solution for Yiping Deng

This is the file containing the solution for this homework. All the codes are running on arch linux and with the latest branch of bird, also the python file given by the professor has been slightly changed in accordance to the release note of bird [link to release note] [https://gitlab.labs.nic.cz/labs/bird/wikis/transition-notes-to-bird-2].

In the release, `bird6` command has been removed.

a)

Codes are included in the file, and the following are some random test to verify the work

```
mininet> a1 ping 2001:638:709:a2::1
PING 2001:638:709:a2::1(2001:638:709:a2::1) 56 data bytes
64 bytes from 2001:638:709:a2::1: icmp_seq=1 ttl=62 time=0.279 ms
64 bytes from 2001:638:709:a2::1: icmp_seq=2 ttl=62 time=0.066 ms
mininet> a1 ping 2001:638:709:a3::1
PING 2001:638:709:a3::1(2001:638:709:a3::1) 56 data bytes
64 bytes from 2001:638:709:a3::1: icmp_seq=1 ttl=61 time=0.231 ms
64 bytes from 2001:638:709:a3::1: icmp_seq=2 ttl=61 time=0.104 ms
mininet> a1 ping 2001:638:709:a4::1
PING 2001:638:709:a4::1(2001:638:709:a4::1) 56 data bytes
64 bytes from 2001:638:709:a4::1: icmp_seq=1 ttl=62 time=0.224 ms
64 bytes from 2001:638:709:a4::1: icmp_seq=2 ttl=62 time=0.074 ms

mininet> b1 ping 2001:638:709:b4::1
PING 2001:638:709:b4::1(2001:638:709:b4::1) 56 data bytes
64 bytes from 2001:638:709:b4::1: icmp_seq=1 ttl=62 time=0.151 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=2 ttl=62 time=0.074 ms
64 bytes from 2001:638:709:b4::1: icmp_seq=3 ttl=62 time=0.066 ms
```

b)

```
mininet> a1 traceroute 2001:638:709:a2::1
traceroute to 2001:638:709:a2::1 (2001:638:709:a2::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  0.054 ms  0.023 ms  0.021 ms
 2  2001:638:709:f::f1:f2 (2001:638:709:f::f1:f2)  0.043 ms  0.032 ms  0.033 ms
 3  2001:638:709:a2::1 (2001:638:709:a2::1)  0.049 ms  0.039 ms  0.039 ms




mininet> f1 ifconfig
f1-eth0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::d440:f9ff:fee8:ea20  prefixlen 64  scopeid 0x20<link>
        inet6 2001:638:709:a1::f1  prefixlen 64  scopeid 0x0<global>
        ether d6:40:f9:e8:ea:20  txqueuelen 1000  (Ethernet)
        RX packets 10  bytes 912 (912.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 10  bytes 1132 (1.1 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

f1-eth1: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 2001:638:709:f::f2:f1  prefixlen 64  scopeid 0x0<global>
        inet6 fe80::423:9dff:fe9d:19c3  prefixlen 64  scopeid 0x20<link>
        ether 06:23:9d:9d:19:c3  txqueuelen 1000  (Ethernet)
        RX packets 30  bytes 3980 (3.8 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 30  bytes 3904 (3.8 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

f1-eth2: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet6 fe80::a02b:c2ff:feaa:5a20  prefixlen 64  scopeid 0x20<link>
        inet6 2001:638:709:f::f4:f1  prefixlen 64  scopeid 0x0<global>
        ether a2:2b:c2:aa:5a:20  txqueuelen 1000  (Ethernet)
        RX packets 37  bytes 4894 (4.7 KiB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 36  bytes 4800 (4.6 KiB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
```

```
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 0  bytes 0 (0.0 B)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 0  bytes 0 (0.0 B)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

mininet> f1 ifconfig f1-eth1 down
mininet> a1 traceroute 2001:638:709:a2::1
traceroute to 2001:638:709:a2::1 (2001:638:709:a2::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  0.073 ms  0.028 ms  0.028 ms
 2  2001:638:709:f::f1:f4 (2001:638:709:f::f1:f4)  0.058 ms  0.046 ms  0.041 ms
 3  2001:638:709:f::f4:f3 (2001:638:709:f::f4:f3)  0.066 ms  0.053 ms  0.050 ms
 4  2001:638:709:f::f3:f2 (2001:638:709:f::f3:f2)  0.072 ms  0.060 ms  0.059 ms
 5  2001:638:709:a2::1 (2001:638:709:a2::1)  0.084 ms  0.069 ms  0.066 ms
```

c)

BGP link created accordingly, some test result

```
mininet> a1 ping 2001:638:709:b2::1
PING 2001:638:709:b2::1(2001:638:709:b2::1) 56 data bytes
64 bytes from 2001:638:709:b2::1: icmp_seq=1 ttl=58 time=0.313 ms
64 bytes from 2001:638:709:b2::1: icmp_seq=2 ttl=58 time=0.119 ms
64 bytes from 2001:638:709:b2::1: icmp_seq=3 ttl=58 time=0.112 ms

mininet> a1 ping 2001:638:709:b3::1
PING 2001:638:709:b3::1(2001:638:709:b3::1) 56 data bytes
64 bytes from 2001:638:709:b3::1: icmp_seq=1 ttl=57 time=0.310 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=2 ttl=57 time=0.113 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=3 ttl=57 time=0.107 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=4 ttl=57 time=0.114 ms
64 bytes from 2001:638:709:b3::1: icmp_seq=5 ttl=57 time=0.110 ms
```

d)

Filters are created accordingly in the `common-bird.conf` file.

e)

Additional filters to penalize a route is added to `common-bird.conf` file. Verify work

```
mininet> a1 traceroute 2001:638:709:b1::1
traceroute to 2001:638:709:b1::1 (2001:638:709:b1::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:a1::f1)  1.561 ms  1.455 ms  1.398 ms
 2  2001:638:709:f::f1:f2 (2001:638:709:f::f1:f2)  1.279 ms  1.177 ms  1.109 ms
 3  2001:638:709:e::e1 (2001:638:709:e::e1)  1.043 ms  0.956 ms  0.879 ms
 4  2001:638:709:b1::1 (2001:638:709:b1::1)  0.804 ms  0.611 ms  0.517 ms

mininet> b1 traceroute 2001:638:709:a1::1
traceroute to 2001:638:709:a1::1 (2001:638:709:a1::1), 30 hops max, 80 byte packets
 1  _gateway (2001:638:709:b1::e1)  1.930 ms  1.823 ms  1.763 ms
 2  2001:638:709:f::f2 (2001:638:709:f::f2)  1.676 ms  1.554 ms  0.054 ms
 3  2001:638:709:f::f2:f3 (2001:638:709:f::f2:f3)  0.071 ms  0.051 ms  0.049 ms
 4  2001:638:709:f::f3:f4 (2001:638:709:f::f3:f4)  0.092 ms  0.090 ms  0.066 ms
 5  2001:638:709:f::f4:f1 (2001:638:709:f::f4:f1)  0.079 ms  0.073 ms  0.070 ms
 6  2001:638:709:a1::1 (2001:638:709:a1::1)  0.087 ms  0.171 ms  0.084 ms
```