Moody's
ANALYTICS

Contact Us

Email
help@economy.com

U.S./Canada
+1.866.275.3266

EMEA
+44.20.7772.5454 (London)
+420.224.222.929 (Prague)

Asia/Pacific
+852.3551.3077

All Others
+1.610.235.5299

Web
www.economy.com
www.moodysanalytics.com

Moody's Analytics Data Buffet API v1.0

User Guide
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Introduction

Data Buffet is the Moody's Analytics repository of international and subnational economic and demographic time series data. We provide several means of manual and automatic access that you can integrate with your workflow, among them, the Data Buffet API (application program interface). The API uses HMAC authentication and JSON responses, and is agnostic regarding the client's operating system and programming language. The API is throttled (rate-limited) to one request per second and one gigabyte of data per month. The principal tutorial in this document is expressed in cURL notation, but the appendixes contain equivalent examples in C#, Java, Python and R.

Overview

The API's core functionality is expressed by three groups of endpoints:

- `/series` – An endpoint to retrieve a single time series.
- `/baskets` – A collection of endpoints pertaining to the baskets stored by a user on Data Buffet.
    - Get a list of baskets
    - Get a single basket by ID
    - Get the contents of a given basket – The *content* of a basket is a list of mnemonics or other expressions, *not* the time series data. To obtain the time series data and the associated metadata, a basket must be executed via the `/orders` endpoint.
- `/orders` – A collection of endpoints to create and manage orders and to retrieve the basket output associated with a completed order.
    - Place an order
    - Delete an order
    - Get a list of orders
    - Check the status of a given order
    - Return the output of a completed order.

The API also provides some helper endpoints that are used for returning enumerations. For more information, please see https://api.economy.com/data/v1/help.

Is the API right for me?

The Data Buffet API is best suited to **programmatically** retrieve a small number of individual series stored on Data Buffet, or execute and retrieve the results of a basket saved on your Data Buffet account. For other tasks, consider these mechanisms, documented elsewhere:

- Explore the contents of the repository: catalog and search features on DataBuffet.com
- Read long-form information about individual series or datasets: Mnemonic 411 and Data Buffet News at DataBuffet.com
- Transfer a large number of series: a basket created on DataBuffet.com
- Maintain a basket by a group of users: group and sharing features of DataBuffet.com
- Deliver a basket when one or more trigger series are updated: Scheduled baskets on DataBuffet.com
- Feed time series data into an Excel workbook calculation, chart or VBA process: Power Tools
- Display a visualization (chart, map) in a Microsoft Excel document with one-touch update: Power Tools

Authentication

Getting API Keys

Access to the API is controlled by the combination of an access key and an encryption key. These keys are issued to a single user. To obtain your keys, go to the "My Subscriptions" section of your Economy.com account: https://www.economy.com/myeconomy/api-key-info.

Figure 1. Example access key and encryption key

```
DB73FDF0-043C-4018-A7EB-CFB57356BA22
7C7C2FEA-6D18-49A1-BEC9-193B67EAE87D
```

Authenticating each request

Every request to the API must contain an HMAC signature, which you generate from your access key, encryption key, and a time stamp. You must attach a signature to every request, and you must re-create the signature with every request; you will receive an `HTTP 401 Unauthorized` error otherwise.

The access key, time stamp and signature need to be passed in as HTTP headers (not as part of the query string). **Do not** transmit the encryption key in the request since it is a secret between you and the server.

Specifically, the signature is a SHA256 hash of the access key, encryption key and time stamp. The time stamp must be formatted as `yyyy-MM-ddTHH:mm:ssZ` using UTC. For example, "July 30, 2018 5:03:28pm EST" must be represented as `2018-07-30T21:03:28Z`.

Figure 2. Example HTTP request header

```
AccessKeyId: DB73FDF0-043C-4018-A7EB-CFB57356BA22
TimeStamp: 2012-08-02T14:25:20Z
Signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83
```

Figure 3. Example signature creation in C#

This C# function creates a signature from an access key, encryption key, and time stamp. See the appendixes for equivalent examples in Java, Python and R.

```
using System;
using System.Text;
using System.Security.Cryptography;

public static string CreateHMACSignature
(string accKey, string encKey, string timeStamp)
{
 string signature = string.Empty;
 byte[] keyBytes = Encoding.UTF8.GetBytes(encKey);
 using (HMAC hmac = new HMACSHA256(keyBytes))
 {
  byte[] bytesToHash = Encoding.UTF8.GetBytes(accKey + timeStamp);
  byte[] hashedBytes = hmac.ComputeHash(bytesToHash);
  for (int i = 0; i < hashedBytes.Length; i++)
  {
   signature += hashedBytes[i].ToString("X2");
  }
 }
 return signature;
}
```

Step-by-step examples

All examples in this section use the access key, time stamp, and signature generated above. Replace these three header values with your newly generated values on every request. The following tutorial uses cURL syntax. See the appendixes for equivalent code examples in C#, Java, Python and R.

Retrieve a single series

The `/series?m={m}&freq={freq}&trans={trans}` endpoint is used to download a single series specified by a mnemonic or expression. The first parameter, `m`, is mandatory; the optional parameters `freq` and `trans` perform a frequency conversion and apply a transformation, respectively. If omitted, the API will use default values. For valid codes, see the Enumerations appendix.

Figure 4. Request

```
curl -X GET \
 'https://api.economy.com/data/v1/series?m=et.iusa&freq=0&trans=0' \
 -H 'accesskeyid: DB73FDF0-043C-4018-A7EB-CFB57356BA22' \
 -H 'signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83' \
 -H 'timestamp: 2012-08-02T14:25:20Z'
```

Figure 5. Response


```
{
  "data": {
    "freq": "MONTH",
    "startDate": "1939-01-31T05:00:00Z",
    "freqCode": 128,
    "start": 1069,
    "periods": 946,
    "data": [
      29923,
      30101,
      30280,
      30094,
      30300,
      30502,
      30419,
      30663,
      ...
    ]
  },
  "mnemonic": "ET.IUSA",
  "concept": "ET",
  "geoCode": "IUSA",
  "geoTitle": "United States",
  "fipCode": "00",
  "description": "Employment: Total Nonfarm, (Ths. #, SA)",
  "source": "U.S. Bureau of Labor Statistics (BLS): Current Employment Statistics…"
  "databank": "IUSA_BLS_CES.db",
  "freqCode": "128",
  "observedAttribute": "AVERAGED",
  "startDate": "1939-01-31T05:00:00Z",
  "endDate": "2017-10-31T04:00:00Z",
  "lastHistory": "N/A",
  "dateCreated": "2013-08-20T19:28:32Z",
  "dateUpdated": "2017-11-03T12:34:06Z",
  "dateExecuted": "2017-11-27T15:26:23Z",
  "error": null,
  "status": "OK"
}
```


