



Hypermedia

The Good, the Bad, & the Ugly

by mike stowe

Disclaimer

This talk isn't designed to be a "here's the solution," but rather to take a look at where we're at, and where we need to go. How to get there, is most likely, up to you.

About Me

- API Fanatic
- Open Source Contributor
- Author, Speaker, Consultant
- 10+ years hacking Professional Code
- Dev Relations Manager at MuleSoft

Follow me on Twitter: [@mikegstowe](https://twitter.com/mikegstowe)

Sometimes I feel that “over-engineering” is this disease that is running wild in our industry and as architects we need to be on constant watch to quickly eliminate it whenever encountered.

- Drew Jaegle

Hypermedia is nothing new.

After all, hypertext has been
known to us since 1965
when defined by Ted Nelson

And goes back as far as 1945
when Vannevar Bush thought
of the concept in his article “As
We May Think”

But what exactly is
Hypermedia...

And how does it play into
RESTful APIs...

Hypermedia is...

a method of structuring information in different media for a single user... whereby related items are connected in the same way as a hypertext.

- Oxford English Dictionary

Hypertext literally means
“**beyond**” text...

Hypertext

A hypertext can be experienced in countless different ways, and it allows the reader a level of control over his or her reading experience that isn't possible with a conventional text.

- Kara Schoonmaker, 2007

In other words...

Hypertext

Is text that is **LINK** driven, allowing the client to control the flow and make decisions on what actions to perform next

Hypertext

Hypertext is a computer-supported medium for information in which many interlinked documents are displayed with their links on a high-resolution computer screen.

- Jeffrey Conklin

You might remember these
hypertext/media driven
applications

HYPERSTUDIO®



Sample
Projects



Show Me
How



Sharing
& Showing



Media
Library



Roger's HyperStacks™
PUBLISHING INC.

Welcome!

To discover the new world of multimedia writing you can begin by exploring the sample projects by clicking on the button to the left.



New Stack



Open Stack



Quit

Curr 501:

Instructional Technology

Course Overview

Assignments

About the Instructor

Grading

Course Syllabus

Course Related Links

Credits



Or my personal favorite...



Nicole has dysentery.

Date: June 30, 1848

Weather: hot

Health: poor

Food: 242 pounds

Next landmark: 41 miles

Miles traveled: 948 miles



You have died of dysentery.

The challenge is that this requires a hypertext/
hypermedia client, and an interpreter to understand and choose the next action.

The other challenge is despite
the need for a client and
interpreter, truly RESTful APIs
must rely on hypermedia...

What needs to be done to make the REST architectural style clear on the notion that hypertext is a constraint? In other words, if the engine of application state (and hence the API) is not being driven by hypertext, then it cannot be RESTful and cannot be a REST API. Period. Is there some broken manual somewhere that needs to be fixed?

- Dr. Roy Fielding



MuleSoft // Dev

But before we go any further,
what is this **HATEOAS**?

Representational State Transfer is made up of six primary constraints:

- Client/Server
- Stateless
- Cacheable
- Uniform Interface
- Layered System
- Code on Demand*

Hypermedia plays a role in:

- Client/Server
- Stateless
- Cacheable
- Uniform Interface
- Layered System
- Code on Demand*

Hypermedia plays a role in:

- Client/Server
- Stateless
- Cacheable
- Uniform Interface
- Layered System
- Code on Demand*

Client/ Server

Stateless

Uniform Interface

Code on Demand

To recap – because REST is **STATELESS**, it has to have a way to **REPRESENT** state.

That is the purpose of hypermedia, to act as the engine of state for the application.

Hypermedia Explorer

User

First Name: Michael

Last Name: Stowe

[Edit](#)

[Message](#)

[Suspend](#)

User

First Name: Joe

Last Name: DaSpamor

[Unsuspend](#)

[Delete](#)

User

First Name: Bob

Last Name: Jones

[Edit](#)

[Message](#)

[Suspend](#)

[Delete](#)

To recap – hypermedia also allows for **independence** between the client and the server, allows for a **uniform interface**, and can help with code on demand.

However, true implementation
of REST and hypermedia is still
a work in progress...

Current REST Hypermedia Specs

Collection+JSON

Collection+JSON

- Created by Mike Amundsen in 2011
- Based on Atom Publication/ Syndication Specs
- JSON and Collection based
- Used widely at one time
- Not as popular as JSON API/ HAL

Collection+JSON

```
{ "collection" :  
  {  
    "version" : "1.0",  
    "href" : "http://example.org/friends/",  
  
    "links" : [  
      {"rel" : "feed", "href" : "http://example.org/friends/rss"},  
      {"rel" : "queries", "href" : "http://example.org/friends/?queries"},  
      {"rel" : "template", "href" : "http://example.org/friends/?template"}  
  
    "items" : [  
      {  
        "href" : "http://example.org/friends/jdoe",  
        "data" : [  
          {"name" : "full-name", "value" : "J. Doe", "prompt" : "Full Name"},  
          {"name" : "email", "value" : "jdoe@example.org", "prompt" : "Email"}  
        ],  
        "links" : [  
          {"rel" : "blog", "href" : "http://examples.org/blogs/jdoe", "prompt" : "Blog"},  
          {"rel" : "avatar", "href" : "http://examples.org/images/jdoe", "prompt" : "Avatar", "render" :  
"image"}  
        ]  
      }  
    ]  
  }  
}
```

