Writing A Web Extension For Firefox

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This presentation lightly introduces how to write a web extension for the Firefox browser. The purpose of our simple extension is to modify the results of a search engine.

The extension was developed because I was suitably annoyed at search engine results that included tracking mechanisms on the result URLs. These mechanisms first appeared in version 100 of the Firefox browser.

I have no idea why the version of Firefox is relevant to the inclusion or exclusion of tracking mechanisms within search results.

Contents

List of Figures

1 Technologies

Technologies used in this demonstration are:

- Firefox web browser.
- Existing Web Extensions from Mozilla.
- Javascript language.
- Text editor.

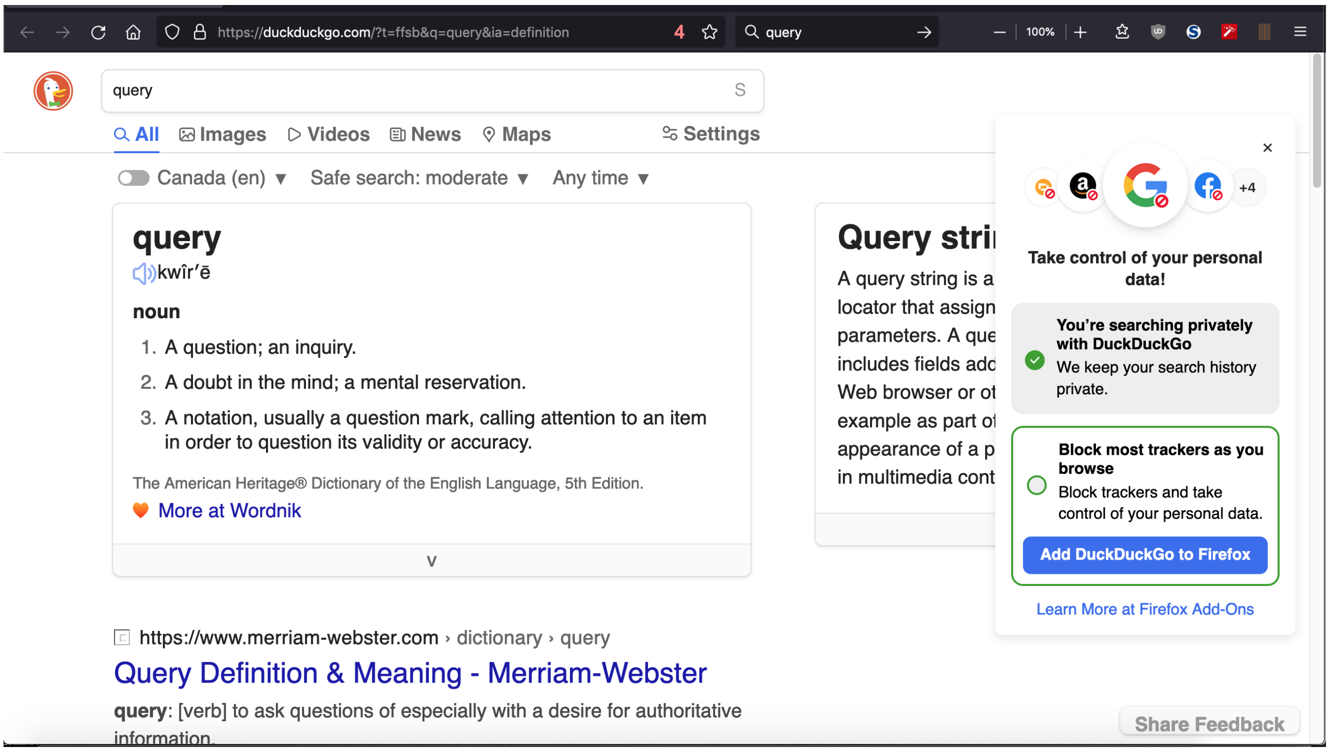
The Chrome browser is ignored because I don't use it.

2 Preamble - My World Wide Web World View

I run most web browsers with client side scripting disabled. That is, Javascript is turned off. I use a web extension called `NoScript` to have a reasonably flexible way to enable Javascript as needed. I also use `uBlock Origin` in its default state for blocking advertisements. I do this because it makes the web less astonishing and more calm. Safer as well, because some downloaded javascript programs can be malicious.

Within this world view, my search engines are also denied Javascript, which can be a challenge. Note that I use Duckduckgo.com as my default search engine.

Figure 1 shows what a DuckDuckGo (DDG) query looks like with no restrictions, i.e. Javascript enabled, and uBlock Origin disabled for it:



query
kwîr′ē

noun

1. A question; an inquiry.
2. A doubt in the mind; a mental reservation.
3. A notation, usually a question mark, calling attention to an item in order to question its validity or accuracy.

The American Heritage® Dictionary of the English Language, 5th Edition.
More at Wordnik

Query stri
A query string is a
locator that assign
parameters. A que
includes fields add
Web browser or ot
example as part of
appearance of a p
in multimedia cont

Take control of your personal data!

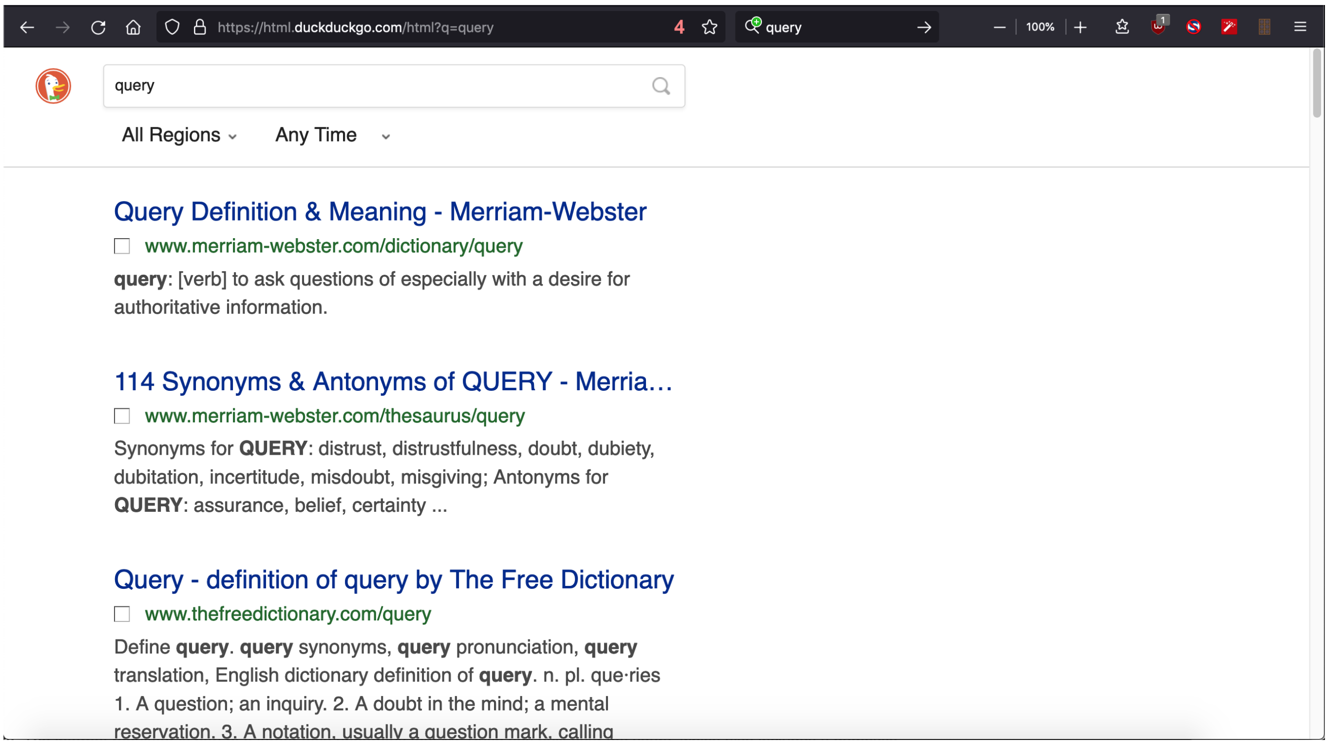
You're searching privately with DuckDuckGo
We keep your search history private.

Block most trackers as you browse
Block trackers and take control of your personal data.

https://www.merriam-webster.com › dictionary › query
Query Definition & Meaning - Merriam-Webster
query: [verb] to ask questions of especially with a desire for authoritative information.

Figure 1: View of DuckDuckGo's unrestricted search results

Compare this to figure 2, a DDG query without Javascript and uBlock Origin's default protections:


https://html.duckduckgo.com/html?q=query

query

All Regions | Any Time

Query Definition & Meaning - Merriam-Webster
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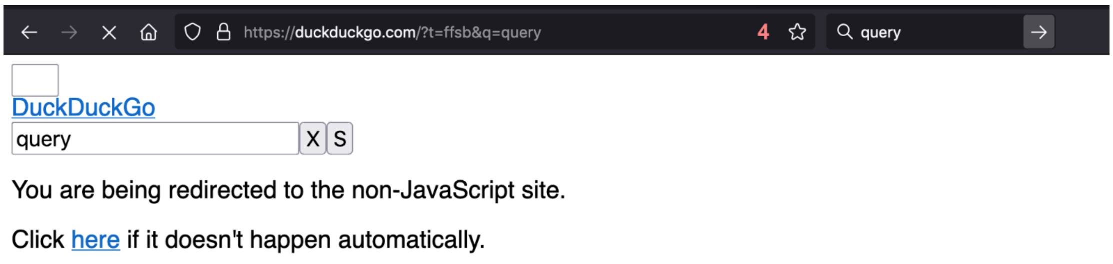
Figure 2: View of DuckDuckGo's restricted search results

It is notable that there was a brief transition screen before the non-Javascript DDG results were displayed, shown in figure 3.


https://duckduckgo.com/?t=ffsb&q=query

DuckDuckGo

query

You are being redirected to the non-JavaScript site.

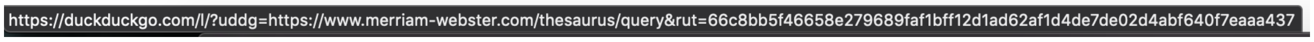
Click here if it doesn't happen automatically.

Figure 3: View of DuckDuckGo's non-javascript transition screen

What does all this have to do with writing a web extension, I hear you ask?

Well, since the release of version 100 and later of Firefox, DuckDuckGo now places a tracking redirection in their result URLs.

This is what the URL status bar shows when the mouse is hovering over a tracked result URL link. It is a very small font, so use your PDF document reader's magnification (about 400% should be good) to see it clearly.



```
https://duckduckgo.com/l/?uddg=https://www.merriam-webster.com/thesaurus/query&rut=66c8bb5f46658e279689faf1bff12d1ad62af1d4de7de02d4abf640f7eaaa437
```

Figure 4: Status bar showing result URL tracking mechanism

Here's what trying to copy and paste it looks like (modified to fit on more than one line):

```
https://duckduckgo.com/l/?uddg=
 https%3A%2F%2Fwww.merriam%2Dwebster.com%2Fthesaurus%2Fquery
 &rut=66c8bb5f46658e279689faf1bff12d1ad62af1d4de7de02d4abf640f7eaaa437
```

The use of URL encoding, i.e. the %2F and friends, is standard in a query string, but also makes it very difficult to attempt to thwart the tracking by trying to extract just the middle portion of the results.

