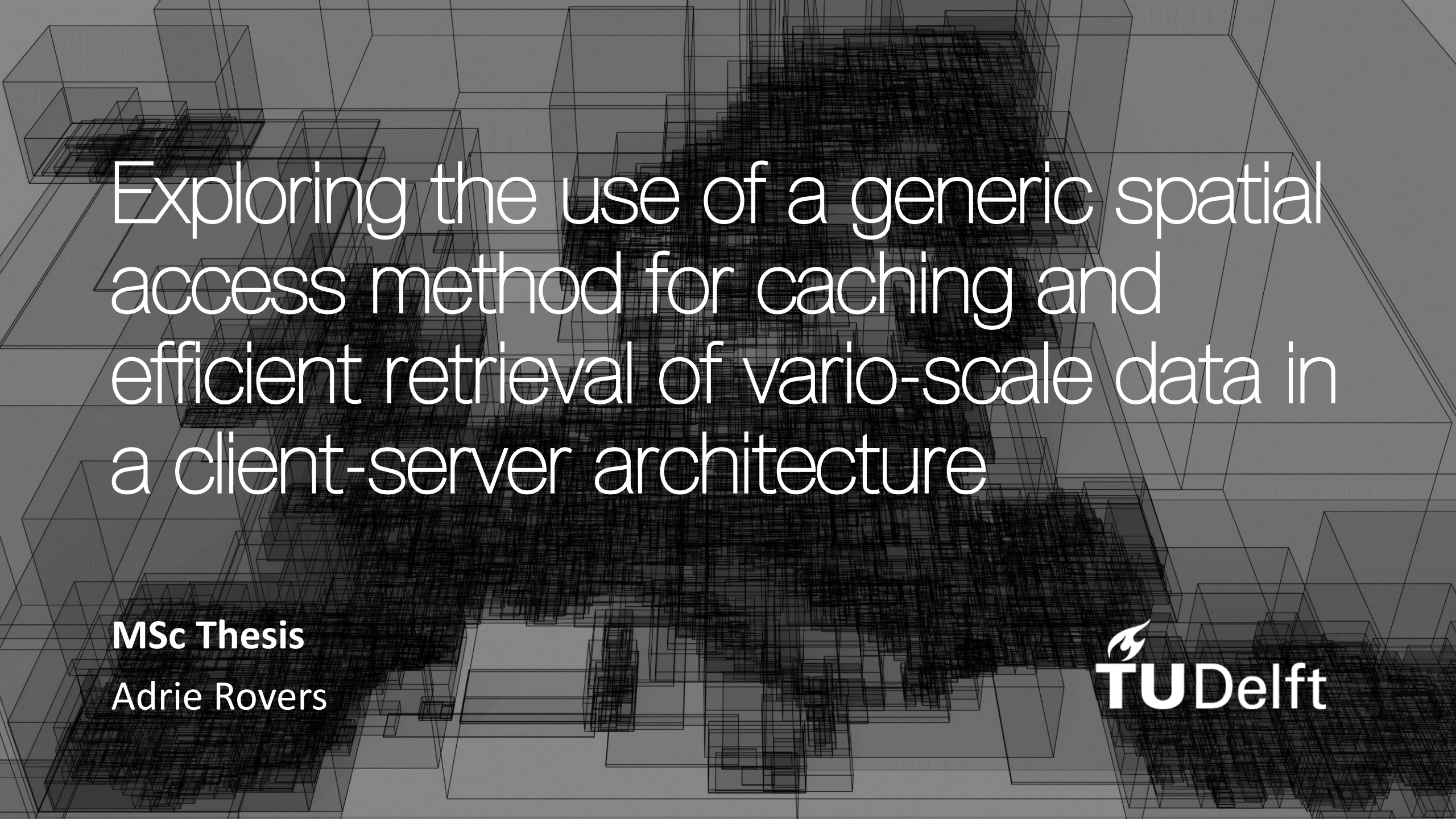

Exploring the use of a generic spatial access method for caching and efficient retrieval of vario-scale data in a client-server architecture

MSc Thesis

Adrie Rovers

TU Delft

Content overview

1. Motivation
2. Objectives
3. Methodology
4. Results
5. Future work

Content overview

1. **Motivation**
2. Objectives
3. Methodology
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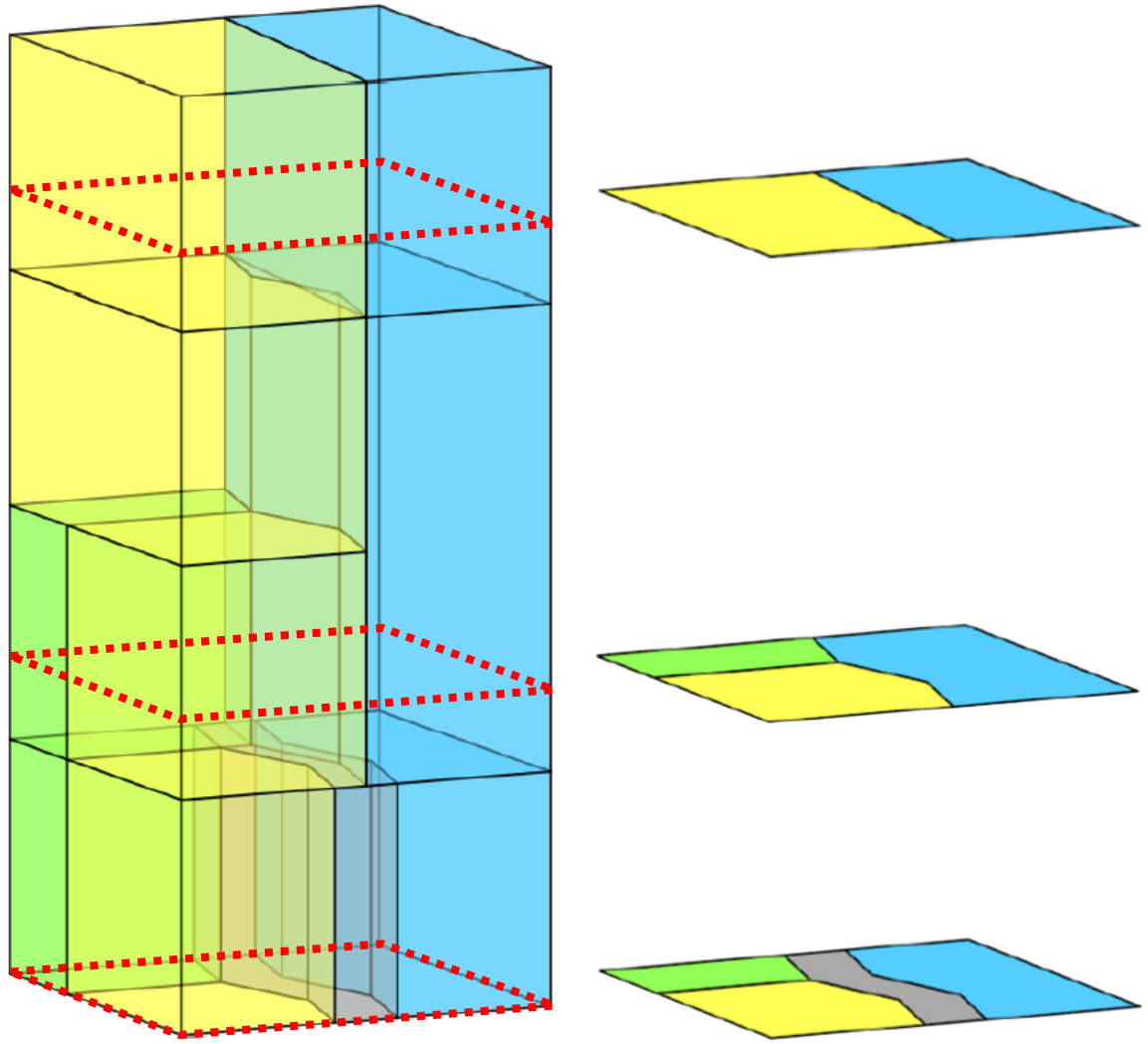
Motivation

- Vario-scale data structures
- Request a map in a client-server architecture



Classic SSC[1]

1: Taken from van Oosterom et al. (2014).

Motivation

Problem statement

Data needs to be transferred over a network:

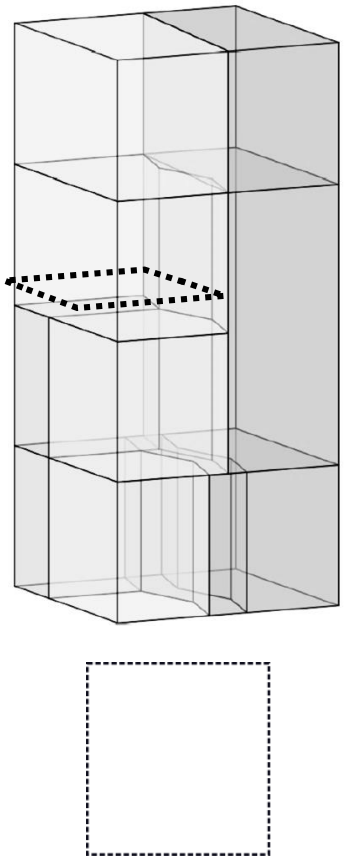
- Have to wait for a response, which can affect responsiveness of client
- Costs for every byte send over the network
- Set-up costs for every request: TCP/IP stack + HTTP headers

Opportunity

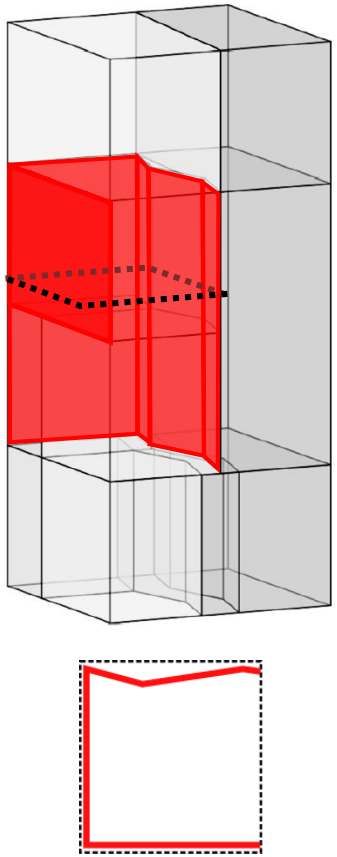
With vario-scale data, there is a possibility to reuse data that is already present on the client and to retrieve only missing data from the server.

Motivation

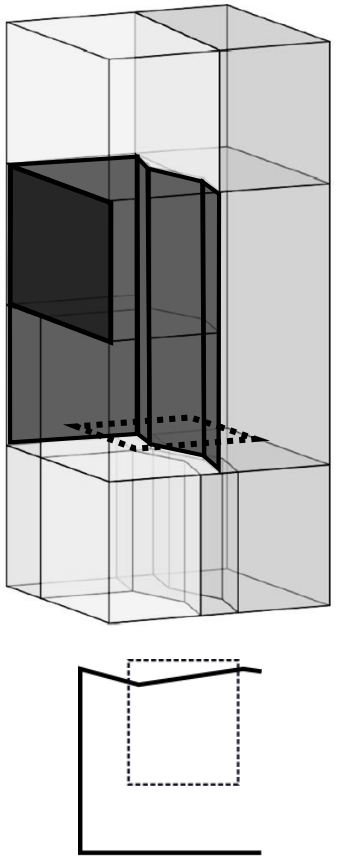
Viewport



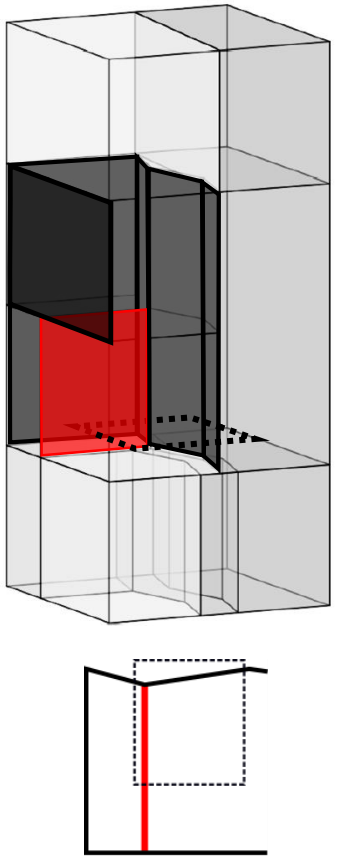
Request



Cached response



Delta request



Motivation

Overall goal

To achieve efficient communication, without too many redundant data transfers, for vario-scale data in a client-server architecture.

Need for research

A method is needed to use the client cache and to support the retrieval of partial vario-scale data from the server.

However, current methods are not yet optimal in terms of scalability and redundancy.

Content overview

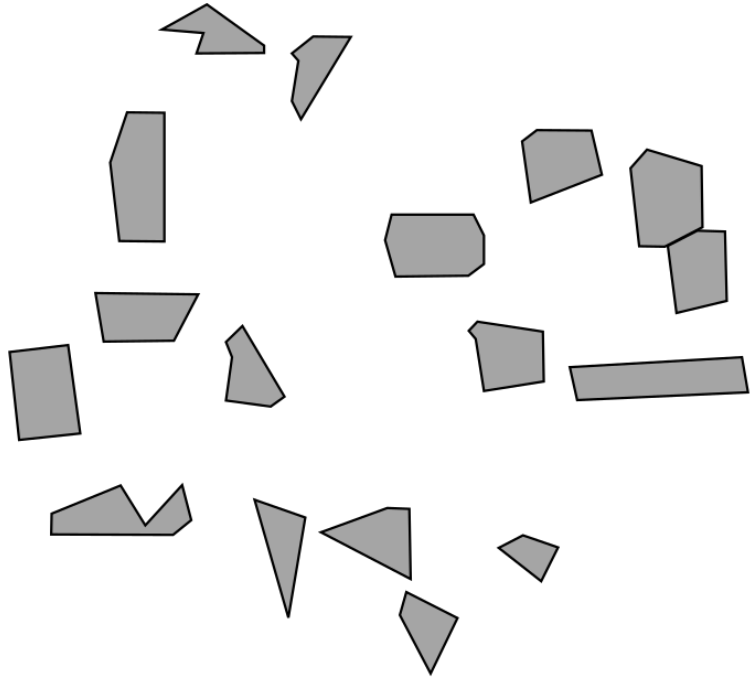
1. Motivation
2. **Objectives**
3. Methodology
4. Results
5. Future work

Objectives

1. Group data that are likely to be used together into packages on the server; based on scale and geographic extent,
2. use client cache to reuse data,
3. and let the client retrieve packages using a spatial index.

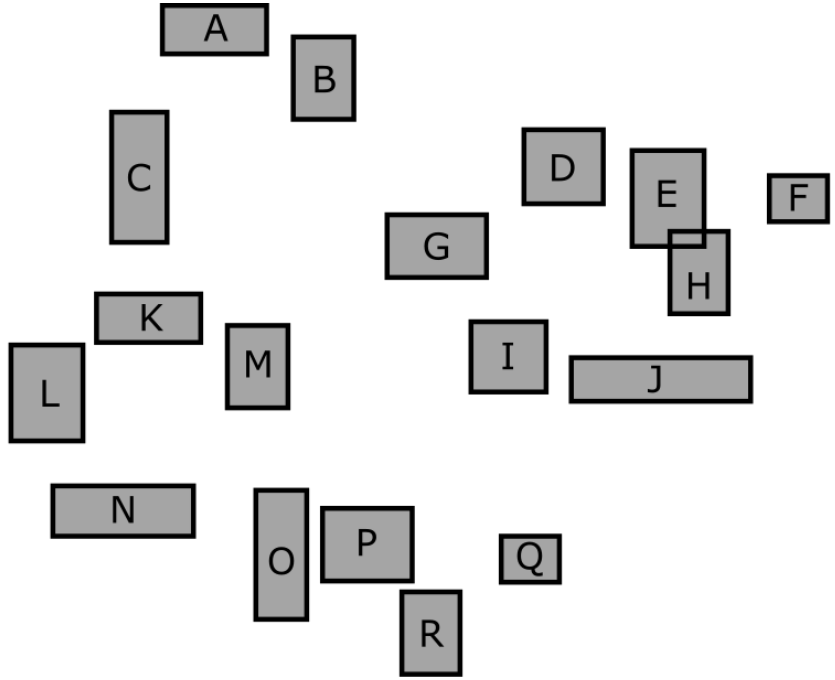
R-tree

- Hierarchical structure build on set of objects



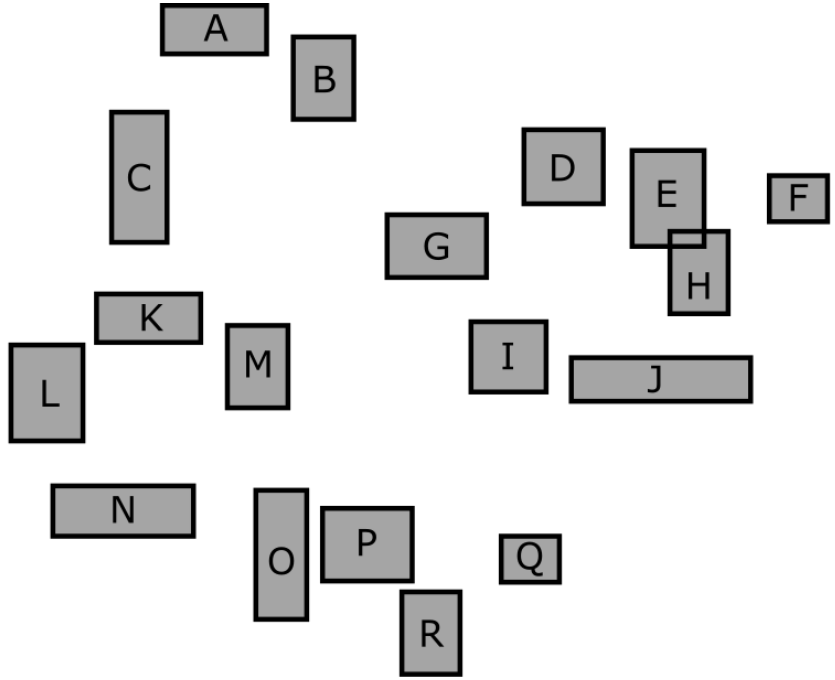
R-tree

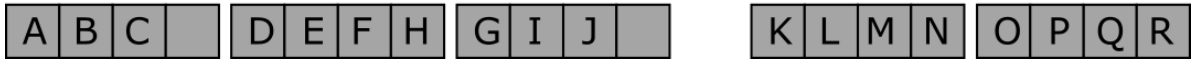
- Hierarchical structure build on set of objects
- Objects represented by BBOX



R-tree

- Hierarchical structure build on set of objects
- Objects represented by BBOX
- Lower-level nodes are recursively grouped together in higher-level nodes





R-tree

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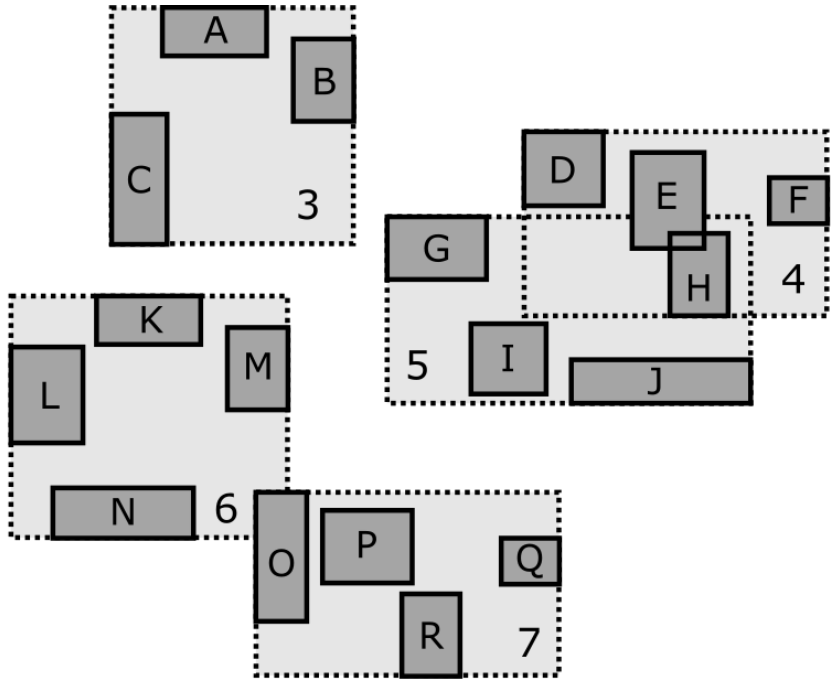

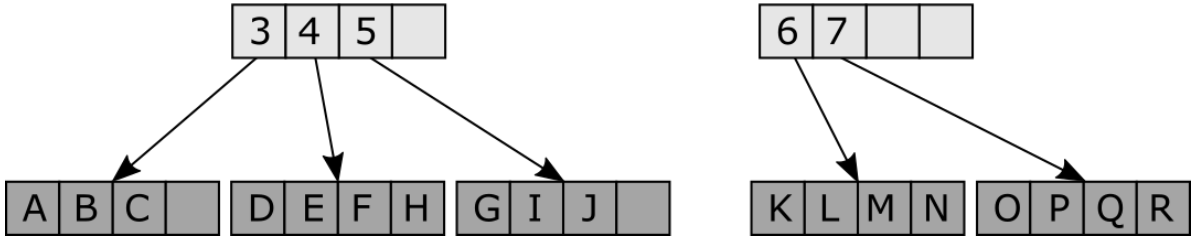

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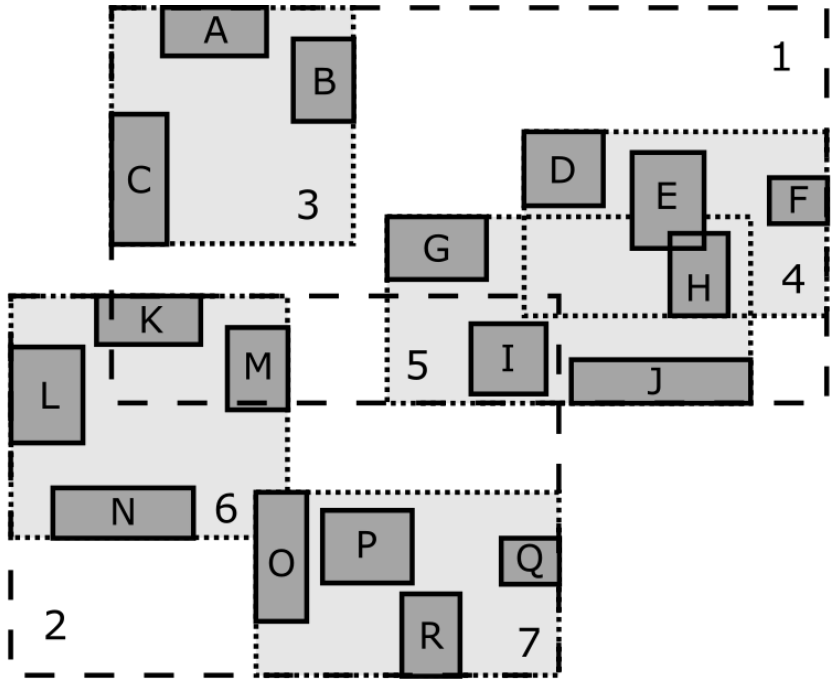
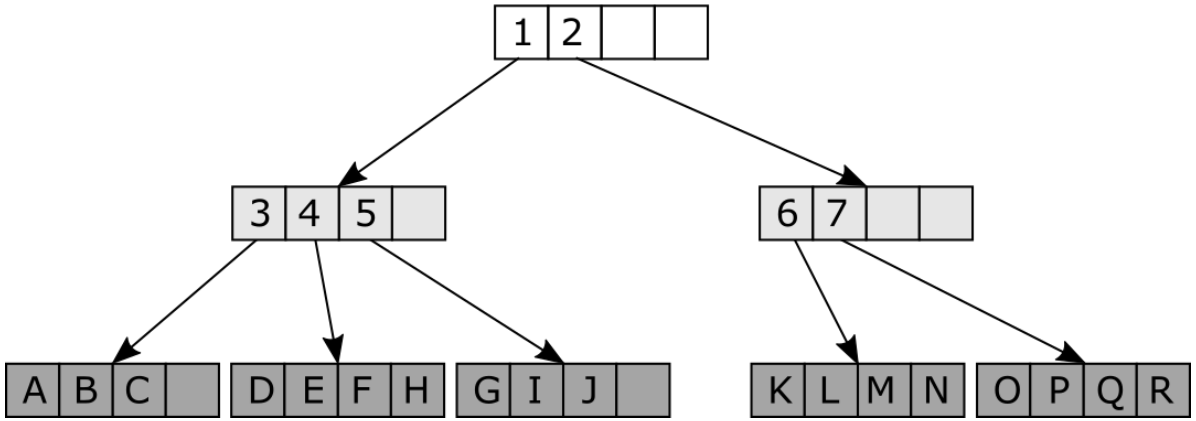
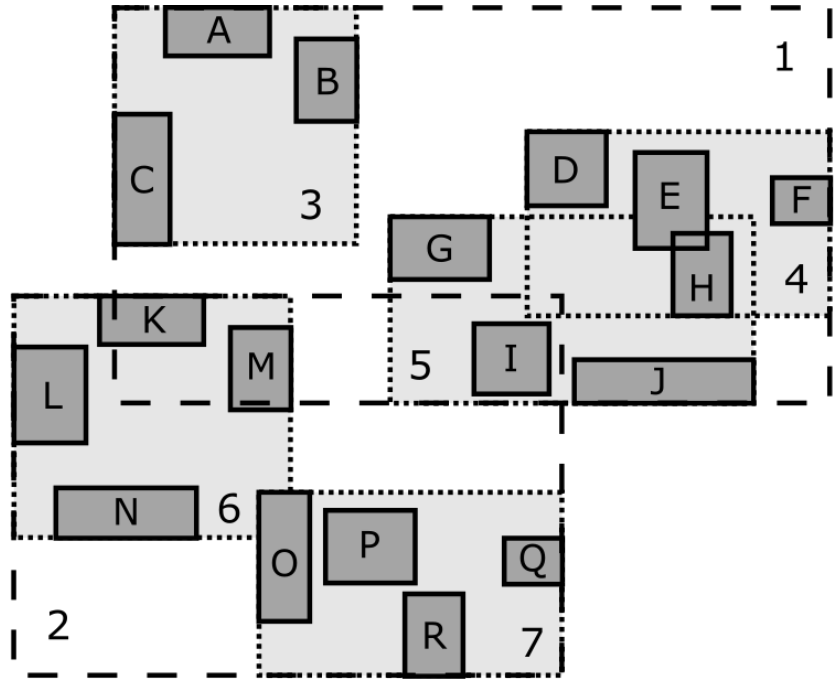
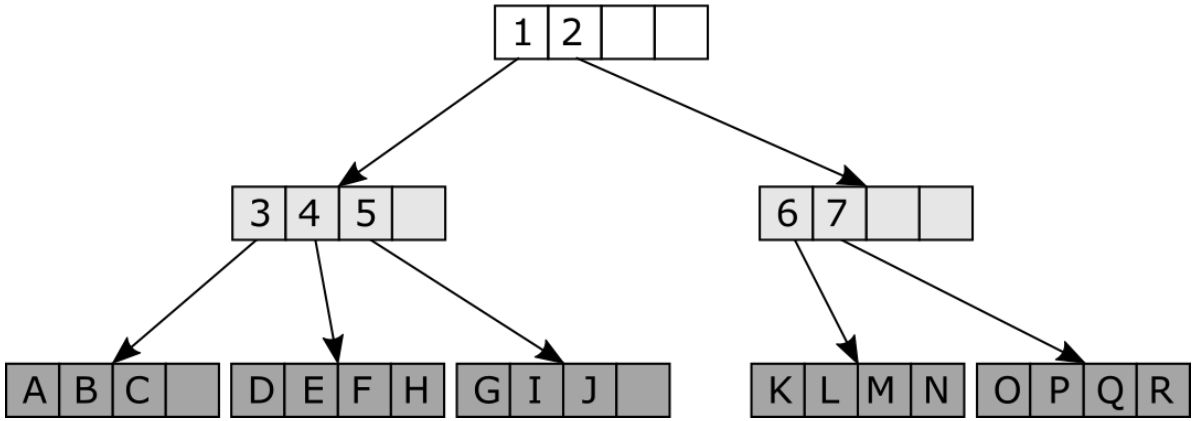