Collection+JSON

Strengths:

- Great for collections
- Templated queries
- Early wide adoption
- Recognized as a standard

Weaknesses:

- JSON only
- Lack of documentation
- identifier
- More complex for developers to implement



JSON API

JSON API

- Created by Steve Klabnik and Yahuda Katz in 2013
- Designed to ensure separation between client and server while also reducing the number of calls without impacting discoverability
- JSON based
- Not *listed* as stable
- One of the most popular specs

JSON API

```
{  
  "links": {  
    "posts.author": {  
      "href": "http://example.com/people/{posts.author}",  
      "type": "people"  
    },  
    "posts.comments": {  
      "href": "http://example.com/comments/{posts.comments}",  
      "type": "comments"  
    }  
  },  
  "posts": [{  
    "id": "1",  
    "title": "Rails is Omakase",  
    "links": {  
      "author": "9",  
      "comments": [ "5", "12", "17", "20" ]  
    }  
  }]  
}
```

JSON API

Strengths:

- Simple, versatile format
- Easy to read/ implement
- Flat link grouping
- URI templating
- Wide adoption
- Strong community
- Recognized as a Hypermedia standard

Weaknesses:

- JSON only
- Lack of documentation identifier
- Slightly more difficult for clients to interpret
- Still considered a work in progress



HAL

HAL

- Created by Mike Kelly in 2011
- Allows for nesting of links
- Supports JSON and XML
- Incorporates documentation
- One of the most popular specs

HAL

```
{  
  "_links": {  
    "self": { "href": "/orders" },  
    "curies": [{ "name": "ea", "href": "http://example.com/docs/rels/{rel}" }, "templated": true }],  
    "next": { "href": "/orders?page=2" },  
    "ea:find": {  
      "href": "/orders{?id}",  
      "templated": true  
    },  
    "ea:admin": [{  
      "href": "/admins/2",  
      "title": "Fred"  
    }, {  
      "href": "/admins/5",  
      "title": "Kate"  
    }]  
  },  
}
```

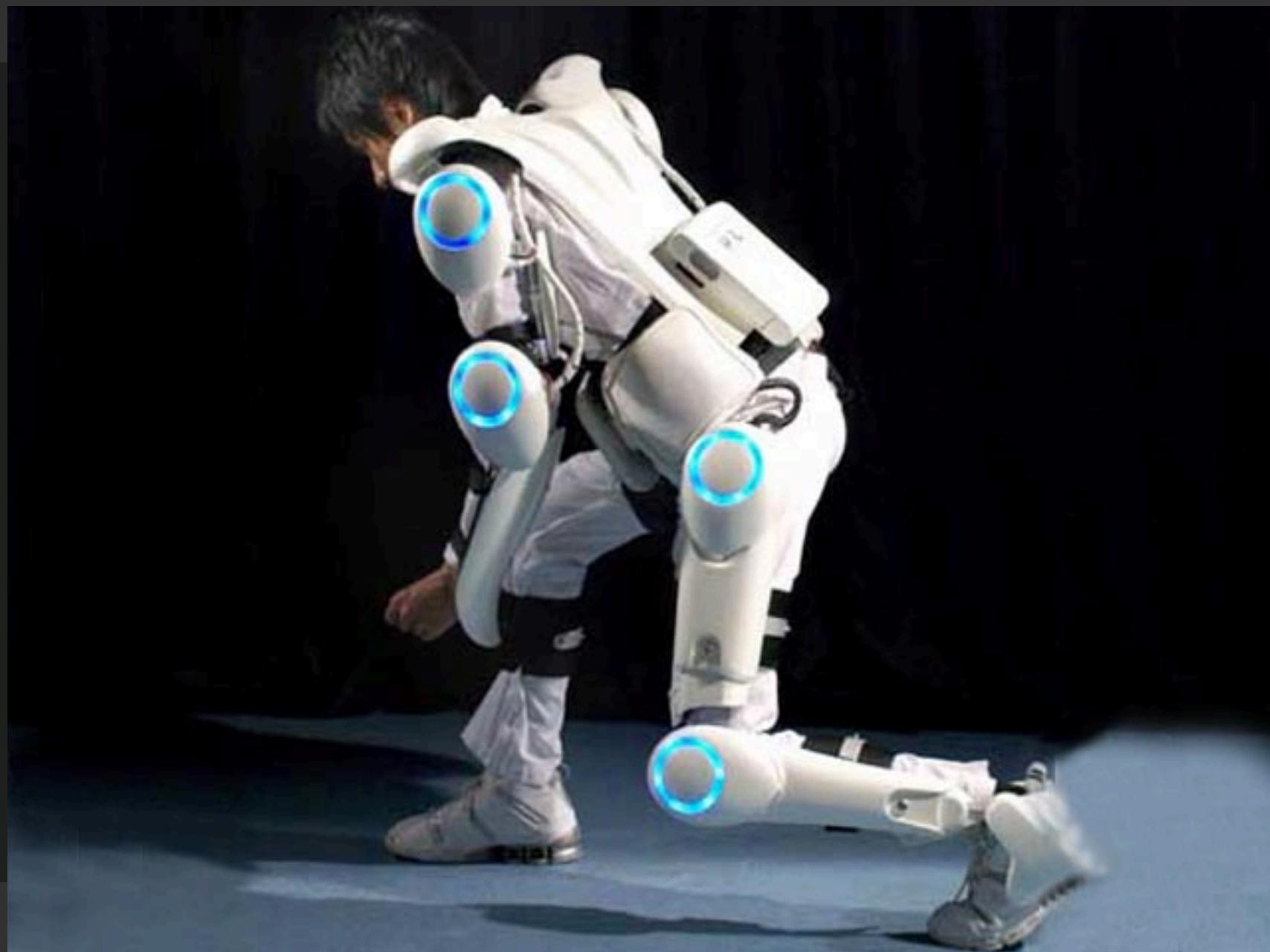
Strengths:

