

INP111 Homework 02 Week #15 (2022-12-15)

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- INP111 Homework 02 Week #15 (2022-12-15)
- Your Own Domain Name Server
 - Brief Descriptions of the Specification
 - Protocol Messages
 - Type Values
 - Additional Requirement: A nip.io like service
 - Configuration Files
 - Zone Files
 - The DNS Client
 - Demonstration
- Grading Policy

Your Own Domain Name Server

This homework aims to implement a Domain Name Server (DNS). Your goal is to **implement a DNS server that can correctly respond when users ask for a DNS record of a particular domain name**. For more details about the domain system and protocol, please refer to RFC 1035 (<https://www.rfc-editor.org/rfc/rfc1035>).

Brief Descriptions of the Specification

You have to read RFC 1035 (<https://www.rfc-editor.org/rfc/rfc1035>) carefully for the details of the query and response messages format of the DNS server. Here we simply provide brief descriptions of the behaviors you **must** implement in this homework.

Additional remarks on the behavior of the DNS server are summarized as follows. These remarks might make your implementation simpler.

establish the names of root servers and list their addresses.

- First, your DNS server has to **read a configuration file** containing the configuration of the DNS server, such as domain information and IP address of the foreign name server. An example of this configuration file is provided in the Configuration Files section. You can use the example file to test your implementation.
- Your DNS server should **respond to a query if a queried domain is handled by your server** (based on the configuration).
- For domains not handled by your server, your DNS server has to **forward the request to the configured foreign server**.

Note: You only need to handle **protocol messages delivered in UDP**.

Protocol Messages

The protocol message format used by DNS servers is defined in RFC 1035 (<https://www.rfc-editor.org/rfc/rfc1035>) and section 2 of RFC 3596 (<https://www.rfc-editor.org/rfc/rfc3596>).

In this homework, you only need to implement standard queries and responses. You do not need to consider the situation when **OPCODE** and **RD** are not 0.

Type Values

The answer, authority, and additional sections share the same resource record format in RFC 1035. The type fields are used in resource records to **specify the meaning of the data in each resource record**. You only need to implement the types required in this homework. The required types and their meaning are listed below:

A : a host address in IPv4
 AAAA : a host address in IPv6
 NS : an authoritative name server → the authority for this zone.
 CNAME : the canonical name for an alias
 SOA : marks the start of a zone of authority
 MX : mail exchange
 TXT : text strings

Additional Requirement: A nip.io (http://nip.io) like service

nip.io (http://nip.io) is a service that resolves any IP address you want from the domain. For example, if you query `127.0.0.1.nip.io`, you get the answer like `127.0.0.1.nip.io. 21600 IN A 127.0.0.1`. You can change the `127.0.0.1` to any IP address you want.

You need to implement a similar service in this homework.

If the query is match `/^([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3})\.([0-9a-zA-Z]{1,61}\.)*{YOUR_DOMAIN}$`, your service should answer the A record that address is the `([0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3}\.[0-9]{1,3})` part of the query and TTL is 1.

For example, suppose that your domain is `inplab.io`, and your server receives a query `87.87.87.87.abc.inplab.io`. Your server should respond `87.87.87.87.abc.inplab.io 1 IN A 87.87.87.87`.
 ↓
 within the domain.

Configuration Files

The format of the configuration file of this homework is defined as follows.

<forwardIP> → DNS沒有資料時往上問的 IP.
 DNS 管轄的 domain {
 <domain 1>,<path of zone file 1>
 <domain 2>,<path of zone file 2>
 ...

Zone Files

The format of a zone file containing records of a domain is defined as follows.

config file 中所
應的內容

```
<domain>
<NAME>, <TYPE>, <CLASS>, <TTL>, <RDATA>
<NAME>, <TYPE>, <CLASS>, <TTL>, <RDATA>
...
```

The format of <RDATA> for each RR type is summarized below.

```
01 A      : <ADDRESS>
AAAA     : <ADDRESS> → IPv6 address.
02 NS     : <NSDNAME>
05 CNAME  : <CNAME>
06 SOA    : <MNAME> <RNAME> <SERIAL> <REFRESH> <RETRY> <EXPIRE> <MINIMUM>
15 MX     : <PREFERENCE> <EXCHANGE>
16 TXT    : <TXT-DATA>
```

Note: We will use a different configuration file of the same format to test your implementation.

Note: All the used configuration files are always in the correct format. You do not need to handle the error case.