R-tree

- Hierarchical structure build on set of objects
- Objects represented by BBOX
- Lower-level nodes are recursively grouped together in higher-level nodes
- Nodes store the BBOX that encloses the entire sub-tree





R-tree

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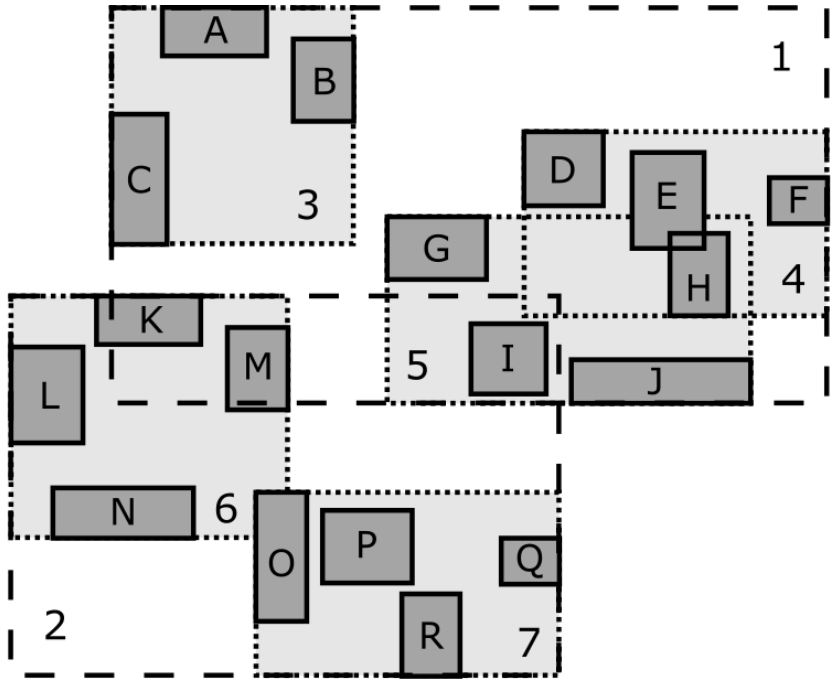
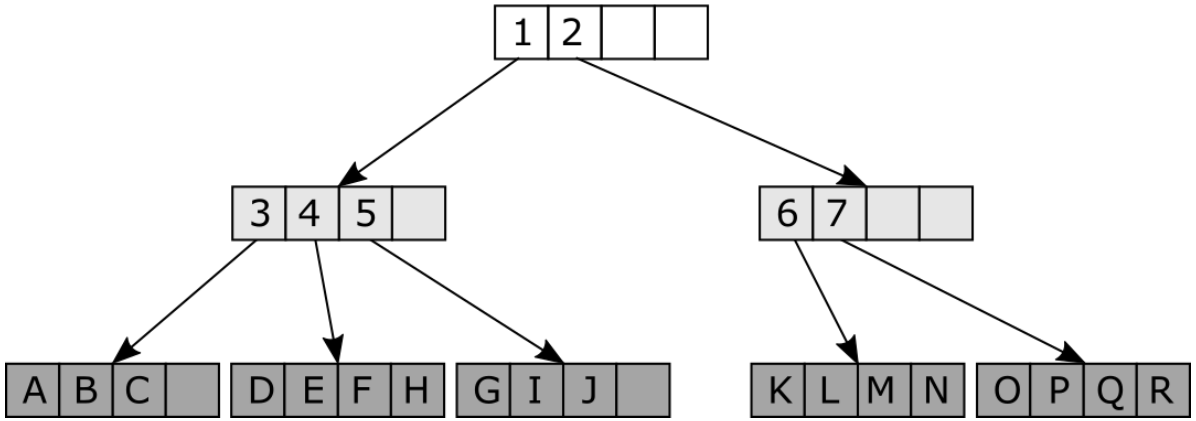
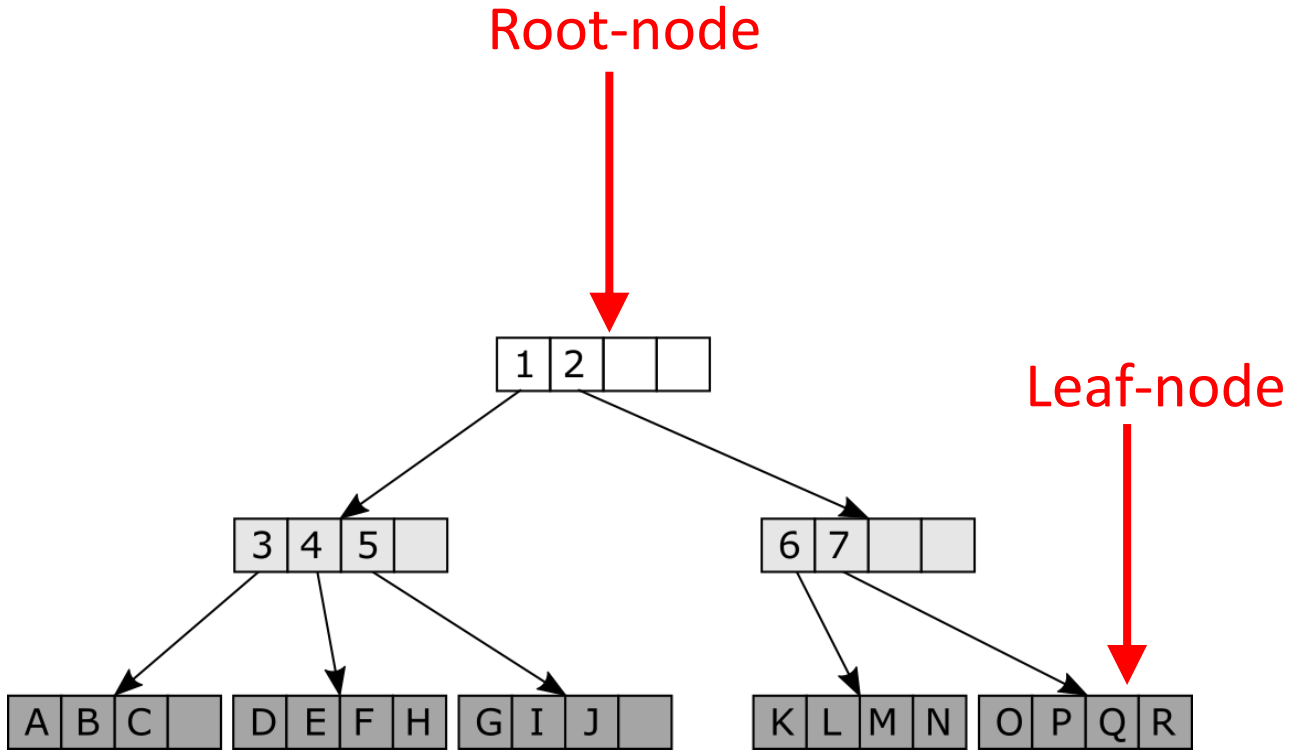
- Nodes store the BBOX that encloses the entire sub-tree
- BBOXES are allowed to have overlap





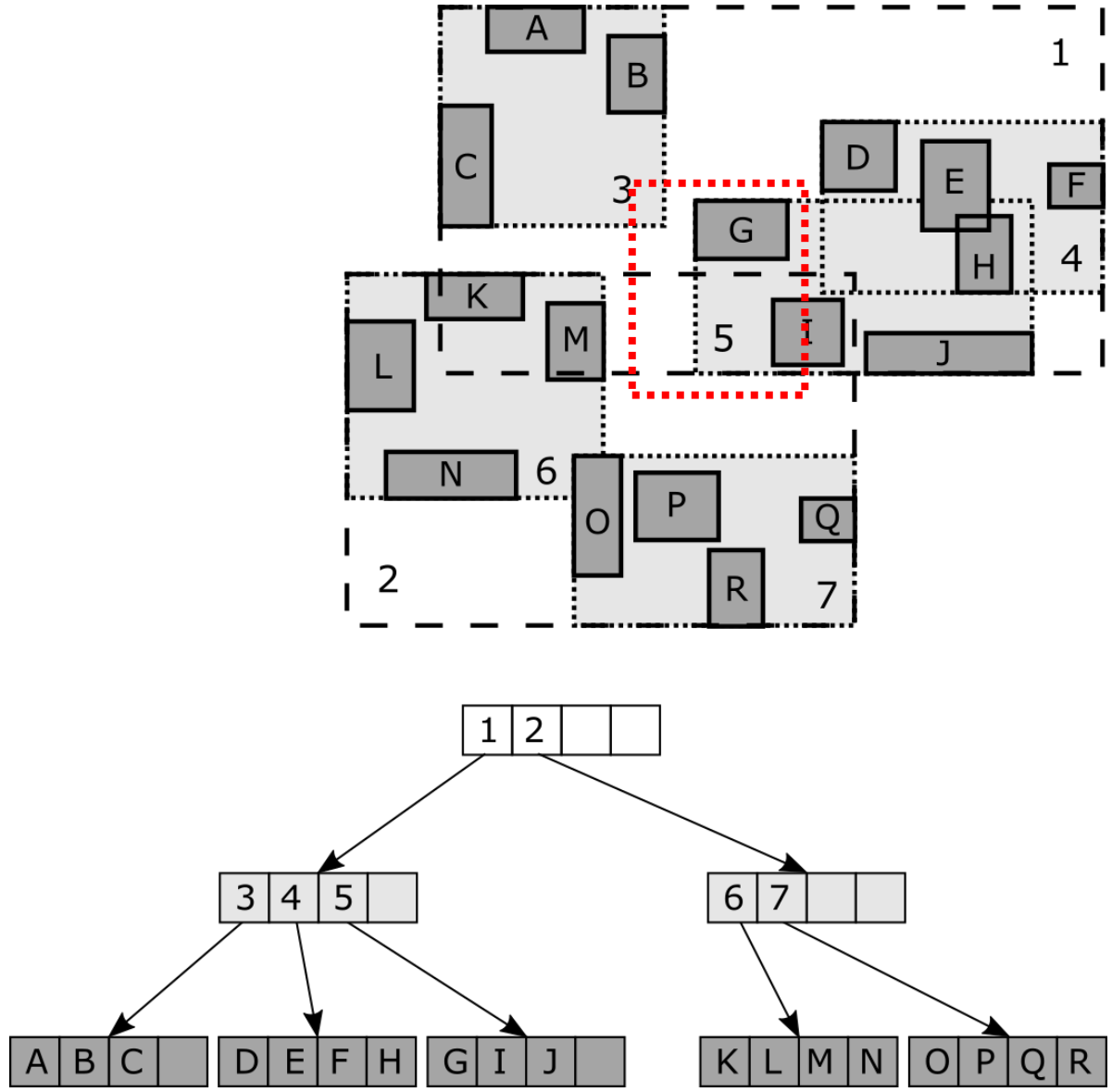
R-tree

- Search starts at root-node
- Leaf nodes usually contain pointers to data



R-tree

- Search starts at root-node
- Leaf nodes usually contain pointers to data
- Tree can be searched by testing for intersection on the BBOXES



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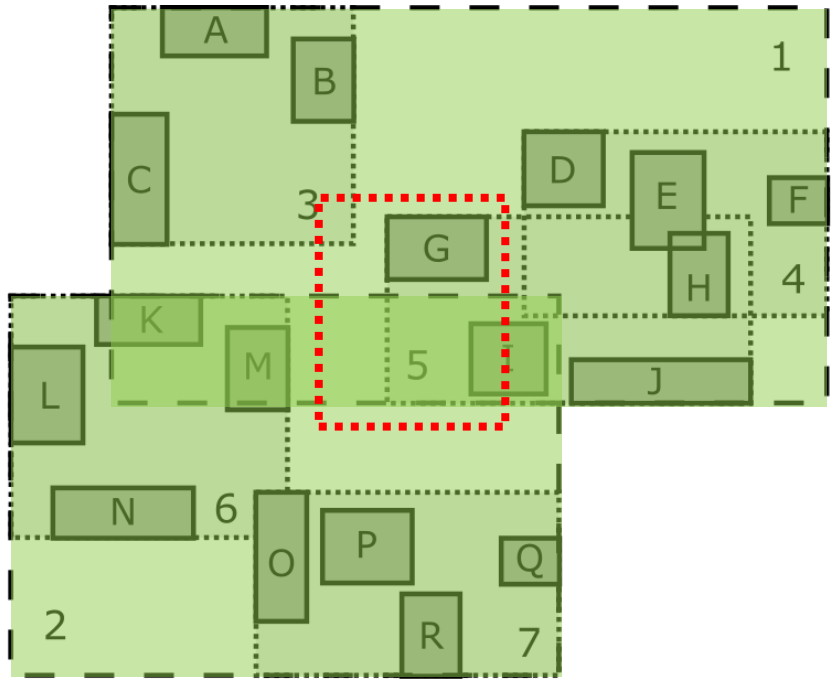

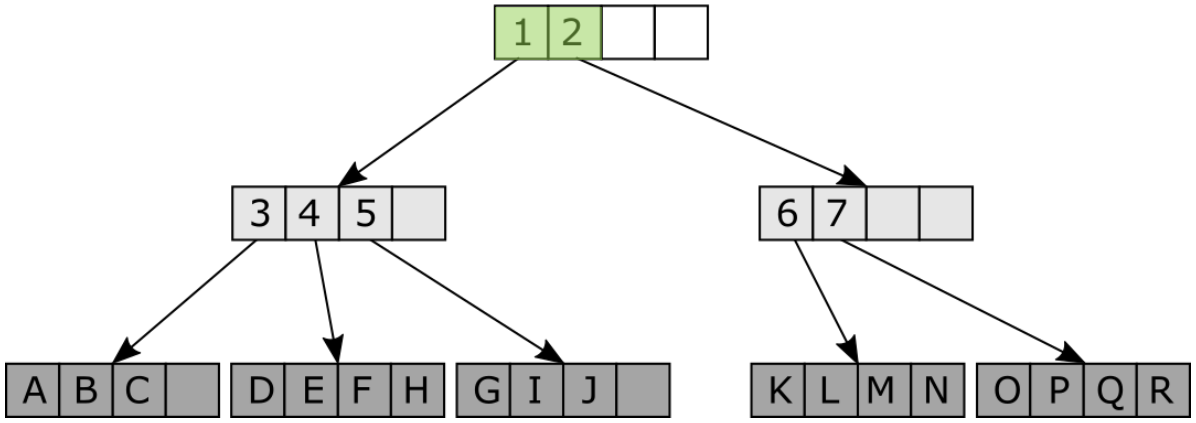

R-tree

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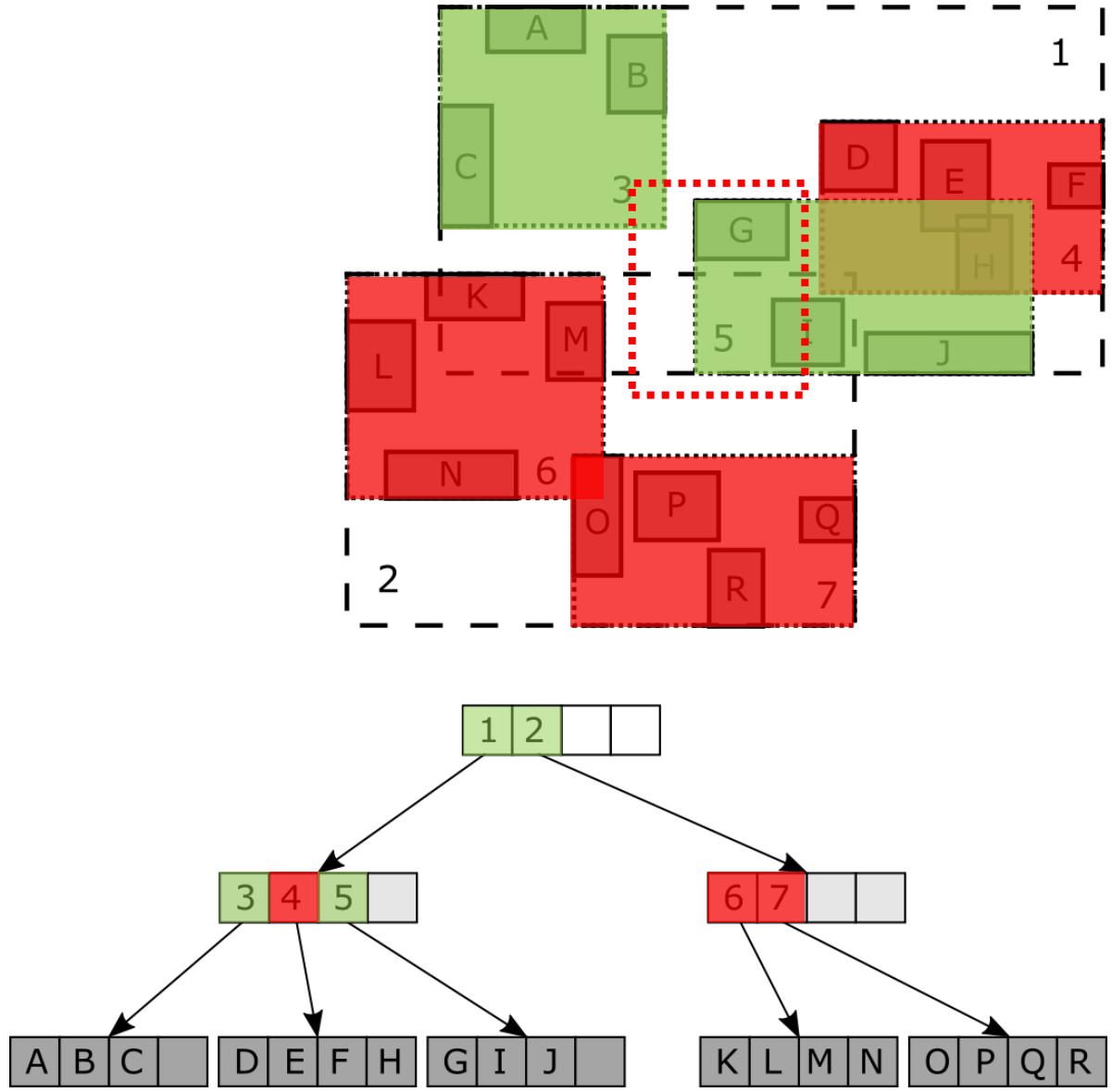
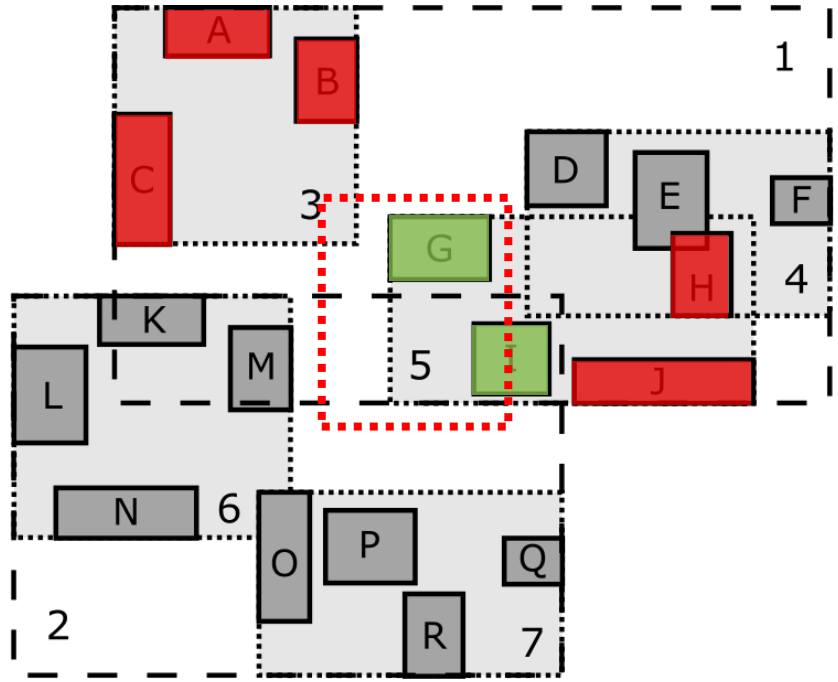
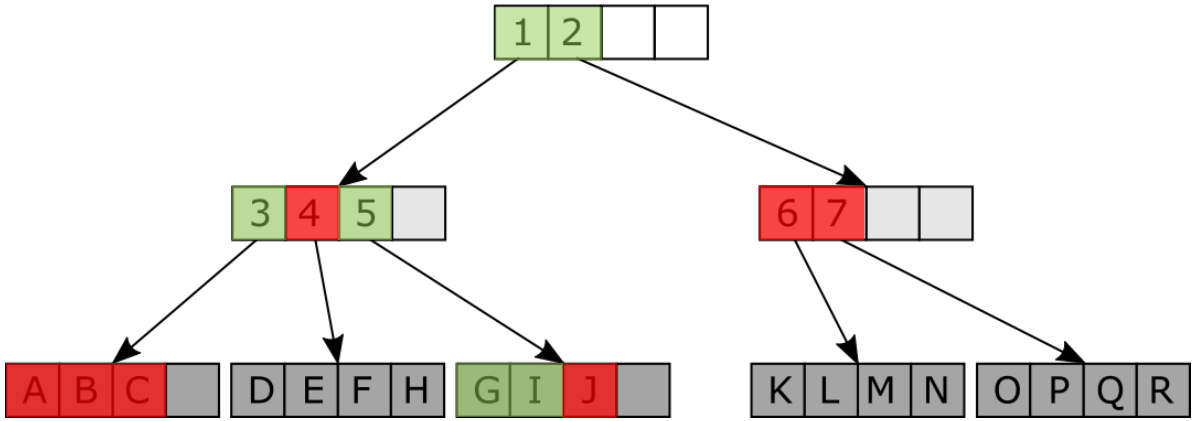


R-tree

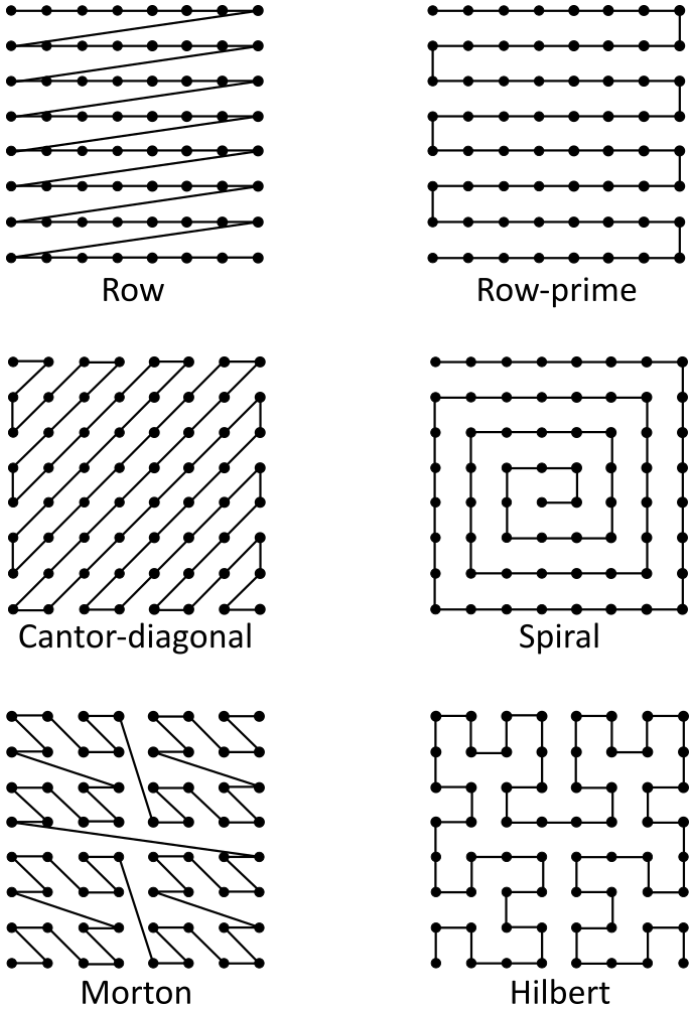
- Search starts at root-node
- Leaf nodes usually contain pointers to data
- Tree can be searched by testing for intersection on the BBOXES
- If there is no intersection with a higher-level node there can be no intersection with any of its children





R-tree

- How to achieve good clustering, i.e. efficiently group objects together?
  - **Top-down:** Repeatedly insert new objects and placing them in those nodes that need the least enlargement
  - **Bottom-up:** By imposing a linear ordering on the objects using a Space Filling Curve
    - A SFC unravels higher dimensional space into a single dimension while preserving spatial proximity



Different space filling curves in 2D

R-tree

- How to achieve good clustering, i.e. efficiently group objects together?
  - **Top-down:** Repeatedly insert new objects and placing them in those nodes that need the least enlargement
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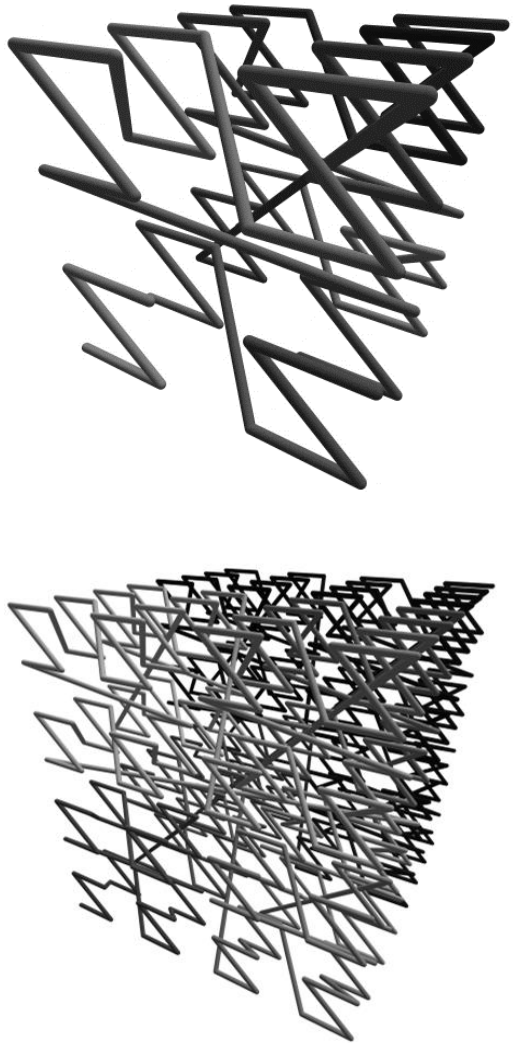

Morton curve in 3D

Images adapted from http://asgerhoedt.dk/?p=276

Content overview

1. Motivation
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3. **Methodology**
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Methodology

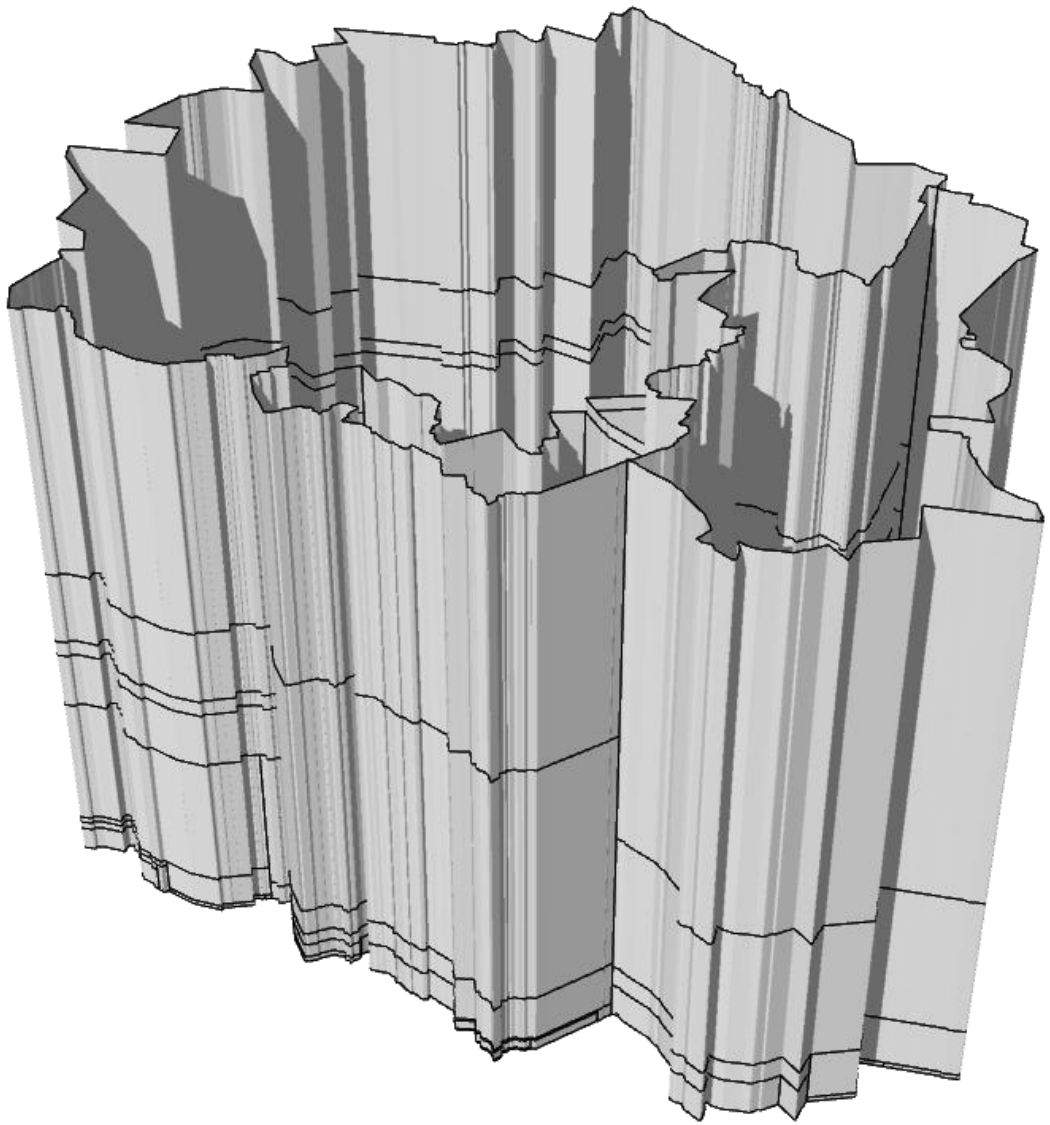
Design requirements

Restrictions placed on the method to make it suitable for use in a client-server architecture.