- Dynamic/ Nestable
- Easy to read/ implement
- Multi-format (JSON/XML)
- URI Templating
- Inclusion of documentation
- Wide adoption
- Strong Community
- RFC proposed/ recognized spec

Weaknesses:

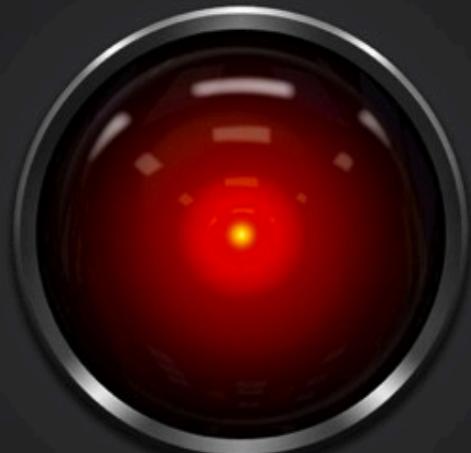
- JSON/XML formats
architecturally different
- CURIES
(documentation) are
tightly coupled

HAL is also...



Not to be confused with...

I think you know what the
problem is just as well as I do



JSON-LD

JSON-LD

- Recognized as a W3C standard in 2014
- Designed as a linking format
- Can be used for both APIs and NoSQL
- Less popular than JSON API / HAL
- Very active community

JSON-LD

```
{  
  "@context": "http://json-ld.org-contexts/person.jsonld",  
  "@id": "http://dbpedia.org/resource/John_Lennon",  
  "name": "John Lennon",  
  "born": "1940-10-09",  
  "spouse": "http://dbpedia.org/resource/Cynthia_Lennon"  
}
```

JSON-LD

Strengths:

- Strong format for Data Linking
- Used across multiple formats
- Strong community
- Large working group
- W3C standard

Weaknesses:

- JSON only
- More complex to integrate/ interpret
- No identifier for documentation

I don't have any funny pictures
for this one...

Siren

Siren

- Created by Kevin Swiber in 2012
- Created specifically for Web APIs
- Presents information on classes, entities, actions, and links
- Incorporates methods
- Supports JSON and XML
- Not as popular as JSON API and HAL
- Still a work in progress

Siren

```
{  
  "class": [ "order" ],  
  "properties": {  
    "orderNumber": 42,  
    "itemCount": 3,  
    "status": "pending"  
  },  
  "entities": [  
    {  
      "class": [ "items", "collection" ],  
      "rel": [ "http://x.io/rels/order-items" ],  
      "href": "http://api.x.io/orders/42/items"  
    },  
    {  
      "class": [ "info", "customer" ],  
      "rel": [ "http://x.io/rels/customer" ],  
      "properties": {  
        "customerId": "pj123",  
        "name": "Peter Joseph"  
      },  
      "links": [  
        { "rel": [ "self" ], "href": "http://api.x.io/customers/pj123" }  
      ]  
    }  
  ],
```

Siren

```
"actions": [
  {
    "name": "add-item",
    "title": "Add Item",
    "method": "POST",
    "href": "http://api.x.io/orders/42/items",
    "type": "application/x-www-form-urlencoded",
    "fields": [
      { "name": "orderNumber", "type": "hidden", "value": "42" },
      { "name": "productCode", "type": "text" },
      { "name": "quantity", "type": "number" }
    ]
  }
],
"links": [
  { "rel": [ "self" ], "href": "http://api.x.io/orders/42" },
  { "rel": [ "previous" ], "href": "http://api.x.io/orders/41" },
  { "rel": [ "next" ], "href": "http://api.x.io/orders/43" }
]
```

Siren

Strengths:

- Provides a more verbose spec
- Query templating
- Incorporates Actions
- Multi-format**

Weaknesses:

- Poor adoption
- Lacks documentation
- Work in progress

CPHL

- Created by me in 2014
- Considered a “brain storming” document
- Multi-format with architectural consistency
- Action driven verses Resource driven
- Incorporates API definition specs (RAML/ Swagger)
- Allows for documentation and Code on Demand
- Not widely adopted or used
- Not considered stable

Provides Strict Naming:

