

BIDIRECTIONAL PROGRAMMING FOR SELF-ADAPTIVE SOFTWARE

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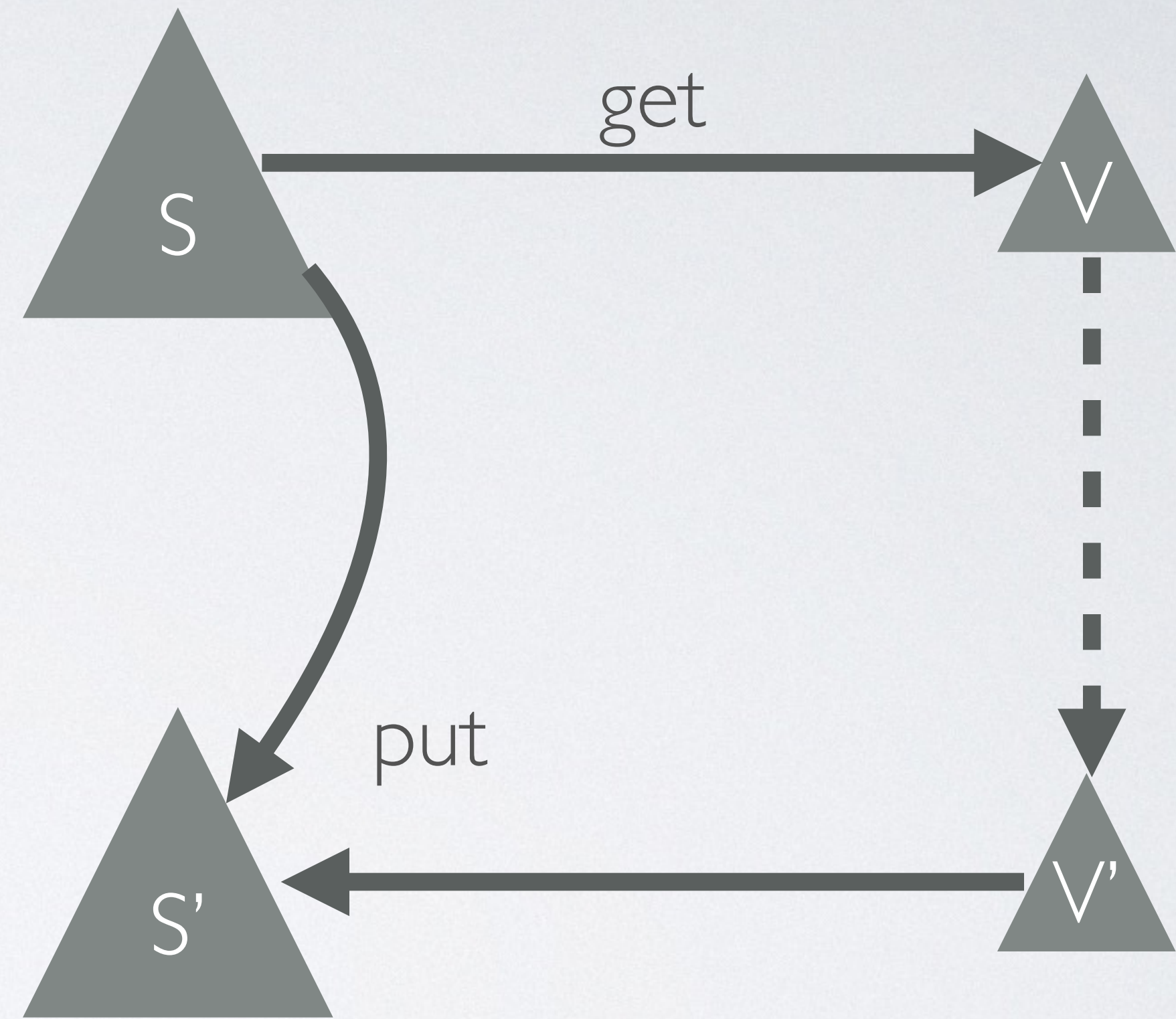
based on discussions with Sebastian Uchitel (U. of Buenos Aires), Zhenjiang Hu (NII), Tao Zan (NII, SOKENDAI), Zirun Zhu (NII, SOKENDAI)

TAKE AWAY: BIDIRECTIONAL
PROGRAMS ARE AWESOME, AND YOU
SHOULD USE THEM.

WHAT IS A BIDIRECTIONAL TRANSFORMATION?