Methodology

Requirements for packages:

- Approximately equal size in bytes



Methodology

Requirements for packages:

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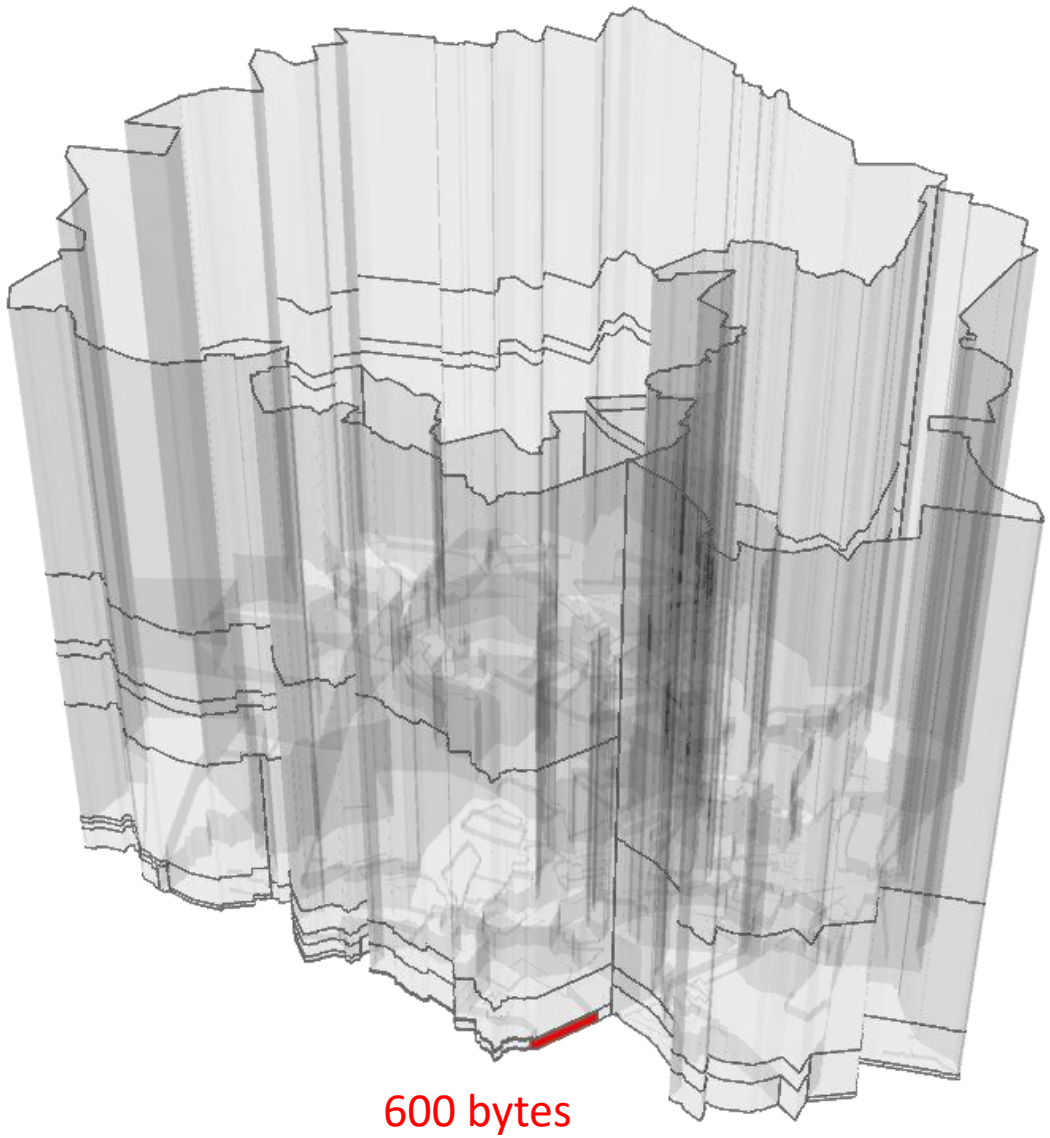

Methodology

Requirements for packages:

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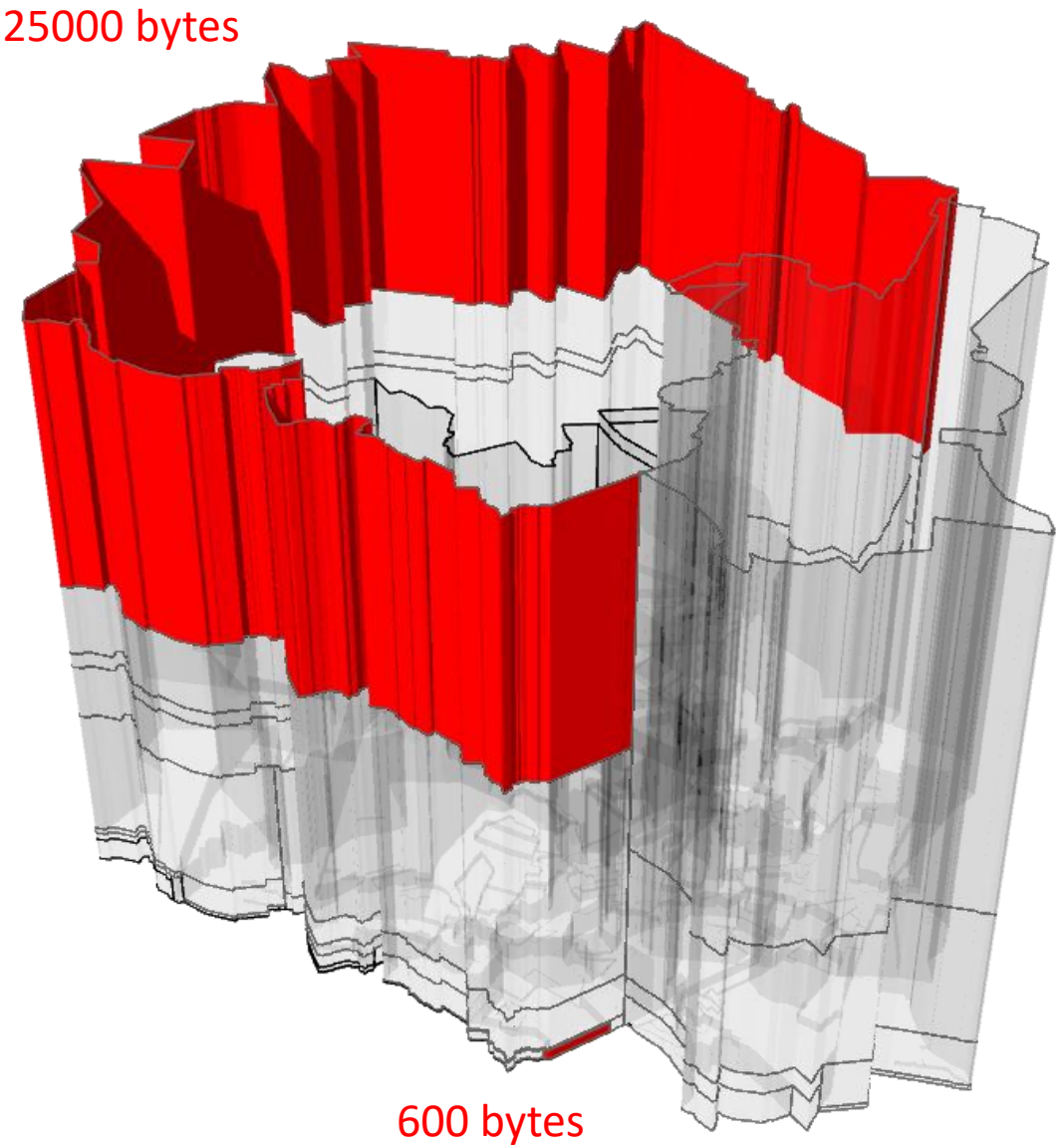


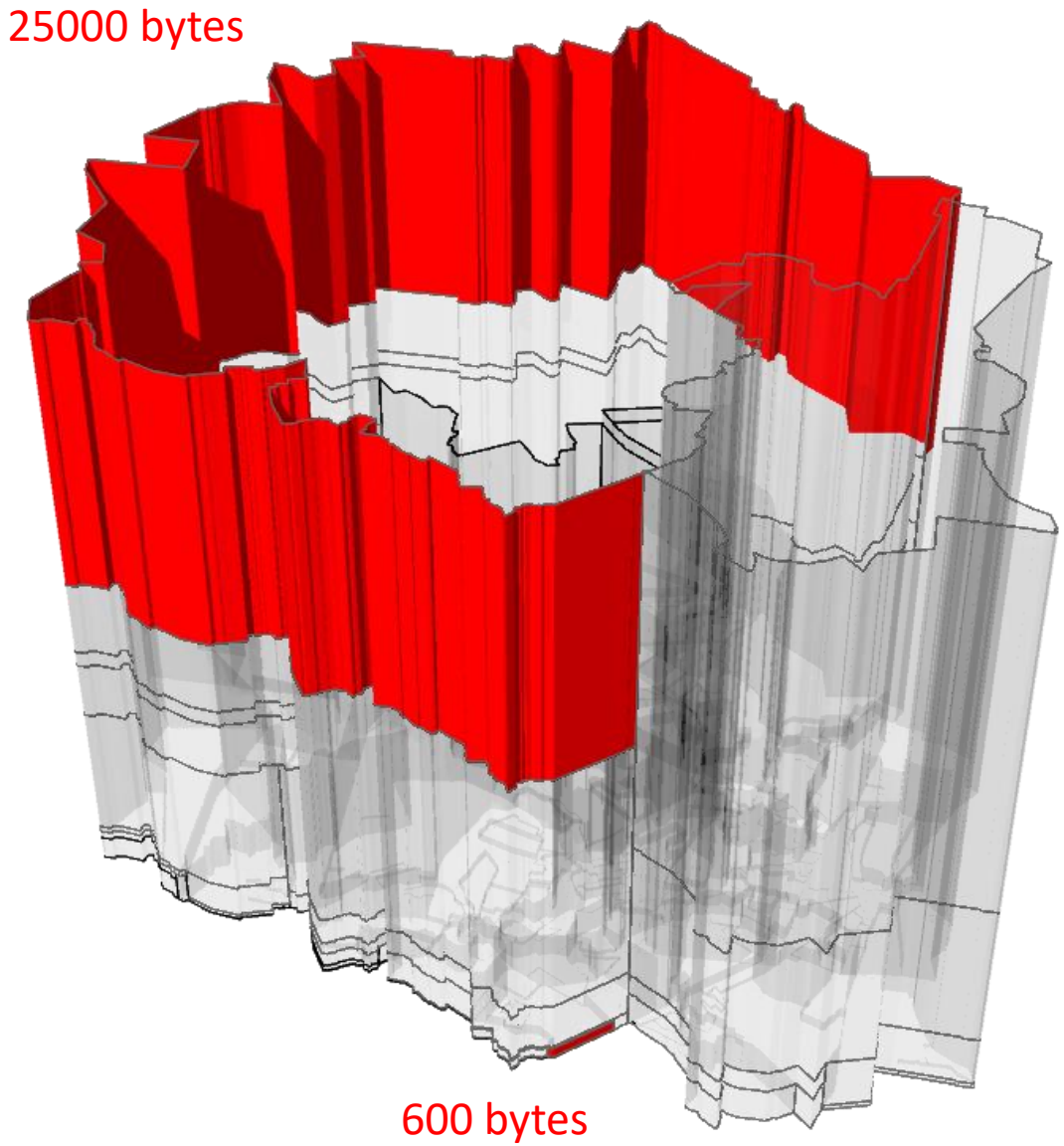
Methodology

Requirements for packages:

- Approximately equal size in bytes

Requirements for the index:

- Axis aligned BBOX
- Leaf nodes refer to packages
- Tree is balanced
- Full space utilization



Methodology

Pre-processing

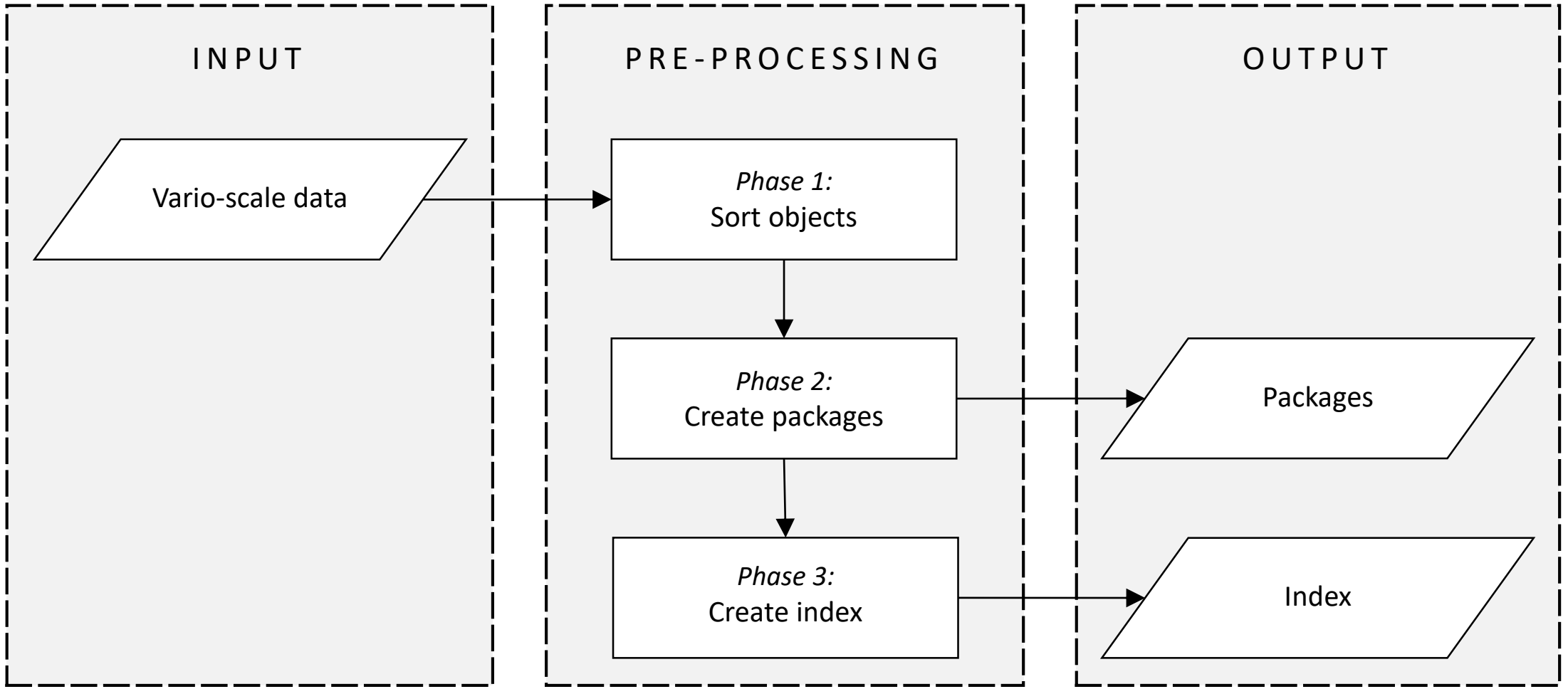
Creating the spatial index and the packages from the source data.

Using the structures

Use of the index structure by the client and processing the packages to make a map.