Executing a basket and downloading its output: Overview

Since the above endpoint (`/series`) allows for downloading only a single series at a time, we do not recommend it for pulling down large sets of data. Instead, it is more efficient to define a basket on Data Buffet, then execute it and download its output via the API. To do so, use the `/baskets` and `/orders` endpoints together:

1. Retrieve a list of your saved baskets using the `/baskets` endpoint. Note: The baskets need to be created and managed on DataBuffet.com, as there are currently no endpoints in the API to perform these operations.
2. Locate the desired basket from the response of the previous step and make a note of its `basketId`.
3. Use the POST `orders?id={id}&type={type}&action={action}` endpoint to create a new basket execution order. Pass the `basketId` from Step 2 in the `{id}` parameter, set `{type}` to "baskets", and set `{action}` to "run."
4. This creates an order in the queue and returns some metadata about the order, including an `orderId`.
5. Since the execution of a basket takes time to complete, use this `orderId` value in a call to the GET `orders/{orderId}` endpoint to get the details on whether the process has completed. Whether the process has completed is indicated by the `dateFinished` response value. If null, the process is still executing; if not null, the process has completed.
6. Once the process is complete, the final step is to retrieve the output file by calling the GET `/orders?id={id}&type=baskets` endpoint. Like the POST request that executed the basket in Step 3, set the `{id}` parameter to the `basketId`.

Pay attention to the distinction between the permanent ID of the basket that is being executed (`basketId`) and the transient ID assigned to the order that is performing this task (`orderId`). Use the latter only when checking if an order has completed.

Retrieve a list of your saved baskets

Figure 6. Request

```
curl -X GET \
 https://api.economy.com/data/v1/baskets/ \
 -H 'accesskeyid: DB73FDF0-043C-4018-A7EB-CFB57356BA22' \
 -H 'signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83' \
 -H 'timestamp: 2012-08-02T14:25:20Z'
```

Figure 7. Response

For brevity, only two baskets with a trimmed list of attributes are shown.

```
[
  {
    "basketId": "5DA8BDFD-8E8F-46F6-AC50-64C1814542EE",
    "name": "BuffetBasket",
    "dateCreated": "2017-09-20T13:03:42.77Z",
    "dateExecuted": "2017-09-23T00:06:53.273Z",
    "dateUpdated": "2017-09-20T13:04:02.957Z",
    ...
  },
  {
    "basketId": "BCBAE6AE-05DC-4EAF-BF58-06EC9E241792",
    "name": "Basket 2017-05-16 07h 57m",
    "dateCreated": "2017-05-16T11:57:43.583Z",
    "dateExecuted": "2017-09-12T18:31:53.14Z",
    "dateUpdated": "2017-05-16T11:57:46.48Z",
    ...
  },
  ...
]
```

Execute a basket

We choose to execute the first basket returned from the prior request (`basketId 5DA8BDFD-8E8F-46F6-AC50-64C1814542EE`).

Figure 8. Request

```
curl -X POST \
 'https://api.economy.com/data/v1/orders?id=5DA8BDFD-8E8F-46F6-AC50-64C1814542EE&type=baskets&action=run' \
 -H 'accesskeyid: DB73FDF0-043C-4018-A7EB-CFB57356BA22' \
 -H 'signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83' \
 -H 'timestamp: 2012-08-02T14:25:20Z'
```

Figure 9. Response

```
{
  "orderId": "DF0AB8F3-19D3-4D7D-9AE5-CB410FC6B6E7",
  "dateOrdered": null,
  "dateStarted": null,
  "dateFinished": null,
  "failedAttempts": 0,
  "processing": false,
  "queueStatus": 0,
  "basketId": null,
  "orderType": 0,
  "enteredQueue": "0001-01-01T00:00:00",
  "updatedQueue": null
}
```

Check the status of your order

Since the previous request returns an `orderId` (`DF0AB8F3-19D3-4D7D-9AE5-CB410FC6B6E7`), we use that value to check if our basket execution order has finished running.

Figure 10. Request

```
curl -X GET \
 'https://api.economy.com/data/v1/orders/DF0AB8F3-19D3-4D7D-9AE5-CB410FC6B6E7' \
 -H 'accesskeyid: DB73FDF0-043C-4018-A7EB-CFB57356BA22' \
 -H 'signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83' \
 -H 'timestamp: 2012-08-02T14:25:20Z'
```

Figure 11. Response

```
{
  "orderId": "DF0AB8F3-19D3-4D7D-9AE5-CB410FC6B6E7",
  „dateOrdered": „2017-11-27T19:36:39.927Z",
  "dateStarted": "2017-11-27T19:36:40.1Z",
  "dateFinished": "2017-11-27T19:36:40.513Z",
  "failedAttempts": 0,
  "processing": false,
  "queueStatus": 2,
  "basketId": "5DA8BDFD-8E8F-46F6-AC50-64C1814542EE",
  "orderType": 1,
  "enteredQueue": "2017-11-27T14:36:39.927",
  "updatedQueue": "2017-11-27T14:36:39.927"
}
```

If the order is not finished running, `dateFinished` is set to `null`. In that case, re-issue the request in a loop after introducing a pause of a second or more until `dateFinished` is *not* null or until a certain time-out period is hit to prevent an infinite loop. (You cannot check more often than once per second, because that is the API's throttle rate.)

Download the output file

After making sure that your order is completed, it is now time to download the output file associated with the execution of the basket. The output file type is set as part of the basket's configuration and cannot be altered via the API. Note that the `id` used in this request is the `basketId`.

