

Design

Link to Closing Ceremony Video where my demo was played:

<https://www.youtube.com/watch?v=qknbai1Dntc&t=3396s>

2 files

- define data struc
- have runner class main method

Visualization/High Level Flow:

- code is all in main method.
- 1. set up the data structure.
 - a. How?
 - i. manually - write the data struc
 - ii. ~~call a function and return it. build out data struc classes myself!~~
- 2. take returned data struc and visualize it
 - a. window will pop up in VSCode
 - b. see [below](#)
- 3. run an algorithm (or arbitrary code) by calling a method, store its return value if any
- 4. take original data structure or return value of method and visualize

Important add on: adjust horizontal vs vertical. ex. linked list is horizontal, binary tree is vertical, root is at top

- configure this in graphviz or whatever visualizer

MVP:

- support array/heap, linked list, doubly linked list, binary trees, graphs
 - write code for these data structures myself
- way to implement
 - **just do linked lists for now (written 6/28/20, early morning)**
 - could validate linked list doesn't have pointer that points to itself, but nah
 - array
 - has its own implementation

- make a wrapper class?
- graph (**might be easier than array, plus more progress done**)
 - if linked list or binary tree, convert to adj list representation for graph (since sparse, not a lot of edges, better than matrix)
 - convert adj list into visual
 - issue: for linkedlist, i like having two vertical boxes, one with data and the other with pointer. will lose this, which is fine for MVP.
- try out on own machine
- make available on extensions store!

What if I cannot visualize something? Have a box with class name and identifier on it, off to the side

low level details:

- code is all in main method.
- 1. set up the data structure.
 - a. How?
 - i. manually - write the data struc with data struc classes i write myself
- 2. take returned data struc and turn it into json
 - a. see below
- 3. visualize it
 - a. window will pop up in VSCode
 - b. see [section](#)
- 4. run an algorithm (or arbitrary code) by calling a method, store its return value if any
- 5. take original data structure or return value of method and visualize

User usage: clones repo, installs prereqs. writes the code in javaSrc Runner.java. runs it. json files written to disk. user types in command to vscode (control shift p), then images rendered and displayed

json format

```
{
  "nodeID" : {
    data: 1
    adjList = [list of node ids]
  }, ...
}
```

step 2:

Use method 1

User creates data structure. passes it to Java method. when the program is run, the java method writes json files to disk.

How does vscode extension know that code has been run? does it need to know?

triggers

- user types in command in extension.ts
 - good for MVP
- can define activationEvents in extension.ts
- nah ~~when java is run (extensions need to be installed), my extension can read from disk~~
 - how does my extension know when java code is run?
- nah ~~without any java extensions, vscode has no java support. java needs to be run by command line.~~
 - can my extension detect a change in the file? this would allow extension to work regardless of how java is run
 - i want to detect change in timestamp of a file (this detects change in file). can i do this in vscode?
 - **use filesystem. filestat has modified time. can check timestamp every second. if change, re-render images**
 - **hacky way, but works**
 - <https://code.visualstudio.com/api/references/vscode-api#FileSystem>
 - <https://code.visualstudio.com/api/references/vscode-api#FileStat>
 - **use textdocument and event listener**
 - <https://code.visualstudio.com/api/references/vscode-api#events>
 -
 - **[TextDocumentContentProvider](#) looks promising**
 - <https://code.visualstudio.com/api/extension-guides/virtual-documents>
 - see <https://code.visualstudio.com/api/references/vscode-api#TextDocument>
 - TextDocument - read the current edit state of a file
 - <https://stackoverflow.com/questions/38782181/read-and-write-file-using-vs-code-extension>
 - doesn't work. is the extension just reading file every second? ~~i can just write the timestamp to the json file. typescript code can read timestamp and store it. if timestamp different, it knows to store it.~~

turning java data structure to json

go with method 1. revisit method 2 after hackathon

method 1:

make data structure. write a java method that takes in the data structure, traverses it if needed, and writes json file to disk.

User calls the java method before and after code is run. write 2 json files to disk and visualize.

issue: not contained within vscode extension. java code required.

method 2:

Want data structure to json conversion to be contained in typescript code (vscode extension)

possibly, maybe do something with vscode java debug extension, but hard?

possible plan:

install java debugger, support for java from redhat.