- **self**: self provides a namespace for links to docs and code related to the exact call the client is on
- **create**: Create a new record via the POST method (equivalent to self::POST)
- **read**: retrieve an item or collection via GET (equivalent to self::GET)
- **update**: utilization of the put/ patch methods to update an item, or all items in a collection* (self::PUT)
- **delete**: deletes the item or the collection* (equivalent to self::DELETE)
- **search**: the resource to perform a search on a collection
- **first**: links to the first record in a collection
- **beginning**: links to the first set of records in a paginated result
- **prev**: links to the previous set of records in a paginated result
- **next**: links to the next set of records in a paginated result
- **last**: links to the last record of a paginated result
- **end**: links to the last set of records in a paginated result
- **base**: links back to the starting point of a hypermedia API



CPHL

```
{  
  "_definition": {  
    "raml": "http://api.domain.com/docs/api/raml",  
    "swagger": "http://api.domain.com/docs/api/swagger"  
  },  
  "_links": {  
    "update": {  
      "title": "Edit User",  
      "description": "edit the user",  
      "href": "/api/resource",  
      "methods": [  
        "put",  
        "patch"  
      ],  
      "formats": {  
        "json": {  
          "mimeType": "application/json",  
          "schema": "http://api.domain.com/docs/api/editSchema.json"  
        },  
        "xml": {  
          "mimeType": "text/xml",  
          "schema": "http://api.domain.com/docs/api/editSchema.xml"  
        }  
      },  
    },  
  },  
}
```



```
"docHref": "http://api.domain.com/docs/edit",
    "code": {
        "php": {
            "href": "http://code.domain.com/phplib/edit.tgz",
            "md5": "0cc175b9c0f1b6a831c399e269772661",
            "recordSpecific": false
        },
        "java": {
            "href": "http://code.domain.com/javalib/edit.tgz",
            "md5": "0cc175b9c0f1b6a831c399e269772661",
            "recordSpecific": false
        },
        "ruby": {
            "href": "http://code.domain.com/rubylib/edit.tgz",
            "md5": "0cc175b9c0f1b6a831c399e269772661",
            "recordSpecific": false
        }
    }
}
```

Strengths:

- Cross-platform (XML, JSON, YAML) architectural consistency
- Incorporates documentation, methods, and code on demand
- Provides strict name templating for common actions

Weaknesses:

- Poor adoption
- Not heavily tested/ supported
- Can become bloated/ overly verbose
- Not stable – brain storming document

Hypermedia Challenges

Nobody knows how to use
hypermedia...

Developers won't utilize
hypermedia in their clients...

A good API shouldn't change...

Hypermedia doesn't solve
versioning...

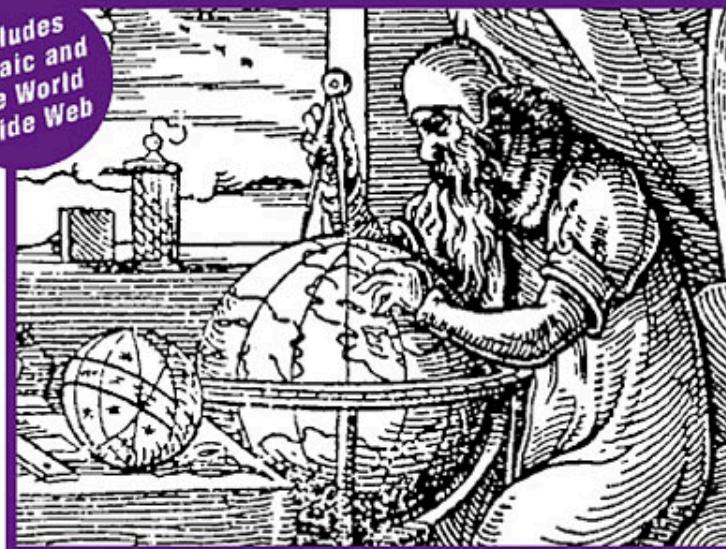
Hypermedia doesn't replace documentation...

SECOND EDITION

Over 450,000
copies sold!

THE WHOLE INTERNET

Includes
Mosaic and
the World
Wide Web



USER'S GUIDE & CATALOG

O'REILLY®

ED KROL

Hypermedia destroys resource
location...

Hypermedia makes sense for
humans, but not machines...

Isn't hypermedia just WSDL/
WADL?

We haven't figured out a good
way to represent hypermedia in
APIs...

Hypermedia on the line

We have to remember we use
Hypermedia every single day...

Webpages are rendered from
HTML - the Hypertext Markup
Language

Users are able to navigate through “interfaces” at their leisure and command:

Search Web

My Yahoo



Hi, Mike S



Mail

- Mail
 - News
 - Sports
 - Finance
 - Weather
 - Autos
 - Homes
 - Dating
 - Shopping
 - Makers
 - Parenting
 - Health
 - Style
 - Beauty
 - Food
 - Movies
 - Travel
 - Tech
 - TV
- More Yahoo Sites >



**YOU COULD SAVE
AN AVERAGE OF OVER
\$548**
when you switch to Progressive

Zip Code **GET A QUOTE**

PROGRESSIVE®

Close Ad X

[Ad Feedback](#) - [AdChoices](#)

Take a bow, America: What every state is best at

Fewest accidental deaths, longest cat lifespans, most polite: Each state is special in its own way. [See how where you live ranks »](#)