This is where I got annoyed.

3 Vexation As A Motivating Force

Having an upgraded version of Firefox that now facilitates DDG's tracking mechanisms left me in a bit of a pickle. It is not easy to downgrade software these days, especially when it auto-updates.

There are a couple of ways to deal with this.

1. Install a web extension that modifies the browser's `User Agent` string, which tells the DuckDuckGo servers that a version of Firefox less than 100 is in use.

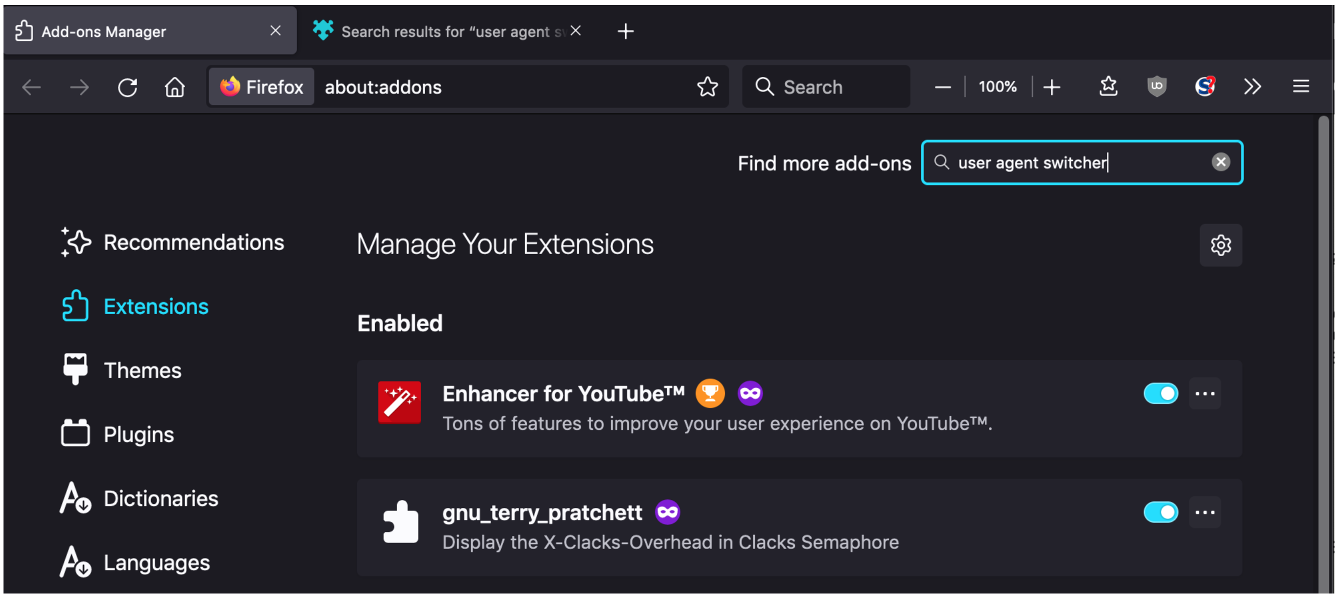
2. Create a web extension that re-writes DDG's result URLs and strips the tracking mechanism.

Both of these are equally valid solutions.

4 User Agent String Manipulation

This wasn't a solution initially, since I hadn't realized that the tracking mechanism was Firefox version related. In fact, it took me a while to determine why I was seeing the tracking URLs on my Windows system, but not my other systems. Turns out the other systems all had extended support releases (ESR) of Firefox that were pre-100 or just older versions. Once I updated them to 100+ versions, they showed the tracking mechanism.

To find out the version cutoff, I installed a user agent switcher from Mozilla's add-on store named `User Agent Switcher and Manager` (UAS). Figure 5 shows the add-ons manager with the `Find more add-ons` search box filled in.

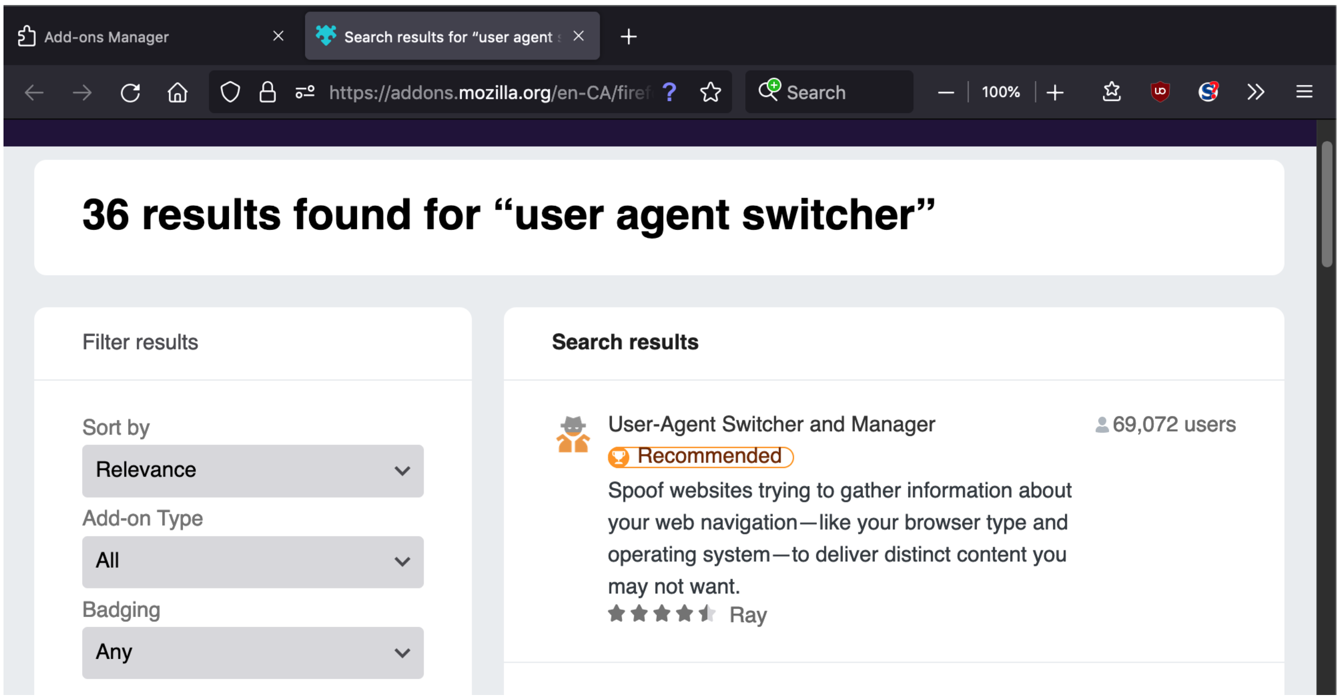


Enhancer for YouTube™
Tons of features to improve your user experience on YouTube™.

gnu_terry_pratchett
Display the X-Clacks-Overhead in Clacks Semaphore

Figure 5: **F**irefox Add-on Manager search for user agent switcher

Figure 6 shows the results with a recommended add-on at the top of the search results.


Add-ons Manager
Search results for "user agent
https://addons.mozilla.org/en-CA/firef
Search
100%

36 results found for "user agent switcher"

Filter results

Sort by: Relevance

Add-on Type: All

Badging: Any

Search results

User-Agent Switcher and Manager — 69,072 users

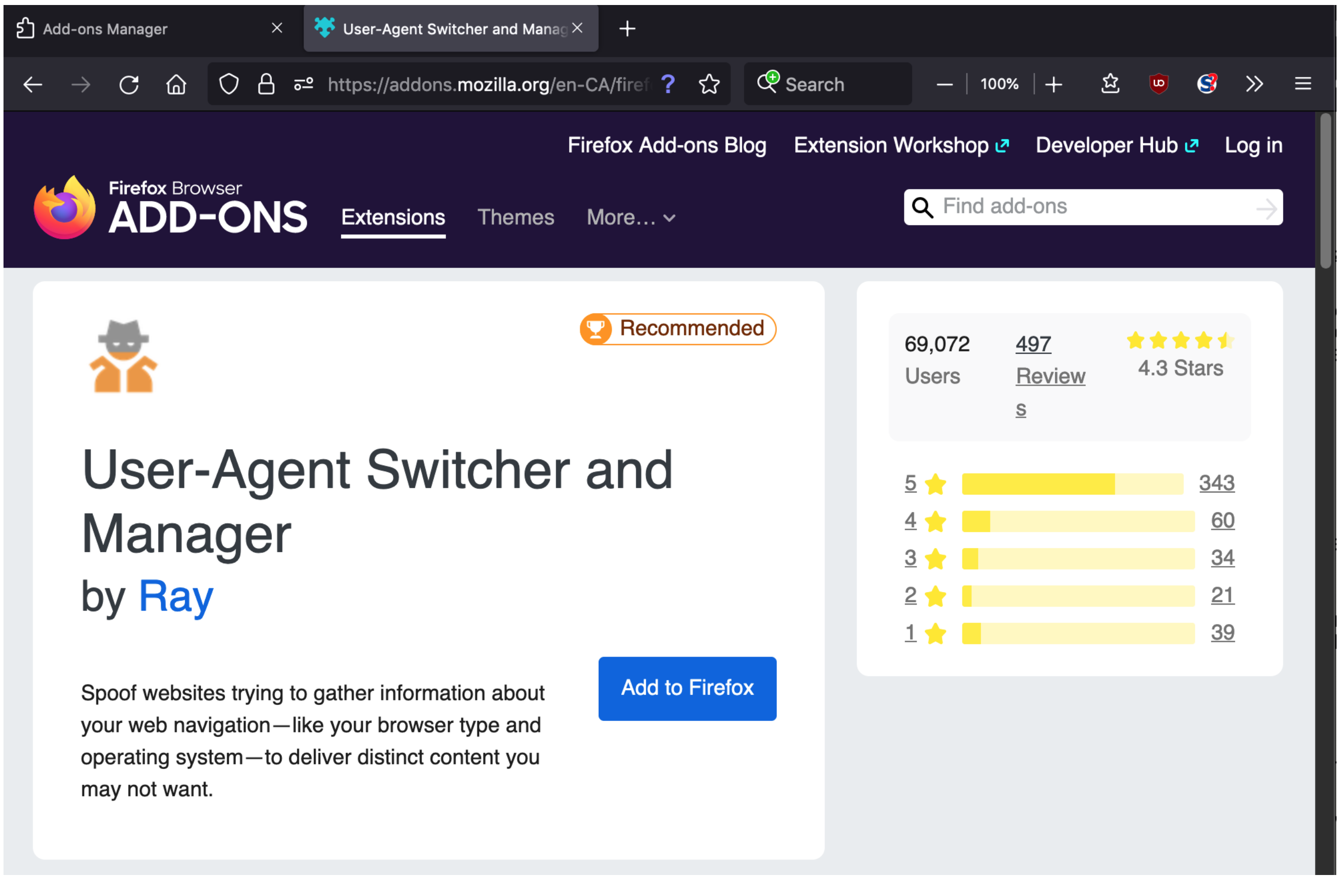
Recommended

Spoof websites trying to gather information about your web navigation—like your browser type and operating system—to deliver distinct content you may not want.