Note: The sample configuration file (config.txt

(https://drive.google.com/file/d/1a9gbvuZXD4FMjKcnwDd_d7FKXxjkfkrZ/view?usp=sharing)) and zone files (zone-example1.org.txt (https://drive.google.com/file/d/1aV7dhibNsmFp8EAQf3-w7ldLuLP_mSNwF/view?usp=sharing) | zone-example2.org.txt (https://drive.google.com/file/d/14hVb7dMi-asMzZfAR_HjwsEUTksH3d33/view?usp=sharing)) are available here. You can use them to test your implementation.

The DNS Client

dig (Domain Information Groper) is a tool we introduced in the lecture before. It performs DNS lookups and displays the answers from the queried name server(s). We use it to test your implementation. You can find the details in the demonstration below or check its main page (<https://www.ibm.com/docs/en/aix/7.1?topic=d-dig-commandhttps:>).

Demonstration

Your DNS server must accept two arguments. Assume your program is named `dns`, the command argument format is `./dns <port-number> <path/to/the/config/file> .`

Suppose the server receives queries from UDP port 1053 on localhost, and the IP address of the foreign name server is 8.8.8.8. You may run the following commands to test each of the test cases listed in the grading policy:

```
$ dig @<server_ip> -p <port> <domainname in its domain>
```

```
lvts@ubuntu:~$ dig @127.0.0.1 -p 1053 example1.org
;; <<<> DiG 9.16.1-Ubuntu <<<> @127.0.0.1 -p 1053 example1.org
;; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 55337
;; flags: qr aa rd; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
;; EDNS: version: 0, flags: udp: 4096
;; COOKIE: 3e397fe436b34747 (echoed)
;; QUESTION SECTION:
;example1.org.                IN      A
;; AUTHORITY SECTION:
example1.org.                 3600    IN      SOA      dns.example1.org. admin.example1.org.
;; Query time: 0 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 22:53:29 PST 2022
;; MSG SIZE rcvd: 135
```

```
0000 00 00 00 00 00 00 00 00 00 00 00 00 08 00 45 00 .....>.....E.
0010 00 51 03 a4 00 00 40 11 78 f6 7f 00 00 01 7f 00 .Q...@.x.....
0020 00 01 ae 93 04 1d 00 3d fe 50 6b 6f 01 20 00 01 .....1.....q
0030 00 00 00 00 00 01 08 65 78 61 6d 70 6c 65 31 03 .....e xample1.
0040 6f 72 67 00 00 01 00 01 00 00 29 04 d0 00 00 00 org.....).....
0050 00 00 0c 00 0a 00 08 5c c9 96 a2 ef 06 9d 40 .....@.....
```

```
lvts@ubuntu:~$ dig @127.0.0.1 -p 1053 example1.org ns
;; <<<> DiG 9.16.1-Ubuntu <<<> @127.0.0.1 -p 1053 example1.org ns
;; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 10503
;; flags: qr aa rd; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 2
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
;; EDNS: version: 0, flags: udp: 4096
;; COOKIE: 11262414efb2fb65 (echoed)
;; QUESTION SECTION:
;example1.org.                IN      NS
;; ANSWER SECTION:
example1.org.                 3600    IN      NS      dns.example1.org.
;; ADDITIONAL SECTION:
dns.example1.org.             3600    IN      A      140.113.123.1
;; Query time: 0 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 22:54:20 PST 2022
;; MSG SIZE rcvd: 127
```

```
0000 ac 9e 17 8e 92 d4 18 3e ef e4 b5 97 08 00 45 00 .....>.....E.
0010 00 45 d1 ed 00 00 40 11 84 0c c0 a8 01 bf 8c 71 .E...@.8.....q
0020 d5 d5 c1 ed 27 1d 00 31 ca b7 9a d3 01 20 00 01 .....1.....{
0030 00 00 00 00 00 01 08 65 78 61 6d 70 6c 65 31 03 .....e xample1.
0040 6f 72 67 00 00 02 00 01 00 00 29 10 00 00 00 00 org.....).....
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0000 18 3e ef e4 b5 97 ac 9e 17 8e 92 d4 08 00 45 00 .>.....E.
0010 00 8f 11 cf 40 00 38 11 0b e1 8c 71 d5 d5 c0 a8 .@.8.....q
0020 01 bf 27 1d c1 ed 00 7b 18 ad 9a d3 85 00 00 01 .....{
0030 00 01 00 00 00 02 08 65 78 61 6d 70 6c 65 31 03 .....e xample1.
0040 6f 72 67 00 00 02 00 01 08 65 78 61 6d 70 6c 65 org.....example
0050 31 03 6f 72 67 00 00 02 00 01 00 00 0e 10 00 12 1.org.....
0060 03 64 6e 73 08 65 78 61 6d 70 6c 65 31 03 6f 72 dns-exa mple1.or
0070 67 00 03 64 6e 73 08 65 78 61 6d 70 6c 65 31 03 g..dns-e xample1.
0080 6f 72 67 00 00 01 00 01 00 00 0e 10 00 04 8c 71 org.....q