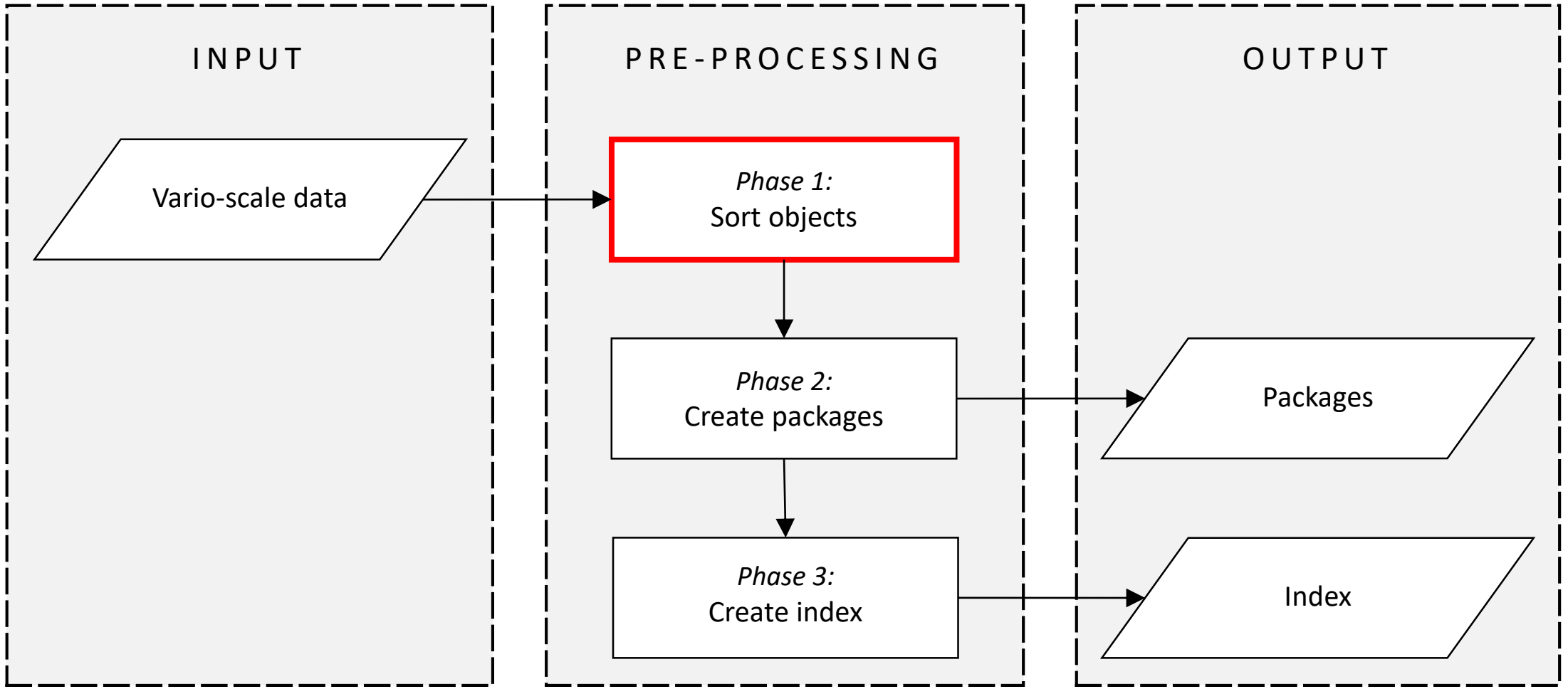
Methodology

Pre-processing



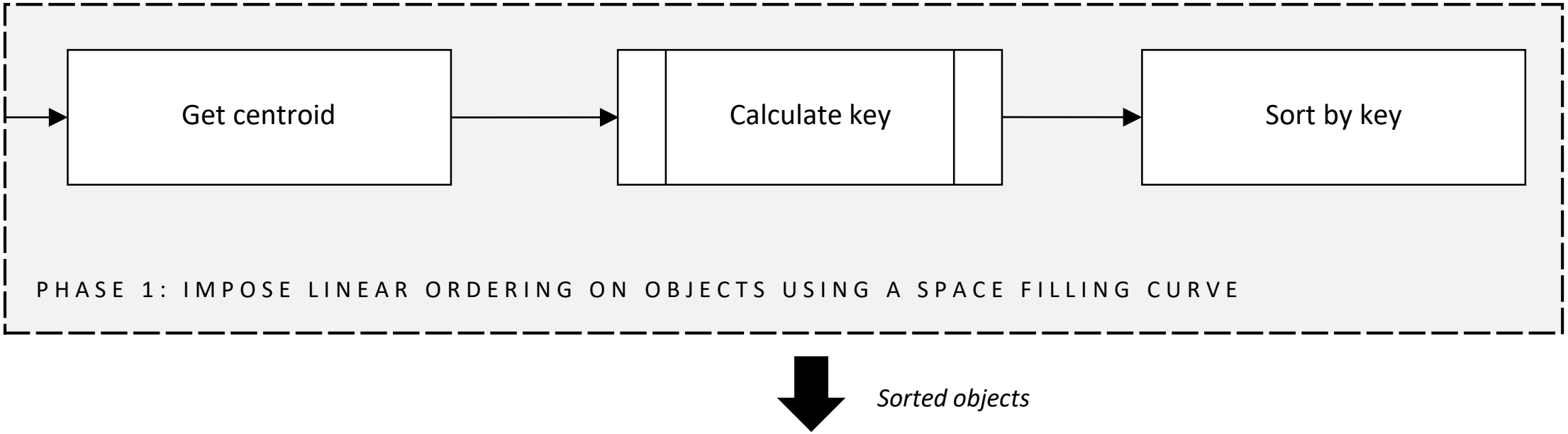
Methodology

Pre-processing



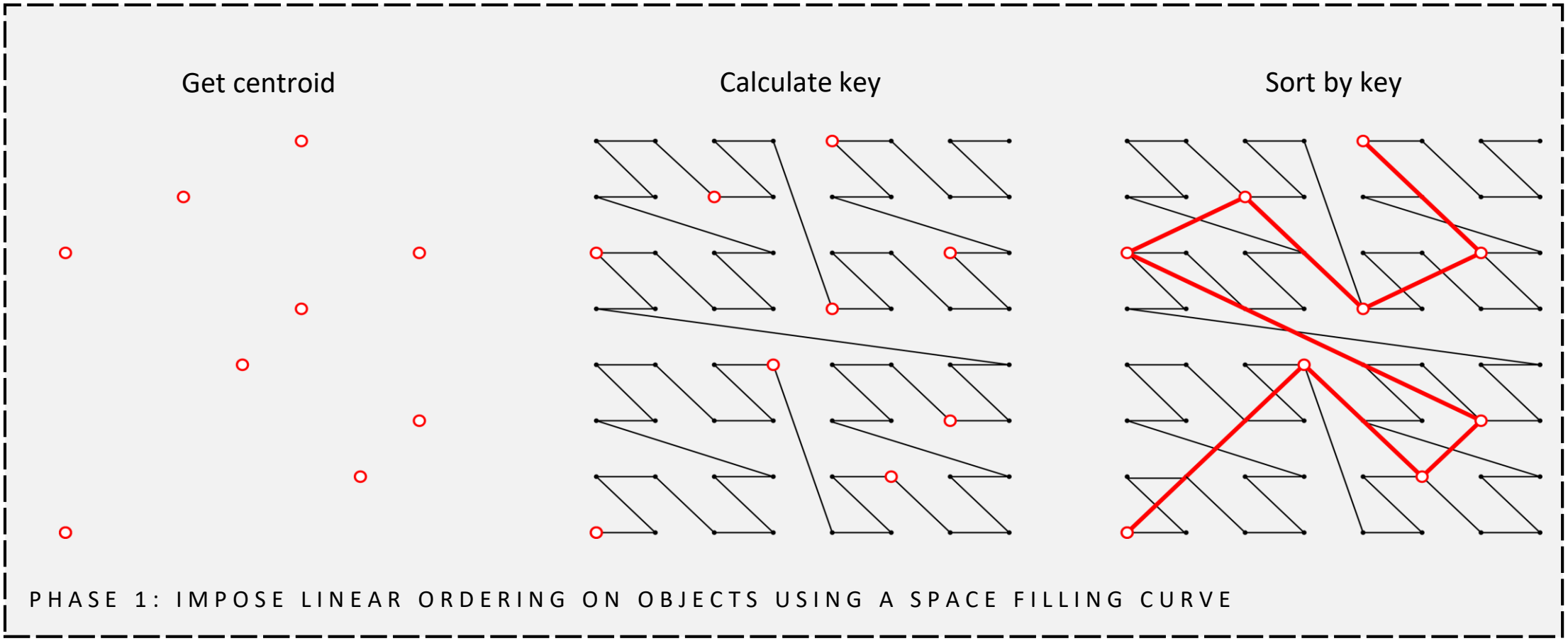
Methodology

Pre-processing



Methodology

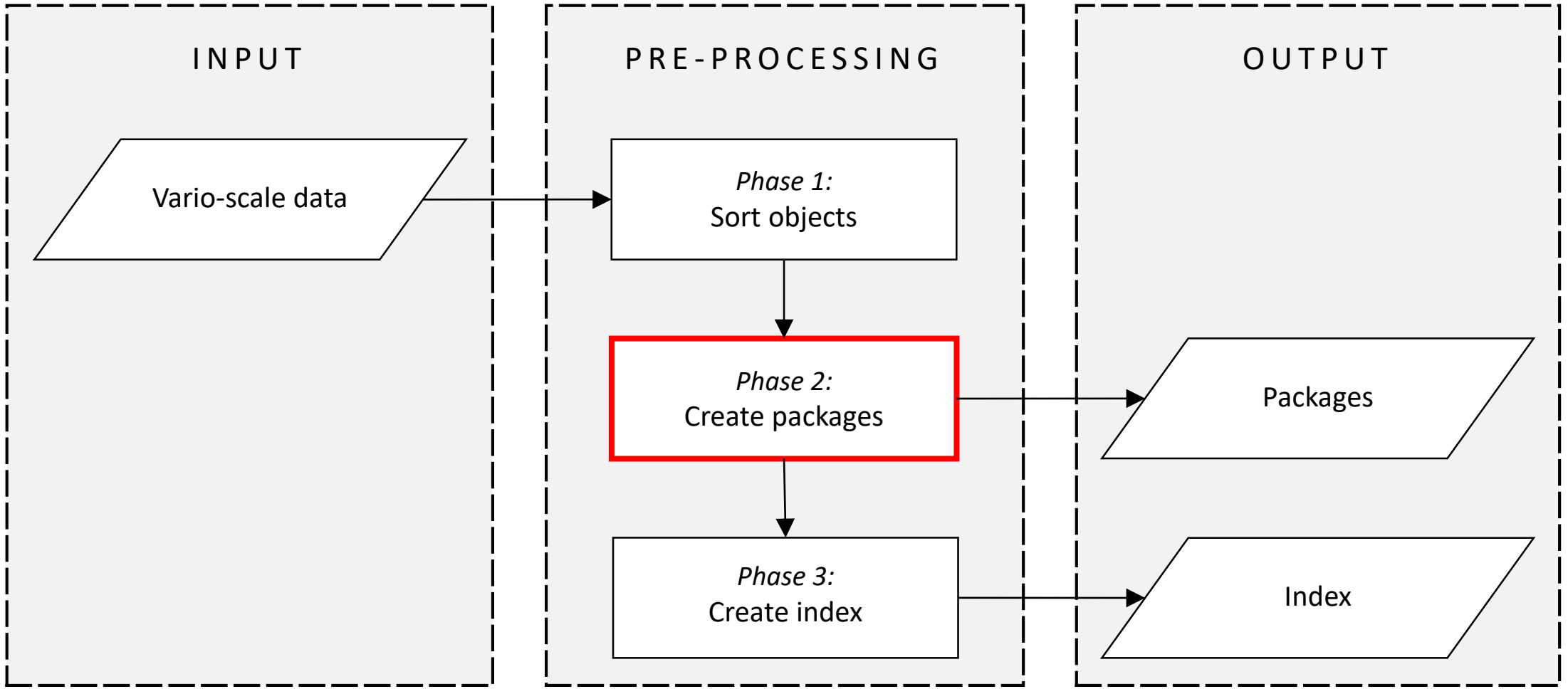
Pre-processing



Sorted objects

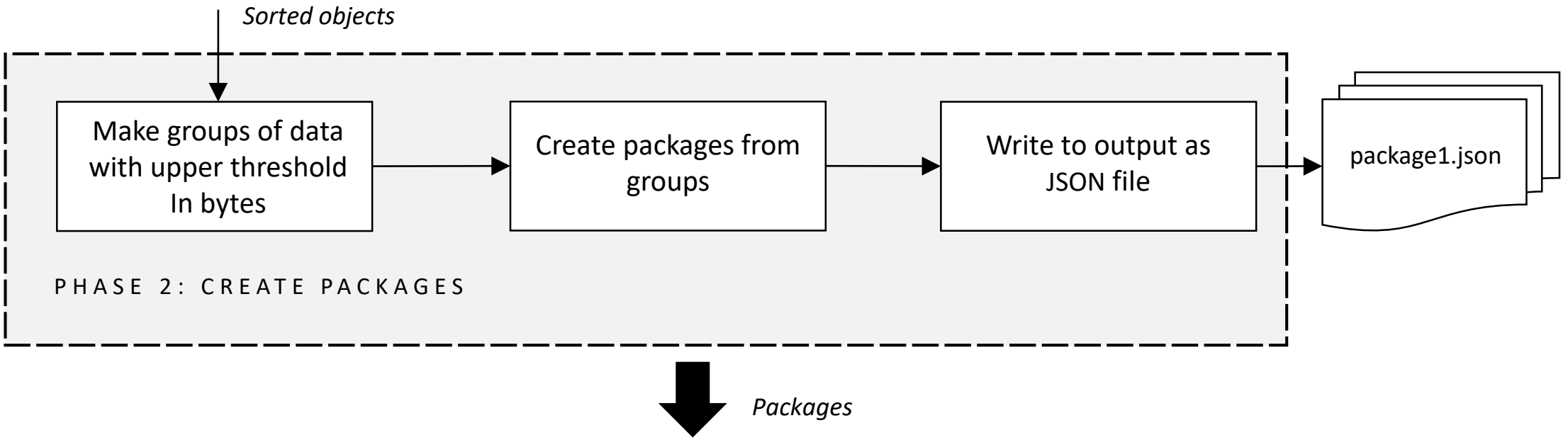
Methodology

Pre-processing



Methodology

Pre-processing



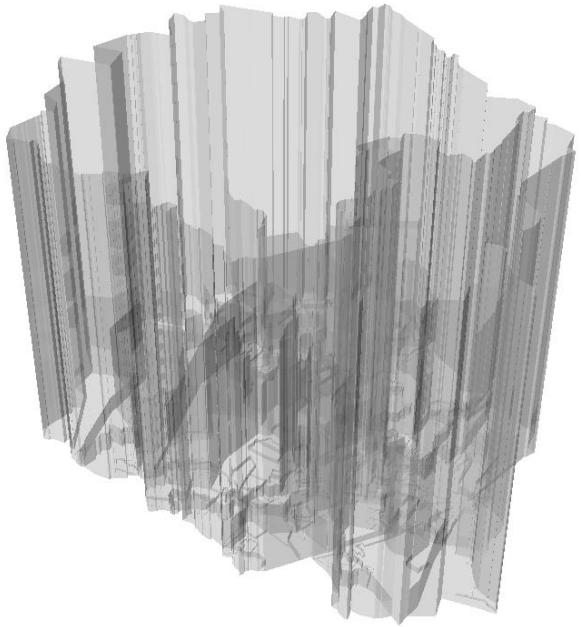
Requirement for packages:

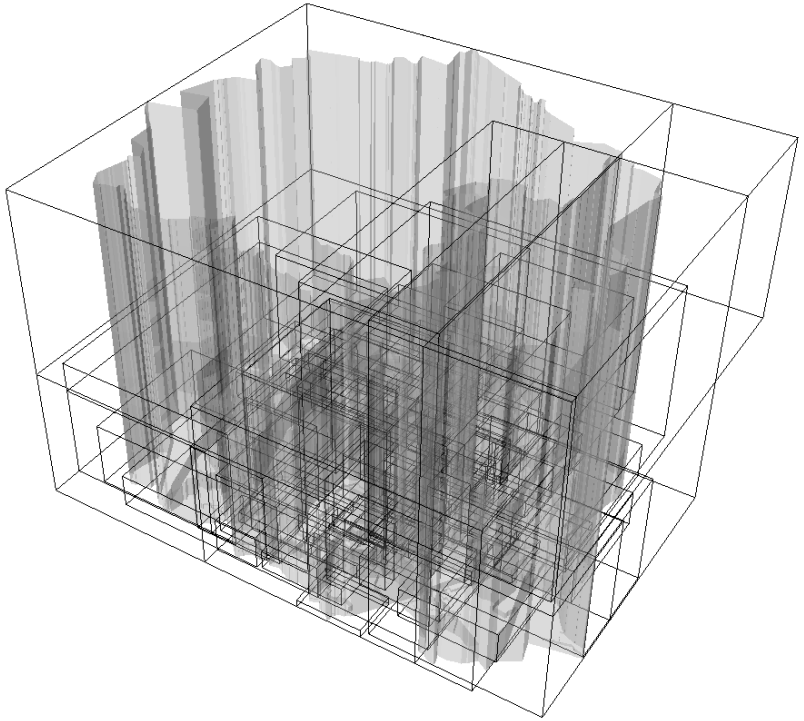
✓ Approximately equal size in bytes

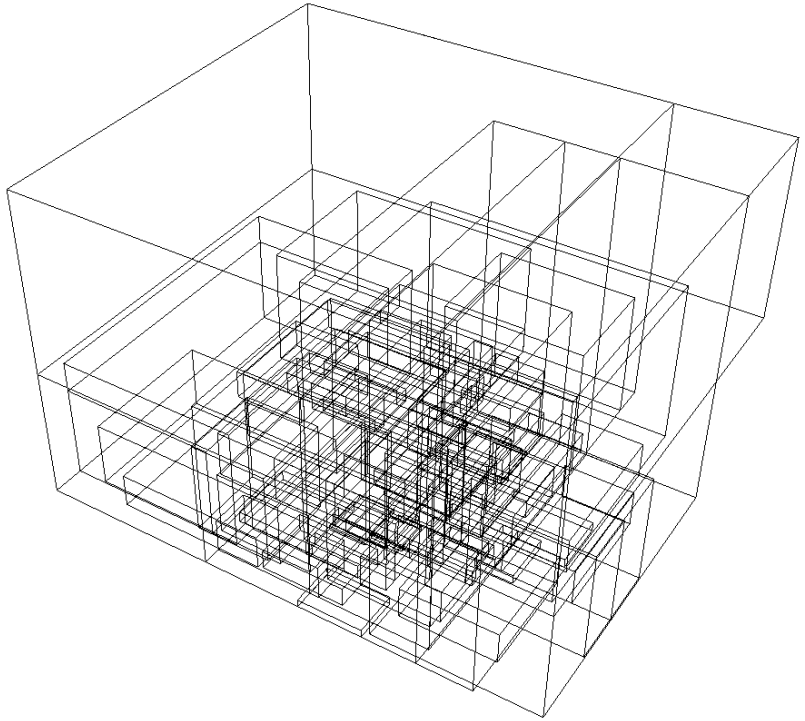
Methodology

Pre-processing

Example of clustering



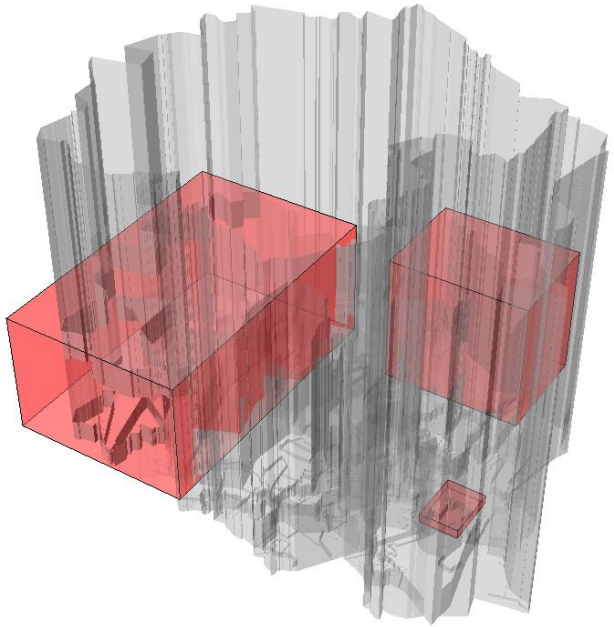


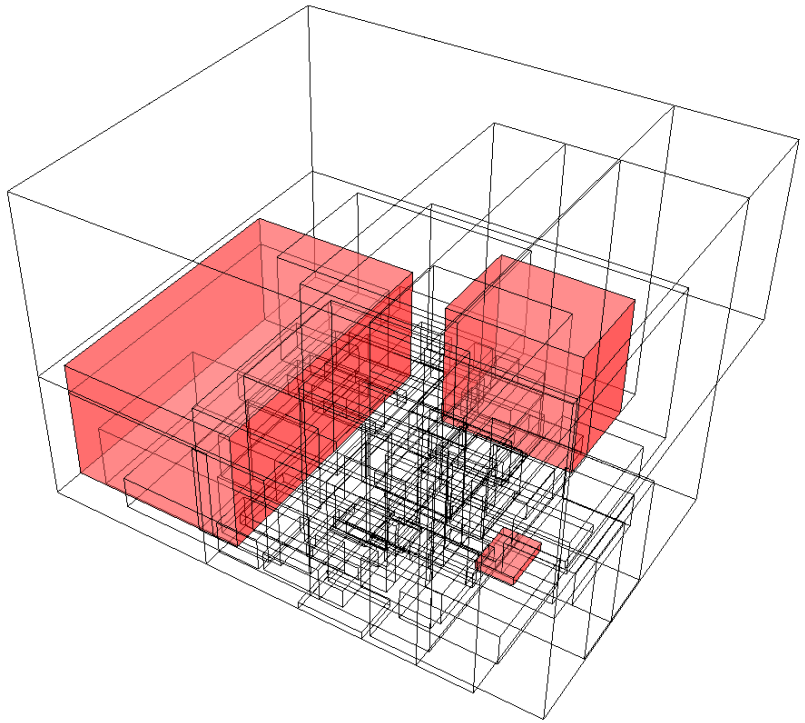


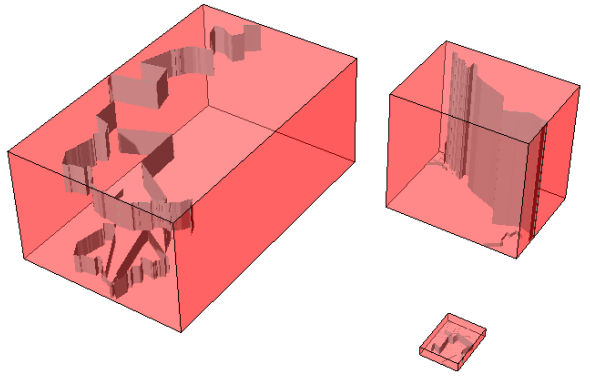
Methodology

Pre-processing

Example of clustering

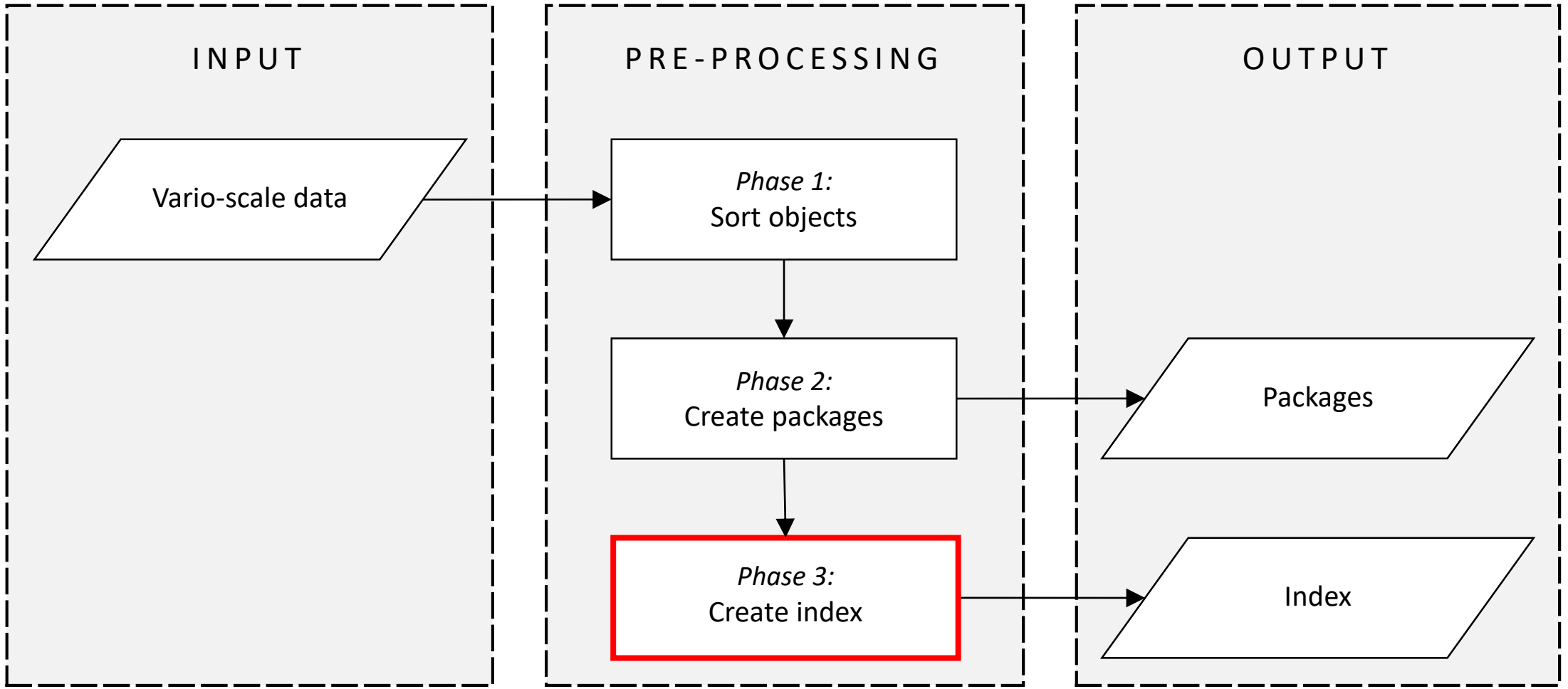






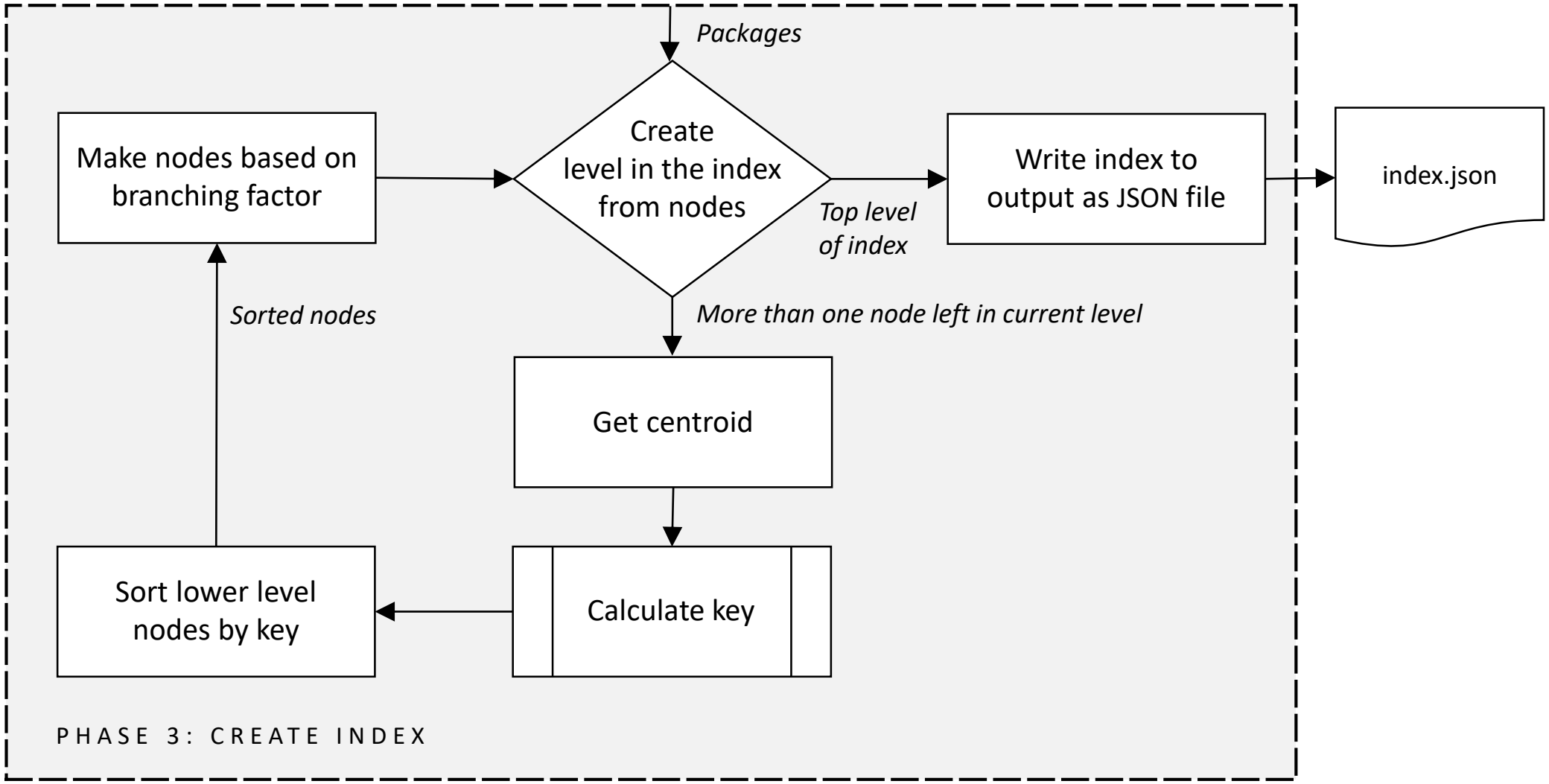
Methodology

Pre-processing



Methodology

Pre-processing

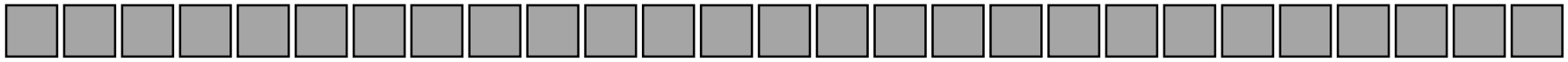


Methodology

Pre-processing

PHASE 3: CREATE INDEX

Input: Sorted packages



23 28 29 33 ..... 78 91 98

Methodology

Pre-processing

PHASE 3: CREATE INDEX

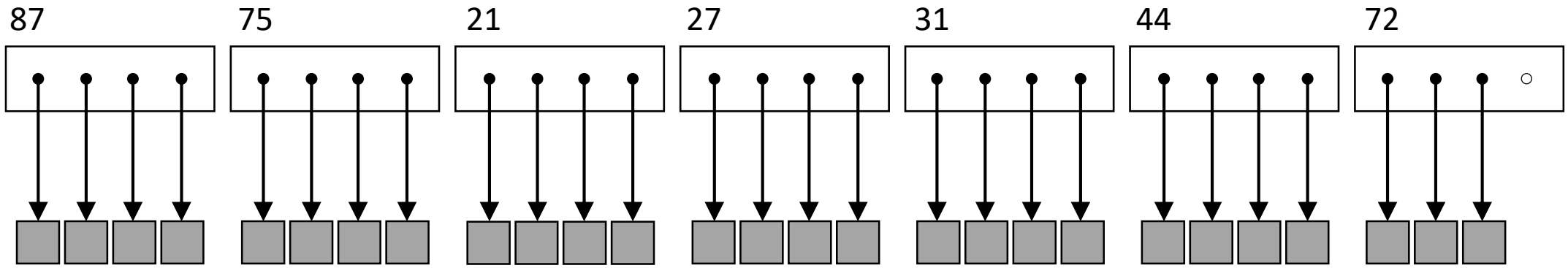
Step 1: Make groups based on branching factor