- <https://github.com/Microsoft/java-debug>
- <https://github.com/Microsoft/vscode-java-debug>
- see launch.json config file

use annotations to determine setup data structure functions.

somehow - access the variables stored in debugger. take root of data structure and convert into json

issue:

- too many unknowns
- how to access variables in debugger?
- how to write java code that will convert data structure into json? where do I put this code? how do i make the code get run?
- downside: have to install additional extensions

rendering of visual

method 6:

try to do this client side

look at webview sample

use iframe and webview to open image

need to: get typescript to run a python script

if can determine file is python script, can add argument to cmd and execute python script in terminal

- have vscode create terminal window for me and run python script
- this may be too much, there may be another way

write helloworld, try to run that.

- take sample and get image to generate
- <https://github.com/microsoft/vscode-extension-samples/tree/master/webview-sample>
-

typescript - dive in and try out. ask questions to mentor or other hackers if run into issues

other hackers use webview and run into similar problems, can ask them

how to access file system:

<https://stackoverflow.com/questions/53559240/how-should-i-access-the-file-system-of-the-vscode-user>

vscode.fs.writeFile and vscode.fs.readFile there's a bunch of file system functions exposed via vscode.fs similar to node's built-in fs

TODO:

take code/data structure. pass as json to a python script (can write json to disk and python read from disk). py script executed from typescript. python script returns file path to visualization

(image written to disk, when rendering in python-py, specify png format). Then visual displayed as webview/iframe.

try implement from here. from MVP try this.

- implement for linked list. convert into adj list in json
- pass to python and visualize. Display image in webview

big things:

- need to get graphviz working
- get webview working.
- execute python script from node.js
 - <https://stackoverflow.com/questions/30689526/how-to-call-python-script-from-nodejs>
 -

Issues:

see issues described in other sections

In scope capabilities

Only support integers as datatype

- generalize to comparable later with generics and compareTo

Out of scope

dont support dynamically sized data structs

- arraylists
- anything from collections interface

Add ons

Add on: add hover. if hover a data structure, visualize it

~~Use AWS Lambda, expose load balancer to public internet~~

Add on: integrate visualization with debugger, show line by line changes

Add on: use annotations for setup and algo methods

Add on: allow user to define their own data structures. tool can read data struc class and visualize it

Description

TODO: please revise

Coding complex data structures is difficult, especially due to the lack of visuals. To make learning data structures and algorithms easier, this extension visualizes data structures before and after they are manipulated. Extension currently only supports Java.

Use case: As a beginner in data structures, I want to write a method to reverse a linked list or perform in order search on a BST. I want to visualize the data structure I'm operating on.

Why?

Coding Java is in english, which may be difficult for those who do not know english well. Visuals serve as a universal language. This extension will lower the barrier for learning how to code methods that operate on classic data structures. This will allow a beginner programmer to learn how to work with these data structures faster.

Although most software engineers don't use these data structures, the data structures are fundamental to computer science and many university computer science classes teach them.

dump from phone notes:

VSCode Extension hackathon

Visualizing data structures - array, linked list, trees, graphs, etc

Make array and graph (digraph, then undirected graph) visualizer, since a linkedlist is like binary tree with one branch

Areaylist - hard to visualize its dynamicness

Basic types: int, string, all objs, references

Picture heap and stack memory? Hard

What if I cannot visualize something? Have a box with class name and identifier on it, off to the side

Do for Java language - can see references

Maybe C is easier? memory alloc - see how much to visualize. Auto run valgrind and gcc wall pedantic

End product: extension on VSCode marketplace

Add on: do slideshow (animation) of algos/code on data struc, highlighting stuff/arrows

Can i embed a web page that does the visualization/animation for me and just get data struc info from the code? Prob not, want to visualize any code operating on data struc

Embed web page with correct algo. Allow data entry via UI and file (json, xml, yaml, etc)

Can i integrate with debugger in other vscode extension? Step thru algo and highlight line?

Setup ci/cd? Travis CI? Probably not needed, too much overhead

Human diversity: no everyone is proficient in english. Visuals are universal language

resource

run python code in typescript and typescript repl

- <https://stackoverflow.com/questions/30689526/how-to-call-python-script-from-nodejs>
- <https://github.com/extrabacon/python-shell>
- <https://www.typescriptlang.org/docs/handbook/variable-declarations.html>
- <https://www.npmjs.com/package/ts-node>

viz.js

- <https://github.com/mdaines/viz.js/>
- <https://github.com/mdaines/viz.js/wiki>
- <https://www.npmjs.com/package/viz.js>

graphviz

- <https://graphviz.org/resources/>

py interface graph viz

- <https://graphviz.readthedocs.io/en/stable/manual.html>
- <https://graphviz.readthedocs.io/en/stable/api.html#digraph>
- <https://graphviz.readthedocs.io/en/stable/api.html#graphviz.Digraph.render>

