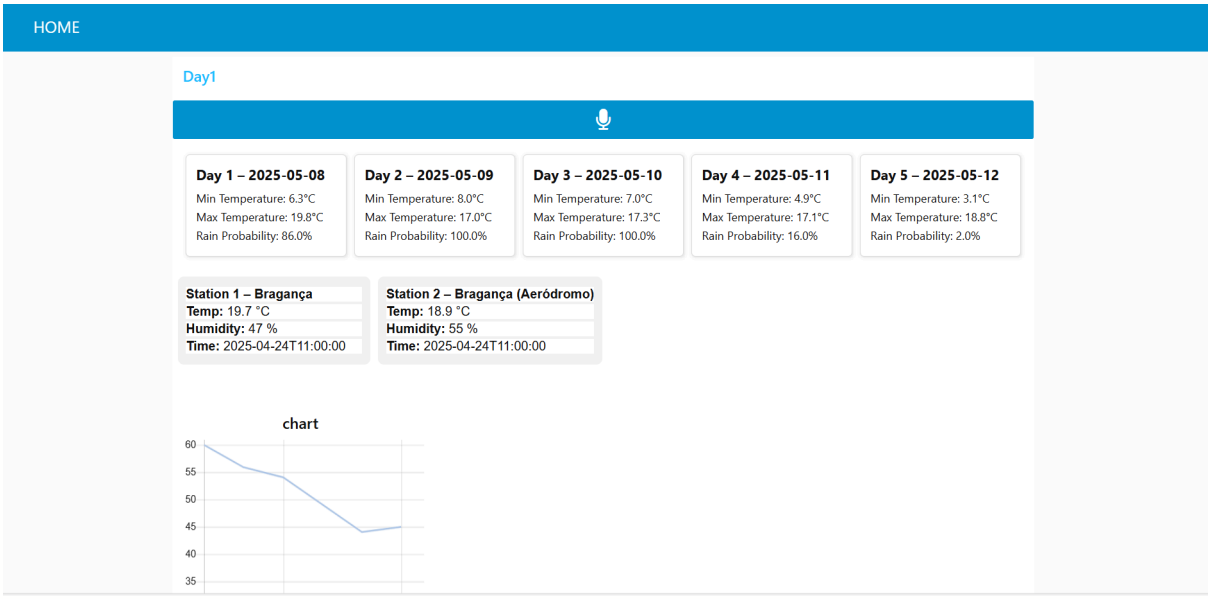
2e.




In addition to collecting and processing meteorological data from the Bragança station, a structured format was created for graphical visualization in the Node-RED interface. Using an additional script, the processed data was converted into two distinct series — one for temperature and another for humidity — based on their respective timestamps. This structure enables the display of a time-series graph, allowing users to easily interpret the evolution of temperature and humidity over the past 24 hours. The interface also integrates a 5-day weather forecast, showing the probability of rain, maximum temperature, and

minimum temperature, extracted from the IPMA API using the endpoint https://api.ipma.pt/open-data/forecast/meteorology/cities/daily/1040200.json.




3. Using Node-Red and the IPMA API, develop a virtual assistant that responds to user voice commands from the Node-RED (voice-chat).

(c) (*) Based on the knowledge acquired in the topics above, develop the voice-controlled weather assistant, which must answer the following questions:

1. User input: “Forecast Rain Today”– Assistant Response: "Probability of Rain today is X %". The value of X is obtained from the IPMA API using the "Daily Weather Forecast up to 5 days aggregated by Location" service.

2. User input: “Forecast Rain Tomorrow”– Assistant Response: "Probability of rain for tomorrow is Y % ". The value of Y is obtained from the IPMA API using the "Daily Weather Forecast up to 5 days aggregated by Location" service.

3. User input: “Current Temperature”– Assistant Response: "The current tem perature is Z degrees Celsius". The value of Z is obtained from the IPMA API using the service "Station Meteorological Observation (hourly data, last 24 hours)".

4. User input: “Current Humidity”– Assistant Response: "The current relative humidity is J %". The value of J is obtained from the IPMA API using the service "Station Meteorological Observation (hourly data, last 24 hours)".

HOME

Day1

**Day 1 – 2025-05-08**
Min Temperature: 6.3°C
Max Temperature: 19.8°C
Rain Probability: 86.0%

**Day 2 – 2025-05-09**
Min Temperature: 8.0°C
Max Temperature: 17.0°C
Rain Probability: 100.0%

**Day 3 – 2025-05-10**
Min Temperature: 7.0°C
Max Temperature: 17.3°C
Rain Probability: 100.0%

**Day 4 – 2025-05-11**
Min Temperature: 4.9°C
Max Temperature: 17.1°C
Rain Probability: 16.0%

**Day 5 – 2025-05-12**
Min Temperature: 3.1°C
Max Temperature: 18.8°C
Rain Probability: 2.0%

**Station 1 – Bragança**
**Temp:** 19.7 °C
**Humidity:** 47 %
**Time:** 2025-04-24T11:00:00

**Station 2 – Bragança (Aeródromo)**
**Temp:** 18.9 °C
**Humidity:** 55 %
**Time:** 2025-04-24T11:00:00