Methodology

Pre-processing

PHASE 3: CREATE INDEX

Step 2: Create nodes and calculate key value for each node

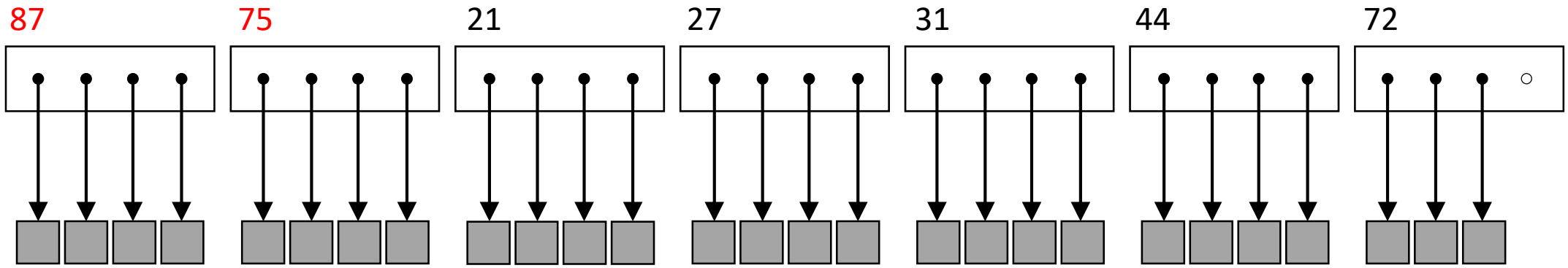


Methodology

Pre-processing

PHASE 3: CREATE INDEX

Step 3: Sort nodes based on key value

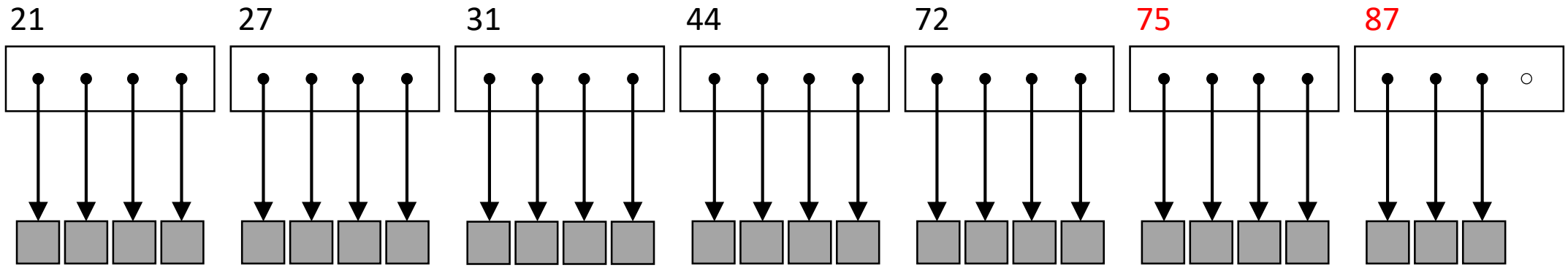


Methodology

Pre-processing

PHASE 3: CREATE INDEX

Step 3: Sort nodes based on key value

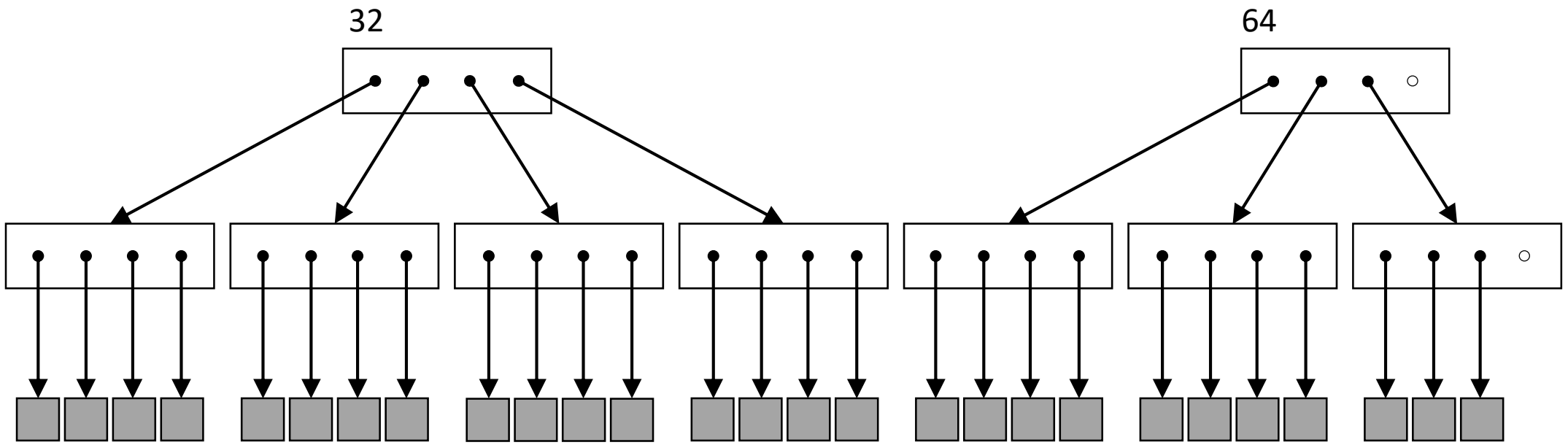


Methodology

Pre-processing

PHASE 3: CREATE INDEX

Step 4: Recursively create higher level nodes until root node is reached

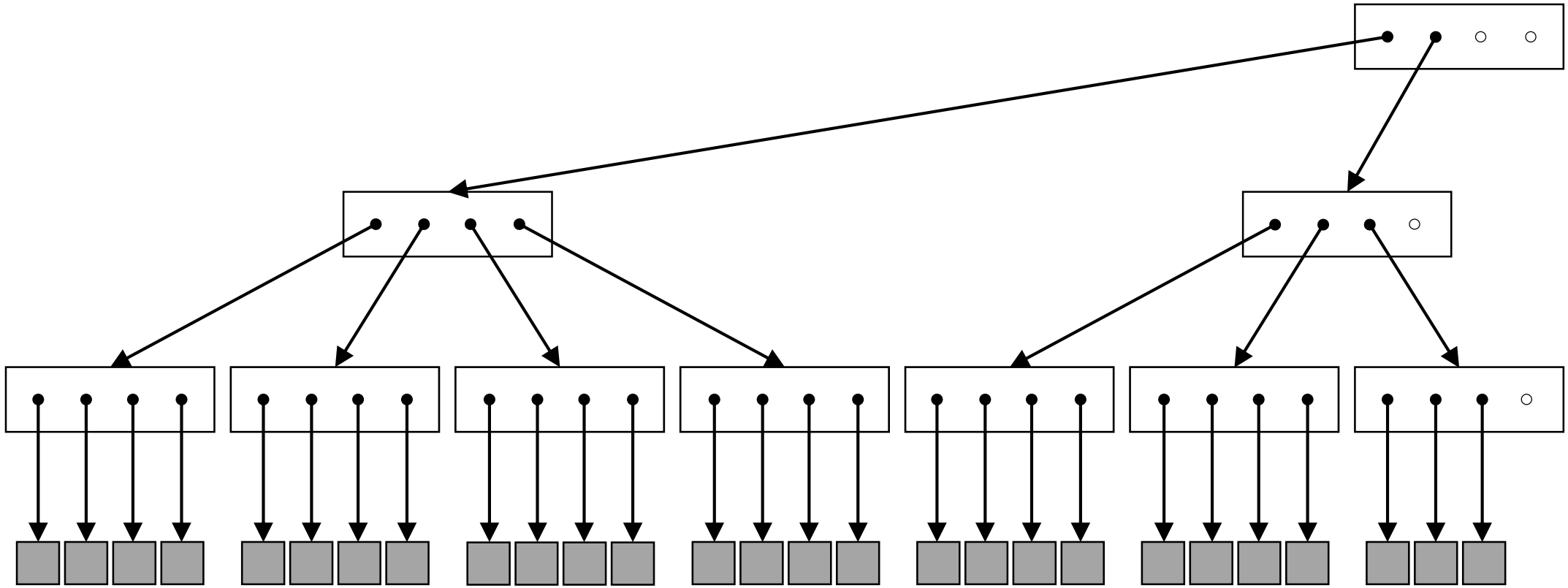


Methodology

Pre-processing

PHASE 3: CREATE INDEX

Full index



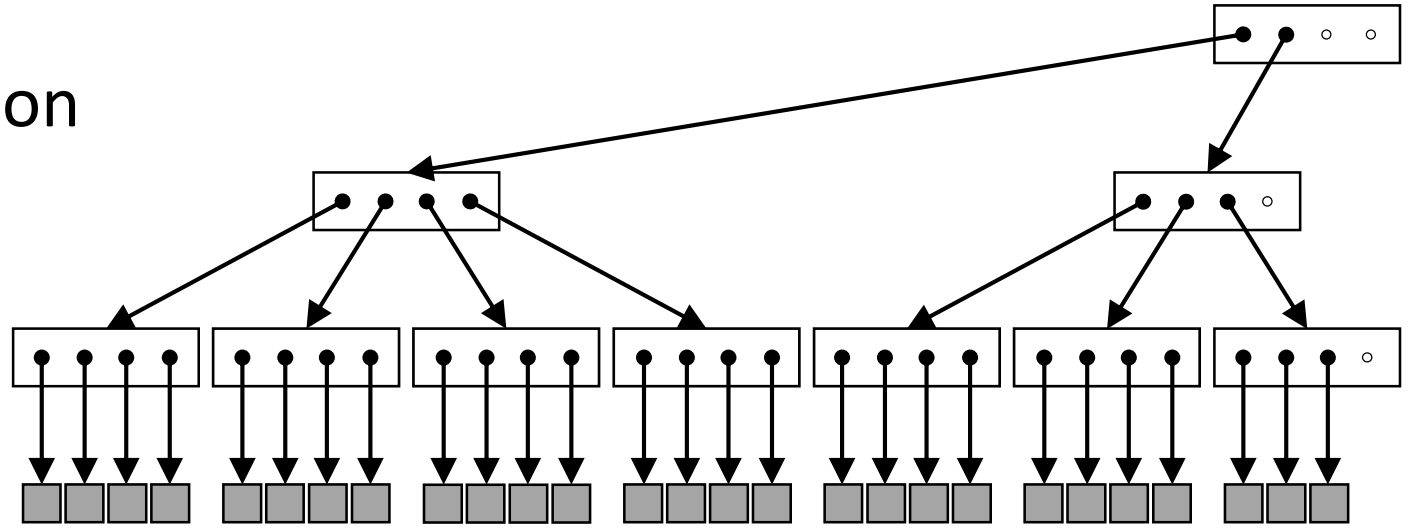
Methodology

Pre-processing

PHASE 3: CREATE INDEX

Requirements for the index:

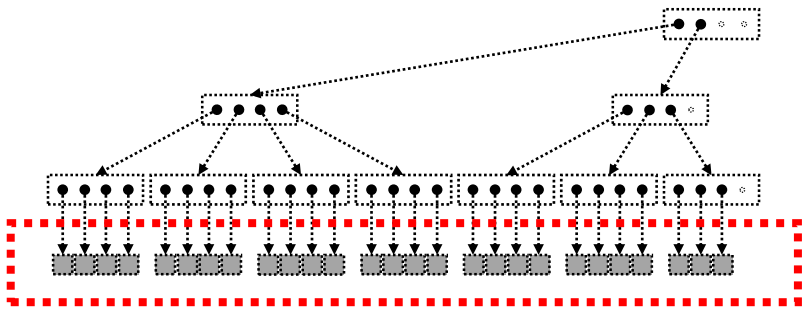
- ✓ Axis-aligned BBOX
- ✓ Leaf nodes refer to packages
- ✓ Tree is balanced
- ✓ Near full space utilization