Ray

Figure 6: User agent switcher search results

Figure 7 shows the `User Agent Switcher and Manager` by Ray add-on entry page.


Add-ons Manager

User-Agent Switcher and Manag

https://addons.mozilla.org/en-CA/firef

Search

100%

Firefox Add-ons Blog · Extension Workshop · Developer Hub · Log in

Firefox Browser ADD-ONS · Extensions · Themes · More… · Find add-ons

Recommended

User-Agent Switcher and Manager
by Ray

Spoof websites trying to gather information about your web navigation—like your browser type and operating system—to deliver distinct content you may not want.

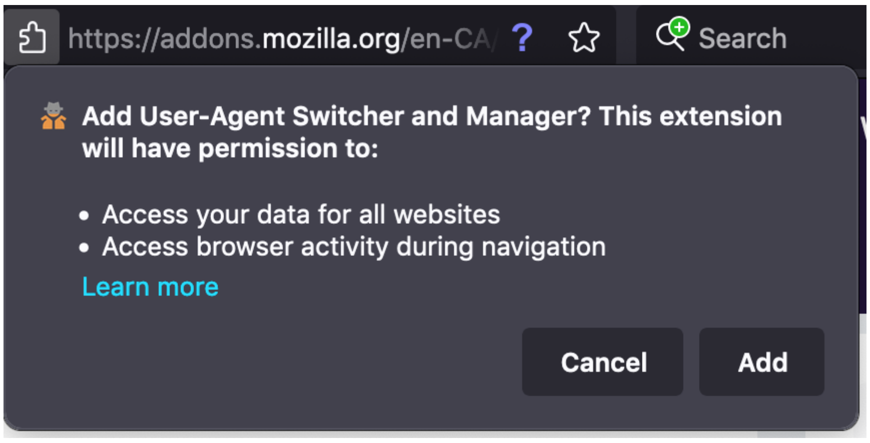
Add to Firefox

69,072 Users · 497 Reviews · 4.3 Stars

5 ★	343
4 ★	60
3 ★	34
2 ★	21
1 ★	39

Figure 7: User Agent Switcher and Manager add-on entry

Figure 8 shows the results of clicking the `Add to Firefox` button and the permissions notice.


https://addons.mozilla.org/en-CA/

Search

Add User-Agent Switcher and Manager? This extension will have permission to:

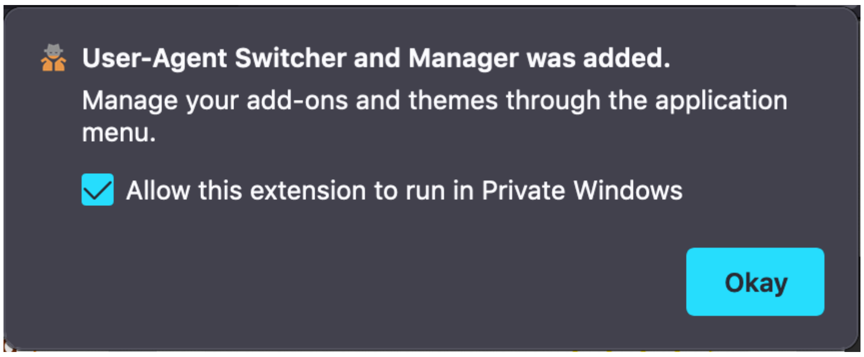
- Access your data for all websites
- Access browser activity during navigation

Learn more

Cancel · Add

Figure 8: User Agent Switcher and Manager Permissions

Figure 9 shows the prompt to allow the extension to work in private windows.


User-Agent Switcher and Manager was added.
Manage your add-ons and themes through the application menu.

☑ Allow this extension to run in Private Windows

Figure 9: User Agent Switcher Allow in Private Windows

Figure 10 shows that UAS is off by default.

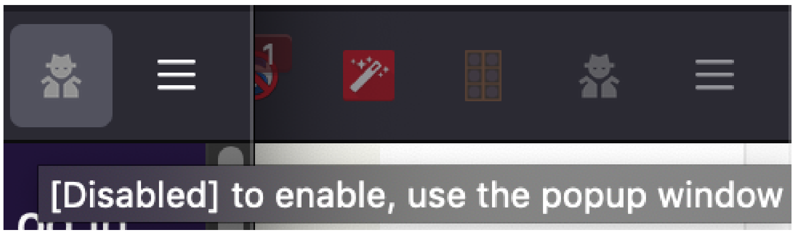
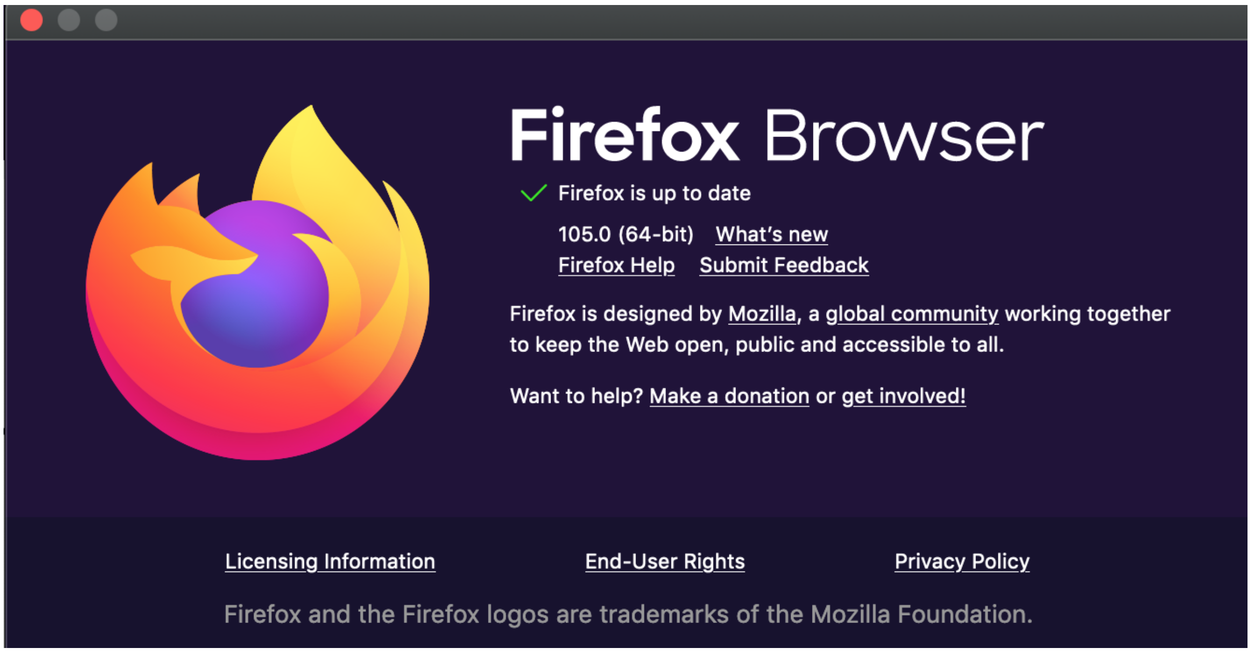

[Disabled] to enable, use the popup window

Figure 10: User Agent Switcher disabled by default

Figure 11 shows the currently installed Firefox version.


Firefox Browser

Firefox is up to date

105.0 (64-bit) What's new

Firefox Help Submit Feedback

Firefox is designed by Mozilla, a global community working together to keep the Web open, public and accessible to all.

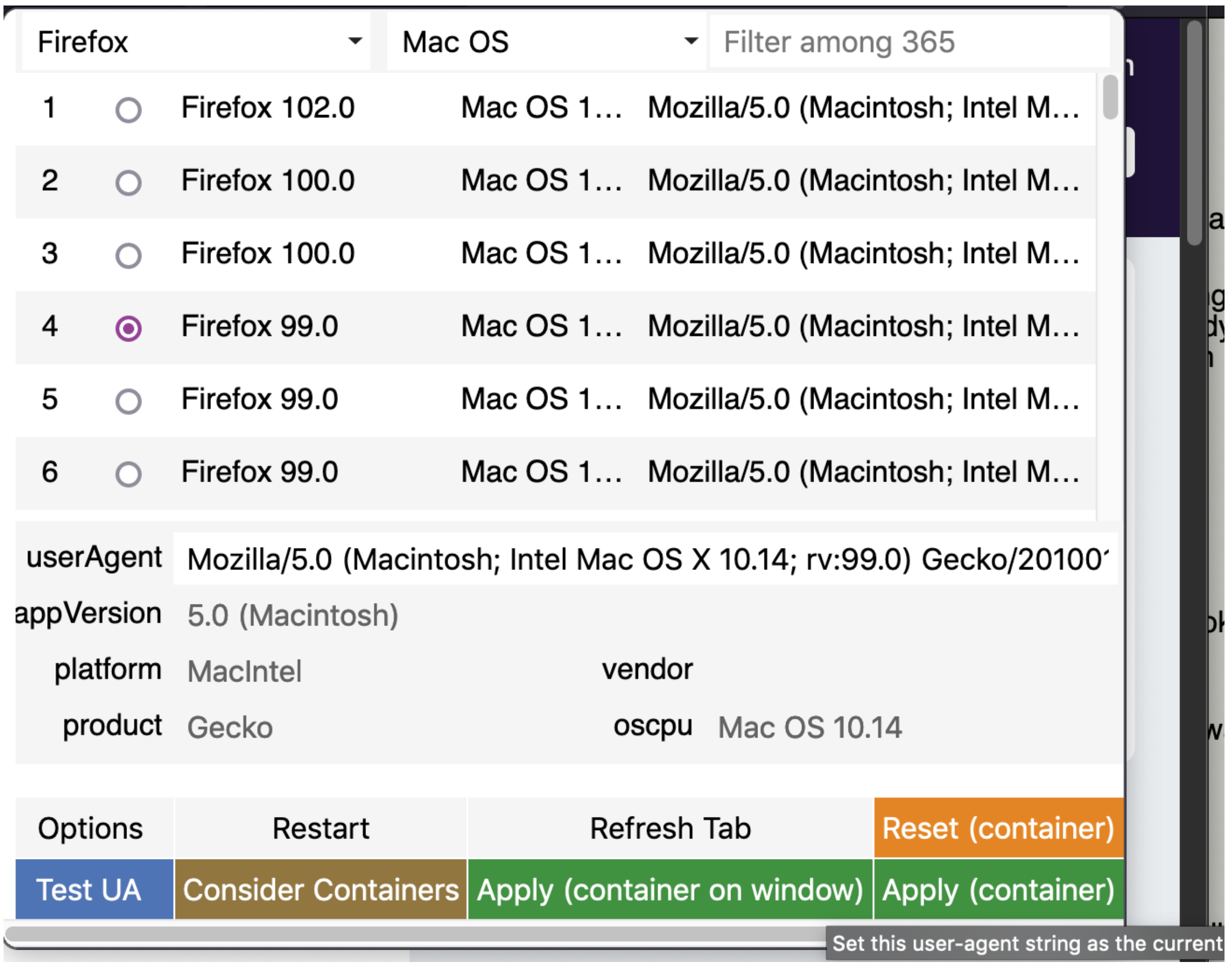
Want to help? Make a donation or get involved!