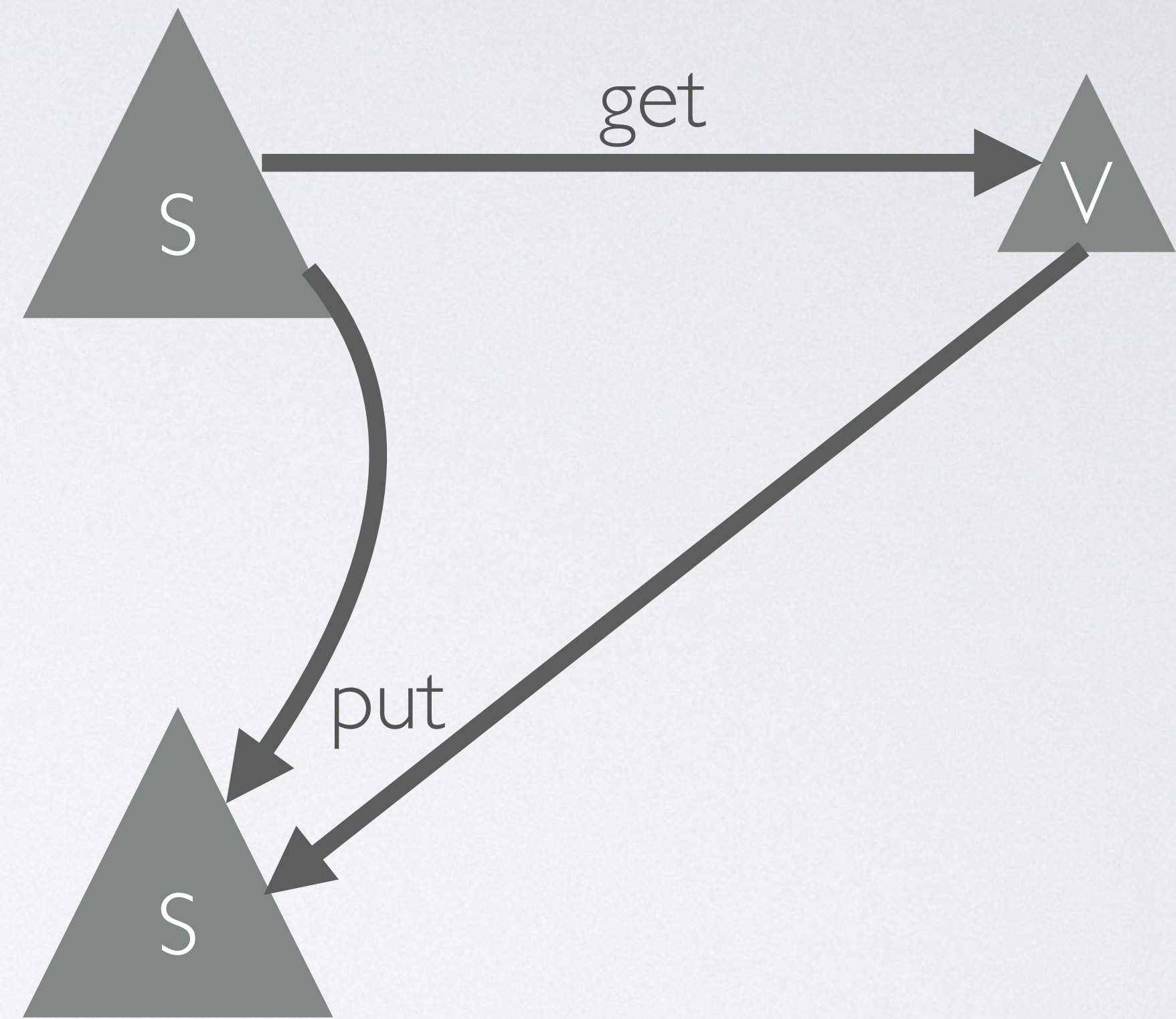
`get :: Source -> View`

`put :: Source -> View -> Source`



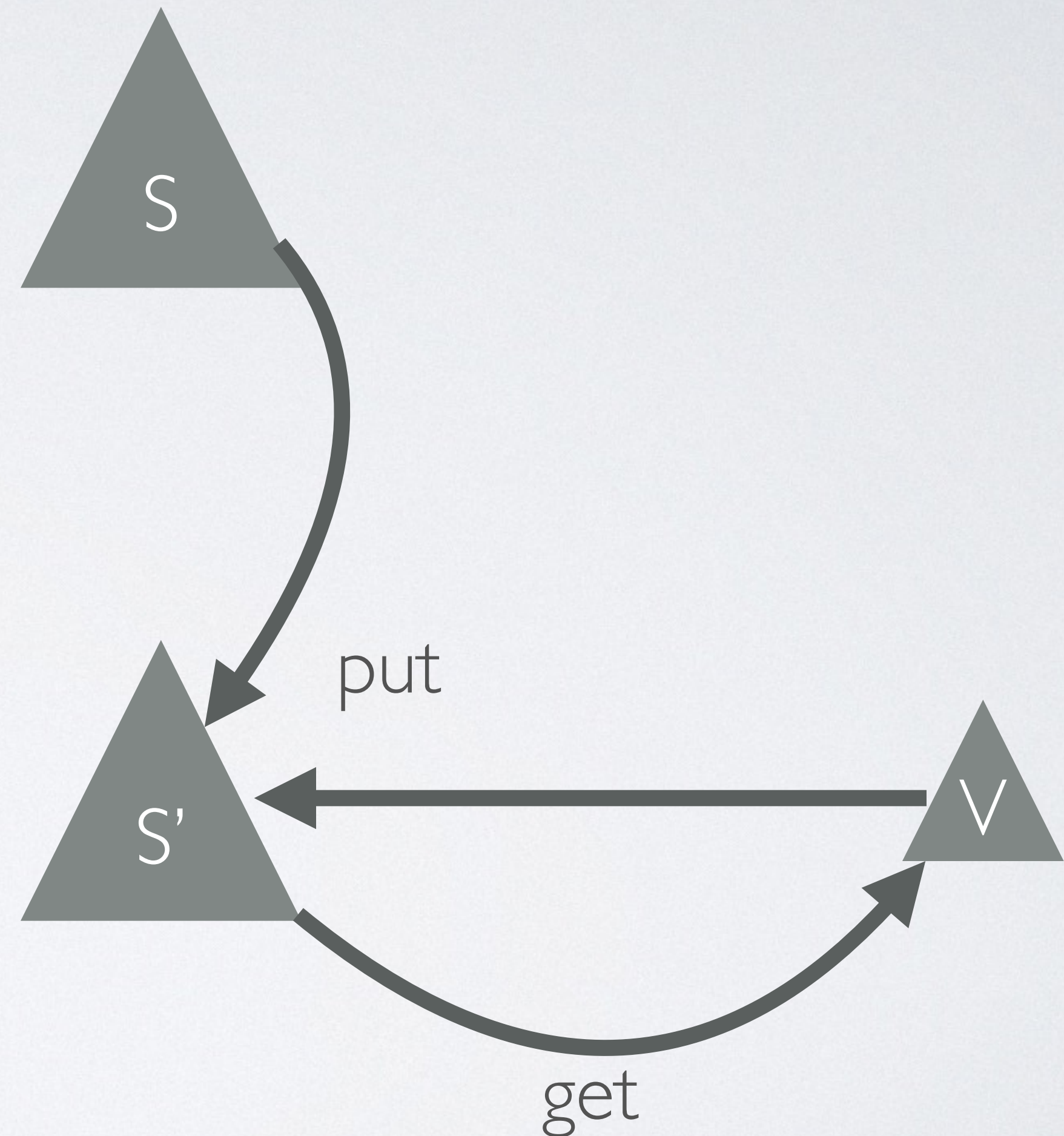
WHAT IS A **WELL-
BEHAVED**
BIDIRECTIONAL
TRANSFORMATION?

GetPut: $\text{put } s \text{ (get } s) = s$



WHAT IS A **WELL-
BEHAVED**
BIDIRECTIONAL
TRANSFORMATION?