Figure 12. Request

```
curl -X GET \
 'https://api.economy.com/data/v1/orders?type=baskets&id=5DA8BDFD-8E8F-46F6-AC50-64C1814542EE' \
 -H 'accesskeyid: DB73FDF0-043C-4018-A7EB-CFB57356BA22' \
 -H 'signature: A7808C5A67C422054364F195B161753083179308482 32C6A08A77224F1017E83' \
 -H 'timestamp: 2012-08-02T14:25:20Z'
```

Response

The response of this request is the binary of the output file associated with the basket. You will need to write this binary stream to a file using the same file name and extension as specified in your basket options. See the Appendix for samples in C#, Java, Python, and R.

Frequently asked questions

- What programming languages does the API support?
- What response types are supported?
- Can I use the API from Linux?
- What kind of authentication does the API use?
- How often do I need to regenerate the signature?
- Is the API throttled?
- What's the fastest way to retrieve a large number of series?
- Can I use the API to populate a data warehouse?
- What kind of Data Buffet objects can I retrieve?
- Which series can I retrieve?
- Can I create or alter a basket?
- If I alter the name of a basket on DataBuffet.com, do I need to change my code?
- Whom do I contact for assistance in using the API?
- Do other Moody's Analytics products have APIs?
- I don't understand this jargon—can you translate?

What programming languages does the API support?

The programming language used at your end is immaterial, so long as it (a) creates HTTP requests that the API can process, and (b) can interpret the JSON-formatted responses produced by the API. The examples in this document use cURL, C#, Java, Python and R.

What response types are supported?

JSON is the only response type returned by the API.

Can I use the API from Linux?

Yes, because the operating system is immaterial. Java, Python and R are commonly used on Linux machines; to run C#, you will need to install the .NET Core framework. Setting up your run-time environment is beyond the scope of this document.

What kind of authentication does the API use?

Our API uses HMAC authentication. See the Authentication section above for more info.

How often do I need to regenerate the signature?

You must re-create the signature prior to every request; otherwise you will receive the "HTTP 401 Unauthorized" error. You may find it useful to create a wrapper function that takes the time stamp, access key and encryption key as arguments, and generates a signature immediately before calling the endpoint.

Is the API throttled?

Yes, in two ways. First, you can execute one request per second per account (but a single request can retrieve one series or a basket containing thousands of series). You will receive "HTTP 429 Too Many Requests" error**.** Second, you can retrieve only one gigabyte of data per month. This includes all of the metadata and HTTP headers, although these are insignificant relative to the data payload. The number of requests and series are not specifically limited.

What's the fastest way to retrieve a large number of series?

Because the API is throttled, do not retrieve the series individually; instead, execute a basket that contains all of the series.

Can I use the API to populate a data warehouse?

Yes. You may create a data warehouse for internal use, but the number of users who may have access to it is stipulated by your contract; please contact your Moody's Analytics sales representative if you have questions. To initially populate the warehouse, and to regularly or promptly update each time series with new periods, Data Buffet's "scheduled basket" mechanism is more efficient than the API. (See Is the API right for me? above.)

What kind of Data Buffet objects can I retrieve?

The API can return a single data series, a list of your saved baskets, the properties of a particular basket, or the output file of an execution of a basket. It also returns common enumerations such as frequency and file types.

Which series can I retrieve?

Your access via API is identical to that via Data Buffet and Power Tools; this includes E-model simulation aliases, our historical, estimated and forecast products, and your custom scenarios. Essentially any expression that a basket can run, you can submit via the API.

Can I create or alter a basket?

No. The API executes baskets you have created manually through DataBuffet.com; to alter their contents, go to DataBuffet.com.

If I alter the name of a basket on DataBuffet.com, do I need to change my code?

No. The `/baskets/{id}` endpoint identifies a basket by an immutable alphanumeric GUID that is assigned by our system, not the human-readable title assigned by you.

Whom do I contact for assistance in using the API?

Please go to the Economy.com Contact Us page for email, chat, and telephone options. If using the email form, set Topic to "Technical Issue."

Do other Moody's Analytics products have APIs?

Yes. We provide APIs for our AutoCycle and Précis products.

I don't understand this jargon—can you translate?

Please see if the glossary in this document helps. It lists terminology pertaining to web APIs, Data Buffet, and related Moody's Analytics products.

Appendix 1: API endpoints

All API endpoints below are relative to the root URL https://api.economy.com/data/v1/. The table below hyperlinks to our online comprehensive technical reference at https://api.economy.com/data/v1/help.

HTTP	Endpoint	Description
Series		
GET	series?m={m}&freq={freq}&trans={trans}	Return a series (metadata and numeric observations) formatted in JSON.
Baskets		
GET	baskets?filetype={filetype}&page={page}&size={size}	Return a JSON list describing baskets available for execution. Optionally paginated.
GET	baskets/{id}	Return a single basket.
GET	baskets/{id}/contents?page={page}&size={size}	Retrieve the contents of a basket.
Frequency		
GET	frequencies	Return a list of frequency codes
Orders		
GET	orders	Return a list of your orders.
GET	orders/{orderId}	Return the status of an execution order.
POST	orders?id={id}&type={type}&action={action}	Place an order to generate a data file; return a JSON object with the order ID.
GET	orders?id={id}&type={type}	Return the streamed file content generated the last time a basket was executed.
DELETE	orders/{orderId}	Delete an order from the queue.
File types		
GET	filetypes?type={type}	Return the file types available for a given object type.

Appendix 2: Error messages

The error codes returned by the Data Buffet API are adaptations of standard HTTP server response codes.

Error code	Diagnosis
401 Unauthorized	The authenticating HMAC signature is outdated. You must generate a new signature with a fresh time stamp (see Authentication section).
429 Too Many Requests	You have exceeded the one request per second rate limit. Throttling is access key-specific.
500 Internal Server Error	Server error.

Appendix 3: Enumerations

ConversionType

Data Buffet provides for the conversion of a time series from its native frequency to a different output frequency (either higher or lower), but the appropriate mathematical process depends on the nature of the series. There are three options, of which `Cubic` is the default.
Full list:

Name	Value	Description
Linear	0	
Constant	1	
Cubic	2	

DateFormat

Partial list (full list available here):

Name	Value	Description
Default	0	
General	1	4/26/99
GeneralPaddedFullYear	3	04/26/1999
ISO8610	10	1999-04-26

DateOption

Full list:

Name	Value	Description
StartAndEnd	0	Start date and End date both specified
Start	1	Only start date specified
EntireSeries	2	The entire history
Period	3	Last N periods specified

Filetype

Available file types can be retrieved by using the `/filetypes?type=baskets` endpoint.

