Staged Deployment in Mirage, an Integrated Software Upgrade Testing and Distribution System

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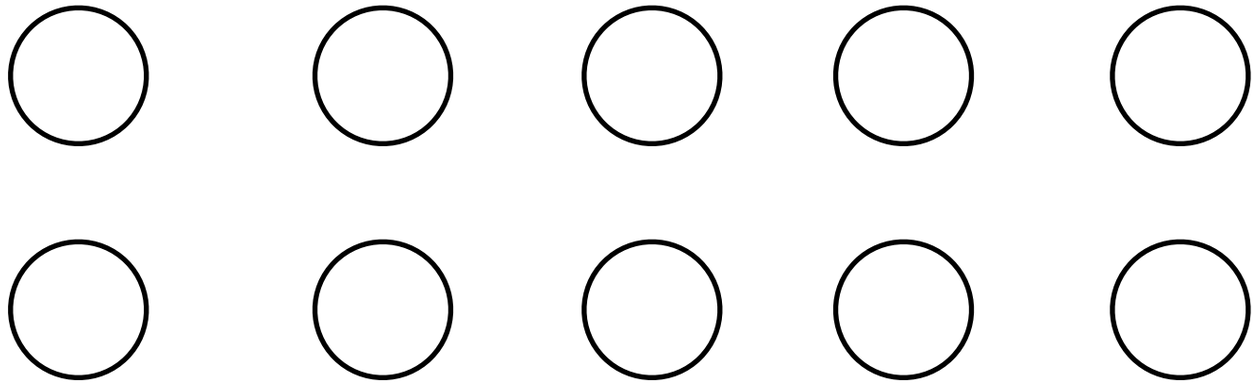
Ricardo Bianchini, Willy Zwaenepoel

ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

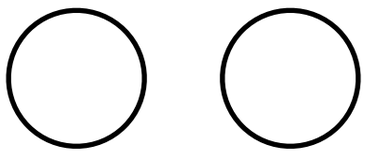
RUTGERS

Software upgrade deployment

OUTSIDE WORLD



VENDOR



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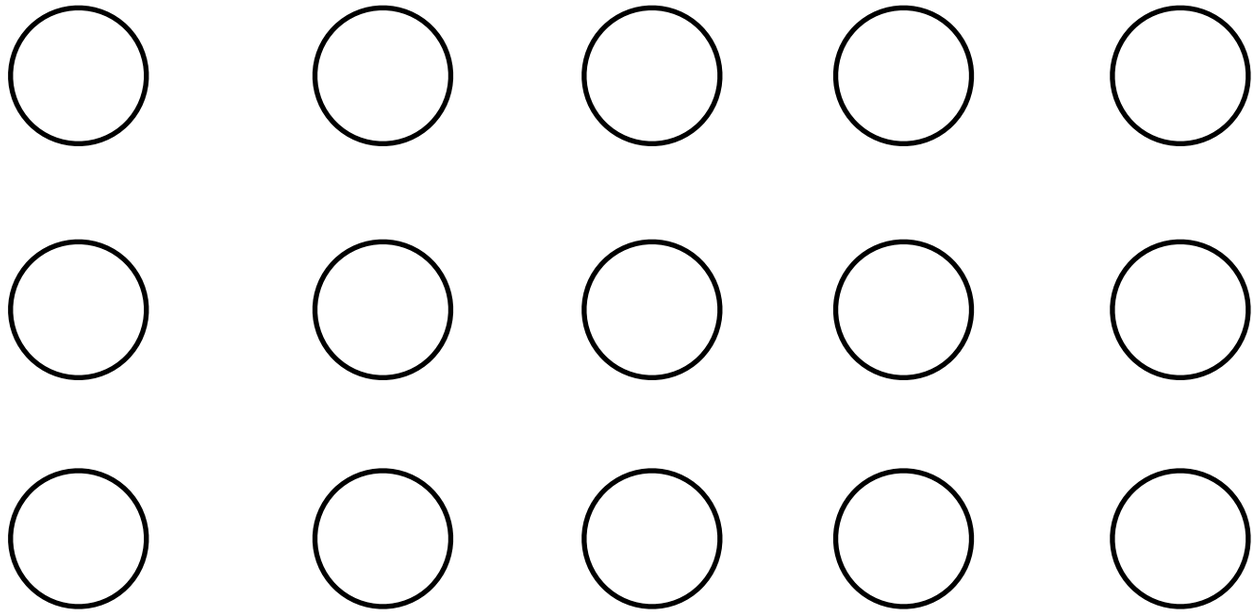