Licensing Information End-User Rights Privacy Policy

Firefox and the Firefox logos are trademarks of the Mozilla Foundation.

Figure 11: Installed Firefox Version

Figure 12 shows setting the user agent to Firefox version 99. We seem to have to click both the `Apply (container on wndow)` and `Apply (container)` buttons (don't know the difference between the two).



Firefox			Mac OS	Filter among 365
1	○	Firefox 102.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…
2	○	Firefox 100.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…
3	○	Firefox 100.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…
4	●	Firefox 99.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…
5	○	Firefox 99.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…
6	○	Firefox 99.0	Mac OS 1…	Mozilla/5.0 (Macintosh; Intel M…

userAgent: Mozilla/5.0 (Macintosh; Intel Mac OS X 10.14; rv:99.0) Gecko/20100

appVersion: 5.0 (Macintosh)

platform: MacIntel

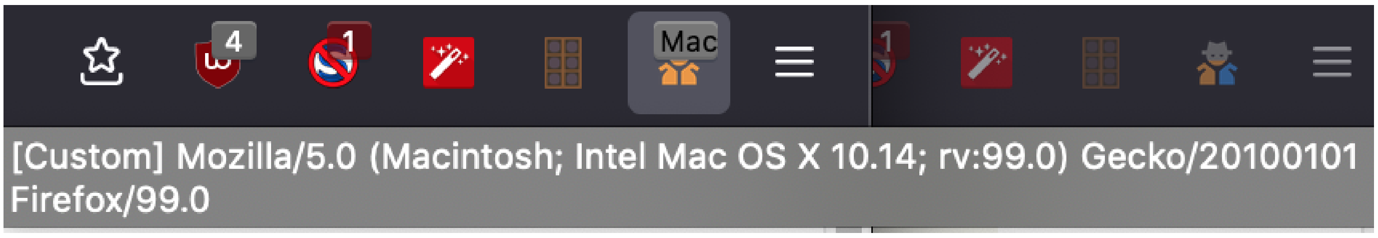
vendor:

product: Gecko

oscpu: Mac OS 10.14

Figure 12: UAS setting Firefox version 99 on Mac OS

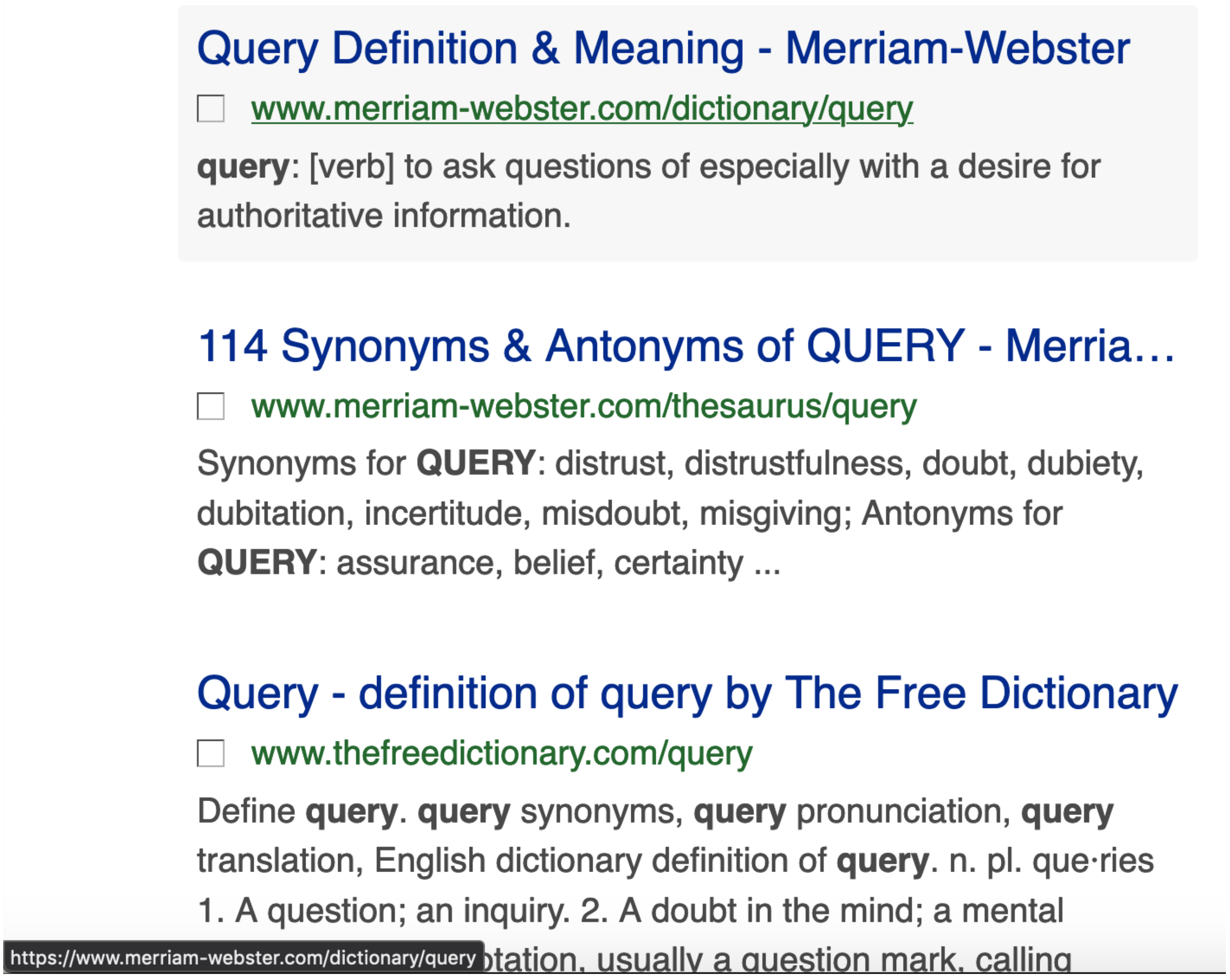
Figure 13 shows UAS reporting the user agent as Firefox version 99.



[Custom] Mozilla/5.0 (Macintosh; Intel Mac OS X 10.14; rv:99.0) Gecko/20100101 Firefox/99.0

Figure 13: Hovering over UAS toolbar button shows user agent for Firefox 99 in use

Figure 14 shows the search results without tracking components for Firefox version 99 (look closely at the status bar).


Query Definition & Meaning - Merriam-Webster

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Synonyms for **QUERY**: distrust, distrustfulness, doubt, dubiety, dubitation, incertitude, misdoubt, misgiving; Antonyms for **QUERY**: assurance, belief, certainty ...

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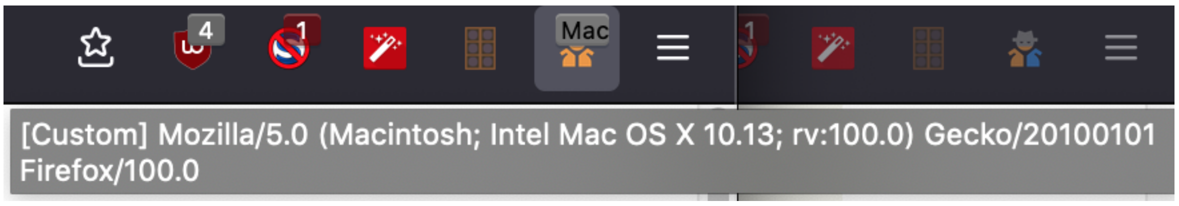
Define **query**. **query** synonyms, **query** pronunciation, **query** translation, English dictionary definition of **query**. n. pl. que·ries 1. A question; an inquiry. 2. A doubt in the mind; a mental

https://www.merriam-webster.com/dictionary/query ptation, usually a question mark, calling

Figure 14: Search results without tracking components for Firefox version 99

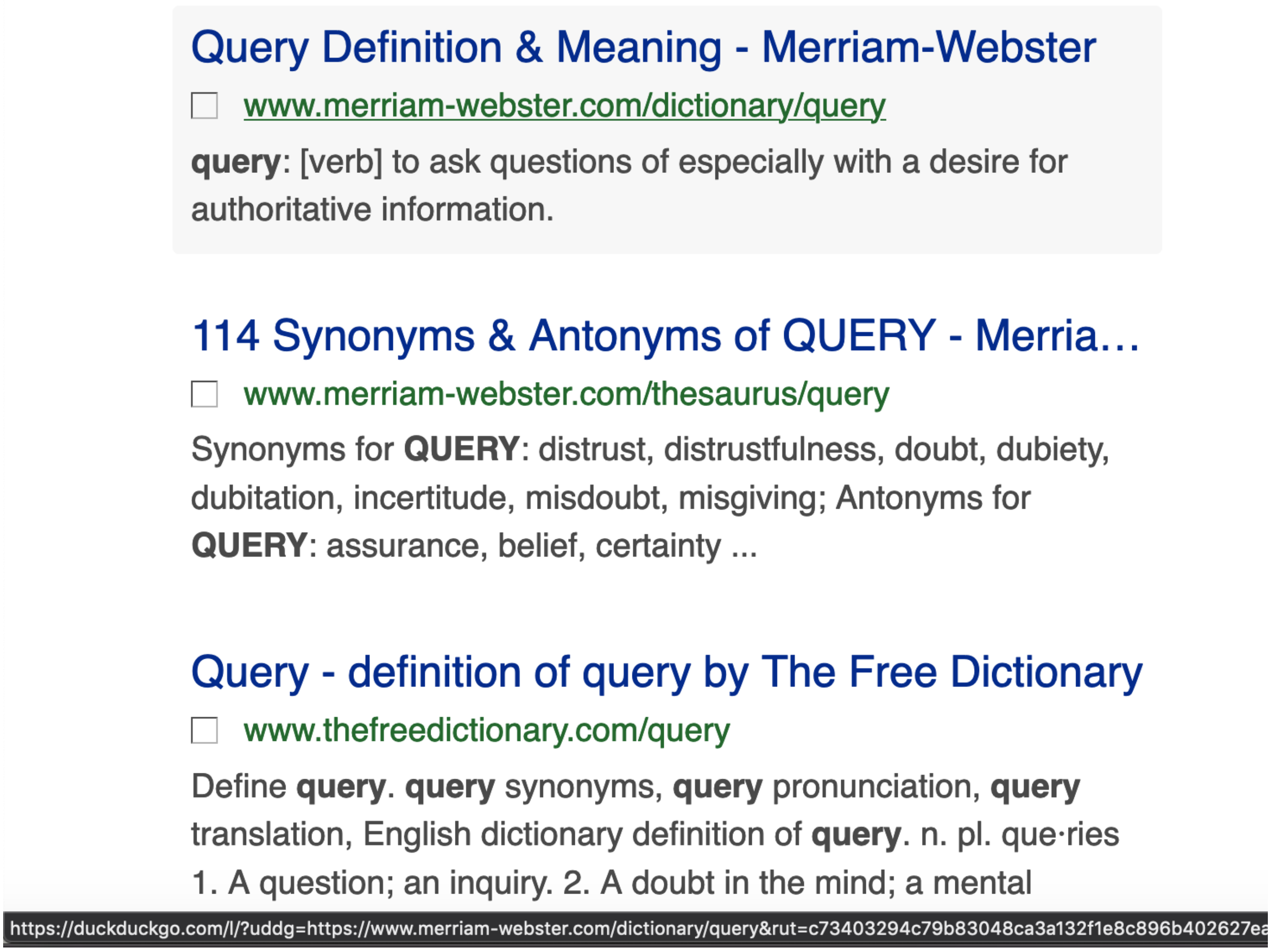
Figure 15 shows UAS reporting the user agent as Firefox version 100.