Frequencies

In each response with a field that is a numeric frequency code, there will be a paired field with a human-readable string.
Partial list (full list available here):

Name	Value	Description
ANNUAL	204	The default annual period ends in December
QUARTERLY	172	The default quarterly period ends with Q4
MONTHLY	128	A monthly period
WSATURDAY	71	A weekly period ending on Saturday
DAILY	49	Daily period, with seven daily values per week
BUSINS	50	Business-daily period, with five daily values per week

TransformationType

Full list:

Name	Value	Description
None	0	No transformation
YearOverYearPctChange	1	Percent difference between two periods a year apart (% Y/Y)
SimpleDifference	2	Level difference between consecutive periods
AnnualizedGrowth	3	Growth rate between consecutive periods, annualized, expressed in percent
PctChange	4	Percent change between consecutive periods
YearOverYearDiff	8	Level difference between two periods a year apart

Appendix 4: Examples in C#

Necessary libraries

```
using System;
using System.IO;
using System.Net;
using System.Text;
using System.Security.Cryptography;
using Newtonsoft.Json;
```

Main program

```
namespace APICodeSample
{
  class Program
  {
    private const string URI_ENDPOINT = "https://api.economy.com/data/v1/";
    private const string ACC_KEY_HEADER = "AccKeyId";
    private const string SIGNATURE_HEADER = "Signature";
    private const string TIME_STAMP_HEADER = "TimeStamp";
    private const string ACC_KEY = "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX";
    private const string ENC_KEY = "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX";

    static void Main(string[] args)
    {
      // All logs and basket files are currently saved to the Desktop.
      string DesktopLocation =
        Environment.GetFolderPath(Environment.SpecialFolder.DesktopDirectory);
      string OrderID = "XXXXX"; // OrderID you want to run.
      string FileName = "XXXXX"; // Filename of file you want to retrieve.

      string result = GetBaskets(ACC_KEY, ENC_KEY);
      var jsonObject = JsonConvert.DeserializeObject(result);
      File.WriteAllText(String.Format(@»{0}\Baskets.json», DesktopLocation),
        JsonConvert.SerializeObject(jsonObject, Formatting.Indented));
      System.Threading.Thread.Sleep(1000);
      PostOrders postObject = new PostOrders();
      string postResult = PostOrders(ACC_KEY, ENC_KEY, OrderID);
      postObject = JsonConvert.DeserializeObject<PostOrders>(postResult);
      File.WriteAllText(String.Format(@"{0}\Execute.json", DesktopLocation),
        JsonConvert.SerializeObject(postObject, Formatting.Indented));
      PostOrders orderStatus = new PostOrders();
      bool orderCompleted = false;
      while (!orderCompleted)
      {
        System.Threading.Thread.Sleep(1000);
        string getOrdersResult = GetOrderStatus(ACC_KEY, ENC_KEY, postObject.OrderID);
        orderStatus = JsonConvert.DeserializeObject<PostOrders>(getOrdersResult);
        JsonConvert.SerializeObject(orderStatus, Formatting.Indented));
        if (orderStatus.dateFinished != null)
        {
          orderCompleted = true;
        }
      }
      System.Threading.Thread.Sleep(1000);
      Stream orderStream = GetOrderStream(ACC_KEY, ENC_KEY, OrderID);

      using (var fs = new FileStream(String.Format(@"{0}\{1}",
        DesktopLocation, FileName), FileMode.Create))
      {
        orderStream.CopyTo(fs);
      }
    }

  // Methods are listed below.
  }
}
```

Create signature

```
public static string CreateHMACSig(string accKey, string encKey, string timeStamp)
{
  string signature = string.Empty;
  byte[] keyBytes = Encoding.UTF8.GetBytes(encKey);
  using (HMAC hmac = new HMACSHA256(keyBytes))
  {
    byte[] bytesToHash = Encoding.UTF8.GetBytes(accKey + timeStamp);
    byte[] hashedBytes = hmac.ComputeHash(bytesToHash);
    for (int i = 0; i < hashedBytes.Length; i++)
    {
      signature += hashedBytes[i].ToString("X2");
    }
  }
  return signature;
}
```

Retrieve a basket

```
public static string GetBaskets(string accKey, string encKey)
{
  string timeStamp = DateTime.UtcNow.ToString("yyyy-MM-ddTHH:mm:ssZ");
  string signature = CreateHMACSig(accKey, encKey, timeStamp);
  Uri uri = new Uri(URI_ENDPOINT + "baskets");
  WebRequest webRequest = WebRequest.Create(uri);
  webRequest.Method = "GET";
  webRequest.Headers.Add(ACC_KEY_HEADER, accKey);
  webRequest.Headers.Add(TIME_STAMP_HEADER, timeStamp);
  webRequest.Headers.Add(SIGNATURE_HEADER, signature);
  WebResponse webResponse = webRequest.GetResponse();

  string json;
  using (Stream stream = webResponse.GetResponseStream())
  {
    using (StreamReader streamReader = new StreamReader(stream))
    {
      json = streamReader.ReadToEnd();
    }
  }
  return json;
}
```

Execute a basket

```
public static string PostOrders(string accKey, string encKey, string basketId)
{
  string timeStamp = DateTime.UtcNow.ToString("yyyy-MM-ddTHH:mm:ssZ");
  string signature = CreateHMACSig(accKey, encKey, timeStamp);
  Uri uri = new Uri(URI_ENDPOINT+"orders"+"?id="+basketId+"&type=baskets&action=run");
  WebRequest webRequest = WebRequest.Create(uri);
  webRequest.Method = "POST";
  webRequest.Headers.Add(ACC_KEY_HEADER, accKey);
  webRequest.Headers.Add(TIME_STAMP_HEADER, timeStamp);
  webRequest.Headers.Add(SIGNATURE_HEADER, signature);
  webRequest.ContentLength = 0;
  WebResponse webResponse = webRequest.GetResponse();

  string json;
  using (Stream stream = webResponse.GetResponseStream())
  {
    using (StreamReader streamReader = new StreamReader(stream))
    {
      json = streamReader.ReadToEnd();
    }
  }
  return json;
}
```