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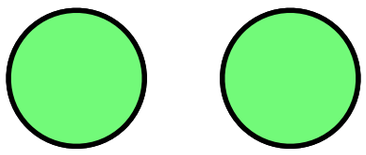

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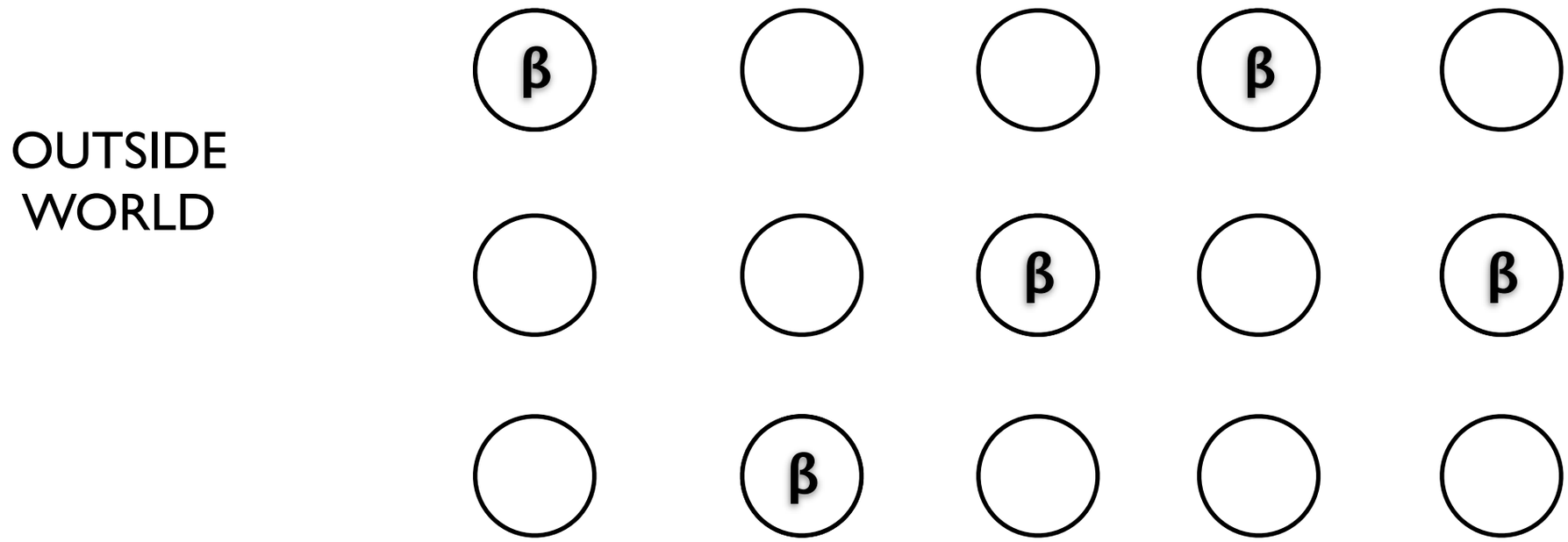
RUTGERS