PutGet: $\text{get}(\text{put } s \ v) = v$



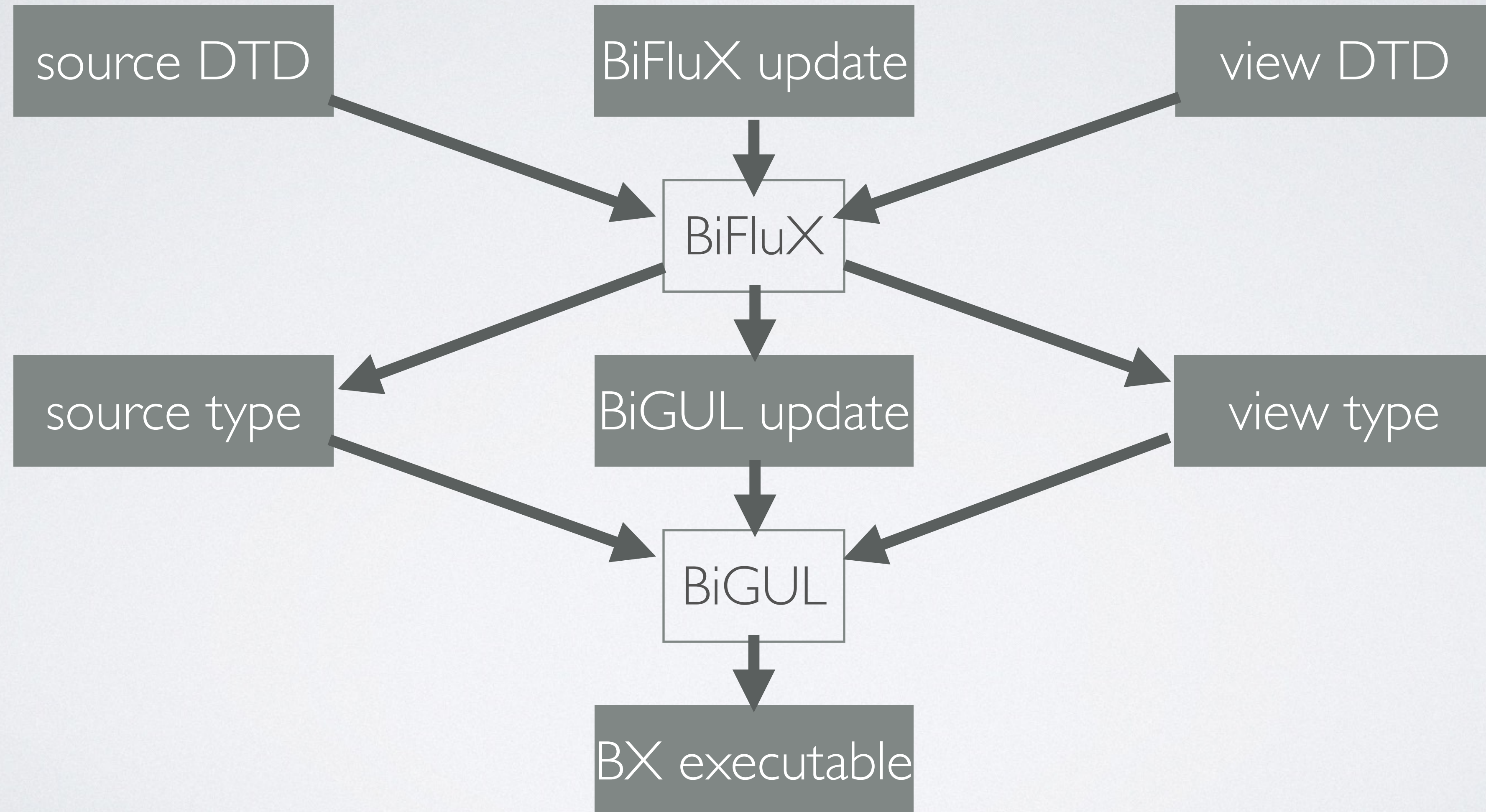
BIDIRECTIONAL PROGRAMS (BIFLUX)

- calendar
 - event (work)
 - name: Meeting
 - date: 9 April 2015, 15:00
 - location: room 2005
 - notes: prepare slides
 - event (private)
 - name: Complaint
 - date: 9 April 2015, 17:00
 - location: pet shop
 - notes: dead parrot
- calview
 - event (work)
 - name: Meeting
 - date: 9 April 2015, 15:00
 - location: room 2005

BIDIRECTIONAL PROGRAMS (BIFLUX)

```
UPDATE $event IN $source/event BY
MATCH ->
    REPLACE $event/starttime WITH $starttime;
    REPLACE $event/endtime WITH $endtime;
    REPLACE $event/location WITH $location
| UNMATCHV -> CREATE VALUE
    <event>
        <starttime/>
        <endtime/>
        <name/>
        <note>nothing</note>
        <location/>
        <private>False</private>
    </event>
| UNMATCHS -> DELETE .
FOR VIEW event[$starttime AS v:starttime,
    $endtime AS v:endtime, $name AS v:name,
    $location AS v:location] IN $view/*
MATCHING SOURCE BY $event/name VIEW BY $name
WHERE private/text() = 'False'
```

BIDIRECTIONAL PROGRAMS (BIGUL)



BIDIRECTIONAL PROGRAMS (BIGUL - SRC)

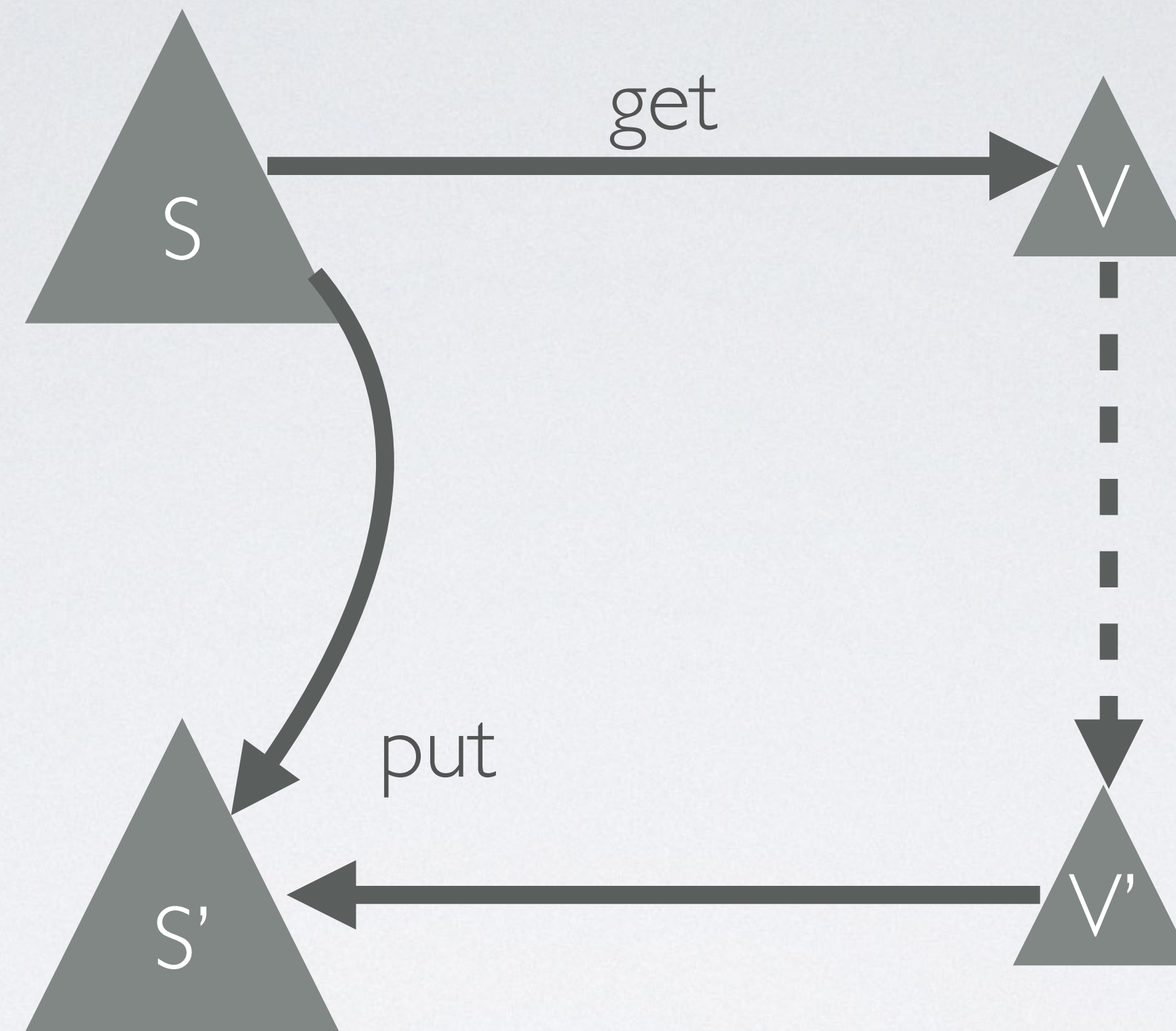
```
type ApiCalls      = [SCall]
type SCall         = (SPermissions, (File, (Line, (Protected, Deleted))))
type File          = String
type Line          = Int
type Deleted       = Bool
type Name          = String
type SPermissions = [SPermission]
type SPermission   = (Name, [ApiVersion])
type Protected     = String
type ApiVersion    = String
```