Get order status

```
public static string GetOrderStatus(string accKey, string encKey, string orderId)
{
  string timeStamp = DateTime.UtcNow.ToString("yyyy-MM-ddTHH:mm:ssZ");
  string signature = CreateHMACSig(accKey, encKey, timeStamp);
  Uri uri = new Uri(URI_ENDPOINT + "orders/" + orderId);
  WebRequest webRequest = WebRequest.Create(uri);
  webRequest.Method = "GET";
  webRequest.Headers.Add(ACC_KEY_HEADER, accKey);
  webRequest.Headers.Add(TIME_STAMP_HEADER, timeStamp);
  webRequest.Headers.Add(SIGNATURE_HEADER, signature);
  WebResponse webResponse = webRequest.GetResponse();

  string json;
  using (Stream stream = webResponse.GetResponseStream())
  {
    using (StreamReader streamReader = new StreamReader(stream))
    {
      json = streamReader.ReadToEnd();
    }
  }
  return json;
}
```

Get output file

```
public static Stream GetOrderStream(string accKey, string encKey, string basketId)
{
  string timeStamp = DateTime.UtcNow.ToString("yyyy-MM-ddTHH:mm:ssZ");
  string signature = CreateHMACSig(accKey, encKey, timeStamp);
  Uri uri = new Uri(URI_ENDPOINT + "orders"+ "?id=" + basketId + "&type=baskets");
  WebRequest webRequest = WebRequest.Create(uri);
  webRequest.Method = "GET";
  webRequest.Headers.Add(ACC_KEY_HEADER, accKey);
  webRequest.Headers.Add(TIME_STAMP_HEADER, timeStamp);
  webRequest.Headers.Add(SIGNATURE_HEADER, signature);
  WebResponse webResponse = webRequest.GetResponse();

  Stream stream = webResponse.GetResponseStream();
  return stream;
}
```

Appendix 5: Examples in Java

Necessary libraries

```
import java.io.BufferedReader;
import java.io.DataOutputStream;
import java.io.File;
import java.io.FileOutputStream;
import java.io.InputStream;
import java.io.InputStreamReader;
import java.io.OutputStream;
import java.net.HttpURLConnection;
import java.net.URL;
import java.nio.file.Path;
import java.nio.file.StandardCopyOption;
import java.time.ZoneOffset;
import java.time.ZonedDateTime;
import java.util.concurrent.TimeUnit;
import java.util.stream.Stream;
import javax.crypto.Mac;
import javax.crypto.spec.SecretKeySpec;
import com.google.gson.Gson;
```

Main program

```
public static void main(String[] args) throws Exception
{
  String DeskTopLocation = System.getProperty("user.home") + "/Desktop".toString();
  String OrderID = "XXXXX";
  String FileName = "XXXXX";

  GetBaskets(ACC_KEY, ENC_KEY);
  TimeUnit.SECONDS.sleep(1);
  Gson gson = new Gson();
  String postResult = PostOrders(ACC_KEY, ENC_KEY, OrderID);
  PostOrders postOrders = gson.fromJson(postResult, PostOrders.class);
  System.out.println(postOrders.orderId);
  PostOrders orderStatus;
  boolean orderCompleted = false;
  while(!orderCompleted)
  {
    TimeUnit.SECONDS.sleep(1);
    String getOrdersResult = GetOrderStatus(ACC_KEY, ENC_KEY, postOrders.orderId);
    orderStatus = gson.fromJson(getOrdersResult, PostOrders.class);
    if(orderStatus.dateFinished != null)
    {
      orderCompleted = true;
    }
  }
  TimeUnit.SECONDS.sleep(1);
  InputStream orderStream = GetOrderStream(ACC_KEY, ENC_KEY, OrderID);
  File targetFile = new File(DeskTopLocation + "\\" + FileName);
  java.nio.file.Files.copy(orderStream,targetFile.toPath(),StandardCopyOption.REPLACE_EXISTING);
}
```

Create signature

```
public static String CreateHMACSig(String accKey, String encKey, String timestamp)
throws Exception
{
  byte[] hmacData = null;
  String signature = ""
  String combinedKey = accKey + timeStamp;
  // Create a new key from the encryption key parameter.
  SecretKeySpec secretKey = new SecretKeySpec(encKey.getBytes("UTF-8"), "HmacSHA256");
  // Create a new HMAC SHA-256 Mac instance.
  Mac mac = Mac.getInstance("HmacSHA256");
  // Initialize this Mac instance with the secret key.
  mac.init(secretKey);
  // Compute the digest of this MAC on the bytes specified.
  hmacData = mac.doFinal(combinedKey.getBytes("UTF-8"));
  // Take one byte at a time from the array, convert to hex, append to sig string.
  for(byte b : hmacData){
    signature += String.format("%02X", b);
  }
  return signature;
}
```

Retrieve a basket

```
public static void GetBaskets(String accKey, String encKey) throws Exception
{
  String timeStamp = ZonedDateTime.now(ZoneOffset.UTC).toString();
  String signature = CreateHMACSig(accKey, encKey, timeStamp);
  URL url = new URL(URI_ENDPOINT + "baskets");
  HttpURLConnection httpConnection = (HttpURLConnection) url.openConnection();
  httpConnection.setRequestMethod("GET");
  httpConnection.setRequestProperty(ACC_KEY_HEADER, accKey);
  httpConnection.setRequestProperty(TIME_STAMP_HEADER, timeStamp);
  httpConnection.setRequestProperty(SIGNATURE_HEADER, signature);

  try
  {
    // Create a buffer for reading off the HTTP input stream.
    BufferedReader inputBuffet = new BufferedReader(new InputStreamReader(httpConnection.getInputStream()));
    String responseData = "";
    String inputLine;
    // Read one line at a time from the buffer and add it to the response string.
    while((inputLine = inputBuffet.readLine()) != null)
    {
      responseData += inputLine;
    }
    inputBuffet.close();
    // Print response data from API.
    System.out.println(responseData.toString());
  }
  catch(Exception ex)
  {
    System.out.println(ex.toString());
  }
}
```