0090 7b 01 00 00 29 10 00 00 00 00 00 00 00 00 00 {...}).....
```

```
lvts@ubuntu:~$ dig @127.0.0.1 -p 1053 example1.org mx
;; <<<> DiG 9.16.1-Ubuntu <<<> @127.0.0.1 -p 1053 example1.org mx
;; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 9944
;; flags: qr aa rd; QUERY: 1, ANSWER: 1, AUTHORITY: 1, ADDITIONAL: 2
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
;; EDNS: version: 0, flags: udp: 4096
;; COOKIE: c16be5776d0dd6f2 (echoed)
;; QUESTION SECTION:
;example1.org.                IN      MX
;; ANSWER SECTION:
example1.org.                 3600    IN      MX      10 mail.example1.org.
;; AUTHORITY SECTION:
example1.org.                 3600    IN      NS      dns.example1.org.
;; ADDITIONAL SECTION:
mail.example1.org.            3600    IN      A      140.113.123.10
;; Query time: 0 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 22:56:40 PST 2022
;; MSG SIZE rcvd: 173
```

```
0000 ac 9e 17 8e 92 d4 18 3e ef e4 b5 97 08 00 45 00 .....>.....E.
0010 00 45 6c 05 00 00 40 11 e9 f4 c0 a8 01 bf 8c 71 .El...@.i.....q
0020 d5 d5 f6 87 27 1d 00 31 1c 25 14 bf 01 20 00 01 .....1 %.....
0030 00 00 00 00 00 01 08 65 78 61 6d 70 6c 65 31 03 .....e xample1.
0040 6f 72 67 00 00 0f 00 01 00 00 29 10 00 00 00 00 org.....).....
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0000 18 3e ef e4 b5 97 ac 9e 17 8e 92 d4 08 00 45 00 .>.....E.
0010 00 bd e3 18 40 00 38 11 3a 69 8c 71 d5 d5 c0 a8 .@.8.....i.q
0020 01 bf 27 1d f6 87 00 a9 d3 0c 14 bf 85 00 00 01 .....{
0030 00 01 00 01 00 02 08 65 78 61 6d 70 6c 65 31 03 .....e xample1.
0040 6f 72 67 00 00 0f 00 01 08 65 78 61 6d 70 6c 65 data org.....example
0050 31 03 6f 72 67 00 00 0f 00 01 00 00 0e 10 00 15 len1.org.....
0060 00 0a 04 6d 61 69 6c 08 65 78 61 6d 70 6c 65 31 prename .org.....mail- example1.o
0070 03 6f 72 67 00 00 08 65 78 61 6d 70 6c 65 31 03 f .org.....exa mple1.o
0080 72 67 00 00 02 00 01 00 00 0e 10 00 12 03 64 6e rg.....dn
0090 73 08 65 78 61 6d 70 6c 65 31 03 6f 72 67 00 04 s-exampl e1.org..
00a0 6d 61 69 6c 08 65 78 61 6d 70 6c 65 31 03 6f 72 mail-exa mple1.or
00b0 67 00 00 01 00 01 00 00 0e 10 00 04 8c 71 7b 0a g.....q{
00c0 00 00 29 10 00 00 00 00 00 00 00 00 00 00 00 {...}).....
```

```
lvts@ubuntu:~$ dig @127.0.0.1 -p 1053 www.example1.org
;; <<<> DiG 9.16.1-Ubuntu <<<> @127.0.0.1 -p 1053 www.example1.org
;; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 25147
;; flags: qr aa rd; QUERY: 1, ANSWER: 1, AUTHORITY: 1, ADDITIONAL: 1
;; WARNING: recursion requested but not available

;; OPT PSEUDOSECTION:
;; EDNS: version: 0, flags: udp: 4096
;; COOKIE: 3f825c2b4a1c257b (echoed)
;; QUESTION SECTION:
;www.example1.org.           IN      A
;; ANSWER SECTION:
www.example1.org.             300     IN      A      140.113.123.80
;; AUTHORITY SECTION:
example1.org.                 3600    IN      NS      dns.example1.org.
;; Query time: 0 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 22:56:00 PST 2022
;; MSG SIZE rcvd: 131
```

```
0000 ac 9e 17 8e 92 d4 18 3e ef e4 b5 97 08 00 45 00 .....>.....E.
0010 00 49 f1 58 00 00 40 11 64 9d c0 a8 01 bf 8c 71 .I.X..@.d.....q
0020 d5 d5 f3 fd 27 1d 00 35 54 59 64 2c 01 20 00 01 .....5 Tyd,....
0030 00 00 00 00 00 01 03 77 77 77 08 65 78 61 6d 70 .....w ww-examp
0040 6c 65 31 03 6f 72 67 00 00 01 00 01 00 00 29 10 le1.org.....)
0050 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 .....
0000 18 3e ef e4 b5 97 ac 9e 17 8e 92 d4 08 00 45 00 .>.....E.
0010 00 93 d5 63 40 00 38 11 48 48 8c 71 d5 d5 c0 a8 .c@.8..HH.q
0020 01 bf 27 1d f3 fd 00 7f a5 cc 64 2c 85 00 00 01 .....d,.....
0030 00 01 00 01 00 01 03 77 77 77 08 65 78 61 6d 70 .....w ww-examp
0040 6c 65 31 03 6f 72 67 00 00 01 00 01 03 77 77 77 le1.org.....www
0050 08 65 78 61 6d 70 6c 65 31 03 6f 72 67 00 00 01 .example 1.org...
0060 00 01 00 00 01 2c 00 04 8c 71 7b 50 08 65 78 61 .q{P-exa
0070 6d 70 6c 65 31 03 6f 72 67 00 00 02 00 01 00 00 mple1.or g
0080 0e 10 00 12 03 64 6e 73 08 65 78 61 6d 70 6c 65 .dns .example
0090 31 03 6f 72 67 00 00 00 29 10 00 00 00 00 00 00 1.org.....)
00a0 00
```