BIDIRECTIONAL PROGRAMS (BIGUL - SRC)

```
type Calls          = [VCall]
type VCall          = (File, (Line, VPermissions))
type VPermissions   = [VPermission]
type VPermission    = Name
```

BIDIRECTIONAL PROGRAMS (BIGUL - UPD)

```
t :: MonadError' e m => ApiVersion -> BiGUL m ApiCalls Calls
t ver = Align (\(ps, (f, (l, (ptd, del)))) -> return (not del))
  (\(_, (f, (l, _))) (f', (l', _)) -> return (f == f' && l == l'))
  (Rearr (RVar `RProd` (RVar `RProd` RVar))
    (EDir (DRight (DRight DVar)) `EProd`
    (EDir (DLeft DVar) `EProd`
    (EDir (DRight (DLeft DVar)) `EProd`
    (EConst () `EProd` EConst ())))))
  (Update (UVar (Align (\(_, vers) -> return (ver `elem` vers))
    (\_ _ -> return True)
    (Rearr RVar (EDir DVar `EProd` EConst ())
      (Update (UVar Replace `UProd` UVar Skip))))
    (\_ -> return ("", [ver]))
    (\_ -> return Nothing)) `UProd`
    (UVar Replace `UProd`
    (UVar Replace `UProd`
    (UVar Skip `UProd` UVar Skip))))))
  (\_ -> return ([], ("", (0, ("", False))))))
  (\(ps, (f, (l, (ptd, del)))) -> return (Just (ps, (f, (l, (ptd, True))))))
```



BP AND SELF-ADAPTATION

Where it can help, and what challenges lie ahead

THE NORWEGIAN BLUE, INC.

online pet shop.

APACHE WEB SERVER

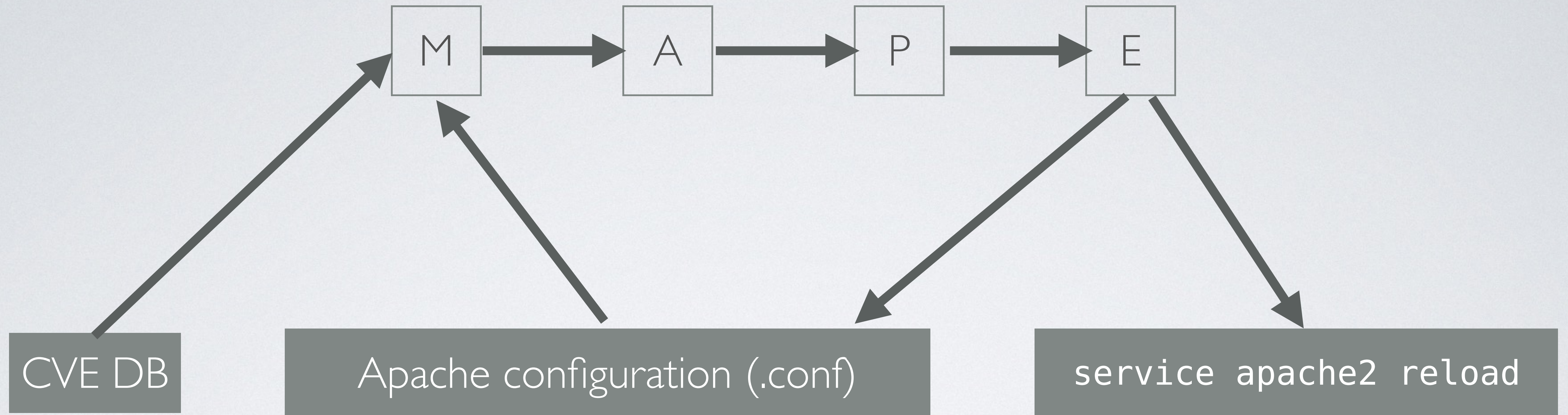
```
<VirtualHost *:443>
  SSLEngine on
  SSLCertificateFile /etc/ssl/certs/resting.norwegianblue.com.pem
  SSLCertificateKeyFile /etc/ssl/private/resting.norwegianblue.com.key
  SSLProtocol TLSv1:TLSv1.1:TLSv1.2
  SSLCipherSuite EECDH+ECDSA+AESGCM:EECDH+aRSA+AESGCM:EECDH+ECDSA+SHA384:EECDH
+ECDSA+SHA256:EECDH+aRSA+SHA384:EECDH+aRSA+SHA256:EECDH+aRSA+RC4:EECDH:EDH
+aRSA:!RC4:!aNULL:!eNULL:!LOW :3DES:!MD5:!EXP:!PSK:!SRP:!DSS:!EXPORT:!aECDH:!
EDH-DSS-DES-CBC3-SHA:!EDH-RSA-DES-CBC3-SHA:!KRB5-DES-CBC3-SHA
  <Directory /var/www/norwegianblue>
    AllowOverride All
  </Directory>
  DocumentRoot /var/www/norwegianblue
  ServerName resting.norwegianblue.com
</VirtualHost>
```