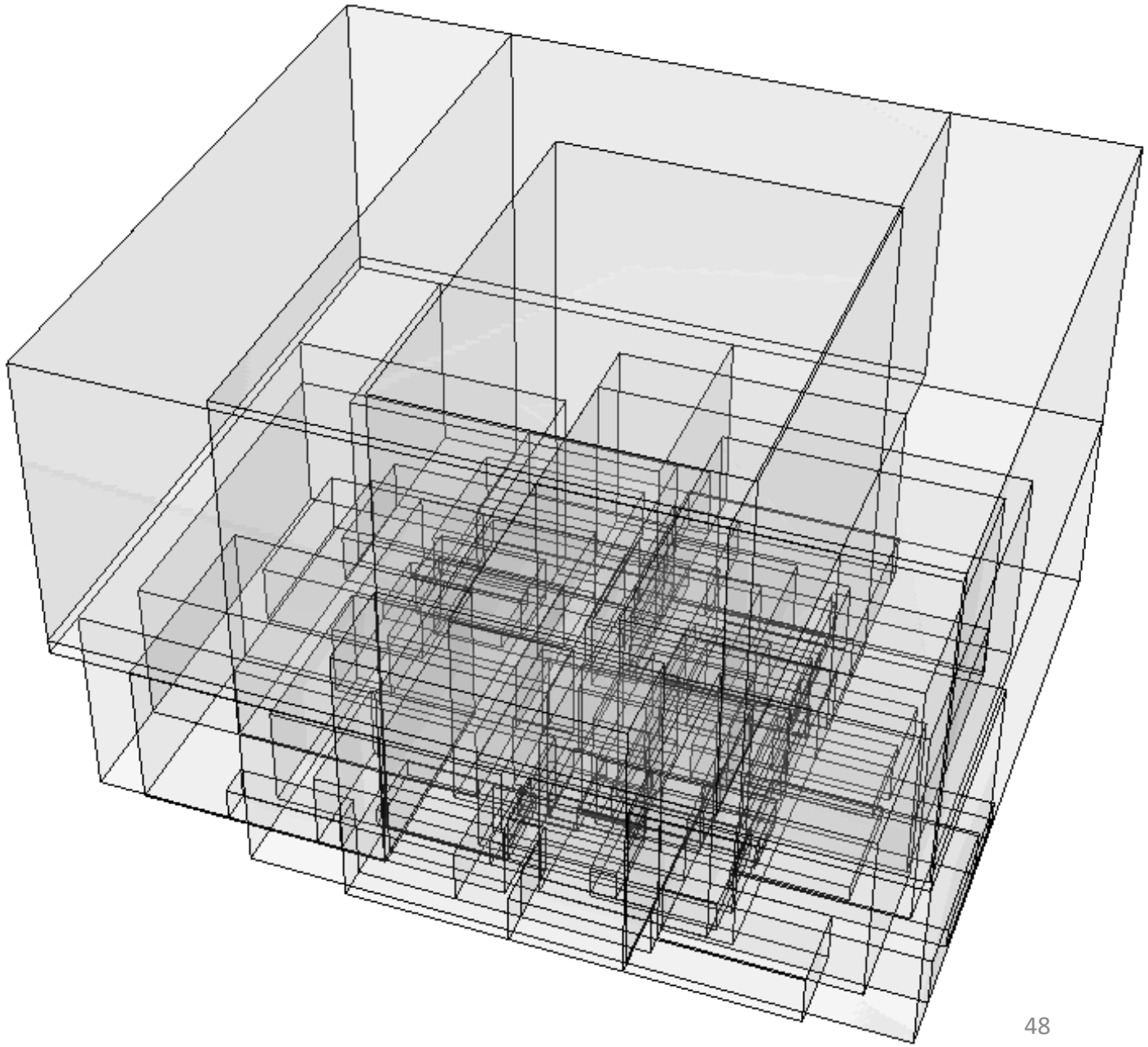


Methodology

Pre-processing

- Packages

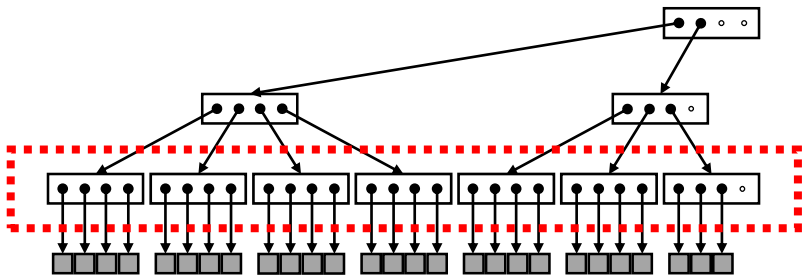


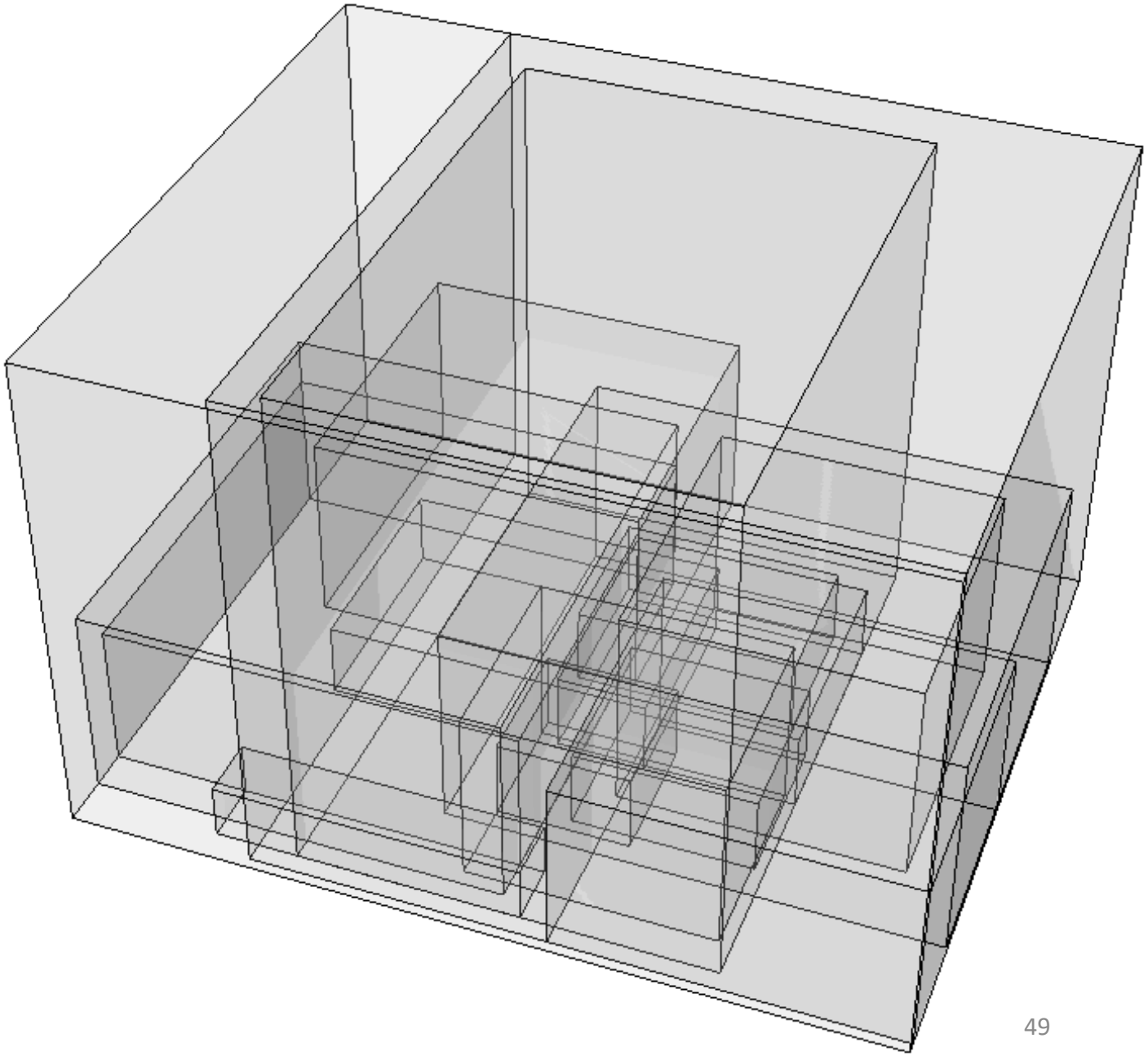


Methodology

Pre-processing

- Leaf nodes

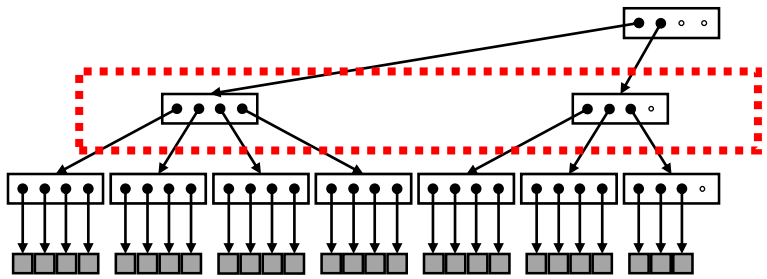


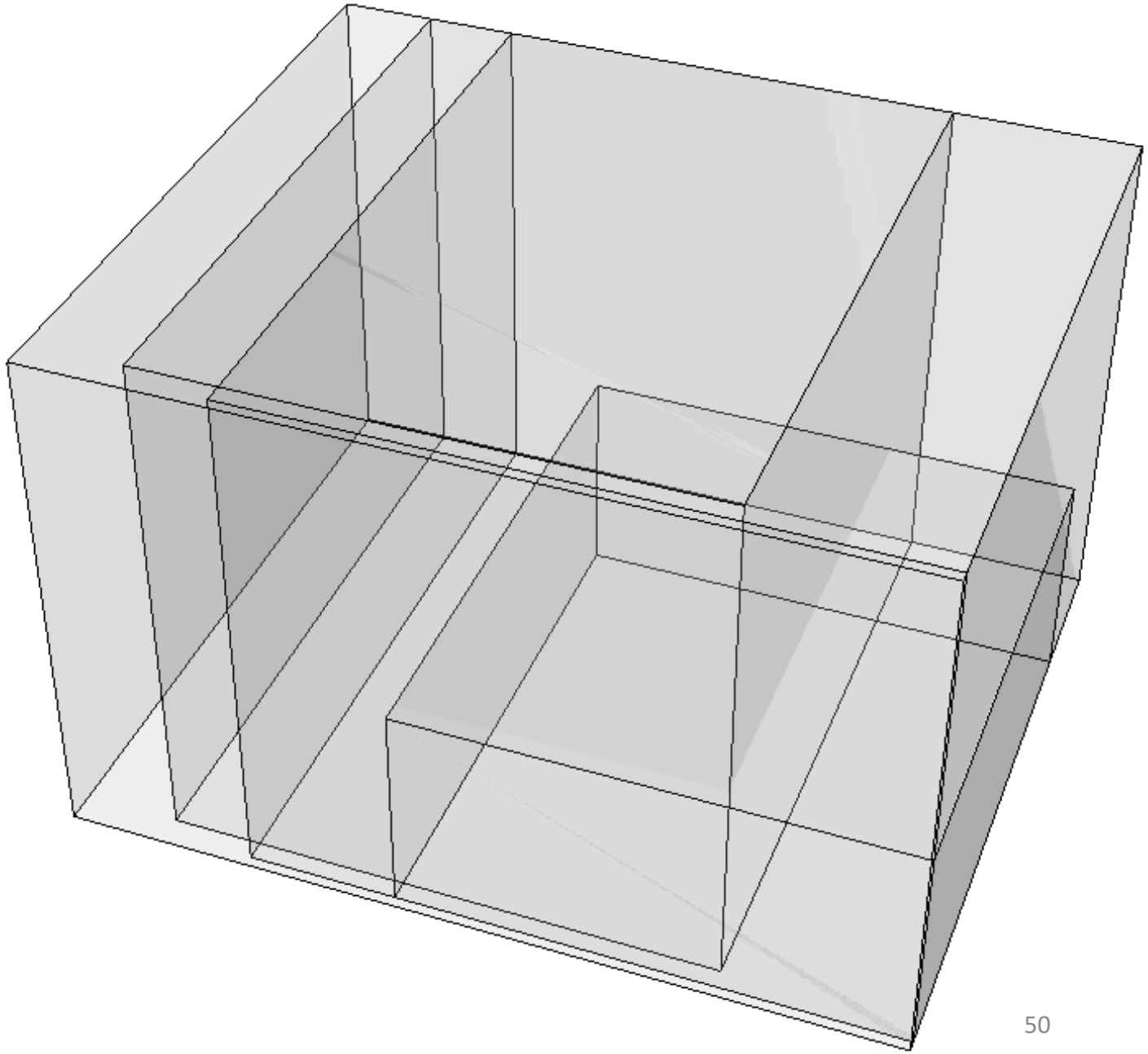


Methodology

Pre-processing

- Level one nodes

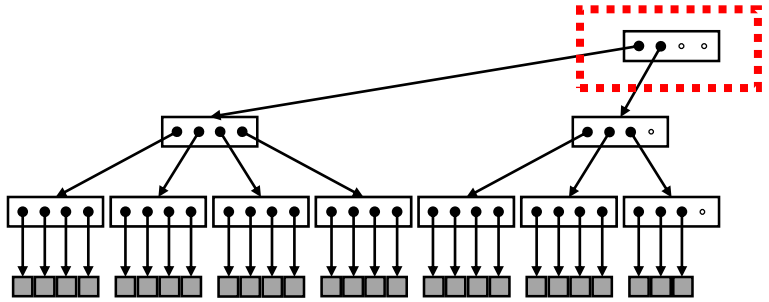


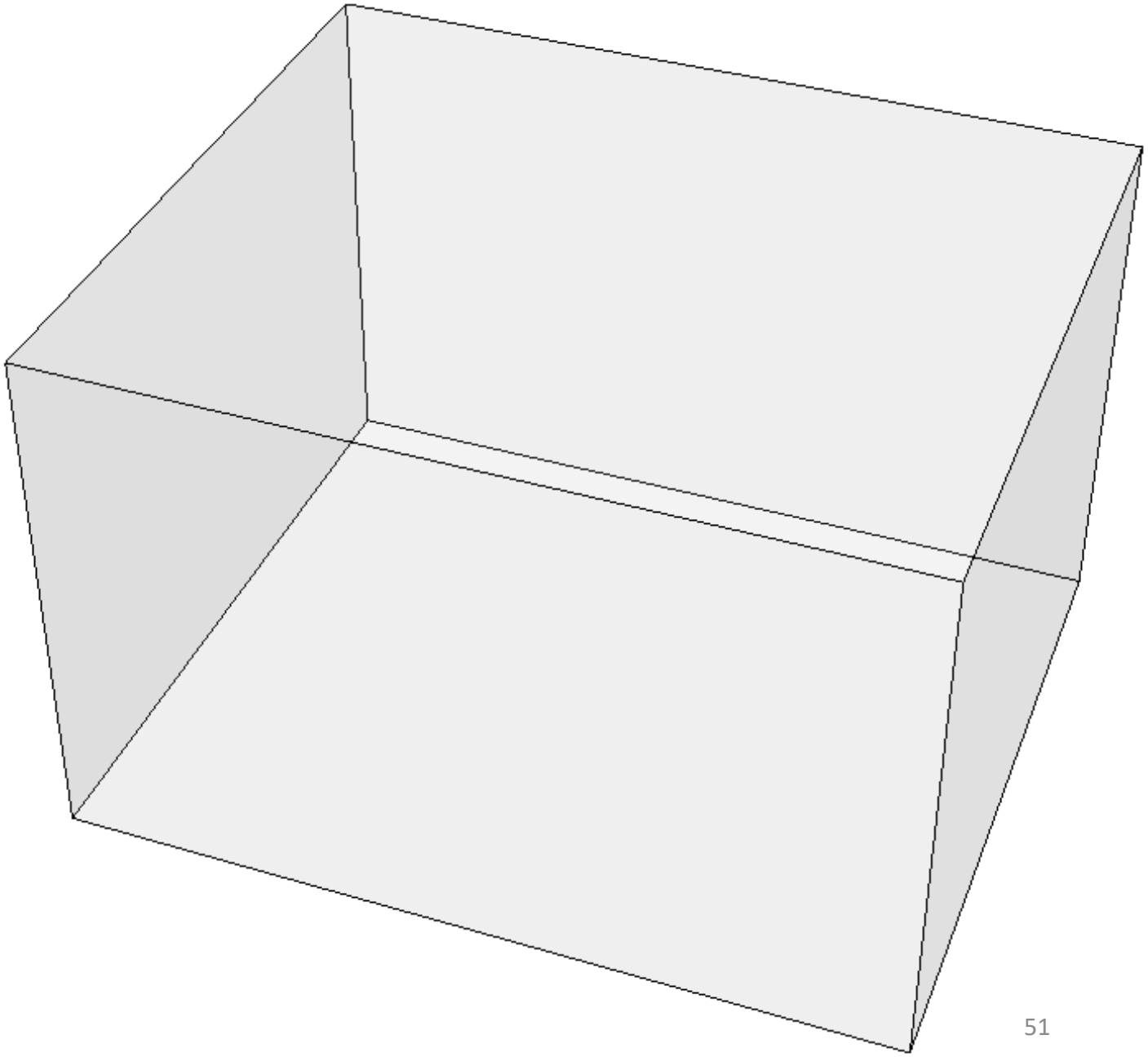


Methodology

Pre-processing

- Root node

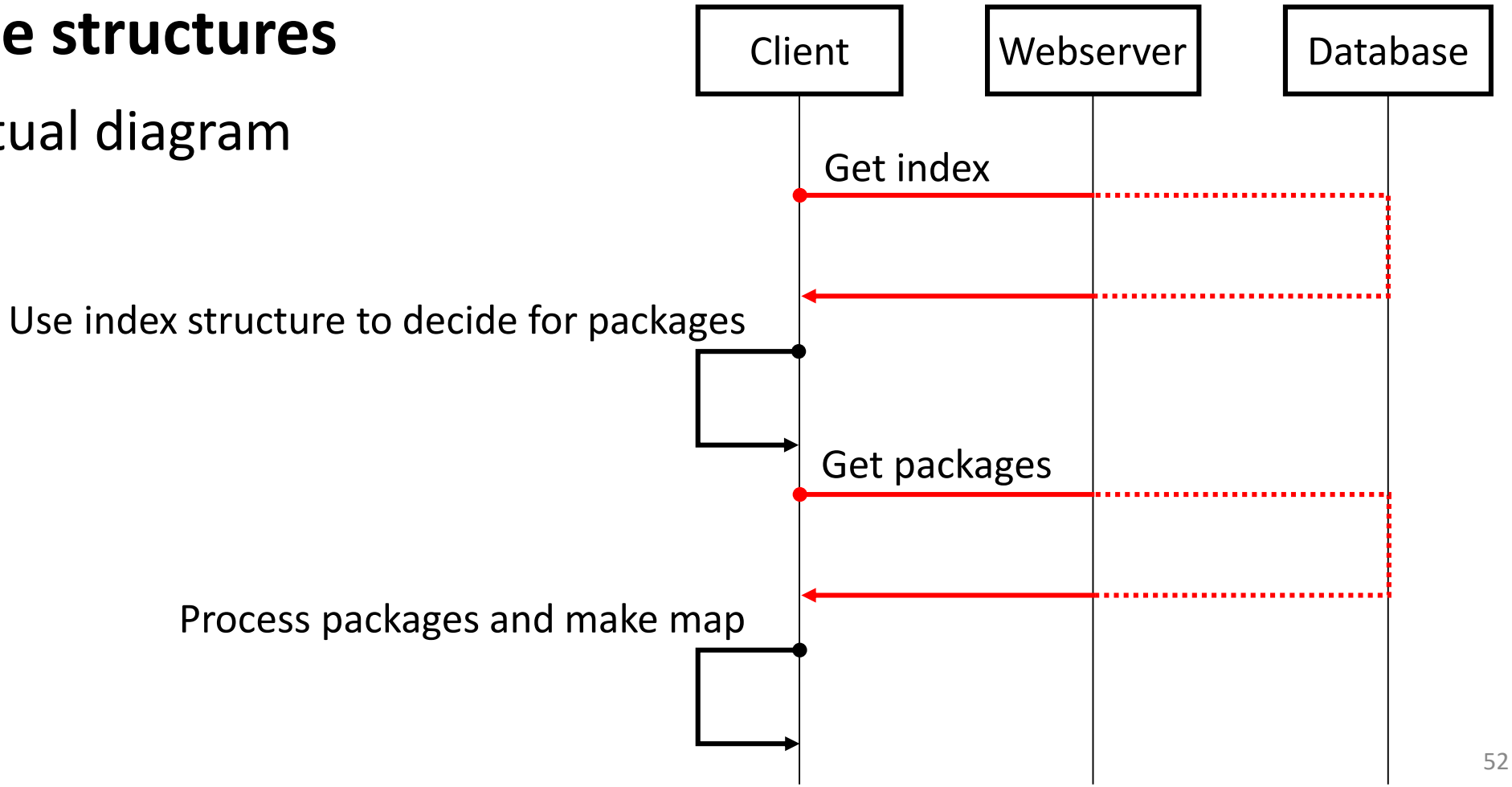




Methodology

Using the structures

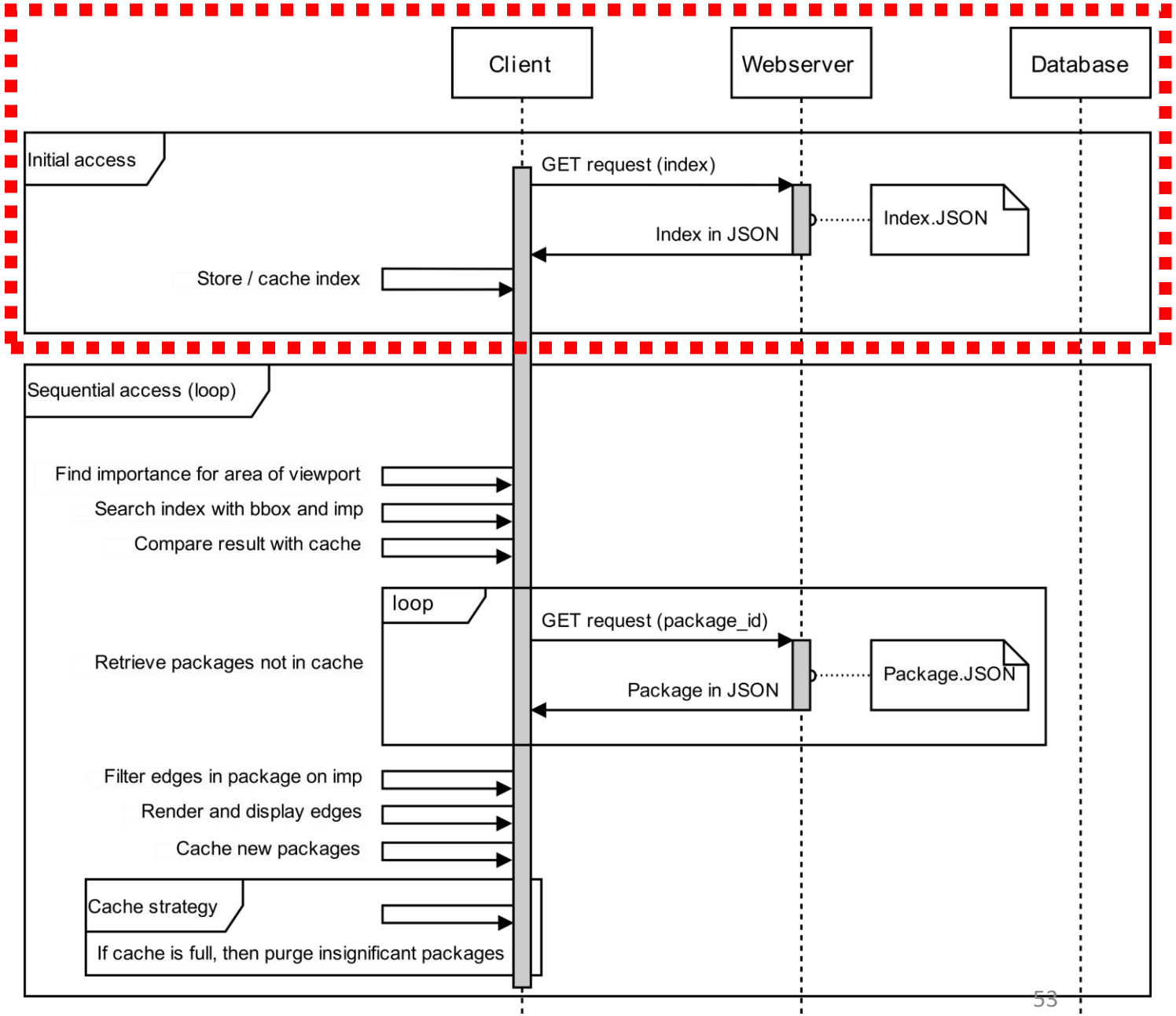
- Conceptual diagram



Methodology

Using the structures

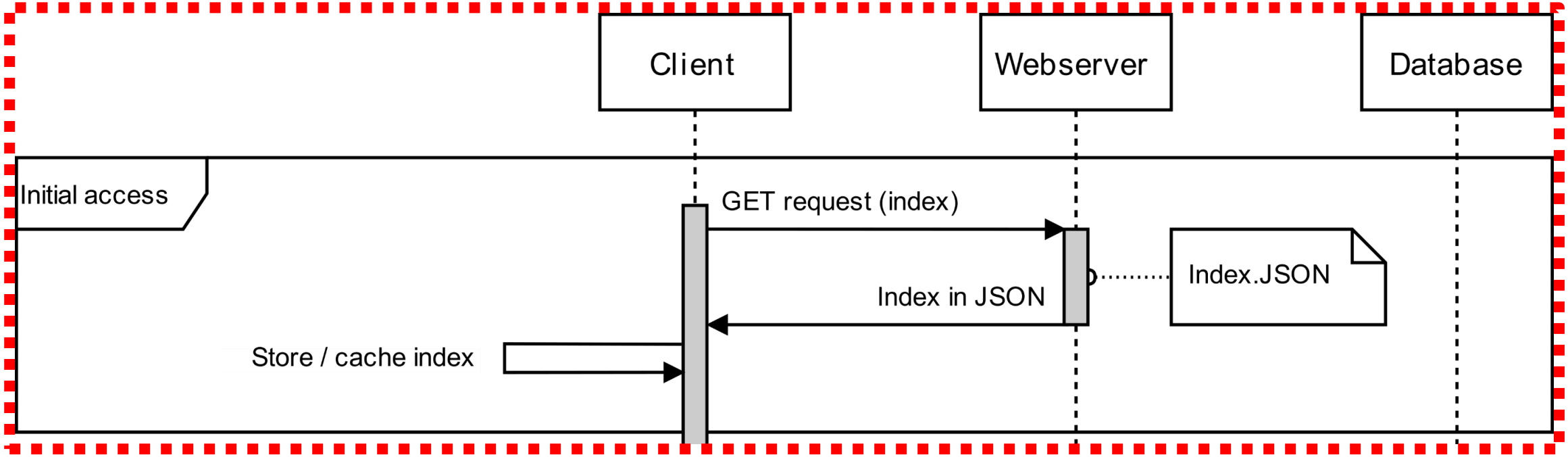
- Sequence diagram



Methodology

Using the structures

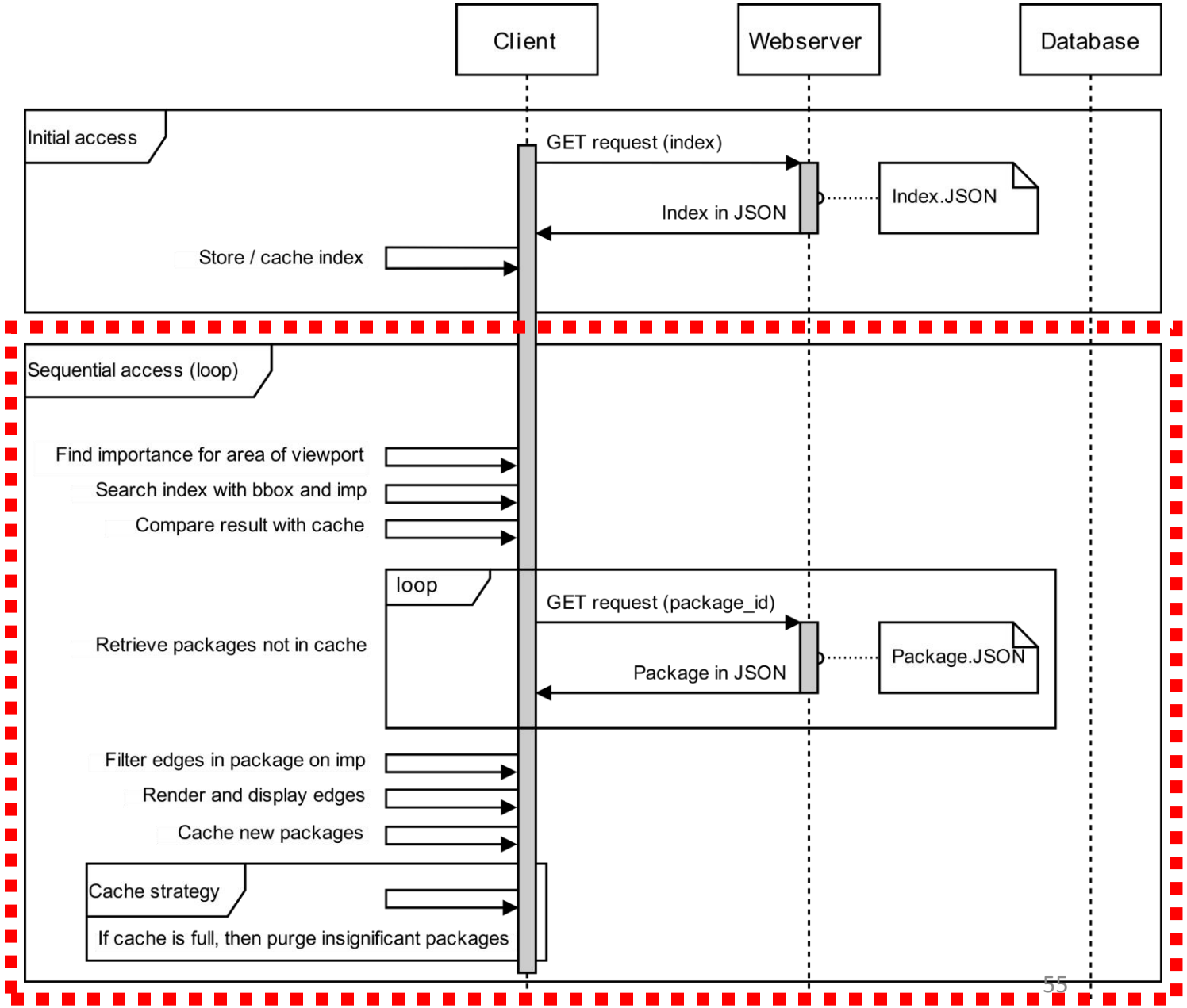
- Sequence diagram

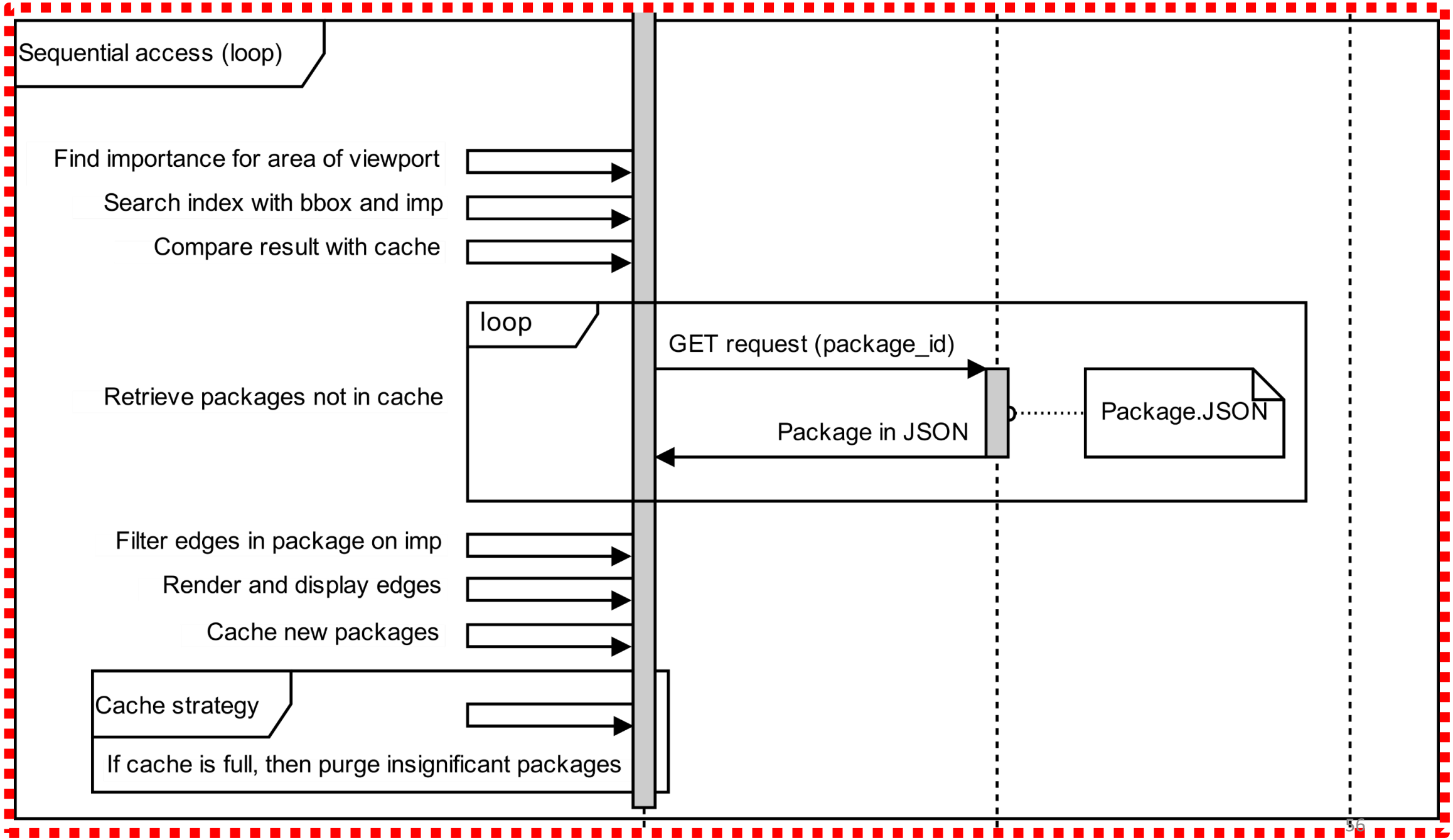


Methodology

Using the structures

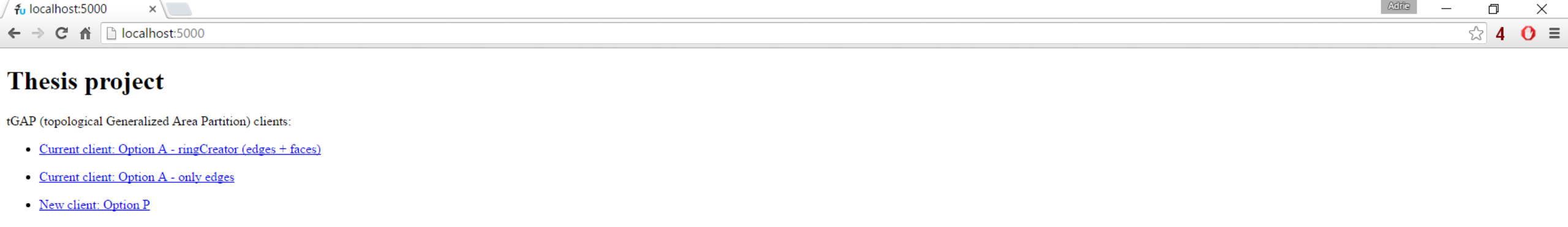
- Sequence diagram




Sequential access (loop)
Find importance for area of viewport
Search index with bbox and imp
Compare result with cache
loop
GET request (package_id)
Retrieve packages not in cache
Package in JSON
Package.JSON
Filter edges in package on imp
Render and display edges
Cache new packages
Cache strategy
If cache is full, then purge insignificant packages

Content overview

1. Motivation
2. Objectives
3. Methodology
4. **Results**
5. Future work


localhost:5000
Adrie
localhost:5000
Thesis project
tGAP (topological Generalized Area Partition) clients:
Current client: Option A - ringCreator (edges + faces)
Current client: Option A - only edges
New client: Option P

Prototype

localhost:5000/a/

localhost:5000/a/

← clients
→ 1147752.2 7027159.9 @z 10.4

settings

Draw tiles

optimal count — optimal number of area objects

20

Developer Tools - http://localhost:5000/a/

Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock

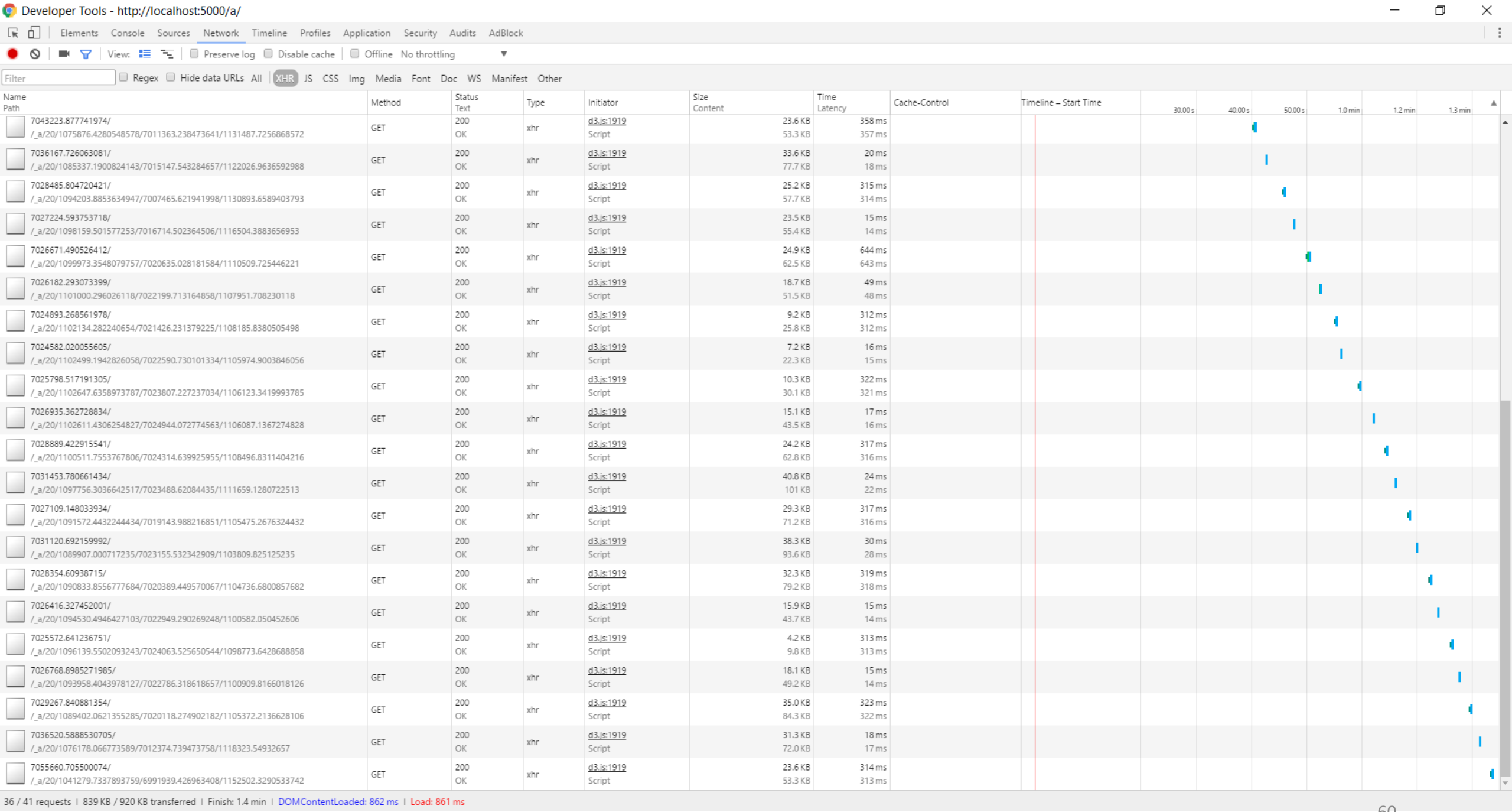
View: Preserve log Disable cache Offline No throttling

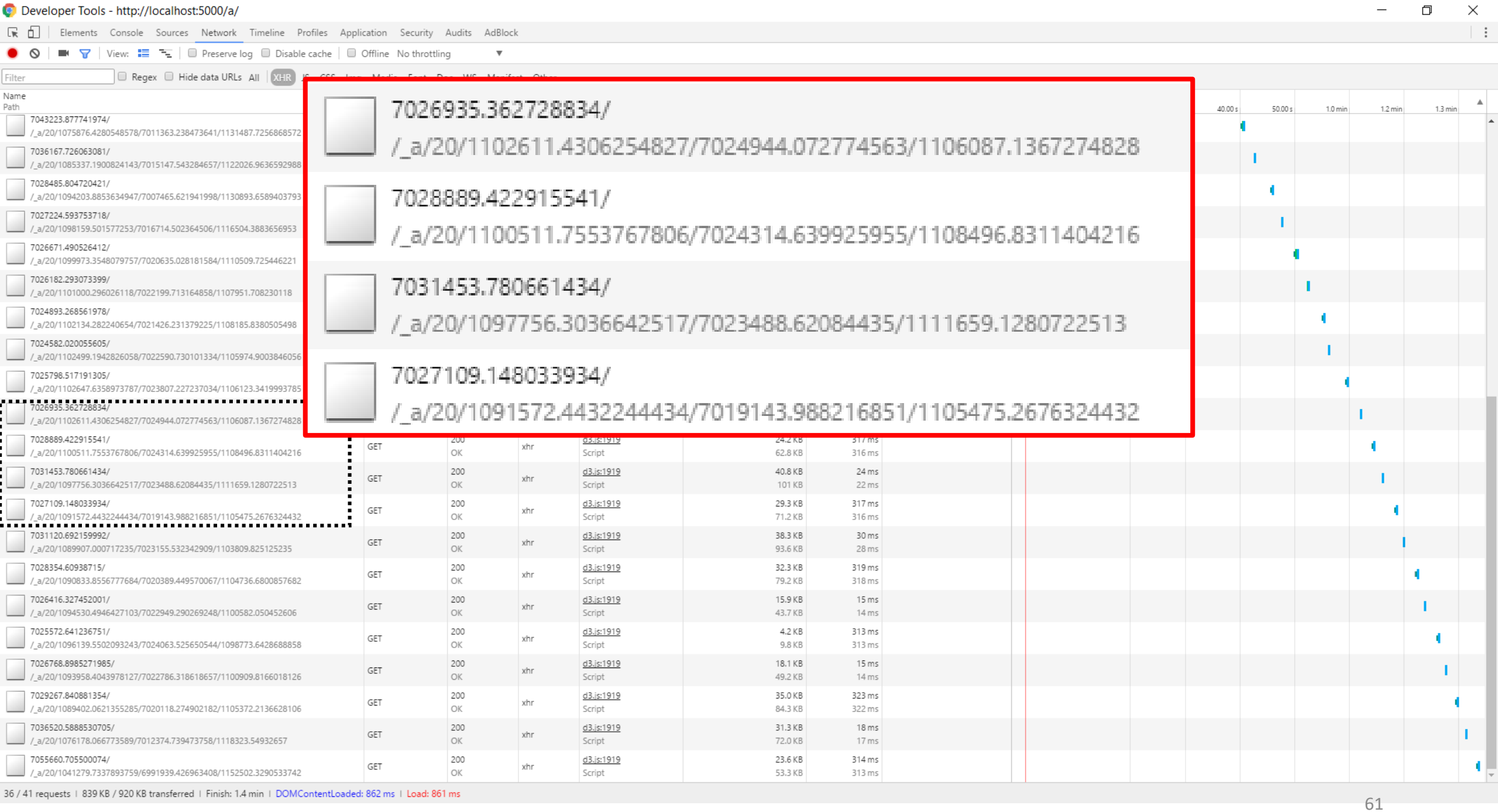
Filter Regex Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

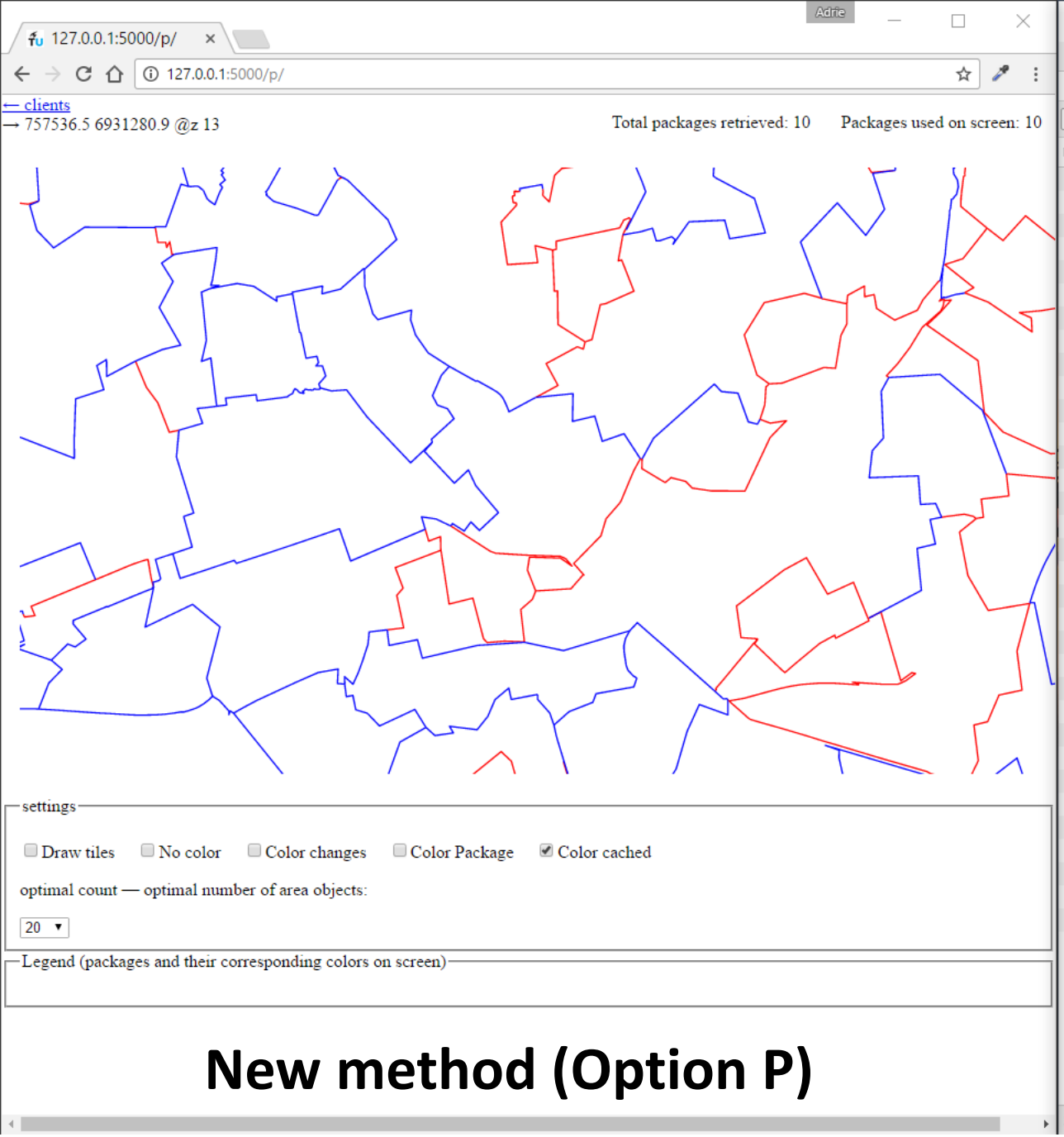
Name	Method	Status	Type	Initiator	Size	Time	Cache-Control	Timeline – Start Time
7391610.941042573/	GET	200	xhr	d3.js:1919	23.6 KB	82 ms		
7344749.498555683/	GET	200	xhr	d3.js:1919	23.6 KB	315 ms		
7303540.777977985/	GET	200	xhr	d3.js:1919	23.6 KB	16 ms		
7267666.503066368/	GET	200	xhr	d3.js:1919	23.6 KB	314 ms		
7236436.132834211/	GET	200	xhr	d3.js:1919	23.6 KB	15 ms		
7209248.516436667/	GET	200	xhr	d3.js:1919	23.6 KB	315 ms		
7185580.321667107/	GET	200	xhr	d3.js:1919	23.6 KB	15 ms		
7117829.830607583/	GET	200	xhr	d3.js:1919	23.6 KB	315 ms		
7105995.733222804/	GET	200	xhr	d3.js:1919	23.6 KB	15 ms		
7095693.553078386/	GET	200	xhr	d3.js:1919	23.6 KB	314 ms		
7086724.984350485/	GET	200	xhr	d3.js:1919	23.6 KB	15 ms		
7086724.984350485/	GET	200	xhr	d3.js:1919	23.6 KB	388 ms		
7078917.391792434/	GET	200	xhr	d3.js:1919	23.6 KB	15 ms		
7066203.439000664/	GET	200	xhr	d3.js:1919	23.6 KB	314 ms		
7052664.268285475/	GET	200	xhr	d3.js:1919	23.6 KB	14 ms		
7043223.877741974/	GET	200	xhr	d3.js:1919	23.6 KB	358 ms		
7036167.726063081/	GET	200	xhr	d3.js:1919	33.6 KB	20 ms		
7028485.804720421/	GET	200	xhr	d3.js:1919	25.2 KB	315 ms		
7027224.593753718/	GET	200	xhr	d3.js:1919	23.5 KB	15 ms		
7026671.490526412/	GET	200	xhr	d3.js:1919	24.9 KB	644 ms		
7026182.293073399/	GET	200	xhr	d3.js:1919	18.7 KB	49 ms		
7024893.268561978/	GET	200	xhr	d3.js:1919	9.2 KB	312 ms		
7024582.020055605/	GET	200	xhr	d3.js:1919	7.2 KB	16 ms		
7025798.517191305/	GET	200	xhr	d3.js:1919	10.3 KB	322 ms		
7026935.362728834/	GET	200	xhr	d3.js:1919	15.1 KB	17 ms		
7028889.422915541/	GET	200	xhr	d3.js:1919	24.2 KB	317 ms		
7031453.780661434/	GET	200	xhr	d3.js:1919	40.8 KB	24 ms		
7027109.148033934/	GET	200	xhr	d3.js:1919	29.3 KB	317 ms		
7031120.692159992/	GET	200	xhr	d3.js:1919	38.3 KB	30 ms		
7028354.60938715/	GET	200	xhr	d3.js:1919	32.3 KB	319 ms		
7026416.327452001/	GET	200	xhr	d3.js:1919	15.9 KB	15 ms		
7025572.641236751/	GET	200	xhr	d3.js:1919	4.2 KB	313 ms		
7026768.8985271985/	GET	200	xhr	d3.js:1919	18.1 KB	15 ms		
7029267.840881354/	GET	200	xhr	d3.js:1919	35.0 KB	323 ms		
7036520.5888530705/	GET	200	xhr	d3.js:1919	31.3 KB	18 ms		
7055660.705500074/	GET	200	xhr	d3.js:1919	23.6 KB	314 ms		