[Custom] Mozilla/5.0 (Macintosh; Intel Mac OS X 10.13; rv:100.0) Gecko/20100101 Firefox/100.0

Figure 15: Hovering over UAS toolbar button shows user agent for Firefox 100 in use

Figure 16 shows the search results **with** tracking components for Firefox version 100 (look closely at the status bar).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Define **query**. **query** synonyms, **query** pronunciation, **query** translation, English dictionary definition of **query**. n. pl. que·ries 1. A question; an inquiry. 2. A doubt in the mind; a mental

https://duckduckgo.com/l/?uddg=https://www.merriam-webster.com/dictionary/query&rut=c73403294c79b83048ca3a132f1e8c896b402627ea

Figure 16: Search results with tracking components for Firefox version 100

One issue with this method is that it may affect how other, non-related web sites react to your browser having a different version. Unintended consequences are very possible.

5 Creating a Web Extension to Modify Result URLs

We are going to be creating files and writing code, so we need a place to work:

```
[fruit:~/dev] student% pwd
/Users/student/dev

[fruit:~/dev] student% mkdir -p extension/badduck

[fruit:~/dev] student% cd !$
cd extension/badduck
[fruit:~/dev/extension/badduck] student%
```

There are a number of moving parts in a web extension. We're only covering a small portion of them, which is enough to do what I want. The two portions we need are:

1. a text file named manifest.json
2. a content script named badduck.js

The main starting point to learning how to write an extension is at the Mozilla developer network:

Your first extension - Mozilla — MDN

The documentation is very well written, and allows for a step-by-step extension writing experience.

5.1 manifest.json

This file is the main management file for an extension. It contains what functions the extension is to perform, on what web sites it performs them, and other things such as identification strings.

```
[fruit:~/dev/extension/badduck] student% cat manifest.json
```

```
{
  "manifest_version": 2,
  "name": "badduck",
  "version": "0.1",

  "description": "Clean result URLs in DuckDuckGo output.",

//  "icons": {
//    "48": "icons/badduck-48.png"
//  },

  "content_scripts": [
    {
      "matches": ["*://*.duckduckgo.com/*"],
      "js": ["badduck.js"]
    }
  ]
}
```

The `manifest_version` key states that this is a version 2 manifest. The manifest version represents a set of rules or standards that extensions and various application programming interfaces (API) abide by. There is a newer version 3 coming, which is purportedly stricter in what it'll allow extension developers to create.

The `name` key is a string value and stores the name of the extension.

The `version` key is a value maintained by the extension programmer and stores the version of the extension.

The `description` key is a string value and stores the description of the extension.

The `icons` key is commented out (by using `//`, the single line commenting symbol in javascript), since it is optional and I did not create an icon.

The `content_scripts` section describes what web sites to match and what javascript code to run within them. There are a number of rules about how the matches work.

The `matches` subkey of `content_scripts` indicates what web sites the extension should activate on.

The `js` subkey of `content_scripts` indicates what javascript code file should inserted into the matched web site and executed.

There are many other things that can be put into the manifest such as:

- browser specific settings for identification
- browser actions, which are toolbar buttons for your extension
- permissions
- lists of files to be made available to web pages, such as images
- HTML code snippets that pop-up to allow for user interaction (with CSS and javascript)
- background scripts

See manifest.json - Mozilla — MDN for more.

5.2 Content Script badduck.js

Our `content_script` is written in, holds nose, javascript. This script is injected into the web pages that match the `matches` keyword in the manifest file. It runs after the page is loaded, as far as i can tell.

```
[fruit:~/dev/extension/badduck] student% cat badduck.js

// Find result__urls and split out the actual site of interest.

// Remind us that we have an extension altering the page.
document.body.style.border = "5px solid red";

console.log("bad duck");

// For easy maintenance, put these in variables
const resultUrlClassName = "result__url";
const splitResultURLOnLeft = "uddg=";
const splitResultURLOnRight = "&rut=";

var vtg_resultURL_list = document.getElementsByClassName(resultUrlClassName);

console.log(vtg_resultURL_list);

// There are a lot of results on the page, so we loop through them all.
```

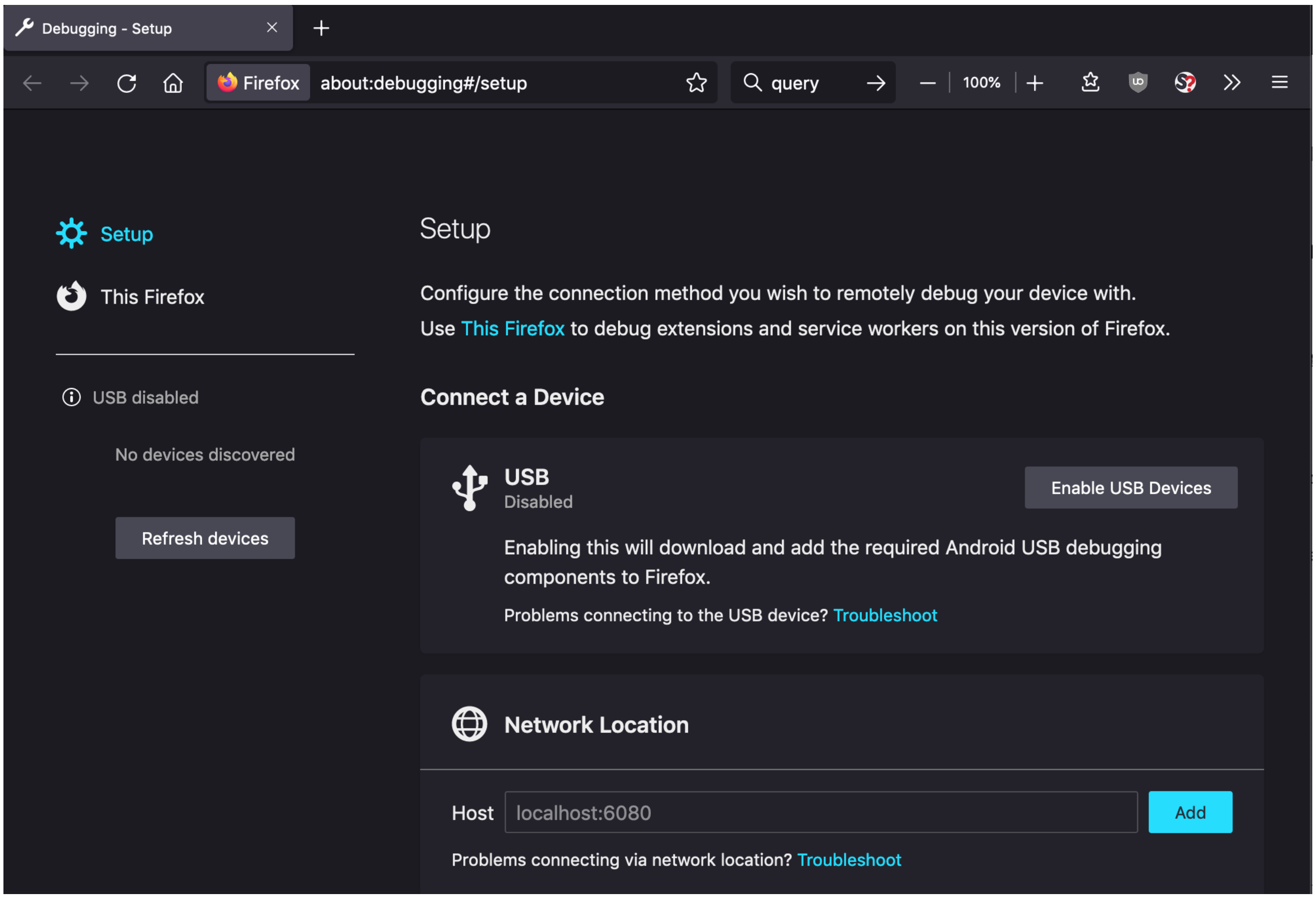
```
for (let vtgUrl of vtg_resultURL_list) {
  console.log("vtgUrl.href = " + vtgUrl.href);

  // The vtgURL.href contains the ugly tracking mechanism.
  // We split it twice, once on the left, to clear out the
  // duckduckgo.com portion.

  // Note the .split() function returns an array, here of two elements.
  let splitOnLeftTwoElementArray = vtgUrl.href.split(splitResultURLOnLeft, 2);
  console.log("splitOnLeftTwoElementArray = " + splitOnLeftTwoElementArray);

  // Check that we got two pieces back.
  if (splitOnLeftTwoElementArray.length == 2) {

    // We ignore the first element of the split left array, which was
    // the duckduckgo.com portion.
    // The second element contains the search result link that
    // we want, but it is URL encoded (the %3E style of thing), which
    // we must decode.

    let afterSplitLeftDecodedString =
        decodeURIComponent(splitOnLeftTwoElementArray[1]);

    // Now we can split the right part of the remaining decoded search result.
    // This is the tracking gibberish including the 'rut=' portion.
    // We also get an array from this split.

    let splitOnRightTwoElementArray =
        afterSplitLeftDecodedString.split(splitResultURLOnRight, 2);
    console.log("splitOnRightTwoElementArray = " + splitOnRightTwoElementArray);

    // The desired, corrected URL is the first element of the split on right array,
    // so we replace the original result href with our cleaned up one.
    vtgUrl.href = splitOnRightTwoElementArray[0];

  } else {
    console.log("split array 1 failed, not 2 elements.");
  }
  console.log("end vtgUrl.href = " + vtgUrl.href);
}
```

Now that we've got our script written, we can load it into the browser. Of course, the script was written in an iterative manner, starting very small and reloading the script over and over again while testing. The reload mechanism can be seen later in figure 20.

5.3 Load An Extension Temporarily - about:debugging

This is one of the ways to load a temporary extension and is described in about:debugging - Firefox Source Docs documentation.

Figure 17 shows the `about:debugging` default screen.



Setup

Configure the connection method you wish to remotely debug your device with.
Use This Firefox to debug extensions and service workers on this version of Firefox.

Connect a Device

USB
Disabled

Enabling this will download and add the required Android USB debugging components to Firefox.

Problems connecting to the USB device? Troubleshoot

Network Location

Host localhost:6080

Problems connecting via network location? Troubleshoot

Figure 17: Bring up the debugging system by entering about:debugging in the URL bar

We want to click on the `This Firefox` item on the left.

Figure 18 shows the `This Firefox` screen of the `about:debugging` page.