Note: Since we do not define any information about "localhost" in the config file, the query is forwarded to the foreign name server when we query for the IP address of localhost.

- Foreign name server IP: 8.8.8.8

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 localhost

; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 localhost
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NXDOMAIN, id: 24431
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 0, AUTHORITY: 1, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;localhost.                IN      A

;; AUTHORITY SECTION:
.                84101   IN      SOA     a.root-servers.net. nstld.verisign-grs.com. 2022121300 1800 900 604800 86400

;; Query time: 8 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:37:36 PST 2022
;; MSG SIZE rcvd: 113
```

- Foreign name server IP: 127.0.0.53

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 localhost

; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 localhost
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 18301
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;localhost.                IN      A

;; ANSWER SECTION:
localhost.              0       IN      A       127.0.0.1

;; Query time: 4 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:36:50 PST 2022
;; MSG SIZE rcvd: 63
```

\$ dig @<server_ip> -p <port> <domainname not in its domain>

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 yahoo.com

; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 yahoo.com
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 16721
;; flags: qr rd ra; QUERY: 1, ANSWER: 6, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;yahoo.com.                IN      A

;; ANSWER SECTION:
yahoo.com.              121     IN      A       74.6.231.20
yahoo.com.              121     IN      A       98.137.11.163
yahoo.com.              121     IN      A       74.6.143.26
yahoo.com.              121     IN      A       98.137.11.164
yahoo.com.              121     IN      A       74.6.143.25
yahoo.com.              121     IN      A       74.6.231.21

;; Query time: 8 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:47:11 PST 2022
;; MSG SIZE rcvd: 188
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> A

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 yahoo.com A
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 yahoo.com A
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 45770
;; flags: qr rd ra; QUERY: 1, ANSWER: 6, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;yahoo.com.                IN      A

;; ANSWER SECTION:
yahoo.com.                 1650    IN      A      98.137.11.163
yahoo.com.                 1650    IN      A      74.6.143.26
yahoo.com.                 1650    IN      A      74.6.143.25
yahoo.com.                 1650    IN      A      74.6.231.20
yahoo.com.                 1650    IN      A      74.6.231.21
yahoo.com.                 1650    IN      A      98.137.11.164

;; Query time: 12 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:48:08 PST 2022
;; MSG SIZE rcvd: 188
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> AAAA

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 yahoo.com AAAA
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 yahoo.com AAAA
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 23823
;; flags: qr rd ra; QUERY: 1, ANSWER: 6, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;yahoo.com.                IN      AAAA

;; ANSWER SECTION:
yahoo.com.                 281     IN      AAAA    2001:4998:24:120d::1:1
yahoo.com.                 281     IN      AAAA    2001:4998:44:3507::8001
yahoo.com.                 281     IN      AAAA    2001:4998:24:120d::1:0
yahoo.com.                 281     IN      AAAA    2001:4998:124:1507::f000
yahoo.com.                 281     IN      AAAA    2001:4998:124:1507::f001
yahoo.com.                 281     IN      AAAA    2001:4998:44:3507::8000