1 – 5 of 110



Army helicopter Sen. Cornyn on What every state Ireland error Modeling: 'Tide is

Trending Now

- | | |
|--------------------------------------|-------------------------------------|
| 1 Stassi Schroeder | 6 Angie Stone |
| 2 Michael Vick | 7 Samsung Galaxy S6 |
| 3 Joanna Jedrzejczyk | 8 Sarah Stage |
| 4 Amber Rose | 9 Honda Accord |
| 5 Mortgage rates | 10 Bella Twins |

[Live concert](#) [Memphis May Fire »](#)

9:10 PM

Only on Yahoo



[@thefatjewish: The King of Instagram](#)
[Katie Couric, Global News Anchor, Yahoo News](#)

Search Web

My Yahoo



Hi, Mike S



Mail



**YOU COULD SAVE
AN AVERAGE OF OVER
\$548**
when you switch to Progressive

Zip Code

GET A QUOTE

PROGRESSIVE®

Close Ad

Ad Feedback AdChoices

Take a bow, America: What every state is best at

Fewest accidental deaths, longest cat lifespans, most polite: Each state is special in its own way [See how where you live ranks »](#)

1 – 5 of 110



Army helicopter



Sen. Cornyn on



What every state



Ireland error



Modeling 'Tide is

Trending Now

- | | |
|--------------------------------------|-------------------------------------|
| 1 Stassi Schroeder | 6 Angie Stone |
| 2 Michael Vick | 7 Samsung Galaxy S6 |
| 3 Joanna Jedrzejczyk | 8 Sarah Stage |
| 4 Amber Rose | 9 Honda Accord |
| 5 Mortgage rates | 10 Bella Twins |

[Live concert](#) [Memphis May Fire »](#)

9:10 PM

Only on Yahoo



@thefatiewish: The King of Instagram

Katie Couric, Global News Anchor, Yahoo News



Enter city or zip code

Search Weather

Search Web

Michael

Mail



Detect my location

My Locations

[Click + to save cities](#)

Edit

Around the World

New York

Los Angeles

Chicago

Houston

Philadelphia

San Francisco

London

Paris

Venice



Hapeville



Is this your current location? Yes | No, detect again

GA, United States

Mostly cloudy

↑73° ↓56°

65°

Forecast

Monthly Trends

Temperature Precipitation

Challenges of **HTML** style Hypermedia in APIs

The Yahoo HTML interface
requires **human interaction**, and
not all APIs want to require
this...

A **machine** can follow the links,
but not necessarily understand
them...

HTML presents a **visual** order,
not a **logical** order...

The question is, what can we
learn from HTML, and what is
technologically **possible**?

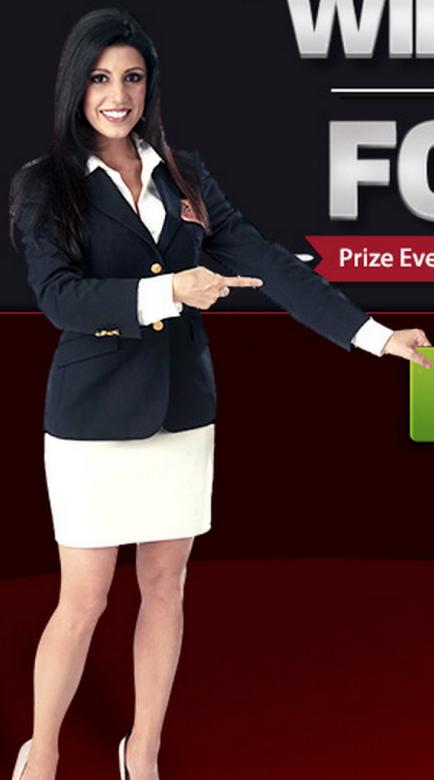
For example, HTML style interfaces can provide guidance towards API **hypertext linking**:

• IMPORTANT PRIZE ALERT! •

Publishers Clearing House

WIN \$7,000.00
a week
FOR LIFE!

Prize Event Winner Announced 4/30 on NBC! 



Enter Now!

Aol.