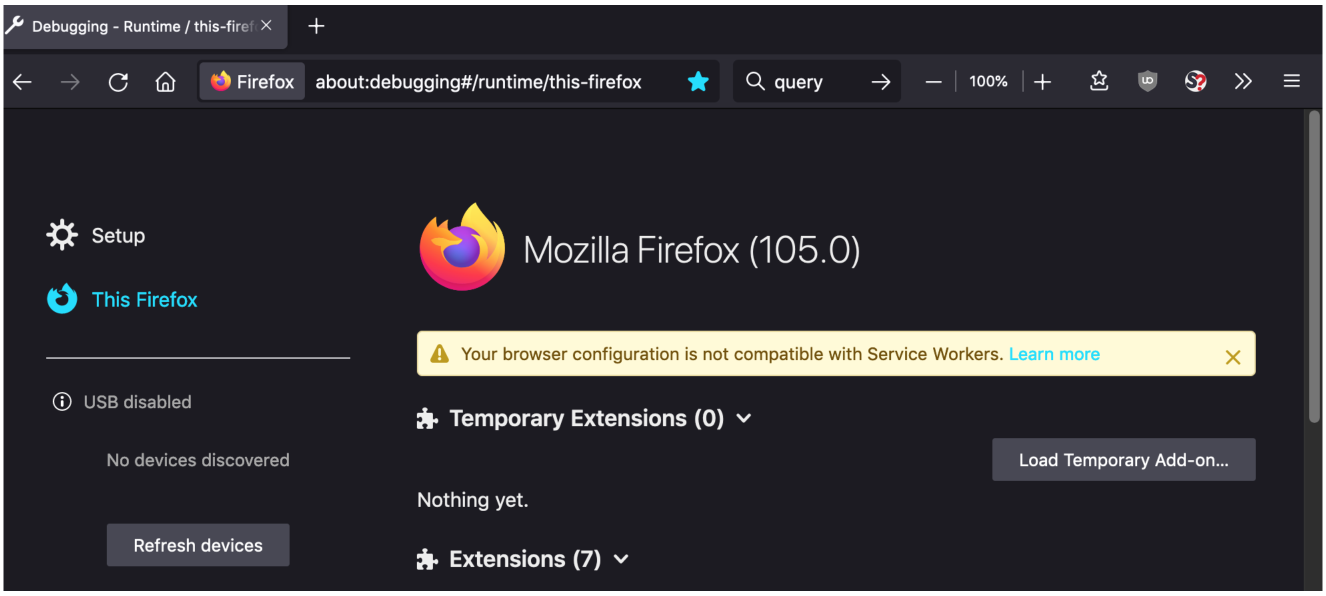


Figure 18: Clicking the `This Firefox` item brings up an temporary extension management screen

We can now click the `Load Temporary Add-on...` button to activate a file picker dialog, wherein we navigate to our `extension/badduck` folder and select the `manifest.json` file.

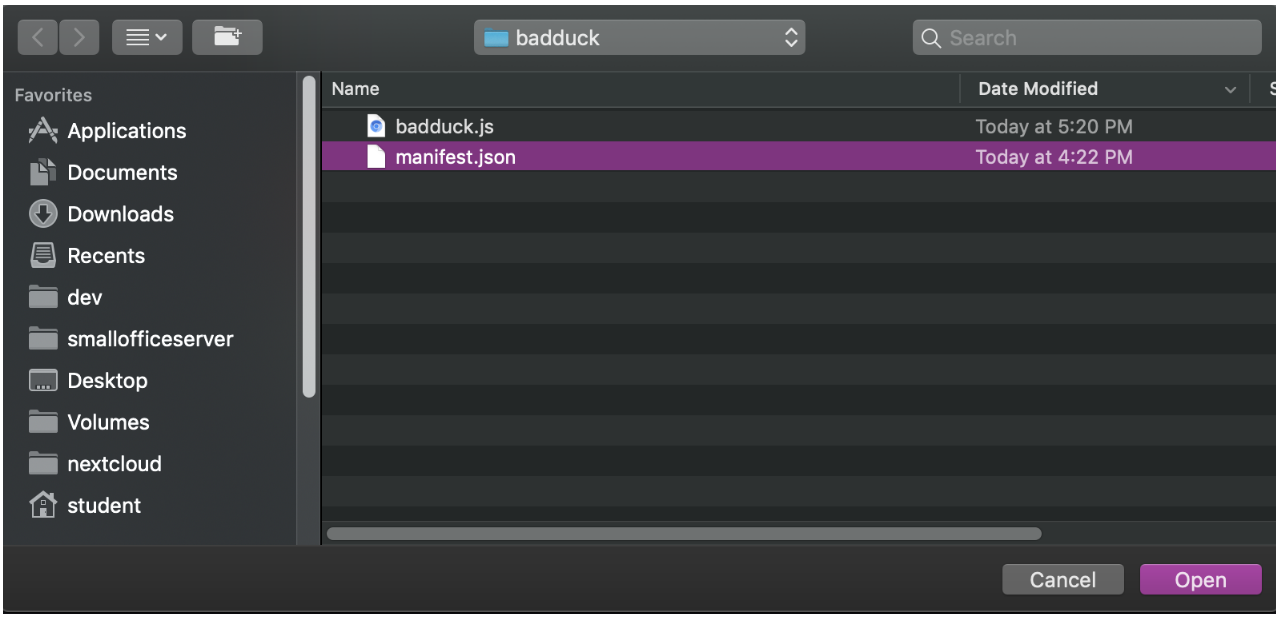
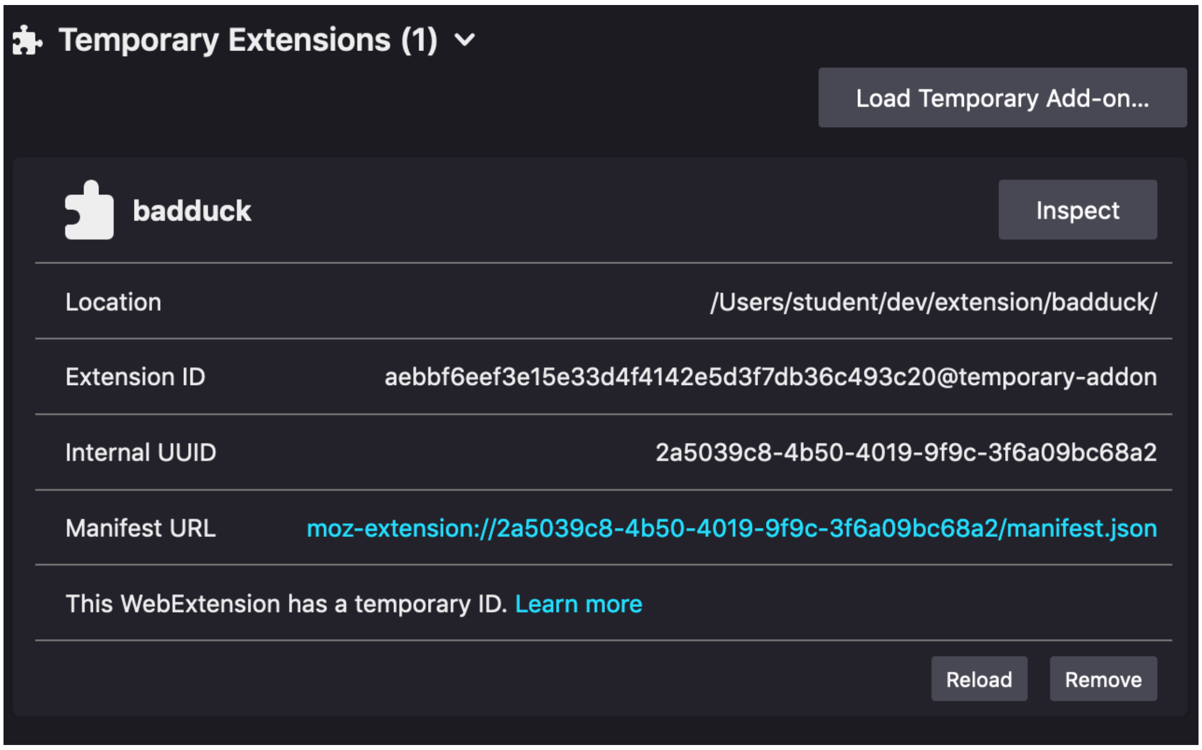


Figure 19: File picker to select manifest.json file

This will load the extension, which remains in use until the browser is closed / restarted.

Figure 20 shows the details of our `badduck` extension.


Temporary Extensions (1)

badduck

Location	/Users/student/dev/extension/badduck/
Extension ID	aebbf6eef3e15e33d4f4142e5d3f7db36c493c20@temporary-addon
Internal UUID	2a5039c8-4b50-4019-9f9c-3f6a09bc68a2
Manifest URL	moz-extension://2a5039c8-4b50-4019-9f9c-3f6a09bc68a2/manifest.json

This WebExtension has a temporary ID. Learn more

Figure 20: The temporary extension has been loaded

One quick thing to note, is that since my browser windows always open in private browsing mode, we have to enable the extension to work in private windows. Extensions, by default, do not work in private windows.

To do this, we have to open the `Add-ons and Themes` settings page.

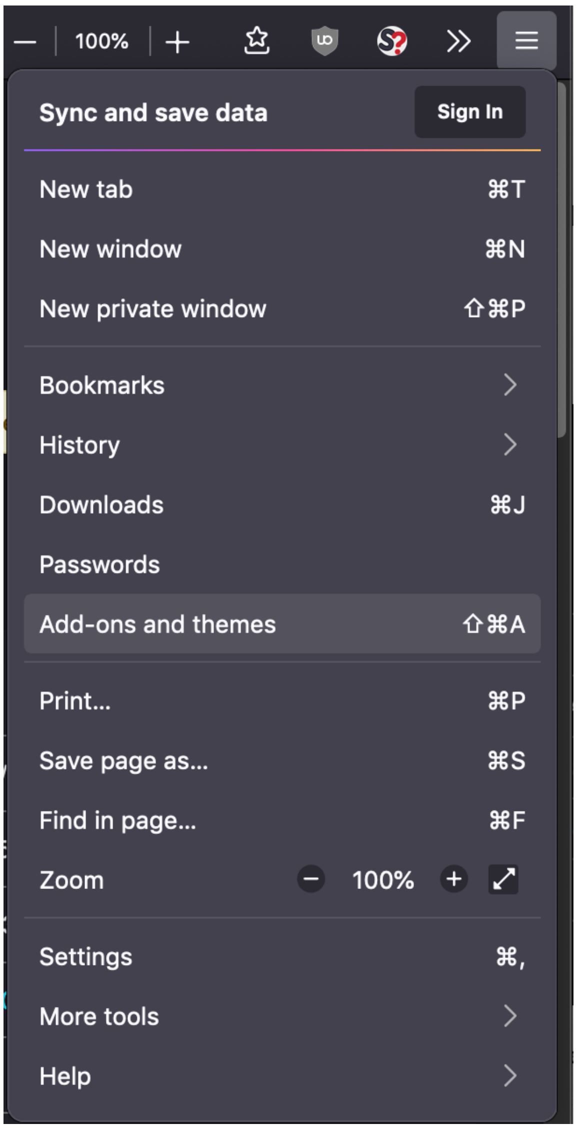
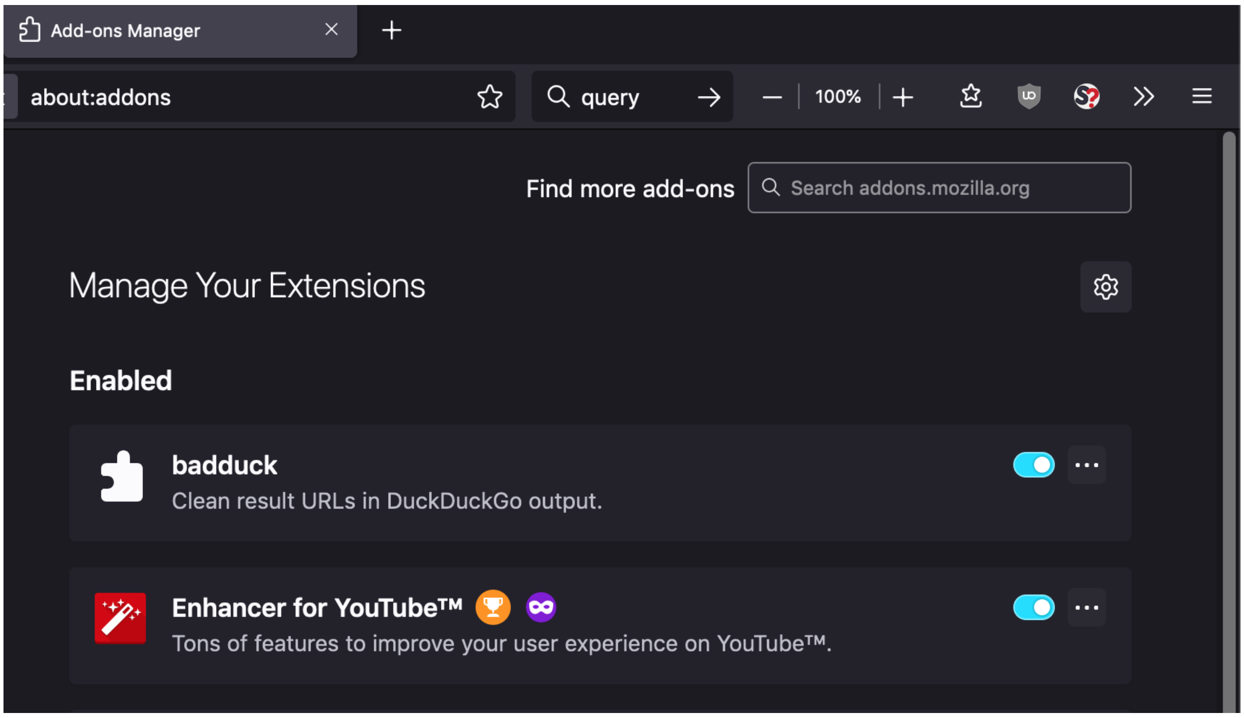