Software upgrade deployment

β: Beta-testers



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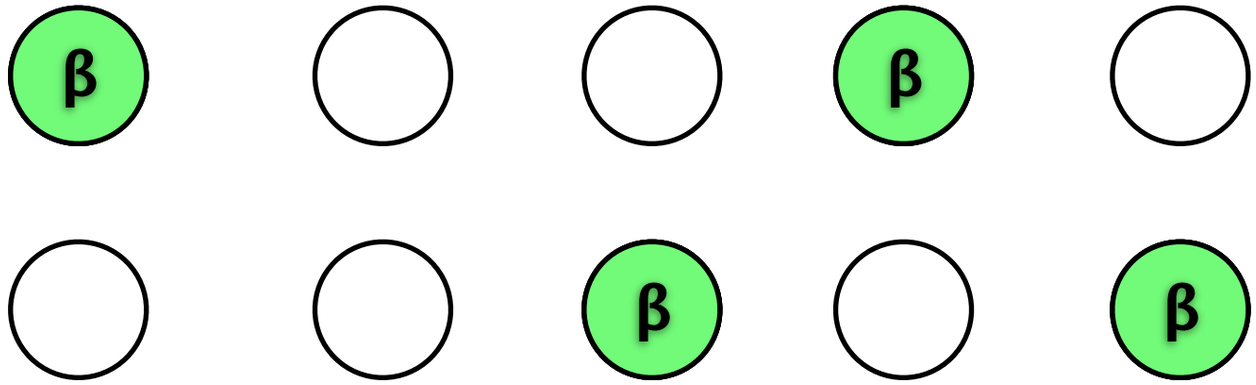

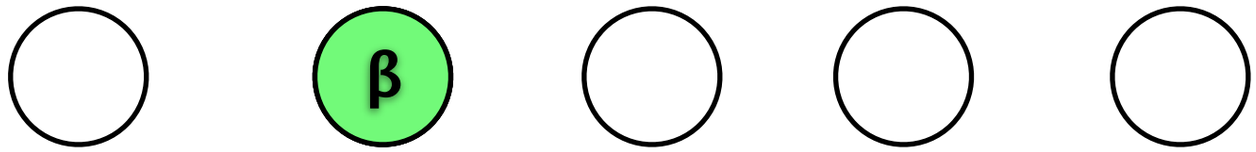

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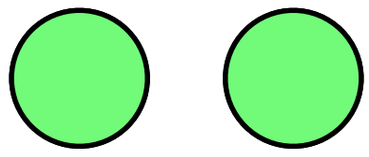

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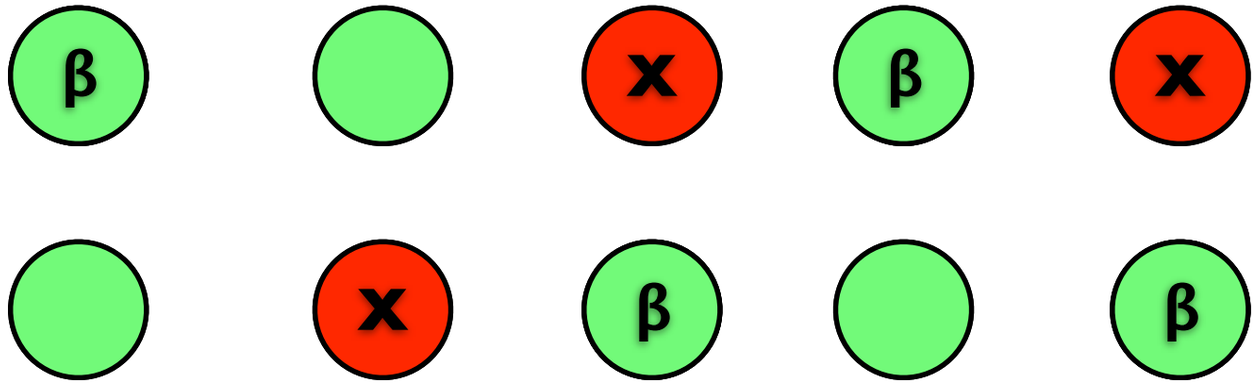

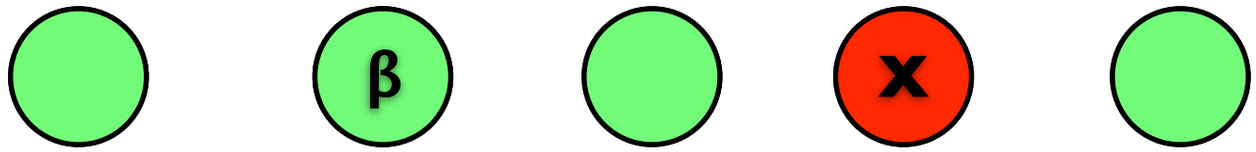

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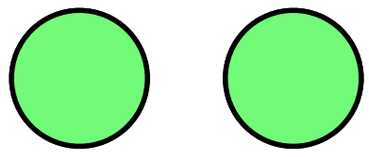