Username or Email

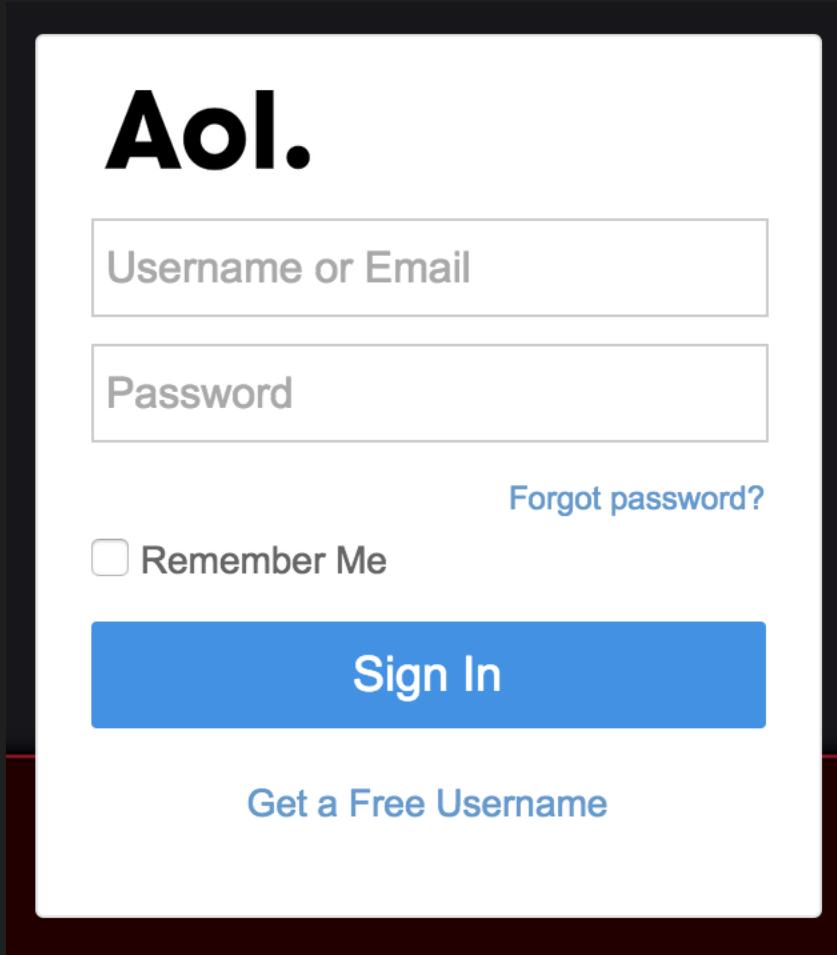
Password

[Forgot password?](#)

Remember Me

Sign In

[Get a Free Username](#)



The image shows the AOL login interface. It features a large "Aol." logo at the top left. Below it are two input fields: "Username or Email" and "Password". To the right of the password field is a "Forgot password?" link. A "Remember Me" checkbox is located below the password field. At the bottom is a large blue "Sign In" button. Below the button is a link to "Get a Free Username".

Aol.

Username or Email

Password

Forgot password?

Remember Me

Sign In

Get a Free Username

/base [get]

/users [get]

/users/resetPassword

/users [post]

HTML also has a **standard**
client and **uniform format**,
something that we do not
currently have for APIs...

In short, when compared to
HTML, REST Hypermedia
specs **fall short**... VERY short.

This is why new specs are
being created... on an ongoing
and **regular basis**

Yahapi

JSON API

HAL

Uber

Mason

Collection+JSON

Siren

CPHL

JSON-LD

And why companies like
PayPal and **Vertical Response**
have created their OWN specs

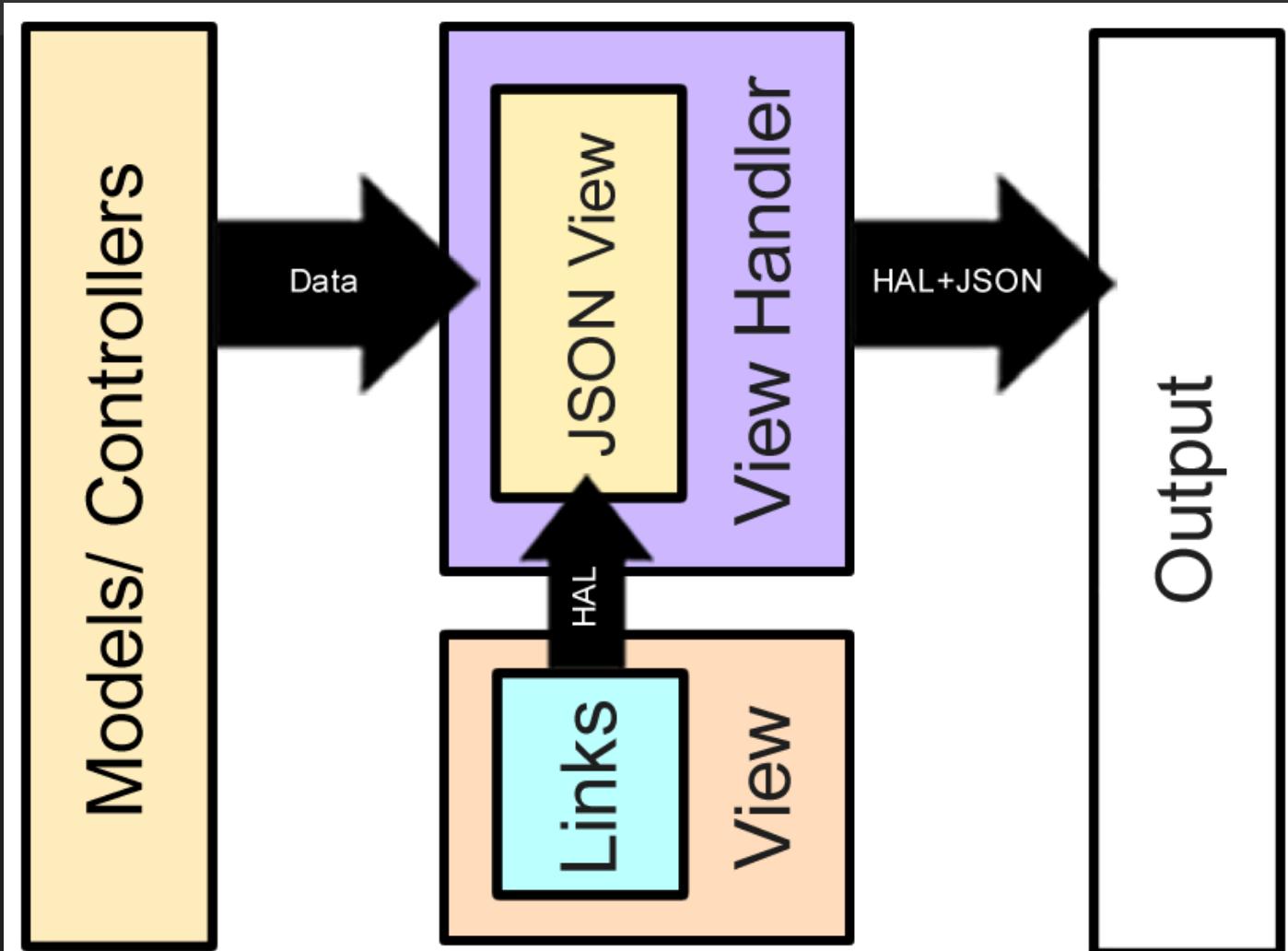
PayPal's Spec

```
"links" : [  
  {  
    "href" : "https://api.sandbox.paypal.com/v1/payments/  
payment/PAY-2XR800907F429382MKEBWOSA",  
    "rel" : "self",  
    "method" : "GET"  
  }, {  
    "href" : "https://api.sandbox.paypal.com/v1/payments/  
payment/PAY-2XR800907F429382MKEBWOSA/execute",  
    "rel" : "update",  
    "method" : "POST"  
  }  
]
```