conda

- https://docs.conda.io/projects/conda/en/4.6.0/_downloads/52a95608c49671267e40c689e0bc00ca/conda-cheatsheet.pdf

json-simple java

- <https://stackabuse.com/reading-and-writing-json-in-java/>
- <https://www.codota.com/code/java/methods/org.json.JSONObject.put>
- <https://www.codota.com/code/java/methods/org.json.simple.JSONObject.toJSONString>
- <https://www.codota.com/code/java/methods/org.json.simple.JSONObject.writeJSONString>
- <https://code.google.com/archive/p/json-simple/>
- <https://blog.codota.com/how-to-convert-a-java-object-into-a-json-string/>

vscode resources

- <https://code.visualstudio.com/api/get-started/your-first-extension>
- <https://github.com/microsoft/vscode-extension-samples>
- <https://github.com/microsoft/vscode-extension-samples/tree/master/webview-sample>
- <https://www.theurlist.com/vscodehackathon>
- <https://code.visualstudio.com/api>
- <https://code.visualstudio.com/api/extension-guides/webview>
- <https://code.visualstudio.com/api/extension-guides/virtual-documents>
- <https://code.visualstudio.com/api/references/vscode-api#TextDocument>
- <https://code.visualstudio.com/api/references/vscode-api#events>

- <https://code.visualstudio.com/api/references/vscode-api#FileSystem>
- <https://code.visualstudio.com/api/references/vscode-api#FileStat>
- <https://stackoverflow.com/questions/37077591/how-do-i-open-a-browser-window-in-a-visual-studio-code-extension>
- <https://stackoverflow.com/questions/53559240/how-should-i-access-the-file-system-of-the-vscode-user>
- <https://stackoverflow.com/questions/38782181/read-and-write-file-using-vs-code-extension>

rendering of visual scraped methods

~~method 5:~~

change - server side same as method 3. Instead of sending client the image, create a static site in AWS S3. Send link to static site to client and open in webview

Ask: How to stand up static site? (implementation detail i'm thinking about)

client sends json representation through http to server (ec2 instance?)

- how is json rep sent?
- how does server receive?
- stand up rest api endpoint in server?

server runs renders image from json (via python graphviz).

- must install python on server

server stands up static site

server sends http request back to client with link to site

v1.0(original) design: use amazon api gateway then trigger AWS lambda

v1.1 design: use AWS lambda. set trigger to be http endpoint. lambda then stands up static site

ask: what aws infra am I running on? EC2 instance? Lambda with trigger?

~~method 4:~~

server side same as method 3. Instead of sending client the image, programmatically upload the image to a website (imgur, or serve image on flask server as web page), send client link to image, open link in web view

serving image on flask server:

send client link to ec2 instance. going to link triggers flask server, which loads a webpage with the image. image stored on ec2 instance

issue: how do I serve multiple webpages with different photos at once?

test: test server side with uploaded image

important addon: make image fit well. use css/bootstrap. center the image

Issues:

not sure if webview will block going to a random URL

very hacky way (but this is a hackathon, so OK. can find better solution later)

Resources:

<https://stackoverflow.com/questions/37077591/how-do-i-open-a-browser-window-in-a-visual-studio-code-extension>

basically, webview api. stackoverflow post has starter code.

important add on: open tabbed window in same tab as code, not new window

add on: use AWS managed service for web app (elastic beanstalk) or use load balancers

method 3:

stand up ec2 instance on aws. put flask server in it.

serialize data structure to json

when a request is received from client with json of data struc to visualize: flask server calls python code that generates the image (graphviz python, latex maybe).

the image is sent to client then rendered

- now issue is: how to send an image over internet from ec2 instance to client?
- how does client render the image?
- need to install latex on red hat linux using yum

issues: internet connectivity needed. user firewall blocks the http request from being sent out?

possible run into networking issues

later: put in AWS lambda, expose load balancer to public internet

method 1:

locally on machine using javascript/typescript library (D3.js)

issues

- **any other graphic generation libraries for javascript? how can I adapt them for typescript?**
 - **google search**
- is D3 typescript compatible?
 - <https://spin.atomicobject.com/2017/07/20/d3-react-typescript/>
 - <https://stackoverflow.com/questions/48305957/typescript-and-d3>
 - <https://github.com/Lemoncode/d3js-typescript-examples>
- user installs libraries

method 2:

have user install latex distribution on machine. generate image that way.

issues:

- requires user to install a latex distribution. not beginner friendly