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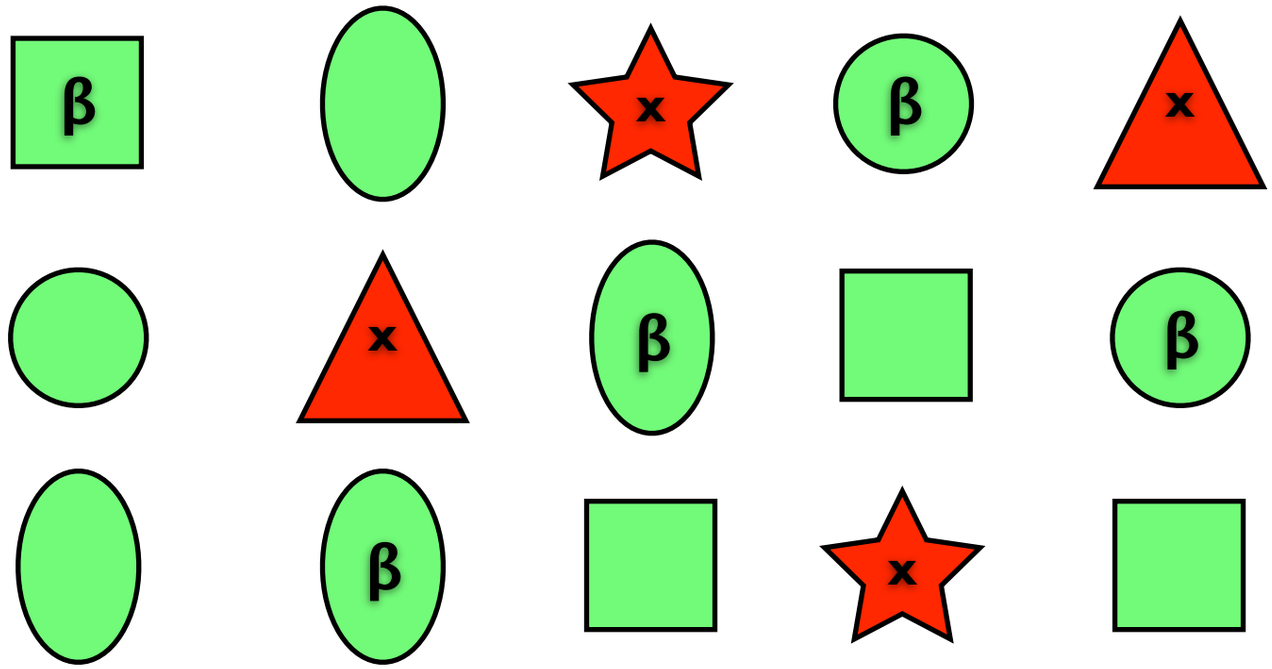

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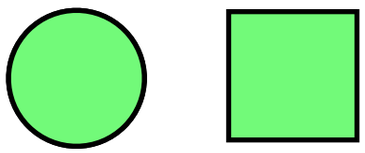

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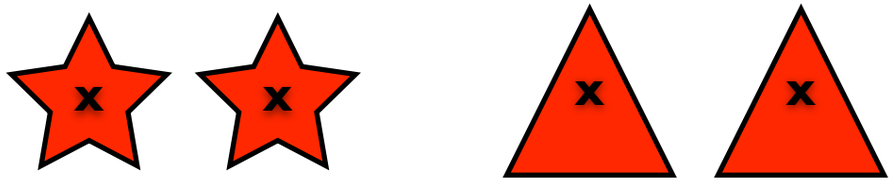