Vertical Response

```
"links": {  
    "up": {  
        "url": "https://vrapi.verticalresponse.com/api/v1/contacts"  
    },  
    "lists": {  
        "url": "https://vrapi.verticalresponse.com/api/v1/contacts/  
1099513934863/lists"  
    },  
    "messages": {  
        "url": "https://vrapi.verticalresponse.com/api/v1/contacts/  
1099513934863/messages"  
    },  
    "stats": {  
        "url": "https://vrapi.verticalresponse.com/api/v1/contacts/  
1099513934863/stats"  
    }  
}
```

It's also what makes integrating hypermedia into your API so hard...



Sample of Decoupled Data/ Links Views in a MVC Architecture

Future of API Hypermedia

You are the future!

Join the discussion:
Google Group – [Hypermedia Web](#)

Because we don't have the
answer yet...

We need to think outside of the
box....

We need to think beyond
today...

But we also need to be careful,
keeping things **simple**...

We need to remember
machines are getting
smarter....

Hypermedia interpreted by
Artificial Intelligence?



User Modeling

The Watson User Modeling service uses linguistic analytics to extract a spectrum of cognitive and social characteristics from the text data that a person generates through text messages, tweets, posts, and more.

Try the service

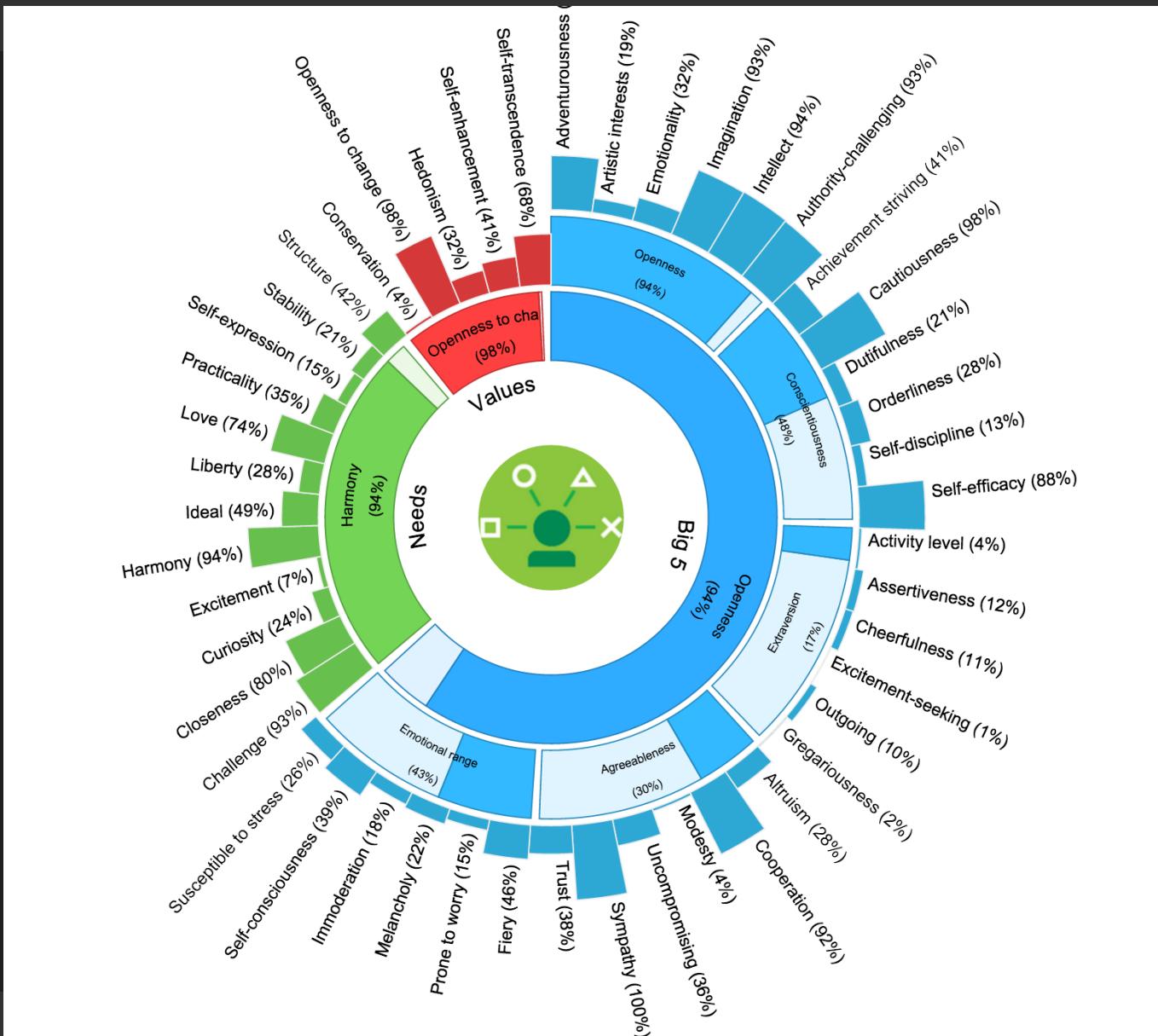
Call me Ishmael. Some years ago—never mind how long precisely—having little or no money in my purse, and nothing particular to interest me on shore, I thought I would sail about a little and see the watery part of the world. It is a way I have of driving off the spleen and regulating the circulation. Whenever I find myself growing grim about the mouth; whenever it is a damp, drizzly November in my soul; whenever I find myself involuntarily pausing before coffin warehouses, and bringing up the rear of every funeral I meet; and especially whenever my hypos get such an upper hand of me, that it requires a strong moral principle to prevent me from deliberately stepping into the street, and methodically knocking people's hats off—then, I account it high time to get to sea as soon as I can. This is my substitute for pistol and ball. With a philosophical flourish Cato throws himself upon his sword; I quietly take to the ship. There is nothing