;; Query time: 12 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:48:34 PST 2022
;; MSG SIZE rcvd: 260
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> NS

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 yahoo.com ns
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 yahoo.com ns
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 64689
;; flags: qr rd ra; QUERY: 1, ANSWER: 5, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;yahoo.com.                IN      NS

;; ANSWER SECTION:
yahoo.com.                 21532   IN      NS      ns1.yahoo.com.
yahoo.com.                 21532   IN      NS      ns4.yahoo.com.
yahoo.com.                 21532   IN      NS      ns3.yahoo.com.
yahoo.com.                 21532   IN      NS      ns2.yahoo.com.
yahoo.com.                 21532   IN      NS      ns5.yahoo.com.

;; Query time: 20 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:49:11 PST 2022
;; MSG SIZE rcvd: 218
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> CNAME


```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 www.nycu.edu.tw cname
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 www.nycu.edu.tw cname
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 22620
;; flags: qr rd ra ad; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;www.nycu.edu.tw.                IN      CNAME

;; ANSWER SECTION:
www.nycu.edu.tw.                2099    IN      CNAME   nycu-nctu.cdn.hinet.net.

;; Query time: 12 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:50:07 PST 2022
;; MSG SIZE   rcvd: 96
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> SOA

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 yahoo.com soa
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 yahoo.com soa
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 42360
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;yahoo.com.                    IN      SOA

;; ANSWER SECTION:
yahoo.com.                    1800    IN      SOA      ns1.yahoo.com. hostmaster.yahoo-inc.com. 2022121303 3600 300 1814400 600

;; Query time: 64 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:52:55 PST 2022
;; MSG SIZE   rcvd: 120
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> MX

```
lvls@ubuntu:~$ dig @127.0.0.1 -p 1053 gmail.com mx
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 gmail.com mx
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 48584
;; flags: qr rd ra; QUERY: 1, ANSWER: 5, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;gmail.com.                    IN      MX

;; ANSWER SECTION:
gmail.com.                    1592    IN      MX       20 alt2.gmail-smtp-in.l.google.com.
gmail.com.                    1592    IN      MX       40 alt4.gmail-smtp-in.l.google.com.
gmail.com.                    1592    IN      MX       5 gmail-smtp-in.l.google.com.
gmail.com.                    1592    IN      MX       30 alt3.gmail-smtp-in.l.google.com.
gmail.com.                    1592    IN      MX       10 alt1.gmail-smtp-in.l.google.com.

;; Query time: 12 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:54:16 PST 2022
;; MSG SIZE   rcvd: 313
```

\$ dig @<server_ip> -p <port> <domainname not in its domain> TXT


```

ivis@ubuntu:~$ dig @127.0.0.1 -p 1053 gmail.com txt
; <<>> DiG 9.16.1-Ubuntu <<>> @127.0.0.1 -p 1053 gmail.com txt
; (1 server found)
;; global options: +cmd
;; Got answer:
;; ->HEADER<- opcode: QUERY, status: NOERROR, id: 1473
;; flags: qr rd ra; QUERY: 1, ANSWER: 2, AUTHORITY: 0, ADDITIONAL: 1

;; OPT PSEUDOSECTION:
; EDNS: version: 0, flags:; udp: 4096
;; QUESTION SECTION:
;gmail.com.                IN      TXT

;; ANSWER SECTION:
gmail.com.                 300     IN      TXT     "globalsign-smime-dv=CDYX+XFHLw2wml6/Gb8+59BsH31KzUr6c1l2BPvqKX8="
gmail.com.                 300     IN      TXT     "v=spf1 redirect=_spf.google.com"

;; Query time: 16 msec
;; SERVER: 127.0.0.1#1053(127.0.0.1)
;; WHEN: Tue Dec 13 01:54:48 PST 2022
;; MSG SIZE rcvd: 177

```

You can play with our server with the dig commands:

```
dig @inp111.zoolab.org -p 10013 <domain name> <RR type>
```

Grading Policy

[25%] Your server can give a correct host address when the requested domain name is in its domain.

[25%] Your server can forward the domain name to the foreign server when your server does not handle the requested domain name. In this way, your server can still receive the correct host address.

[35%] Your server can handle the 7 type values listed above. Your server can filter resource records based on different type values (each type worth 5 points).

[15%] Your server needs to return A record response when the query meets the format `/^([0-9]{1,3}\. [0-9]{1,3}\. [0-9]{1,3}\. [0-9]{1,3})\. ([0-9a-zA-Z]{1,61}\.) * {YOUR DOMAIN}$/` . The detailed description of this part is introduced in the section.