Figure 21: Using the hamburger menu to display the Add-ons and themes control

The `Add-ons Manager` comes up, which shows us our new, temporary extension.



Manage Your Extensions

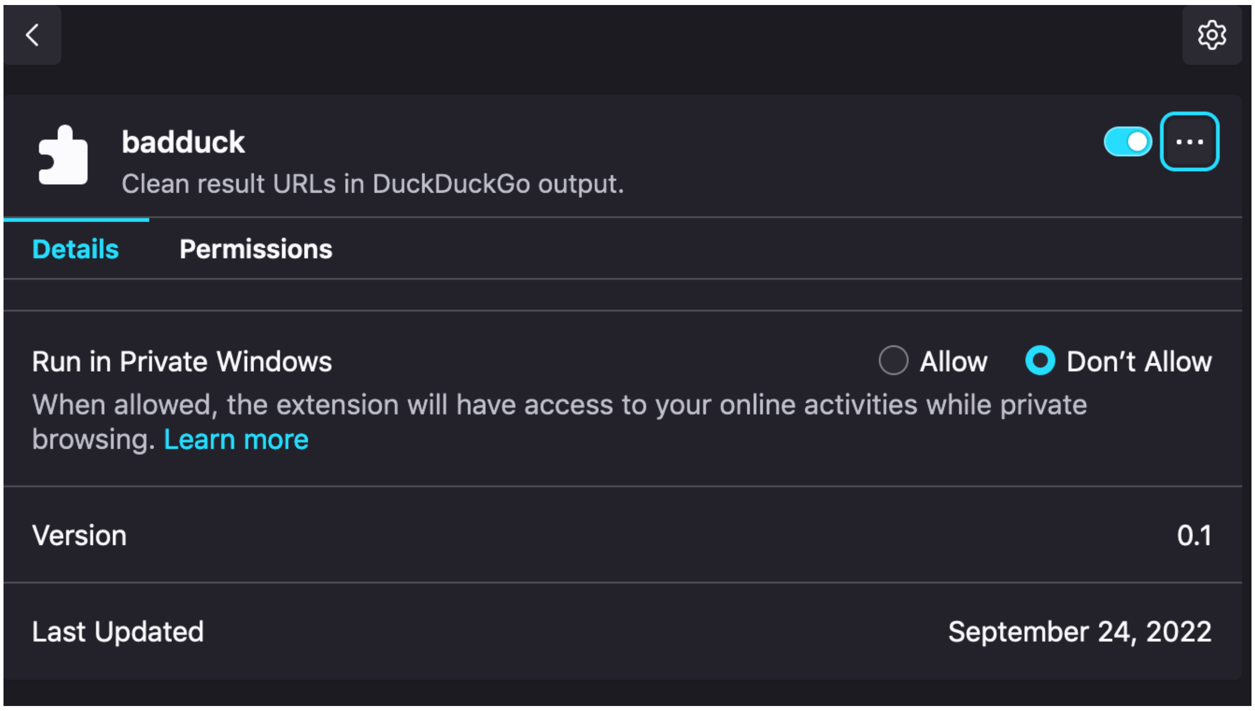
Enabled

badduck
Clean result URLs in DuckDuckGo output.

Enhancer for YouTube™
Tons of features to improve your user experience on YouTube™.

Figure 22: Add-ons Manager showing our temporary extension

Clicking on the `badduck` extension listing brings up its details where we can enable its use in private browsing.


badduck
Clean result URLs in DuckDuckGo output.

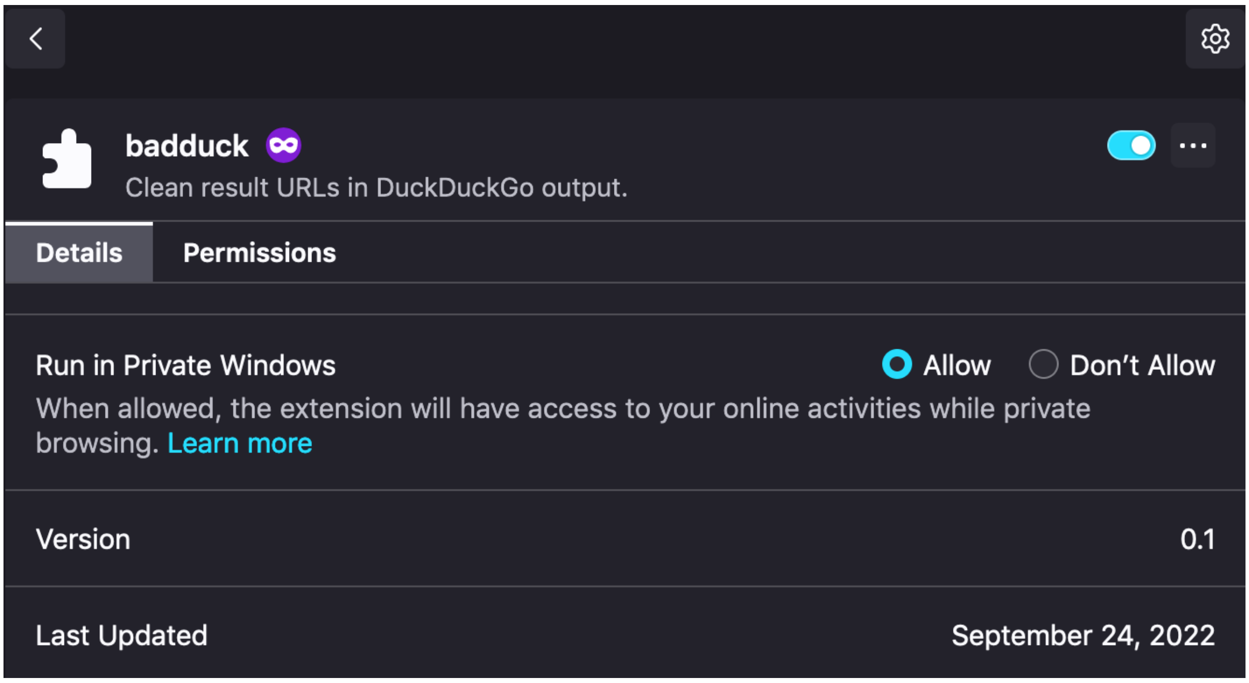
Run in Private Windows ○ Allow [✓ Don't Allow]
When allowed, the extension will have access to your online activities while private browsing. Learn more

Version 0.1

Last Updated September 24, 2022

Figure 23: Temporary extension without private window permission

Click the `Allow` radio button to enable the extension for private browsing.


badduck
Clean result URLs in DuckDuckGo output.

Details | Permissions

Run in Private Windows [✓ Allow] Don't Allow

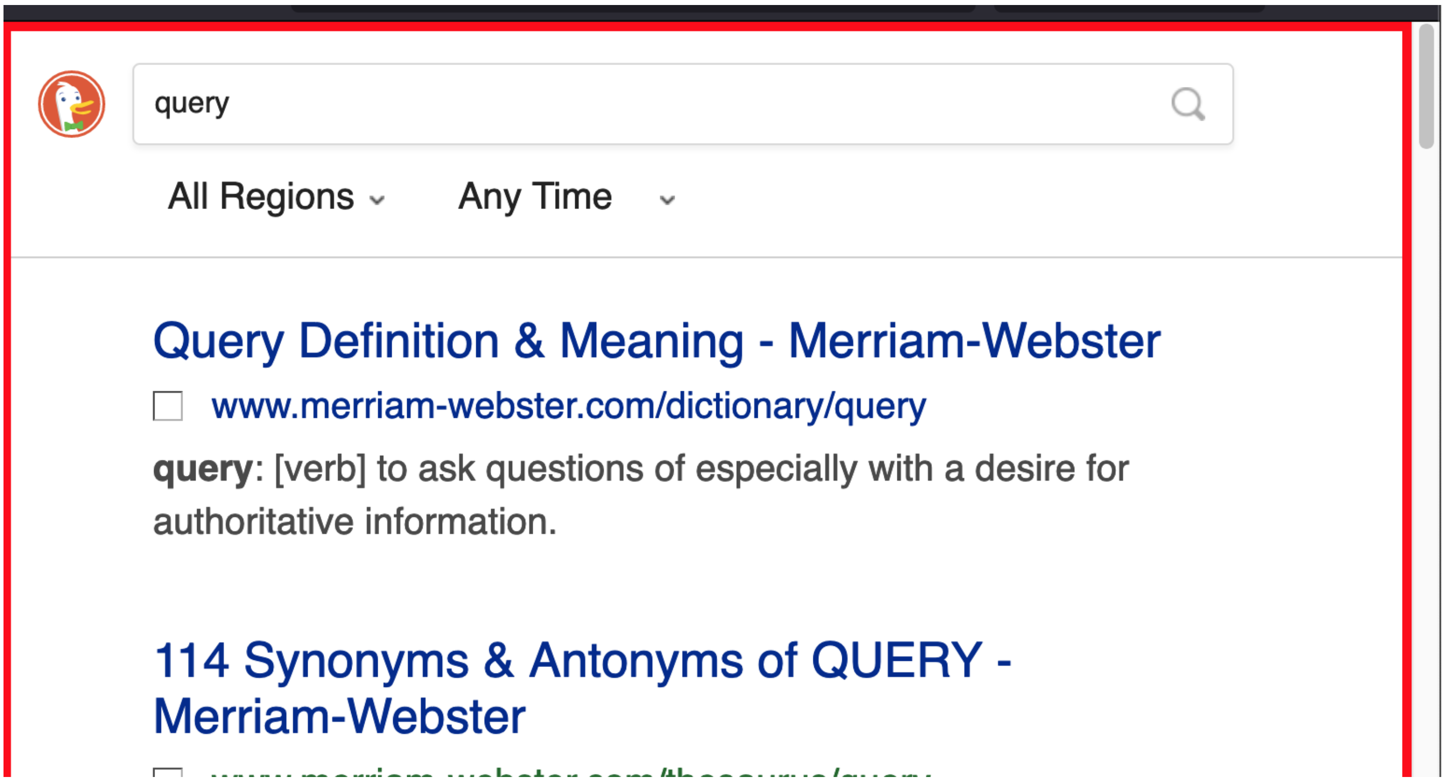
When allowed, the extension will have access to your online activities while private browsing. Learn more