POODLE

CVE-2014-3566

Man-in-the-middle attack on SSLv3



SELF-ADAPTATION

Keeping the configuration secure

NGINX SERVER

```
server {
    listen 443 ssl;
    server_name
stunned.norwegianblue.com;

    ssl_certificate /etc/ssl/certs/
stunned.norwegianblue.com.pem;
    ssl_certificate_key /etc/ssl/private/
stunned.norwegianblue.com.key;

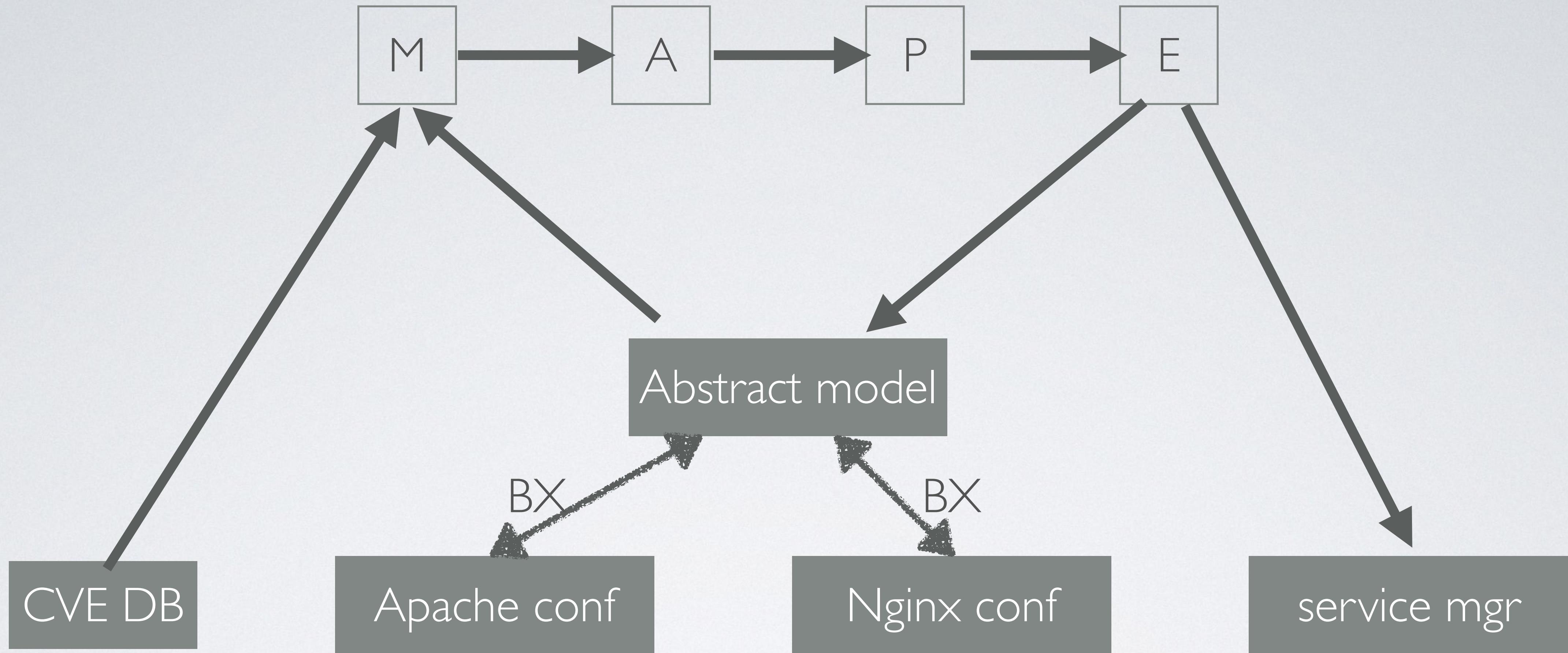
    ssl_protocols TLSv1 TLSv1.1 TLSv1.2;
    ssl_prefer_server_ciphers on;
    ssl_ciphers "EECDH+ECDSA+AESGCM EECDH
+aRSA+AESGCM EECDH+ECDSA+SHA384 EECDH
+ECDSA+SHA256 EECDH+aRSA+SHA384 EECDH
+aRSA+SHA256 EECDH+aRSA+RC4 EECDH EDH
+aRSA !RC4 !aNULL !eNULL !LOW !3DES !
MD5 !EXP !PSK !SRP !DSS !EXPORT !
aECDH !EDH-DSS-DES-CBC3-SHA !EDH-RSA-
DES-CBC3-SHA !KRB5-DES-CBC3-SHA";
}
```

```
ssl_dhparam /etc/ssl/dhparams.pem;

# Path to the root of your installation
root /var/www/norwegianblue/;
# set max upload size
client_max_body_size 10G;
fastcgi_buffers 64 4K;
```

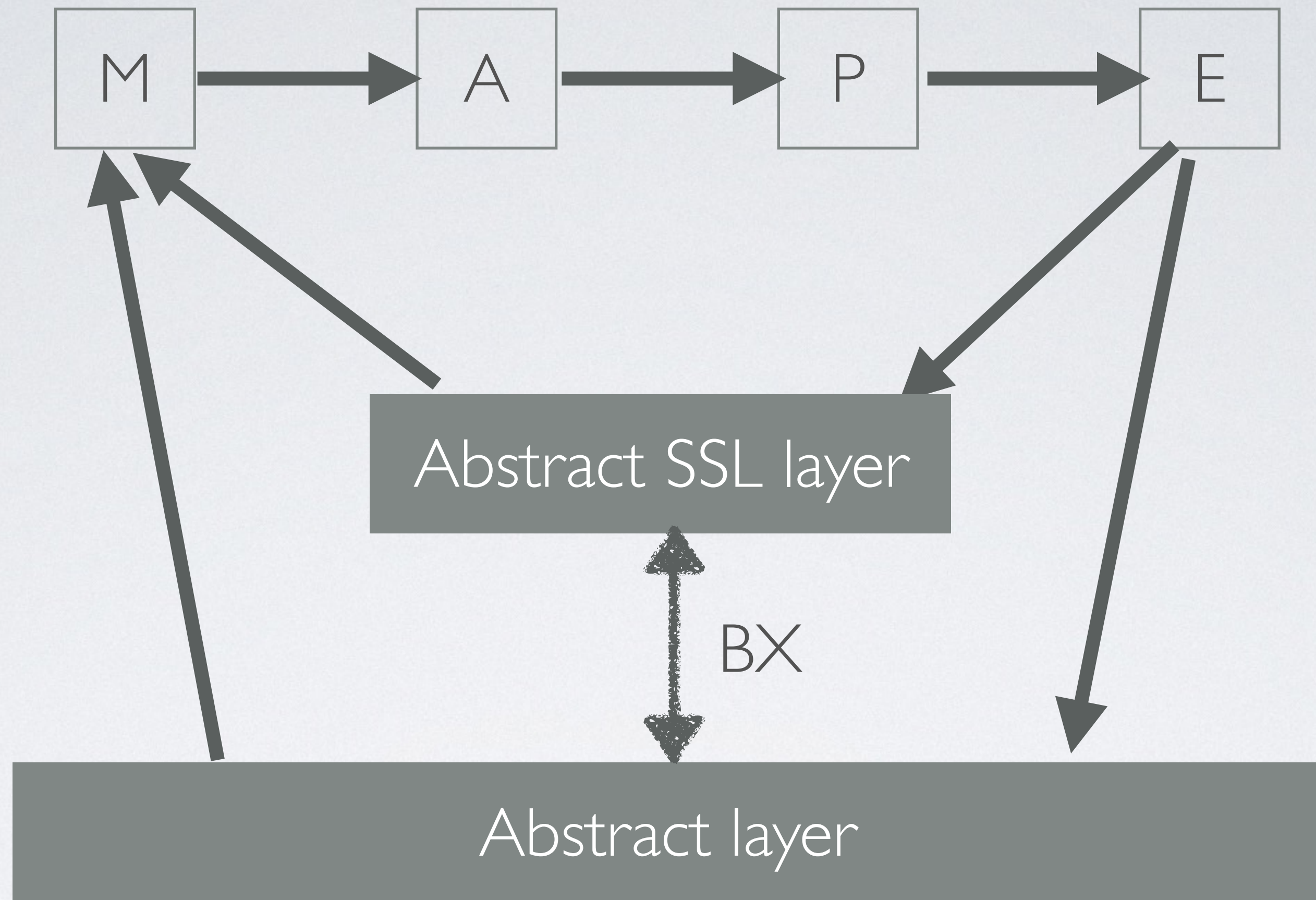
```
location = /robots.txt {
    allow all;
    log_not_found off;
    access_log off;
}
```

```
location ~ ^/(?:\.htaccess|data|config|db_s
deny all;
}
```