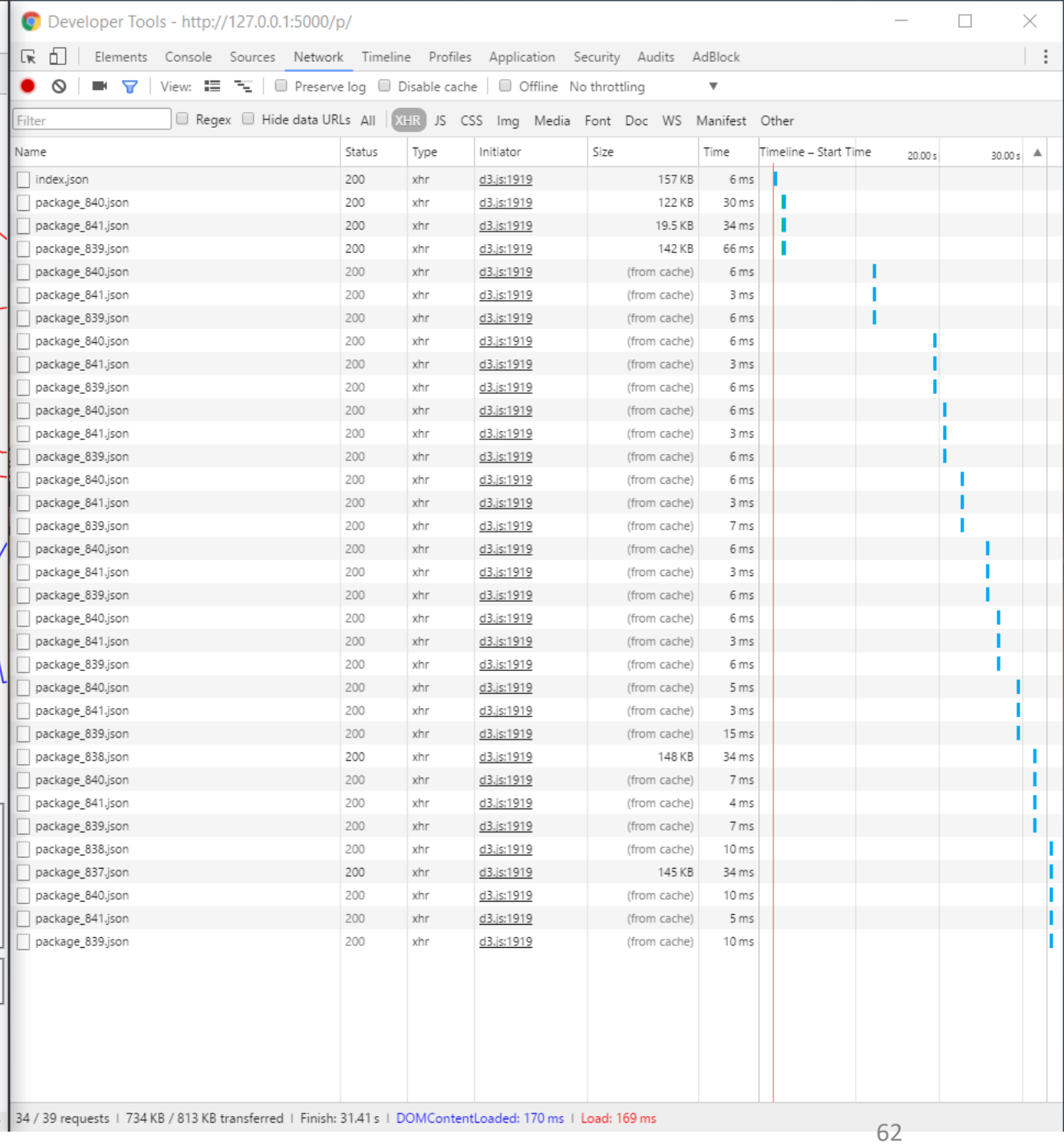
36 / 41 requests | 839 KB / 920 KB transferred | Finish: 1.4 min | DOMContentLoaded: 862 ms | Load: 861 ms

Current method (Option A)

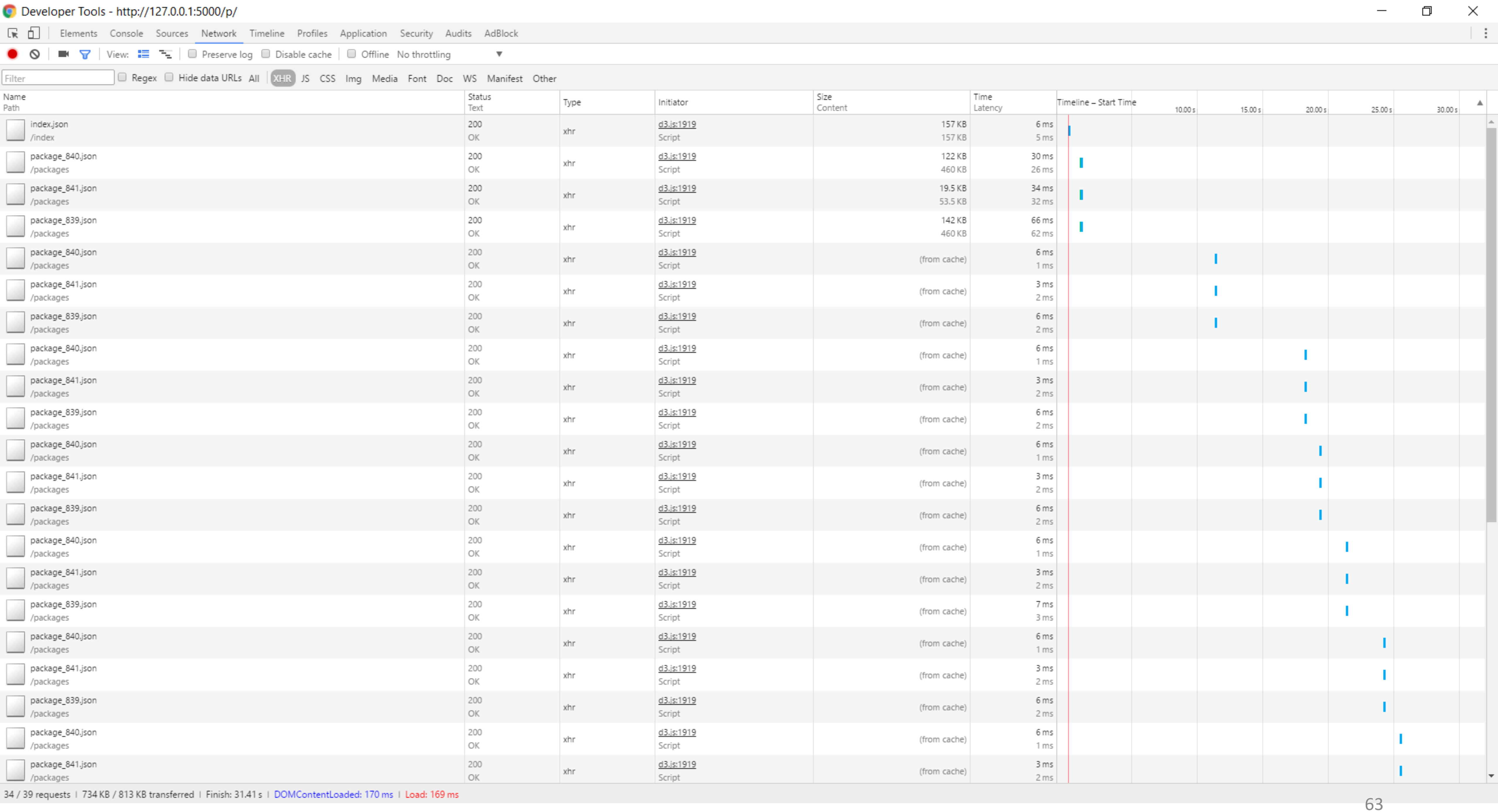

Developer Tools - http://localhost:5000/a/
Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock
View: Preserve log Disable cache Offline No throttling
Filter Regex Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other
Name Path | Method | Status Text | Type | Initiator | Size Content | Time Latency | Cache-Control | Timeline – Start Time
30.00 s 40.00 s 50.00 s 1.0 min 1.2 min 1.3 min
7043223.877741974/ /_a/20/1075876.4280548578/7011363.238473641/1131487.7256868572 GET 200 OK xhr d3.js:1919 Script 23.6 KB 53.3 KB 358 ms 357 ms
7036167.726063081/ /_a/20/1085337.1900824143/7015147.543284657/1122026.9636592988 GET 200 OK xhr d3.js:1919 Script 33.6 KB 77.7 KB 20 ms 18 ms
7028485.804720421/ /_a/20/1094203.8853634947/7007465.621941998/1130893.6589403793 GET 200 OK xhr d3.js:1919 Script 25.2 KB 57.7 KB 315 ms 314 ms
7027224.593753718/ /_a/20/1098159.501577253/7016714.502364506/1116504.3883656953 GET 200 OK xhr d3.js:1919 Script 23.5 KB 55.4 KB 15 ms 14 ms
7026671.490526412/ /_a/20/1099973.3548079757/7020635.028181584/1110509.725446221 GET 200 OK xhr d3.js:1919 Script 24.9 KB 62.5 KB 644 ms 643 ms
7026182.293073399/ /_a/20/1101000.296026118/7022199.713164858/1107951.708230118 GET 200 OK xhr d3.js:1919 Script 18.7 KB 51.5 KB 49 ms 48 ms
7024893.268561978/ /_a/20/1102134.282240654/7021426.231379225/1108185.8380505498 GET 200 OK xhr d3.js:1919 Script 9.2 KB 25.8 KB 312 ms 312 ms
7024582.020055605/ /_a/20/1102499.1942826058/7022590.730101334/1105974.9003846056 GET 200 OK xhr d3.js:1919 Script 7.2 KB 22.3 KB 16 ms 15 ms
7025798.517191305/ /_a/20/1102647.6358973787/7023807.227237034/1106123.3419993785 GET 200 OK xhr d3.js:1919 Script 10.3 KB 30.1 KB 322 ms 321 ms
7026935.362728834/ /_a/20/1102611.4306254827/7024944.072774563/1106087.1367274828 GET 200 OK xhr d3.js:1919 Script 15.1 KB 43.5 KB 17 ms 16 ms
7028889.422915541/ /_a/20/1100511.7553767806/7024314.639925955/1108496.8311404216 GET 200 OK xhr d3.js:1919 Script 24.2 KB 62.8 KB 317 ms 316 ms
7031453.780661434/ /_a/20/1097756.3036642517/7023488.62084435/1111659.1280722513 GET 200 OK xhr d3.js:1919 Script 40.8 KB 101 KB 24 ms 22 ms
7027109.148033934/ /_a/20/1091572.4432244434/7019143.988216851/1105475.2676324432 GET 200 OK xhr d3.js:1919 Script 29.3 KB 71.2 KB 317 ms 316 ms
7031120.692159992/ /_a/20/1089907.000717235/7023155.532342909/1103809.825125235 GET 200 OK xhr d3.js:1919 Script 38.3 KB 93.6 KB 30 ms 28 ms
7028354.60938715/ /_a/20/1090833.8556777684/7020389.449570067/1104736.6800857682 GET 200 OK xhr d3.js:1919 Script 32.3 KB 79.2 KB 319 ms 318 ms
7026416.327452001/ /_a/20/1094530.4946427103/7022949.290269248/1100582.050452606 GET 200 OK xhr d3.js:1919 Script 15.9 KB 43.7 KB 15 ms 14 ms
7025572.641236751/ /_a/20/1096139.5502093243/7024063.525650544/1098773.6428688858 GET 200 OK xhr d3.js:1919 Script 4.2 KB 9.8 KB 313 ms 313 ms
7026768.8985271985/ /_a/20/1093958.4043978127/7022786.318618657/1100909.8166018126 GET 200 OK xhr d3.js:1919 Script 18.1 KB 49.2 KB 15 ms 14 ms
7029267.840881354/ /_a/20/1089402.0621355285/7020118.274902182/1105372.2136628106 GET 200 OK xhr d3.js:1919 Script 35.0 KB 84.3 KB 323 ms 322 ms
7036520.5888530705/ /_a/20/1076178.066773589/7012374.739473758/1118323.54932657 GET 200 OK xhr d3.js:1919 Script 31.3 KB 72.0 KB 18 ms 17 ms
7055660.705500074/ /_a/20/1041279.7337893759/6991939.426963408/1152502.3290533742 GET 200 OK xhr d3.js:1919 Script 23.6 KB 53.3 KB 314 ms 313 ms
36 / 41 requests | 839 KB / 920 KB transferred | Finish: 1.4 min | DOMContentLoaded: 862 ms | Load: 861 ms


Developer Tools - http://localhost:5000/a/
Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock
Preserve log Disable cache Offline No throttling
Filter Regex Hide data URLs All XHR
Name Path
7026935.362728834/
/_a/20/1102611.4306254827/7024944.072774563/1106087.1367274828
7028889.422915541/
/_a/20/1100511.7553767806/7024314.639925955/1108496.8311404216
7031453.780661434/
/_a/20/1097756.3036642517/7023488.62084435/1111659.1280722513
7027109.148033934/
/_a/20/1091572.443224434/7019143.988216851/1105475.2676324432
40.00 s 50.00 s 1.0 min 1.2 min 1.3 min
36 / 41 requests | 839 KB / 920 KB transferred | Finish: 1.4 min | DOMContentLoaded: 862 ms | Load: 861 ms





New method (Option P)



Name / Path	Status / Text	Type	Initiator	Size / Content	Time / Latency
index.json /index	200 OK	xhr	d3.js:1919 Script	157 KB 157 KB	6 ms 5 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	122 KB 460 KB	30 ms 26 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	19.5 KB 53.5 KB	34 ms 32 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	142 KB 460 KB	66 ms 62 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	7 ms 3 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms

Developer Tools - http://127.0.0.1:5000/p/

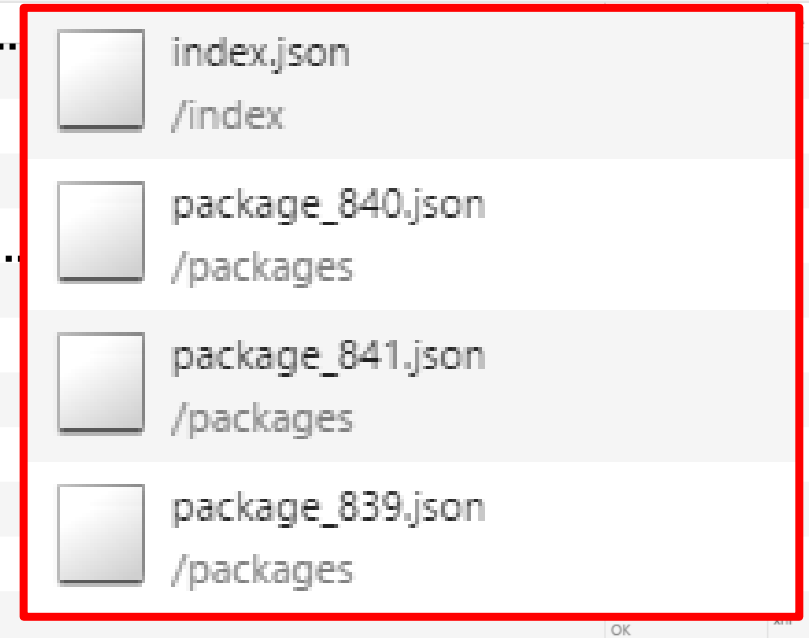
Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock

View: Preserve log Disable cache Offline No throttling

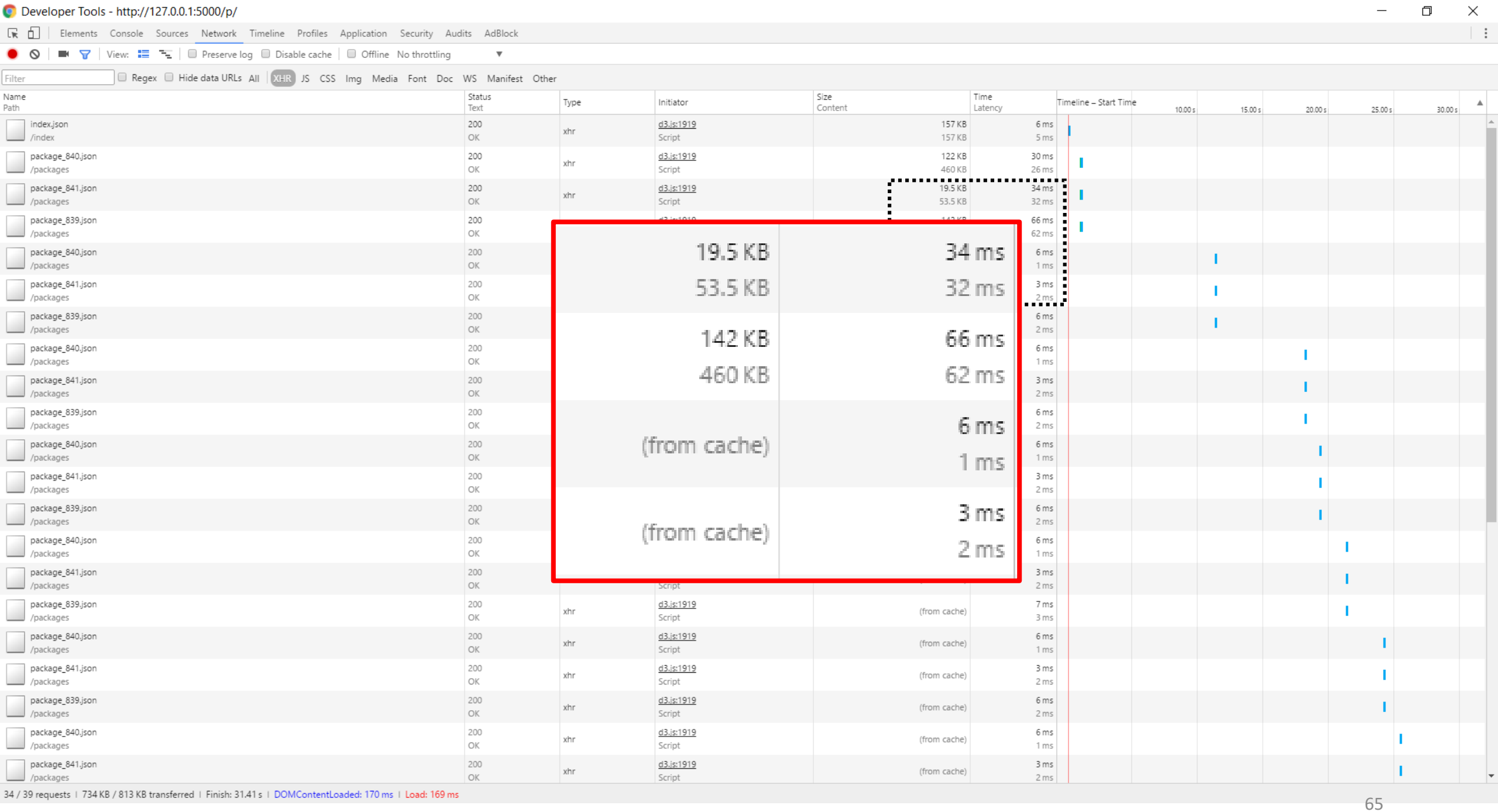
Filter Regex Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other

Name / Path	Status	Type	Initiator	Size / Content	Time / Latency	Timeline – Start Time
index.json /index			d3.js:1919 Script	157 KB 157 KB	6 ms 5 ms	
package_840.json /packages			d3.js:1919 Script	122 KB 460 KB	30 ms 26 ms	
package_841.json /packages			d3.js:1919 Script	19.5 KB 53.5 KB	34 ms 32 ms	
package_839.json /packages			d3.js:1919 Script	142 KB 460 KB	66 ms 62 ms	
package_840.json /packages			d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages			d3.js:1919 Script	(from cache)	3 ms 2 ms	
package_839.json /packages			d3.js:1919 Script	(from cache)	6 ms 2 ms	
package_840.json /packages			d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages			d3.js:1919 Script	(from cache)	3 ms 2 ms	
package_839.json /packages			d3.js:1919 Script	(from cache)	6 ms 2 ms	
package_840.json /packages	200 OK		d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms	
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms	
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms	
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	7 ms 3 ms	
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms	
package_839.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 2 ms	
package_840.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	6 ms 1 ms	
package_841.json /packages	200 OK	xhr	d3.js:1919 Script	(from cache)	3 ms 2 ms	

Timeline – Start Time: 10.00 s, 15.00 s, 20.00 s, 25.00 s, 30.00 s



34 / 39 requests | 734 KB / 813 KB transferred | Finish: 31.41 s | DOMContentLoaded: 170 ms | Load: 169 ms


Developer Tools - http://127.0.0.1:5000/p/
Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock
Preserve log Disable cache Offline No throttling
Filter Regex Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other
Name Path
Status Text
Type
Initiator
Size Content
Time Latency
Timeline – Start Time
10.00 s
15.00 s
20.00 s
25.00 s
30.00 s
index.json /index 200 OK xhr d3.js:1919 Script 157 KB 157 KB 6 ms 5 ms
package_840.json /packages 200 OK xhr d3.js:1919 Script 122 KB 460 KB 30 ms 26 ms
package_841.json /packages 200 OK xhr d3.js:1919 Script 19.5 KB 53.5 KB 34 ms 32 ms
package_839.json /packages 200 OK 66 ms 62 ms
package_840.json /packages 200 OK 6 ms 1 ms
package_841.json /packages 200 OK 3 ms 2 ms
package_839.json /packages 200 OK 6 ms 2 ms
package_840.json /packages 200 OK 6 ms 1 ms
package_841.json /packages 200 OK 3 ms 2 ms
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package_839.json /packages 200 OK 6 ms 2 ms
package_840.json /packages 200 OK 6 ms 1 ms
package_841.json /packages 200 OK 3 ms 2 ms
package_839.json /packages 200 OK xhr d3.js:1919 Script (from cache) 7 ms 3 ms
package_840.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 1 ms
package_841.json /packages 200 OK xhr d3.js:1919 Script (from cache) 3 ms 2 ms
package_839.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 2 ms
package_840.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 1 ms
package_841.json /packages 200 OK xhr d3.js:1919 Script (from cache) 3 ms 2 ms
19.5 KB
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460 KB
66 ms
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(from cache)
6 ms
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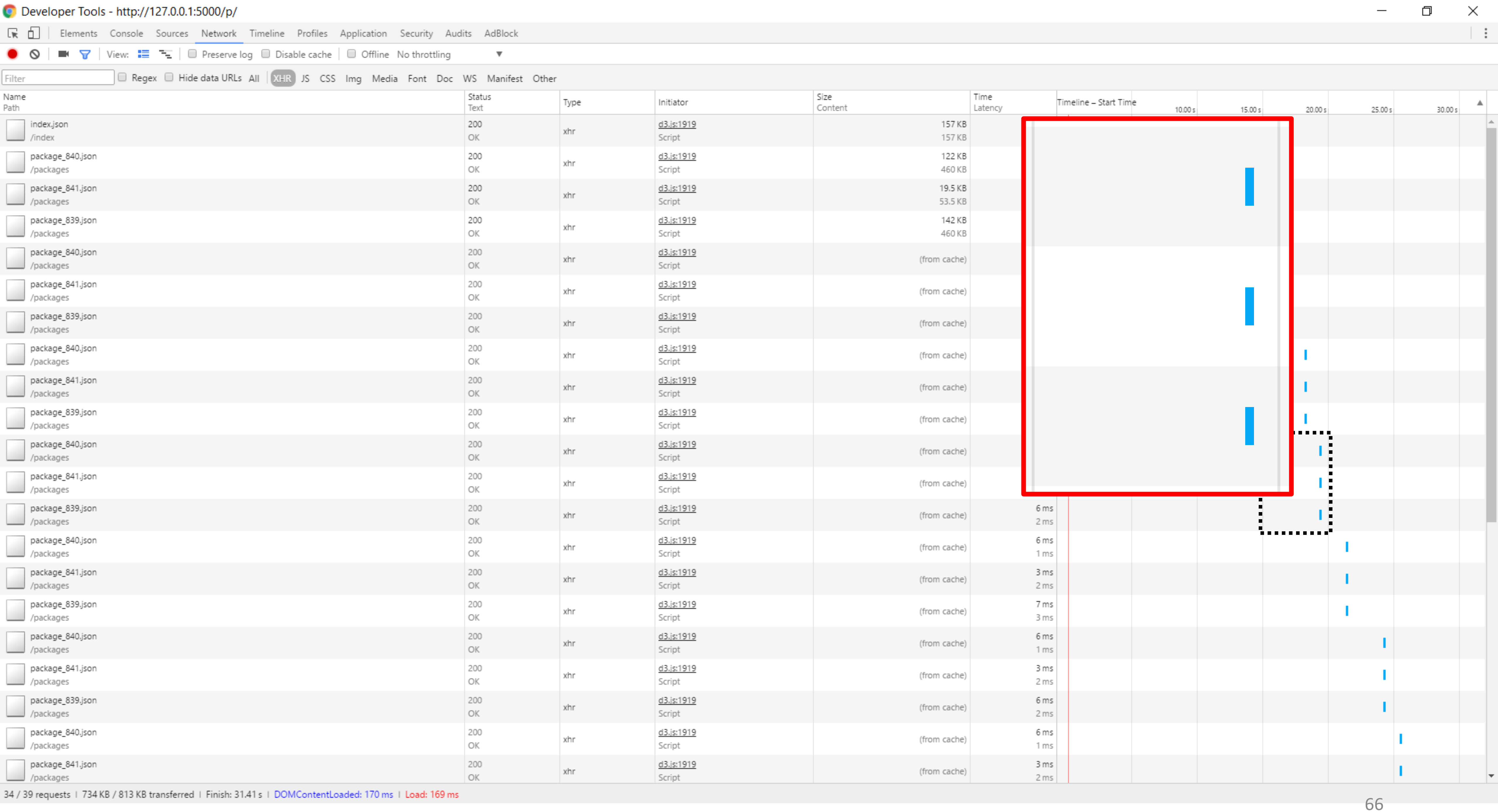
(from cache)
3 ms
2 ms
34 / 39 requests | 734 KB / 813 KB transferred | Finish: 31.41 s | DOMContentLoaded: 170 ms | Load: 169 ms


Developer Tools - http://127.0.0.1:5000/p/
Elements Console Sources Network Timeline Profiles Application Security Audits AdBlock
View: Preserve log Disable cache Offline No throttling
Filter Regex Hide data URLs All XHR JS CSS Img Media Font Doc WS Manifest Other
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index.json /index 200 OK xhr d3.js:1919 Script 157 KB 157 KB
package_840.json /packages 200 OK xhr d3.js:1919 Script 122 KB 460 KB
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package_840.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 1 ms
package_841.json /packages 200 OK xhr d3.js:1919 Script (from cache) 3 ms 2 ms
package_839.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 2 ms
package_840.json /packages 200 OK xhr d3.js:1919 Script (from cache) 6 ms 1 ms
package_841.json /packages 200 OK xhr d3.js:1919 Script (from cache) 3 ms 2 ms
34 / 39 requests | 734 KB / 813 KB transferred | Finish: 31.41 s | DOMContentLoaded: 170 ms | Load: 169 ms