Version 0.1

Last Updated September 24, 2022

Figure 24: **A**llowing the temporary extension to work in private windows

We should now be able to test our extension with a search. We want to make sure the search result has a red border to indicate the extension is functioning at a minimum.


query

All Regions ⌄ Any Time ⌄

Query Definition & Meaning - Merriam-Webster

www.merriam-webster.com/dictionary/query

query: [verb] to ask questions of especially with a desire for authoritative information.

114 Synonyms & Antonyms of QUERY - Merriam-Webster

Figure 25: **S**earch results showing our red border

Not visible in figure 25 are the cleaned result URLs, but they are present. Hovering over the title and then the HREF of a result set shows the difference.

5.4 Console Output

Sprinkled throughout the `badduck.js` script are calls to `console.log()`. These are the `print` statement equivalent for debugging during extension development.

We can access this log by opening the inspection panels via a right-click on the web page, as shown in figure 26

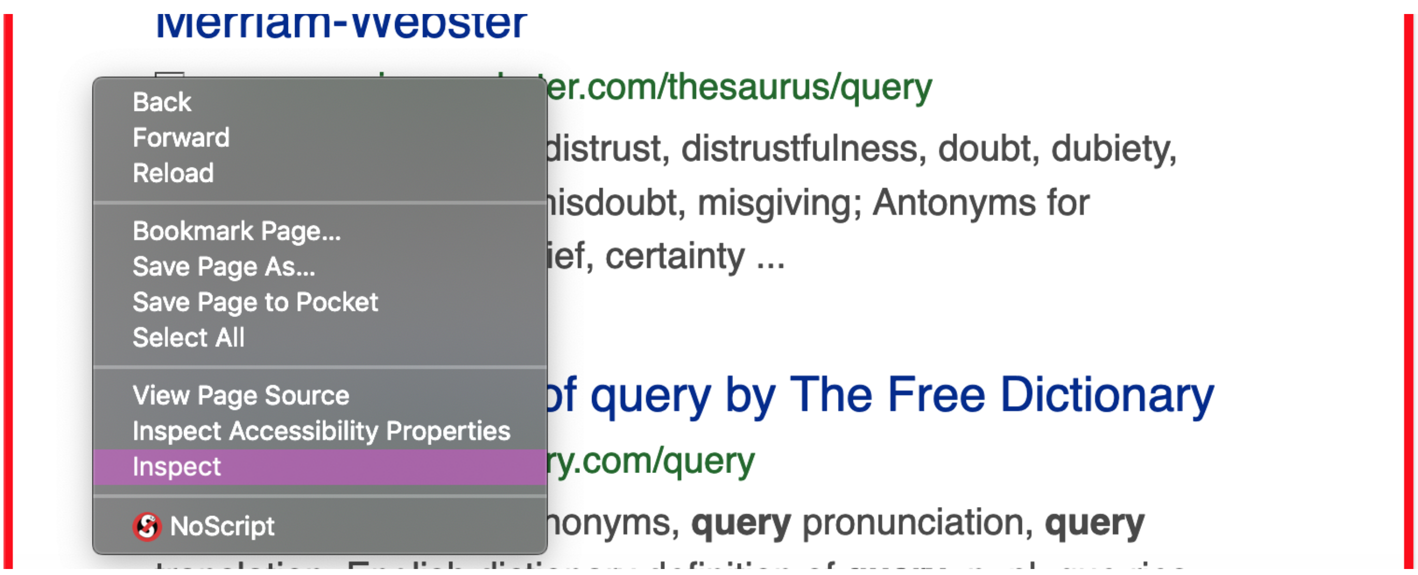
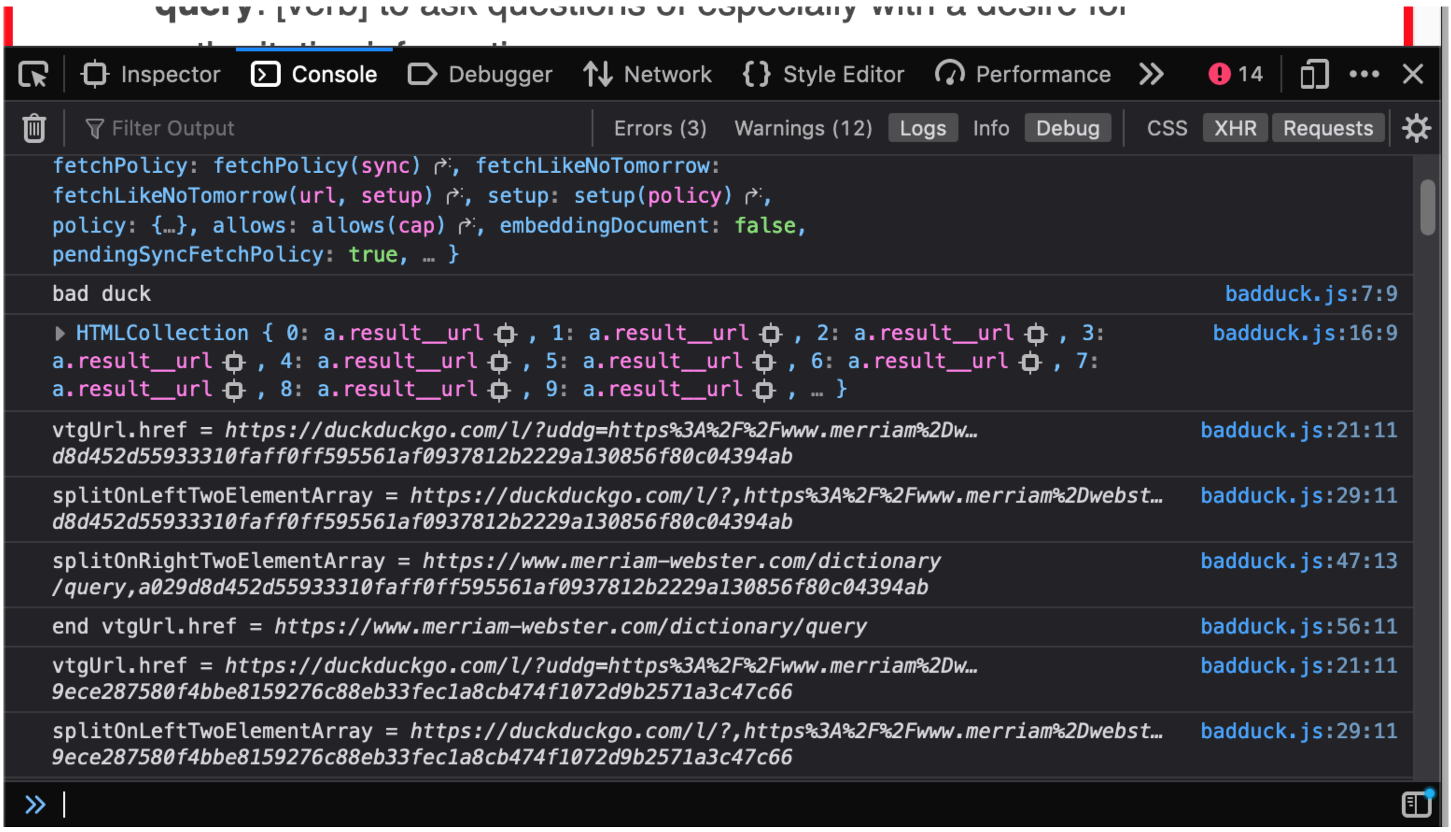


Figure 26: Activating the Inspect command to view logs

When the inspector opens, we have to select a few items to be able to see the log entries. The first is to click the `Console` selector; Console then click the `Logs` header: Logs Info Debug



```
fetchPolicy: fetchPolicy(sync) , fetchLikeNoTomorrow:
fetchLikeNoTomorrow(url, setup) , setup: setup(policy) ,
policy: {…}, allows: allows(cap) , embeddingDocument: false,
pendingSyncFetchPolicy: true, … }
bad duck                                                                                 badduck.js:7:9
▸ HTMLCollection { 0: a.result__url , 1: a.result__url , 2: a.result__url , 3:          badduck.js:16:9
a.result__url , 4: a.result__url , 5: a.result__url , 6: a.result__url , 7:
a.result__url , 8: a.result__url , 9: a.result__url , … }
vtgUrl.href = https://duckduckgo.com/l/?uddg=https%3A%2F%2Fwww.merriam%2Dw…              badduck.js:21:11
d8d452d55933310faff0ff595561af0937812b2229a130856f80c04394ab
splitOnLeftTwoElementArray = https://duckduckgo.com/l/?,https%3A%2F%2Fwww.merriam%2Dwebst…  badduck.js:29:11
d8d452d55933310faff0ff595561af0937812b2229a130856f80c04394ab
splitOnRightTwoElementArray = https://www.merriam-webster.com/dictionary                 badduck.js:47:13
/query,a029d8d452d55933310faff0ff595561af0937812b2229a130856f80c04394ab
end vtgUrl.href = https://www.merriam-webster.com/dictionary/query                       badduck.js:56:11
vtgUrl.href = https://duckduckgo.com/l/?uddg=https%3A%2F%2Fwww.merriam%2Dw…              badduck.js:21:11
9ece287580f4bbe8159276c88eb33fec1a8cb474f1072d9b2571a3c47c66
splitOnLeftTwoElementArray = https://duckduckgo.com/l/?,https%3A%2F%2Fwww.merriam%2Dwebst…  badduck.js:29:11
9ece287580f4bbe8159276c88eb33fec1a8cb474f1072d9b2571a3c47c66
»
```

Figure 27: Activating the Inspect command to view logs

We can see our first `bad duck` print out, as well as our `badduck.js` filename in the right hand column. The rest of the output is our various logging statements for our arrays and `split()` commands.

6 Conclusion

It is very easy to get started writing an extension. I encourage you to try your hand at it.

I did not cover such things as publishing, getting a developer account and all the other stuff required to make an official extension.

I may look into how to make this extension more permanent, without requiring any account, but we'll see. It currently works and my browser stays open for long periods of time, so reloading once in a while is not a hardship.