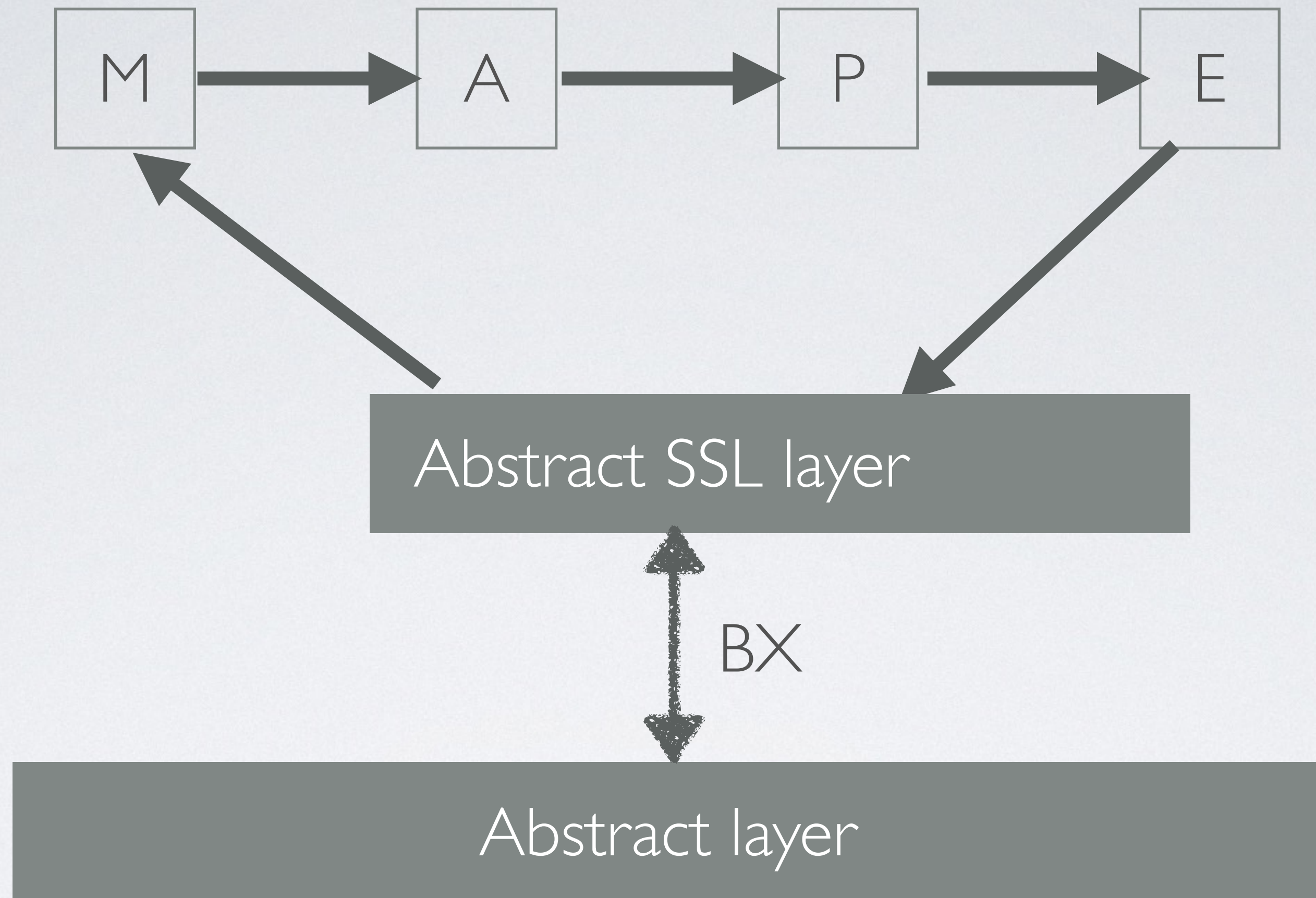
AN ABSTRACT LAYER

Bidirectional programming for abstraction and migration



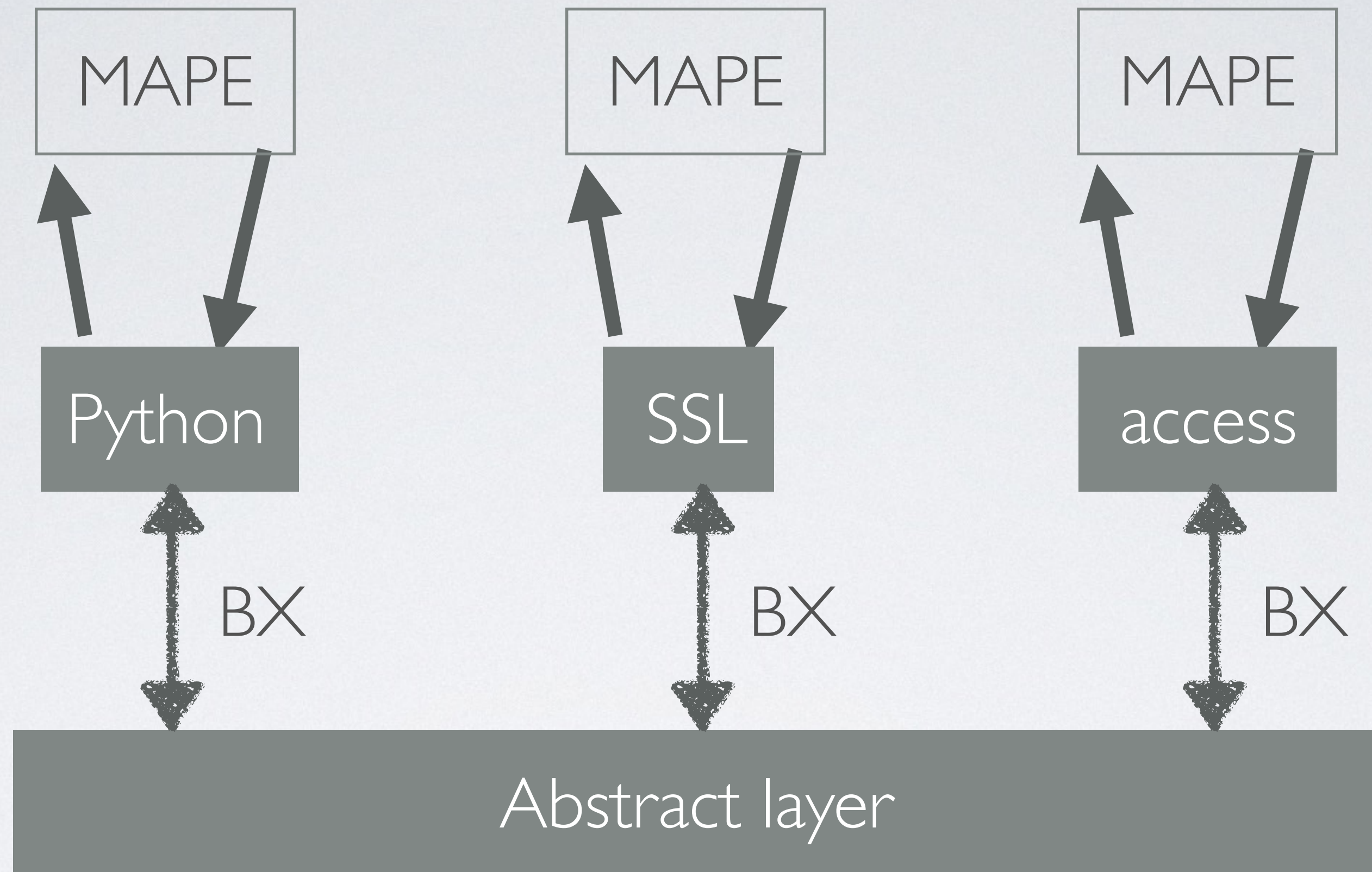
A SMALL MODEL IS A GOOD MODEL

Bidirectional programming to the rescue, again



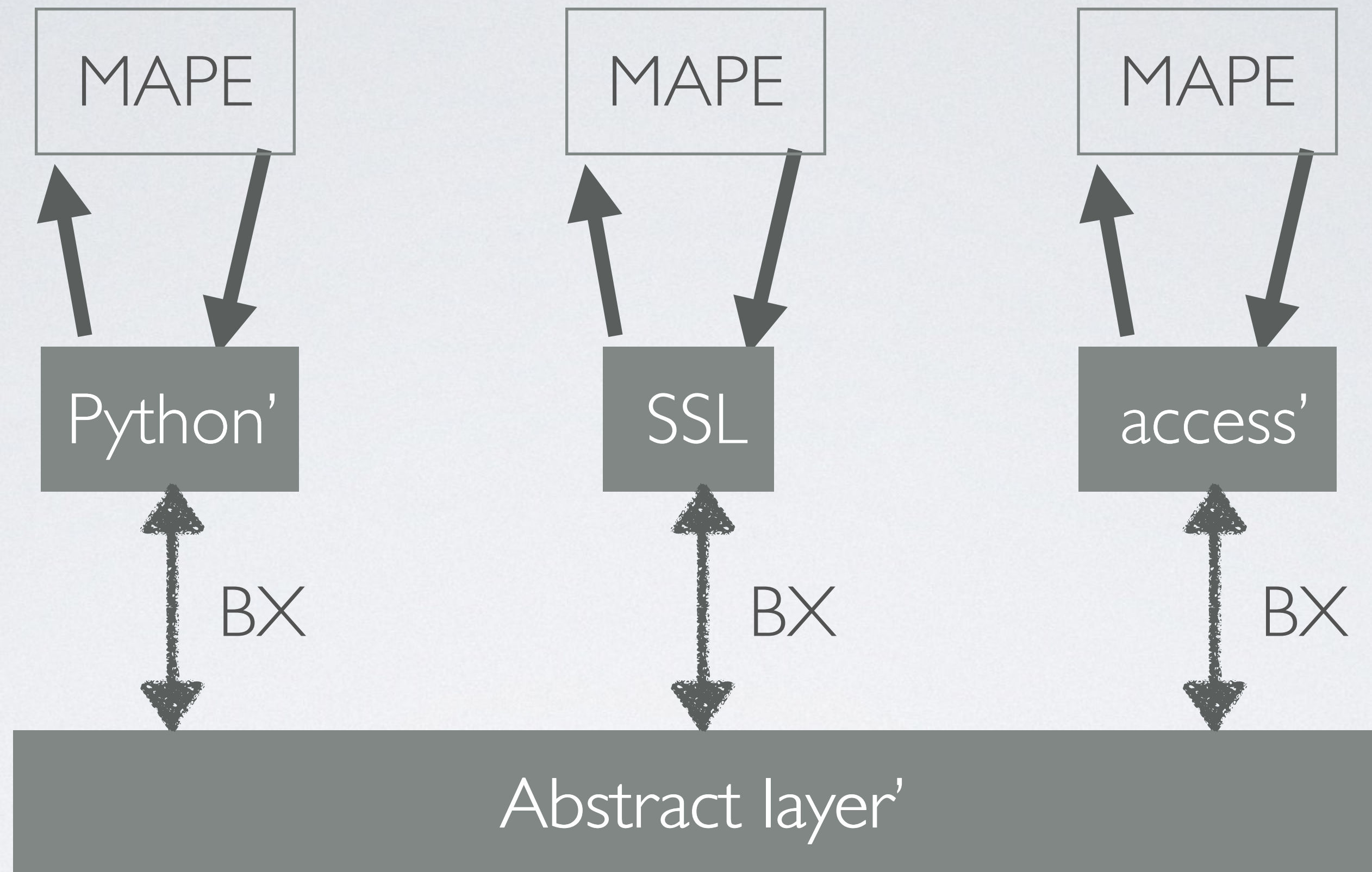
THE SMALLER THE BETTER

Model size may vary at runtime



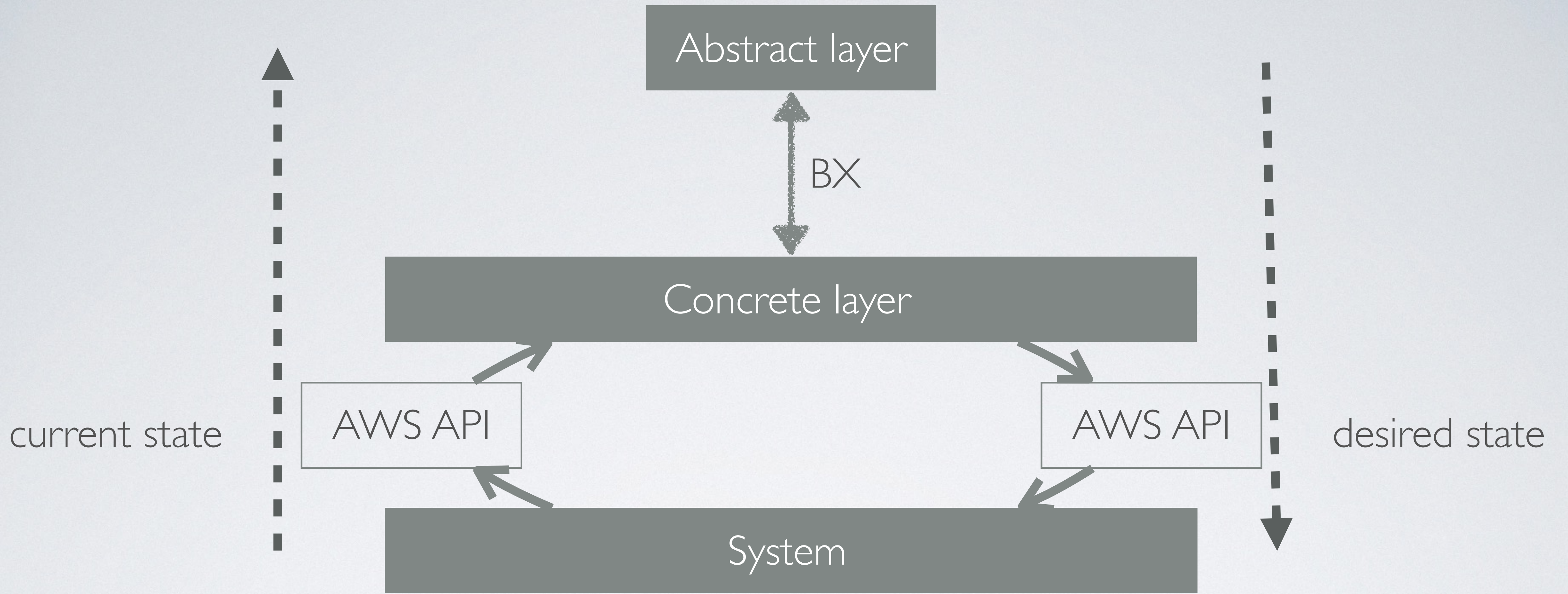
MULTIPLE SMALL MODELS

N loops



SYNCHRONISATION

Straightforward, with bidirectional transformations