Execute a basket

```
public static String PostOrders(String accKey, String encKey, String basketId)
throws Exception
{
  String timeStamp = ZonedDateTime.now(ZoneOffset.UTC).toString();
  String signature = CreateHMACSig(accKey, encKey, timeStamp);
  URL url = new URL(URI_ENDPOINT+"orders"+"?id="+basketId+"&type=baskets&action=run");
  HttpURLConnection httpConnection = (HttpURLConnection) url.openConnection();
  httpConnection.setRequestMethod("POST");
  httpConnection.setRequestProperty(ACC_KEY_HEADER, accKey);
  httpConnection.setRequestProperty(TIME_STAMP_HEADER, timeStamp);
  httpConnection.setRequestProperty(SIGNATURE_HEADER, signature);

  httpConnection.setRequestProperty("Content-Length", "0");
  httpConnection.setDoOutput(true);
  byte[] data = {};
  DataOutputStream wr = new DataOutputStream( httpConnection.getOutputStream());
  wr.write( data );
  wr.flush();

  try
  {
    BufferedReader inputBuffet = new BufferedReader(
      new InputStreamReader(httpConnection.getInputStream()));
    String responseData = "";
    String inputLine;

    while((inputLine = inputBuffet.readLine()) != null)
    {
      responseData += inputLine;
    }
    inputBuffet.close();
    System.out.println(responseData.toString());
    return responseData.toString();
  }
  catch(Exception ex)
  {
    System.out.println(ex.toString());
    return ex.toString();
  }
}
```

Get order status

```
public static String GetOrderStatus(String accKey, String encKey, String orderID)
throws Exception
{
  String timeStamp = ZonedDateTime.now(ZoneOffset.UTC).toString();
  String signature = CreateHMACSig(accKey, encKey, timeStamp);
  URL url = new URL(URI_ENDPOINT + "orders/" + orderID);
  HttpURLConnection httpConnection = (HttpURLConnection) url.openConnection();
  httpConnection.setRequestMethod("GET");
  httpConnection.setRequestProperty(ACC_KEY_HEADER, accKey);
  httpConnection.setRequestProperty(TIME_STAMP_HEADER, timeStamp);
  httpConnection.setRequestProperty(SIGNATURE_HEADER, signature);

  try
  {
    BufferedReader inputBuffet = new BufferedReader(
     new InputStreamReader(httpConnection.getInputStream()));
    String responseData = "";
    String inputLine;
    while((inputLine = inputBuffet.readLine()) != null)
    {
      responseData += inputLine;
    }
    inputBuffet.close();
    System.out.println(responseData.toString());
    return responseData.toString();
  }
  catch(Exception ex)
  {
    System.out.println(ex.toString());
    return ex.toString();
  }
}
```

Get output file

```
public static InputStream GetOrderStream(String accKey, String encKey, String basketId)
throws Exception
{
  String timeStamp = ZonedDateTime.now(ZoneOffset.UTC).toString();
  String signature = CreateHMACSig(accKey, encKey, timeStamp);
  URL url = new URL(URI_ENDPOINT + "orders"+ "?id=" + basketId + "&type=baskets");
  HttpURLConnection httpConnection = (HttpURLConnection) url.openConnection();
  httpConnection.setRequestMethod("GET");
  httpConnection.setRequestProperty(ACC_KEY_HEADER, accKey);
  httpConnection.setRequestProperty(TIME_STAMP_HEADER, timeStamp);
  httpConnection.setRequestProperty(SIGNATURE_HEADER, signature);

  try
  {
    InputStream stream = httpConnection.getInputStream();
    return stream;
  }
  catch(Exception ex)
  {
    System.out.println(ex.toString());
    InputStream emptyStream = null;
    return emptyStream;
  }
}
```

Appendix 6: Examples in Python

Note: Unlike most programming languages, Python is sensitive to whitespace, and the line breaks in these code samples have been distorted for clarity.

Necessary libraries

```
import requests
import hashlib
import hmac
import datetime
import json
import pandas as pd
from time import sleep
```

API wrapper function

```
#####
# Function: Make API request, including a freshly generated signature.
#
# Arguments:
# 1. Part of the endpoint, i.e., the URL after "https://api.economy.com/data/v1/"
# 2. Your access key.
# 3. Your personal encryption key.
# 4. Optional: default GET, but specify POST when requesting action from the API.
#
# Returns:
# HTTP response object.
def api_call(apiCommand, accKey, encKey, call_type="GET"):
  url = "https://api.economy.com/data/v1/" + apiCommand
  timeStamp = datetime.datetime.strftime(
    datetime.datetime.utcnow(), "%Y-%m-%dT%H:%M:%SZ")
  payload = bytes(accKey + timeStamp, "utf-8")
  signature = hmac.new(bytes(encKey, "utf-8"), payload, digestmod=hashlib.sha256)
  head = {"AccKeyId":accKey,
          "Signature":signature.hexdigest(),
          "TimeStamp":timeStamp}
  sleep(1)
  if call_type == "POST":
    response = requests.post(url, headers=head)
  elif call_type =="DELETE":
    response = requests.delete(url, headers=head)
  else:
    response = requests.get(url, headers=head)

  return(response)
```

Retrieve a basket

```
#####
# Setup:
# 1. Store your access key, encryption key, and basket name.
# Get your keys at:
# https://www.economy.com/myeconomy/api-key-info
ENC_KEY = "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX"
ACC_KEY = "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX"
BASKET_NAME = "Test Basket"

#####
# Identify a basket to execute:
# 2. Get list of baskets.
# 3. Extract the basket with a given name, and save its ID for later.
baskets = pd.DataFrame(json.loads(api_call("baskets/", ACC_KEY, ENC_KEY).text))
basketId = baskets.loc[baskets["name"]==BASKET_NAME, "basketId"].item()
print("Basket ID: " + basketId)
print("Basket Name: " + BASKET_NAME)

# 4. Execute a particular basket using its ID.
# This requires that the optional argument "type" be set to "POST".
call = ("orders?type=baskets&action=run&id=" + basketId)
order = api_call(call, ACC_KEY, ENC_KEY, call_type="POST")
orderId = order.text[12:48]
print("Order ID: " + orderId)

#####
# Download the output:
# 5. Periodically check if the order has completed.
if order.status_code != 200:
  sleep(3)
  print("Failed! Status Code: "+ str(order.status_code))
else:
  sleep(3)
  print("Successful Order! Status Code: " + str(order.status_code))

# 6. Download completed output.
new_call = ("orders?type=baskets&id=" + basketId)
get_basket = api_call(new_call, ACC_KEY, ENC_KEY)
get_basket = (str(get_basket.content).split("\\r\\n"))

# 7. Format the data frame.
data_df= pd.DataFrame(get_basket)
data_df = data_df[0].str.split(',', expand=True)
headers = data_df.iloc[0]
headers[0] = "Mnemonic"
data_df.columns = headers
data_df = data_df.set_index(data_df["Mnemonic"])
data_df = data_df[:-1]
data_df.dropna(axis=1, how='all')
filter = data_df != ""
data_df = data_df[filter]

# 8. Summary of the data frame.
num_rows = str(len(data_df.index))
num_columns = str(len(data_df.columns))
print("Ready to use "+ BASKET_NAME + " DataFrame!")
print("DataFrame contains: " + num_columns + " columns & " + num_rows + " rows")
```