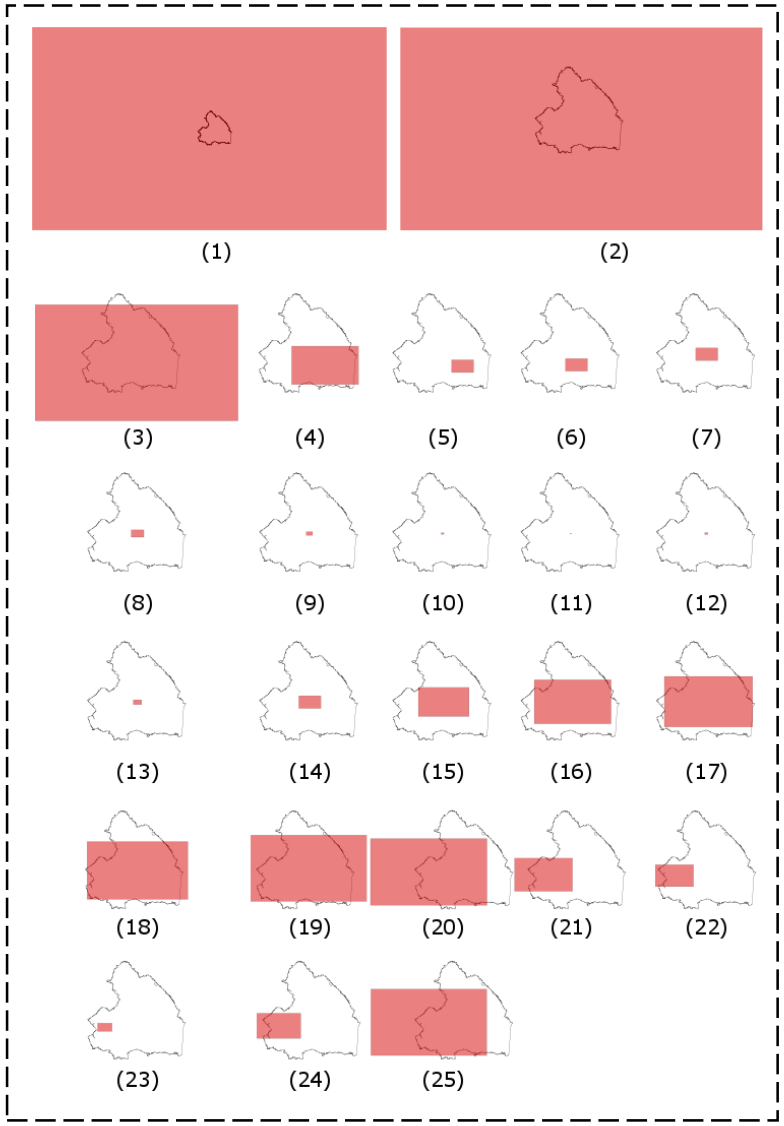
Validation

Scenario 1

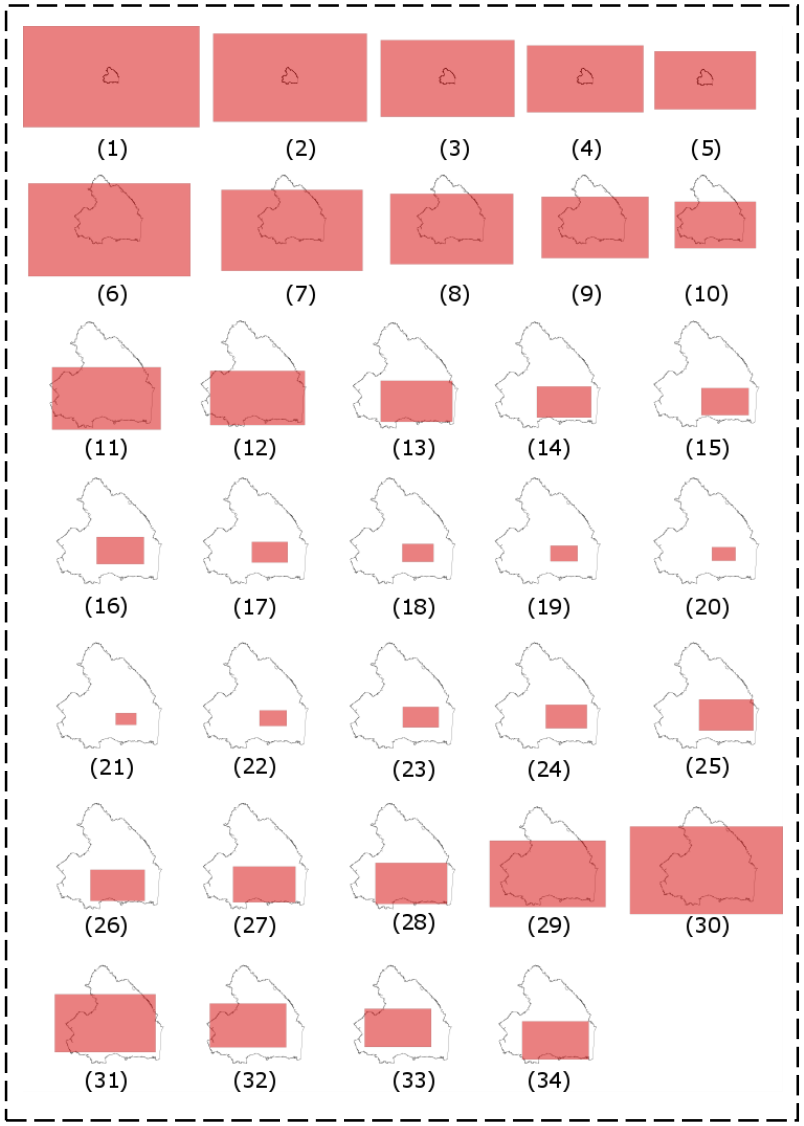
Exploring: Quickly zoom and pan.

Scenario 2

Gradual zoom and pan around area of interest.

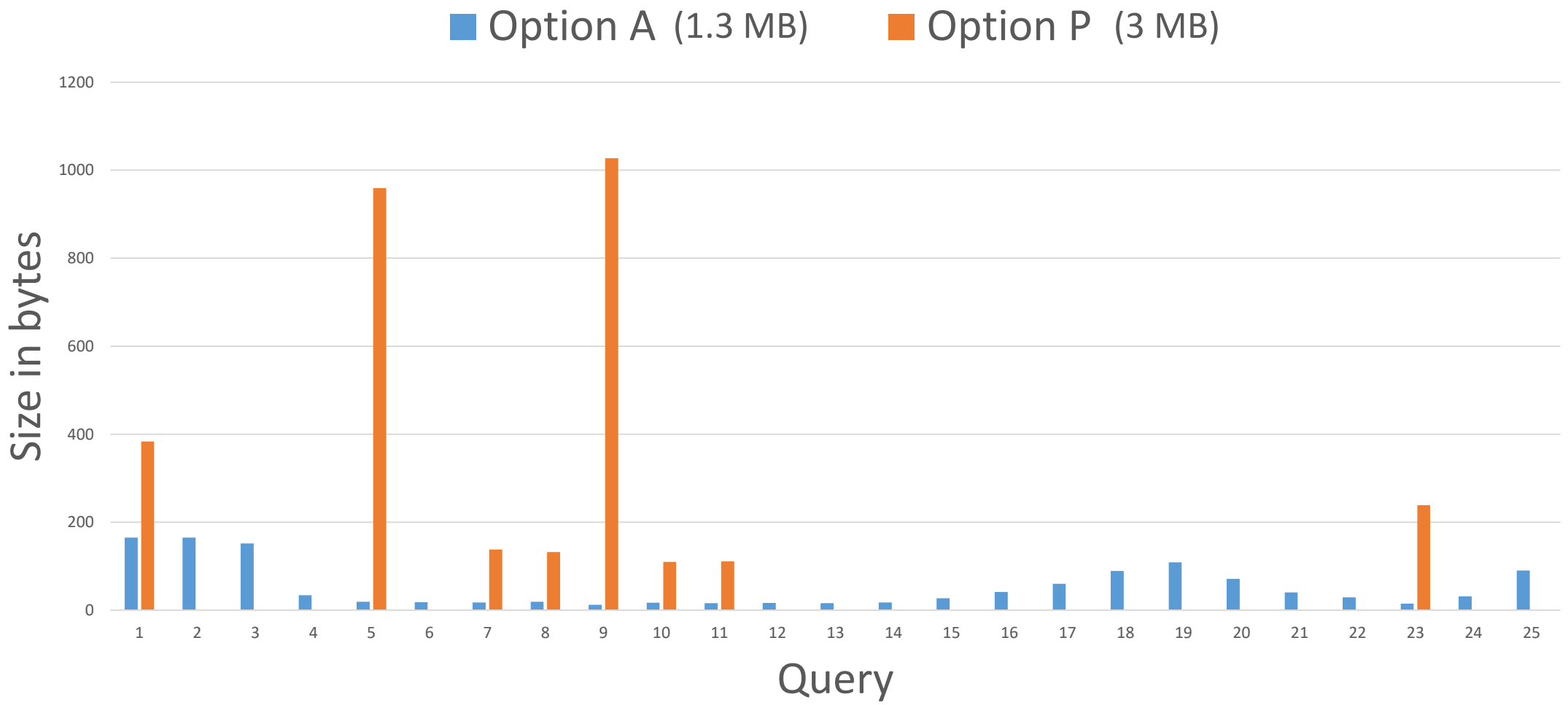


Scenario 1

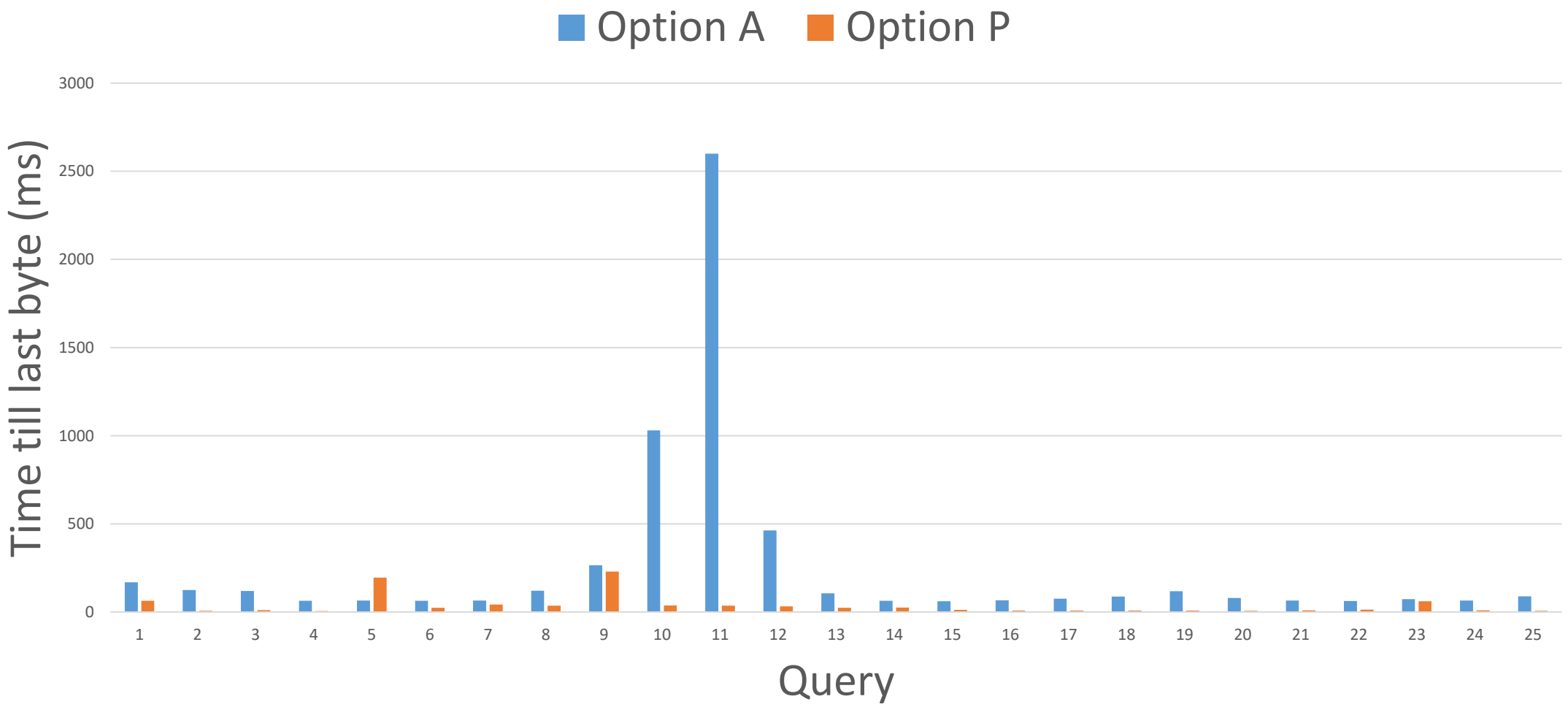


Scenario 2

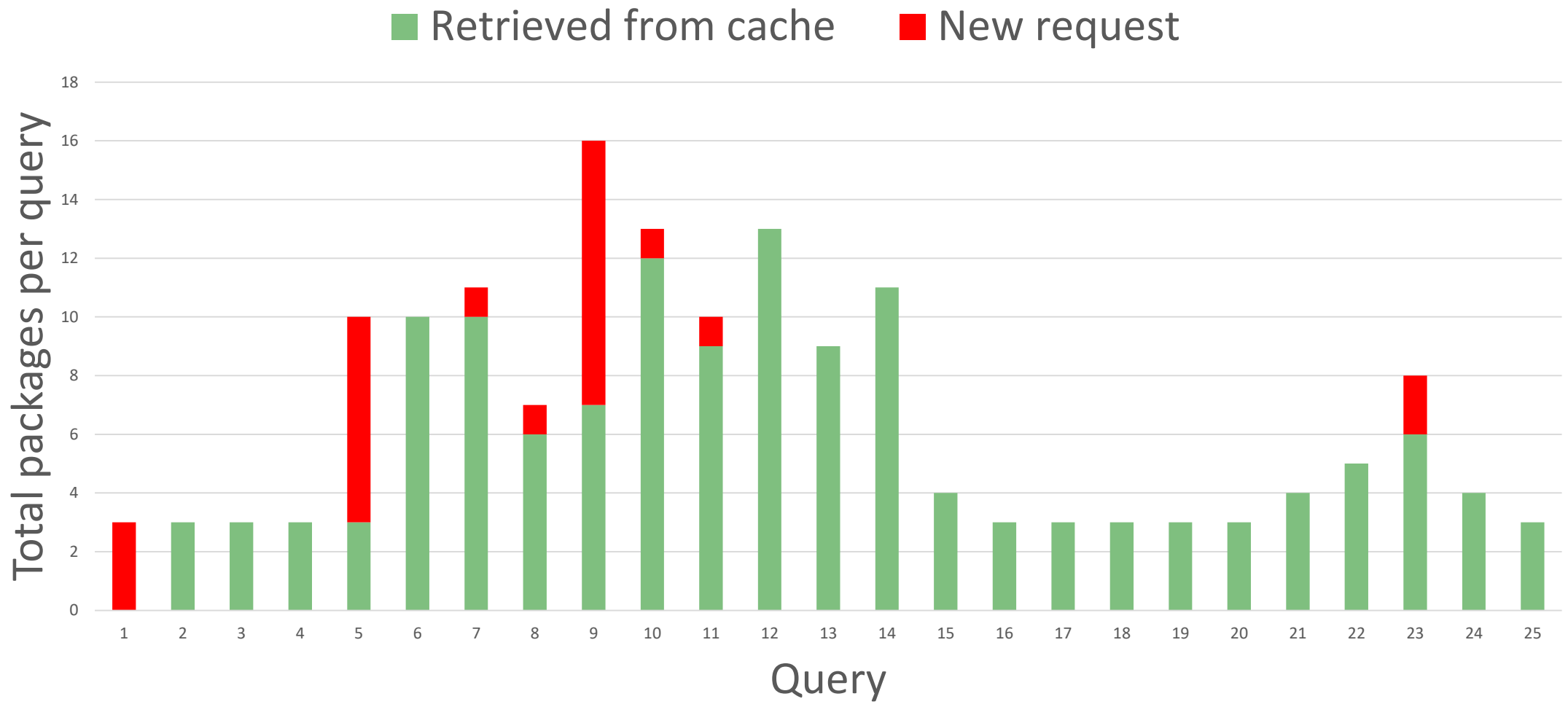
Scenario 1: Data transfers



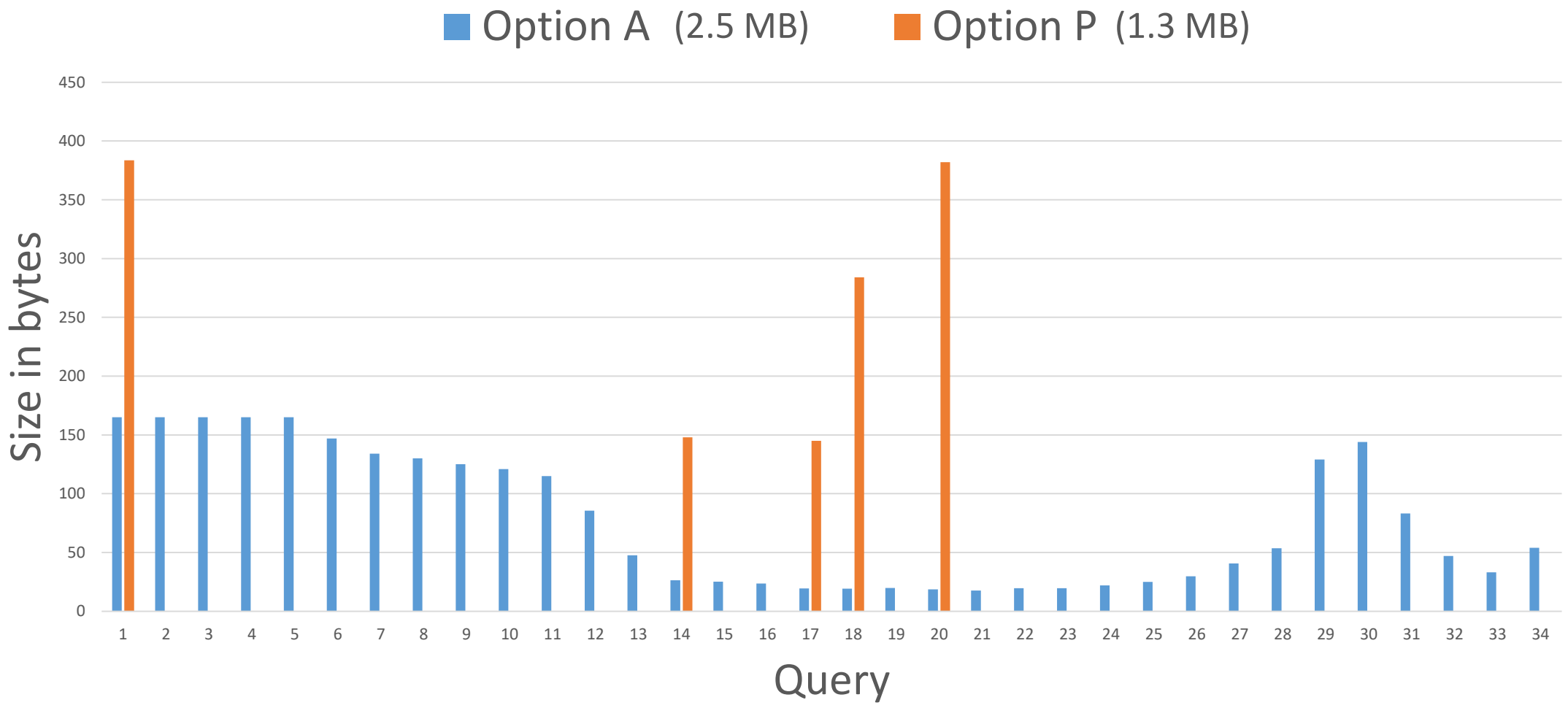
Scenario 1: Response times



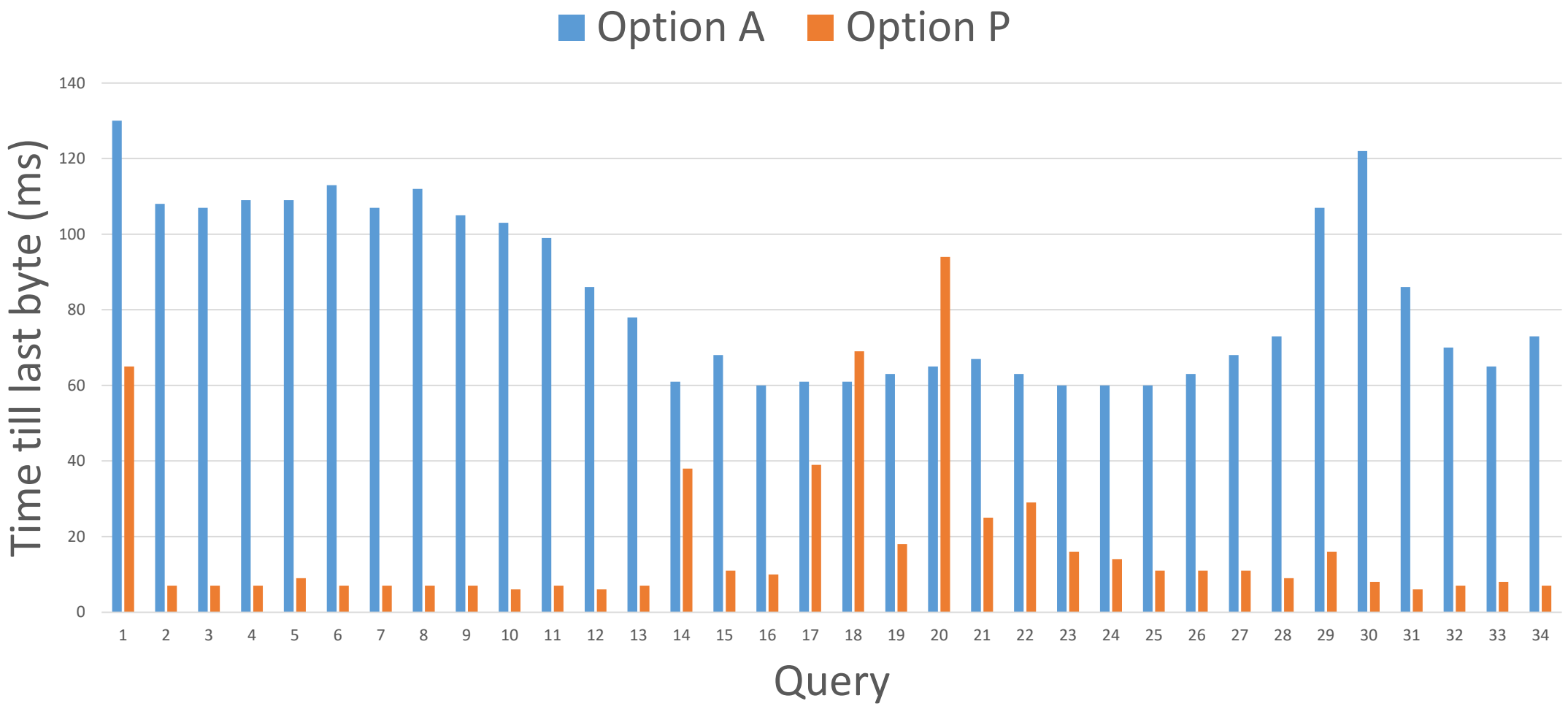
Scenario 1: Total packages needed to make the map (Option P)



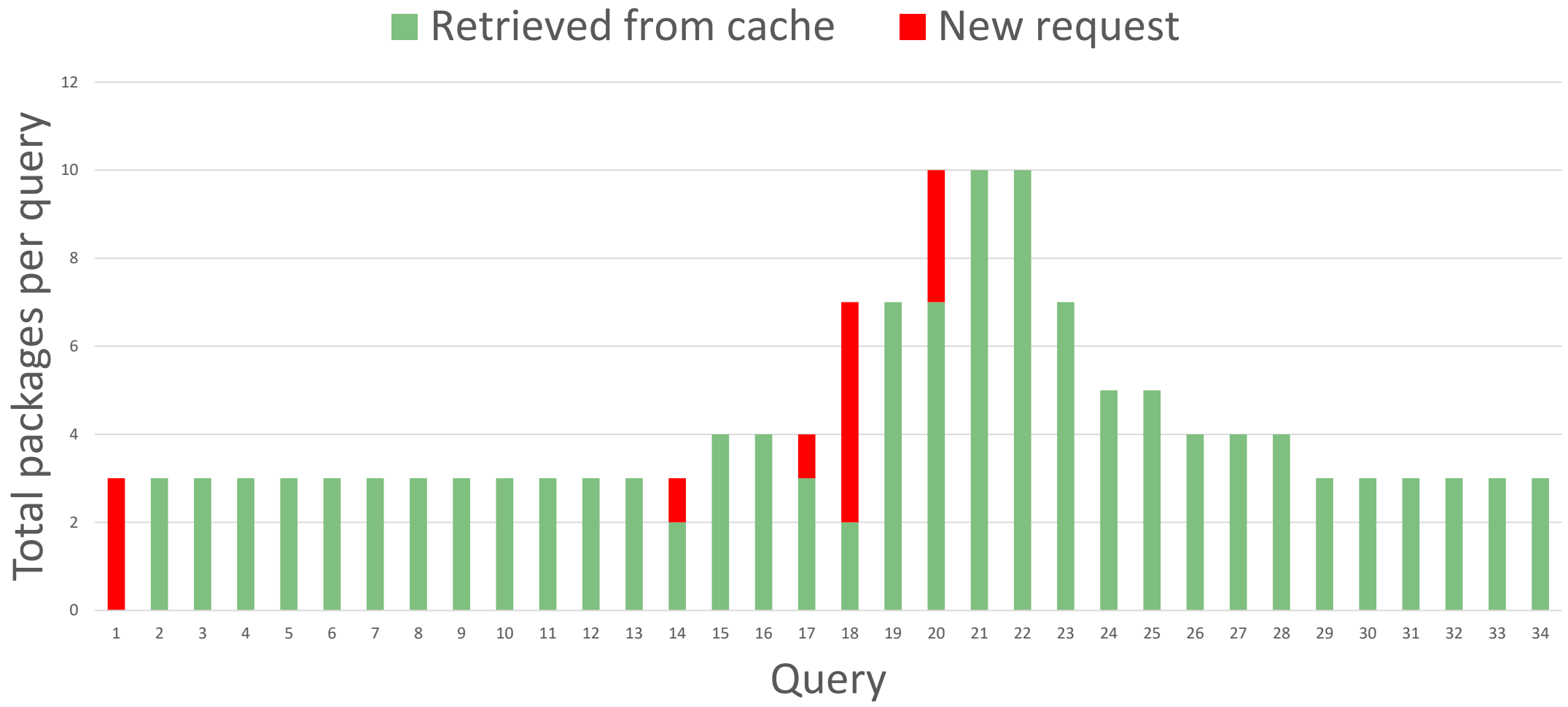
Scenario 2: Data transfers



Scenario 2: Response times



Scenario 2: Total packages needed to make the map (Option P)



Content overview

1. Motivation
2. Objectives
3. Methodology
4. Results
5. **Future work**

Future work

- **Test with larger dataset**
- **Cache strategy:**

  If the dataset gets larger, how do we find out which data is most likely to be reused and which data should be discarded if the cache limit exceeds?
- **Possibility to retrieve index in parts:**

  To be able to make a generalized map without retrieving the whole index if the dataset gets larger.

Future work

- **Achieving compression:**

  Make use of the fact that data is transferred in groups. It should be possible to define the coordinates of the edges relatively to a package reference.

- **Improve clustering:**

  The performance of the method depends on the effectiveness of the algorithm that clusters the data.

- **Test in non-localhost setting:**

  Tests should be performed over a real network, with an average download speed, to see if results would change.

Future work

- **Retrieve the faces for the classic SSC:**

  Method was only tested with edges. Next step is to also incorporate the faces in order to color the objects.

- **Smooth SSC:**

  Test if new method can also be used for visualizing polyhedrons in the smooth SSC with the GPU.

- **Point clouds:**

  Method is generic and can possibly also be used for the transfer and reuse of 4D point clouds.

Thank you!