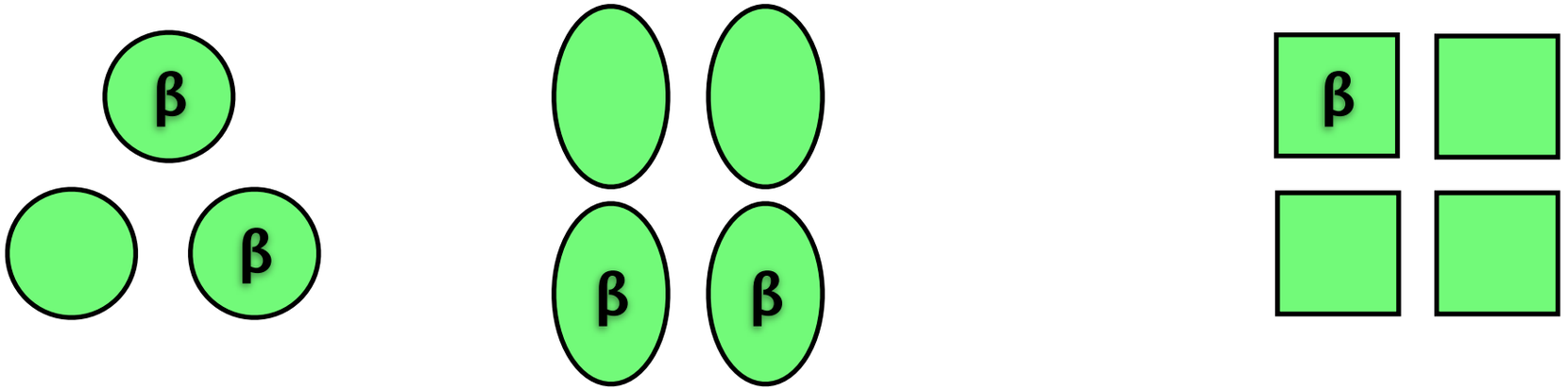

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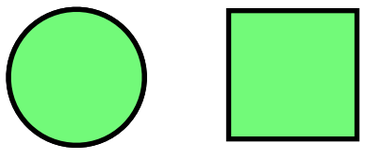

Staged deployment in Mirage

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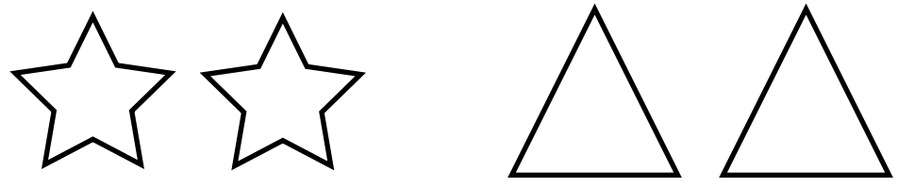