Appendix 7: Examples in R

Necessary libraries

```
library(digest)
library(jsonlite)
library(httr)
```

API wrapper function

```
#####
# Function: Make API request, including a freshly generated signature.
#
# Arguments:
# 1. Part of the endpoint, i.e., the URL after "https://api.economy.com/data/v1/"
# 2. Your access key.
# 3. Your personal encryption key.
# 4. Optional: default GET, but specify POST when requesting action from the API.
#
# Returns:
# httr content object
api.call <- function(apiCommand, accKey, encKey, type="GET"){
  url <- paste("https://api.economy.com/data/v1/", apiCommand, sep="")
  print(url)
  timeStamp <- format(as.POSIXct(Sys.time()), "%Y-%m-%dT%H:%M:%SZ", tz="UTC")
  hashMsg   <- paste(accKey, timeStamp, sep="")
  signature <- hmac(encKey, hashMsg, "sha256")

  Sys.sleep(1)
  if (type == "POST") {
    req <- httr::POST(url, httr::add_headers("AccKeyId" = accKey,
                                             "Signature" = signature,
                                             "TimeStamp" = timeStamp))
  } else {
    req <- httr::GET(url, httr::add_headers("AccKeyId" = accKey,
                                            "Signature" = signature,
                                            "TimeStamp" = timeStamp))
  }
  return(req)
}
```

Retrieve a basket

```
#####
# Setup:
# 1. Store your access key, encryption key, and basket name.
# Get your keys at:
# https://www.economy.com/myeconomy/api-key-info
ACC_KEY     <- "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX"
ENC_KEY     <- "XXXXXXXX-XXXX-XXXX-XXXX-XXXXXXXXXXXX"
BASKET_NAME <- "Test basket"

#####
# Identify a basket to execute:
# 2. Get list of baskets.
# 3. Extract the basket with a given name, and save its ID for later.
baskets.json <- api.call("baskets/", ACC_KEY, ENC_KEY)
baskets      <- fromJSON(httr::content(baskets.json, as="text"))
basketID     <- baskets$basketId[baskets$name==BASKET_NAME]

# 4. Execute a particular basket using its ID.
# This requires that the optional argument "type" be set to "POST".
call    <- paste("orders?type=baskets&action=run&id=", basketID, sep="")
order   <- api.call(call, ACC_KEY, ENC_KEY, type="POST")
orderID <- fromJSON(httr::content(order, as="text"))$orderId

#####
# Download the output:
# 5. Periodically check if the order has completed.
call <- paste("orders/", orderID, sep="")
processing.check <- TRUE
while(processing.check) {
  status <- api.call(call, ACC_KEY, ENC_KEY)
  processing.check <- fromJSON(httr::content(status, as="text"))$processing
  Sys.sleep(10)
}
rm(status)

# 6. Download completed output.
call    <- paste("orders?type=baskets&id=", basketID, sep="")
request <- api.call(call, ACC_KEY, ENC_KEY)

# 7. This works for CSV baskets:
cat(httr::content(request, as="text", type="text/html", encoding="UTF-8"),
    file="basket.data", sep="\n")
df_data <- as.data.frame(read.csv("basket.data"))

# 8. View the data.
View(df_data)

# 9. Clean up.
unlink("basket.data")
rm(ACC_KEY, ENC_KEY)
rm(baskets, basketID, baskets.json)
rm(order, orderID)
rm(processing.check, call, request)
```

Further reading

API documentation and functionality

- API key management
- Technical user guide
- How to authenticate
- Code samples in C#, Java, Python, R

Background on Data Buffet

- Using Data Buffet: Which series can you download?
- Using Data Buffet: Basket wild card expressions
- Using Data Buffet: Basket fields
- Using Data Buffet: Basket formulas
- Using Data Buffet: Transformations
- Using Data Buffet: Dates in basket output
- Using Data Buffet: Automatic retrieval
- Using Power Tools: Introduction to v.8

Glossary

access key: Part of the credentials used to access the Data Buffet API. A unique 36-character hexadecimal string, which is combined with the encryption key (qv) to produce the signature (qv).

API: Application programming interface. Generically, a set of function signatures (input and output parameters) to perform documented behavior. See also: web API (qv).

AutoCycle: See: Moody's AutoCycle™ (qv).

basket: A facility of Data Buffet (qv). A basket consists of a list of time series (qv) mnemonics (qv) (or other expressions that evaluate to time series) and a set of formatting options. When executed, a basket retrieves the specified date range of the specified series, and specified metadata (qv) thereof, and emits an output file (qv) in the specified file format and layout. Analogous to a shopping list.

basket formula: An expression in a Data Buffet basket (qv) that operates on one or more native time series (qv) to synthesize a time series. May contain arithmetic, frequency conversion (qv) and/or transformation (qv) operations.

basket output file: A file emitted by the Data Buffet basket (qv) facility that contains the values of the specified series at a particular moment, in a particular specified format. When executed manually on Data Buffet, the output file is immediately delivered through the web browser; a basket can also be executed automatically by a periodic or triggered schedule. In both cases, a copy of the output file is cached on the user's account. The Data Buffet API (qv) enables access to basket output in JSON (qv) format.