Clear

Analyze

Output

Big 5	
Openness	94%
Adventurousness	72%
Artistic interests	19%
Emotionality	32%
Imagination	93%
Intellect	94%
Authority-challenging	93%
Conscientiousness	48%
Achievement striving	41%
Cautiousness	98%
Dutifulness	21%
Orderliness	28%
Self-discipline	13%
Self-efficacy	88%
Extraversion	17%
Activity level	4%
Assertiveness	12%
Cheerfulness	11%



This AI 'solves' Super Mario Bros. and other classic NES games

GAMING / 12 APRIL 13 / by IAN STEADMAN

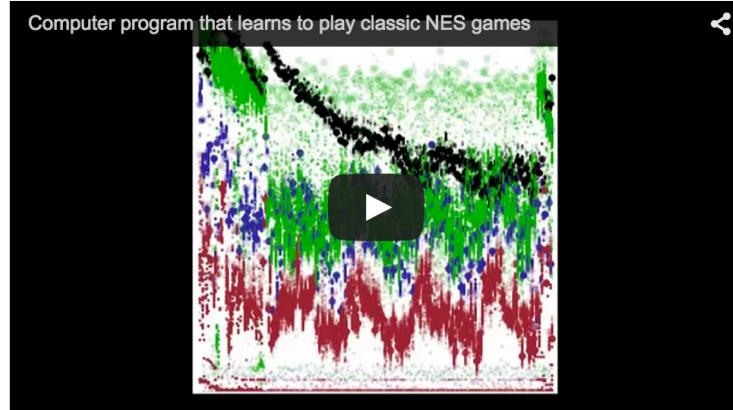


[Twitter Tweet](#) [Facebook Recommend](#) [G+1](#) [LinkedIn Share](#)



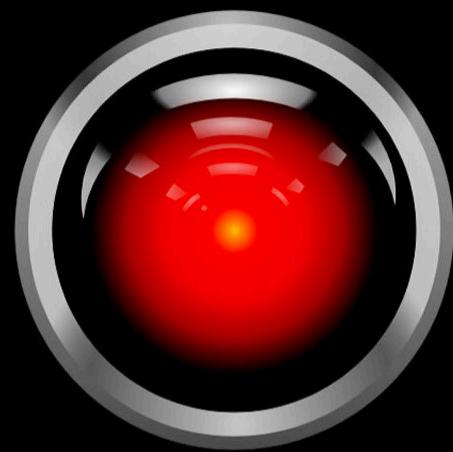
In the 28 years since *Super Mario Bros.* was released it's obviously been comprehensively beaten, thoroughly, many thousands of times in that time by players around the world. But have you ever made the game beat itself?

That's what computer scientist Tom Murphy has done. At SigBovik 2013 he presented a program that "solves" how to play *Super Mario Bros.*, or any other NES game, like it's just another kind of



Computer program that learns to play classic NES games [suckerpinch](#)

So then again... maybe...



HELLO DAVE



Get the Book – and More! Sign up @
<http://champions.mulesoft.com>



@MuleDev
www.mulesoft.com