BEYOND SELF-CONFIGURATION

current system vs. desired system

desired state



current state + delta



current state

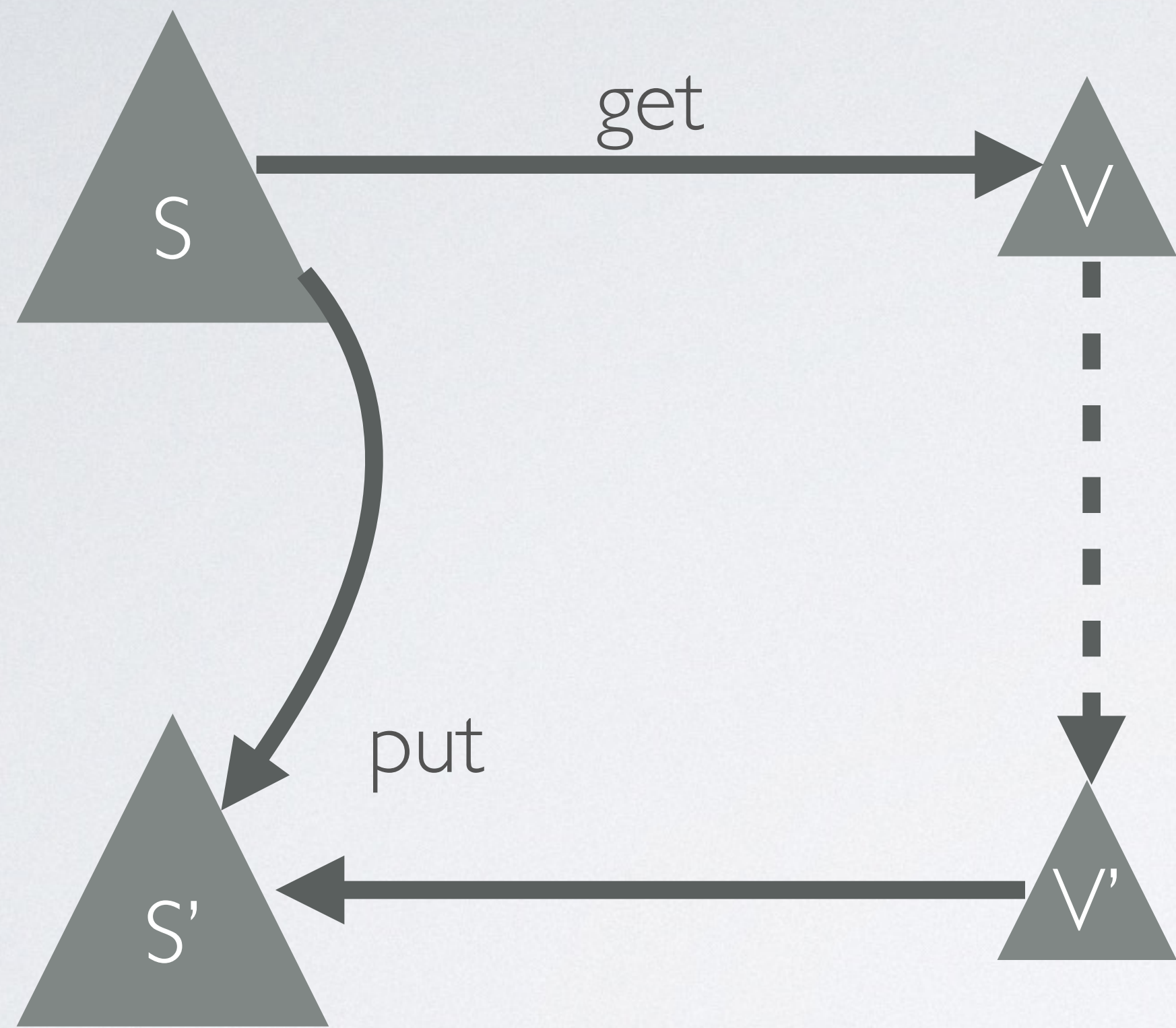


DELTA

Bidirectional programs to the rescue, once more!

ASSIGNMENT:

In small groups, find where bidirectional programs could help you develop self-adaptive systems



REFERENCES

- [BiFluX]: H. Pacheco, T. Zan, and Z. Hu, “BiFluX: A Bidirectional Functional Update Language for XML,” in 6th International Symposium on Principles and Practice of Declarative Programming (PPDP 2014), 2014.
- [BX]: S. Fischer, Z. Hu, and H. Pacheco, “‘Putback’ is the Essence of Bidirectional Programming,” National Institute of Informatics, GRACE-TR 2012-08, Dec. 2012.
- [SACMAT]: L. Montrieux and Z. Hu, “Towards Attribute-Based Authorisation for Bidirectional Programming,” 2015, pp. 185–196.

IMAGE CREDITS

- Poodle by Marcia O'Connor CC-by-nc 2.0
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