Coordinated Universal Time: A civil time standard based on atomic clocks and astronomical measurements, and an associated representation using a 24-hour clock that includes year, month, day, hour, minute and second, and fixed punctuation. The format is `yyyy-mm-ddThh:mm:ssZ`, for example, `2018-07-30T21:03:28Z`. This format is used when making requests to the Data Buffet API (qv). A.k.a. universal coordinated time, universal time coordinated, UTC.

cURL: Client for URLs. An open-source command-line software application to demonstrate HTTP (qv) requests and responses. Its syntax is often used to concisely document the behavior of web APIs (qv). See: curl.haxx.se

CreditCycle: see: Moody's CreditCycle™ (qv).

CSV: Comma-Separated Value. A file format that consists of plain text, where fields are separated by comma characters, and records are separated by line breaks.

Data Buffet: A web-based product of Moody's Analytics that contains a repository of economic and demographic time series (qv), organization mechanisms, and associated search, automatic retrieval, and visualization mechanisms, including baskets (qv). The database systems are shared between CreditForecast.com, DataBuffet.com, and other web products, and provide a back-end to Power Tools (qv) and the Data Buffet API (qv).

Data Buffet API: A web-based API (qv) that can access (a) the time series in Data Buffet (qv), and (b) baskets (qv) stored on a user's

Data Buffet account.

E-model: A product of Moody's Analytics. A web-based tool that allows users to run scenarios with their own assumptions.

encryption key: Part of the credentials used to access the Data Buffet API. A unique 36-character hexadecimal string, which is combined with the access key (qv) to produce the signature (qv).

end point: In a web API (qv), a unique, static URL that represents an object or collection of objects; to interact with these resources, you point an HTTP client (qv) at the endpoint.

frequency: The characteristic fixed interval at which a time series (qv) is measured. Data Buffet (qv) contains time series of frequencies daily (i.e., one measurement per day), weekly, monthly, quarterly, semiannual and annual. Censal data are represented as an annual series with alternating ND values (qv).

frequency conversion: The mathematical translation of a time series (qv) from an input frequency (qv) to a different output frequency. Data Buffet provides GUI controls in its modules, and the CONVERT function for use in basket formulas (qv). Is impacted by the presence of ND values (qv).

GUID: Globally Unique Identifier. GUIDs are used in enterprise software development as database keys, component identifiers, and in COM programming; they are generated by individual users with an algorithm that virtually guarantees uniqueness. A GUID is a 128-bit integer, commonly expressed as a 32-character hexadecimal string delimited by hyphens. In the Data Buffet API, access and encryption keys, and basket and order identifiers, are GUIDs. A.k.a. Universally Unique Identifier, UUID.

HMAC: Hash-based Message Authentication Code. An international software standard (RFC2104 et seq) to verify the integrity of information transmitted over an unreliable medium such as the internet.

HTTP: HyperText Transfer Protocol. An international software standard (RFC2616 et seq) for an application-layer, client-server, stateless protocol for transmitting hypermedia documents and control information. See: https://www.w3.org/Protocols/, https://developer.mozilla.org/en-US/docs/Web/HTTP

HTTP client: Software that can communicate via HTTP (qv) with a server, for example, a web browser, cURL (qv), or a custom application that queries a web API (qv).

JSON: JavaScript Object Notation: An international software standard (ECMA-404), a lightweight data-interchange format that is easy for software to parse and generate, for humans to read and write, and is programming language-independent. JSON is the format in which the Data Buffet API (qv) delivers individual time series (qv) and basket output (qv). See: www.json.org.

MIME: Multipurpose Internet Mail Extension. An international software standard (RFC2045 et seq) that identifies how a file transmitted over the internet (as by email or HTTP) should be interpreted by the recipient.

metadata: Structured data that describes other data.

mnemonic: In Data Buffet (qv), an alphanumeric string that uniquely identifies a time series (qv). In its simplest form, a basket (qv) is a list of mnemonics.

Moody's Analytics Power Tools for Microsoft Office: A suite of Microsoft Office™ add-ins for Excel, PowerPoint and Word. The add-in for Excel allows direct retrieval of time series (qv) data and metadata into a spreadsheet; for all three applications, visualizations can be retrieved.

Moody's AutoCycle™: A software solution to forecast car prices, incorporating economic data and scenarios from Moody's Analytics. See: https://www.economy.com/products/data/autocycle

Moody's CreditCycle™: A software solution to model consumer credit risk; it combines customer data, economic data from Moody's Analytics, and consumer credit data from Equifax. See: https://www.economy.com/products/consumer-credit-analytics/moodys-creditcycle

ND value: No Data. Each observation (qv) in a time series (qv) on Data Buffet (qv) may be a specific numeric value or the "ND" marker. The specific meaning depends on the dataset, and may include "planned holiday interruption," "unplanned interruption," "value suppressed for confidentiality," "negligible," etc. The presence of ND values will impact the frequency conversion (qv) and transformation (qv) functions.

OAuth: An open software standard (RFC5849 et seq) for services over HTTP to provide "secure delegated access" whereby server owners authorize third-party access without the clients sharing their credentials.

observation: Each numeric measurement in a time series (qv).

output file: See: basket output file (qv).

Power Tools: See: Moody's Analytics Power Tools for Microsoft Office (qv).

rate limiting: With a web API (qv), a policy that controls how many requests from a given user will be processed per unit of time, typically for billing purposes or to promote adequate performance for all users.

SHA256: Secure Hash Algorithm. A cryptographic hash function that produces a 256-bit (32-byte) output.

signature: A cryptographic string generated from the access key (qv), encryption key (qv), and a time stamp and transmitted to a web API (qv) that uses HMAC (qv) authentication. See also: SHA256 (qv).

throttling: See: rate limiting.

time series: Generically, a vector of measurements (observations [qv]) at periodic intervals. In Data Buffet (qv), a data object that contains numeric values, metadata (qv) fields that explain how to interpret (frequency [qv] , etc.) and identify it (description, source), and one or more identifying mnemonics (qv).

transformation: In Data Buffet (qv), a mathematical translation of a time series (qv) for analysis. Transformations are provided by GUI controls in each module or can be expressed explicitly using a basket formula (qv). The main transformations are simple difference, year-over-year difference, percent change, year-over-year percent change, and annualized growth rate.

UTC: See: Coordinated Universal Time (qv).

web API: A programmatic, server-side interface consisting of one or more endpoints (qv), typically expressed in JSON (qv) or XML, and exposed to the web, typically by an HTTP server.

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