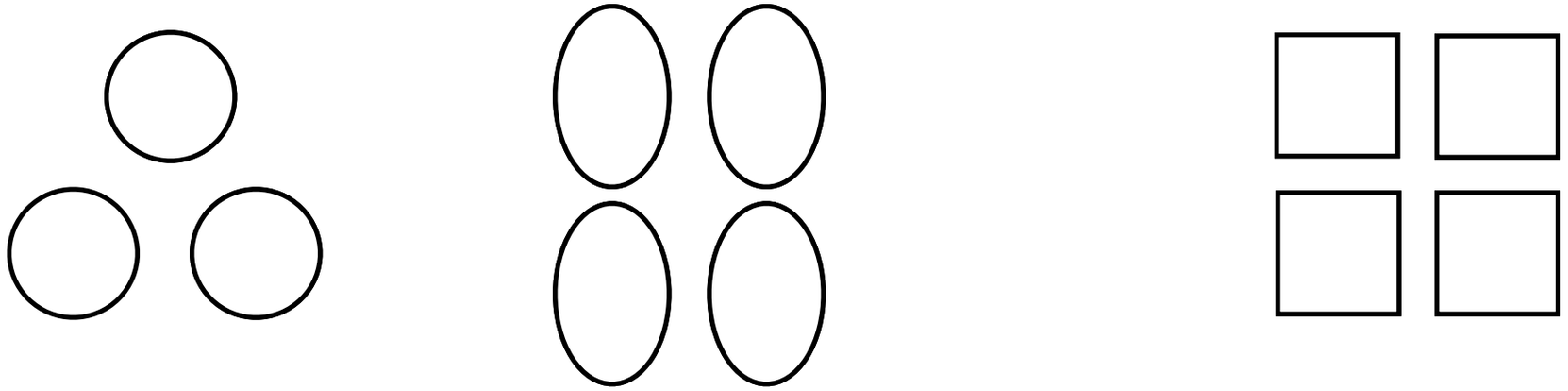

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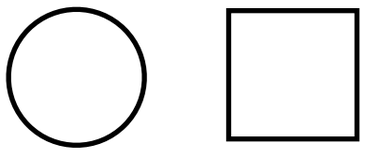

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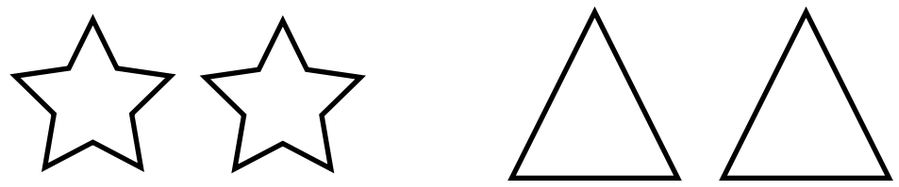

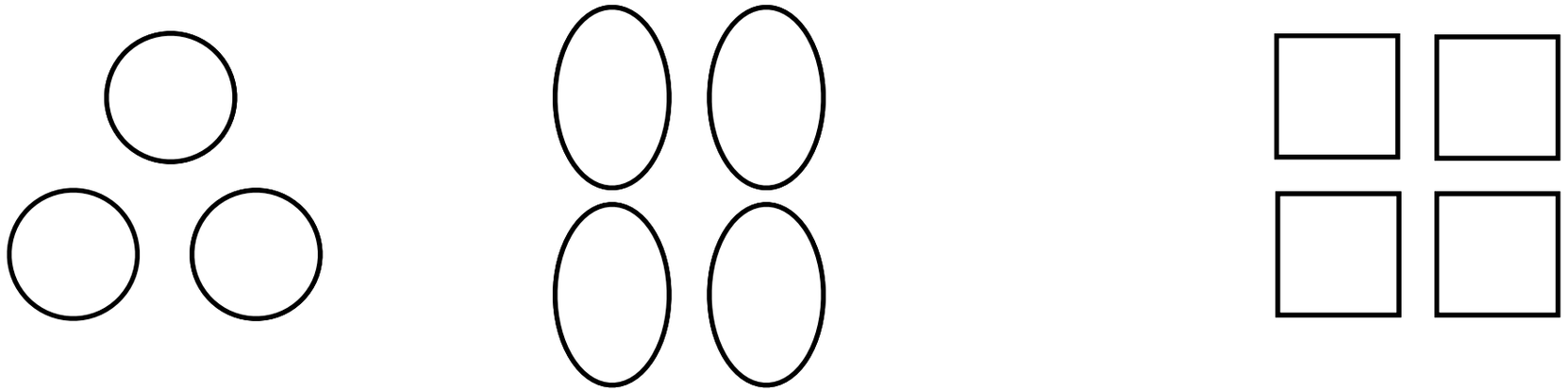

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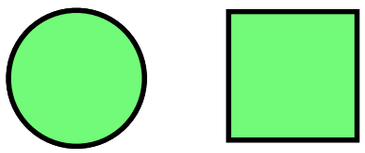
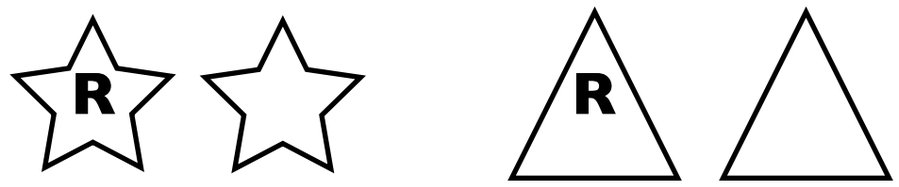
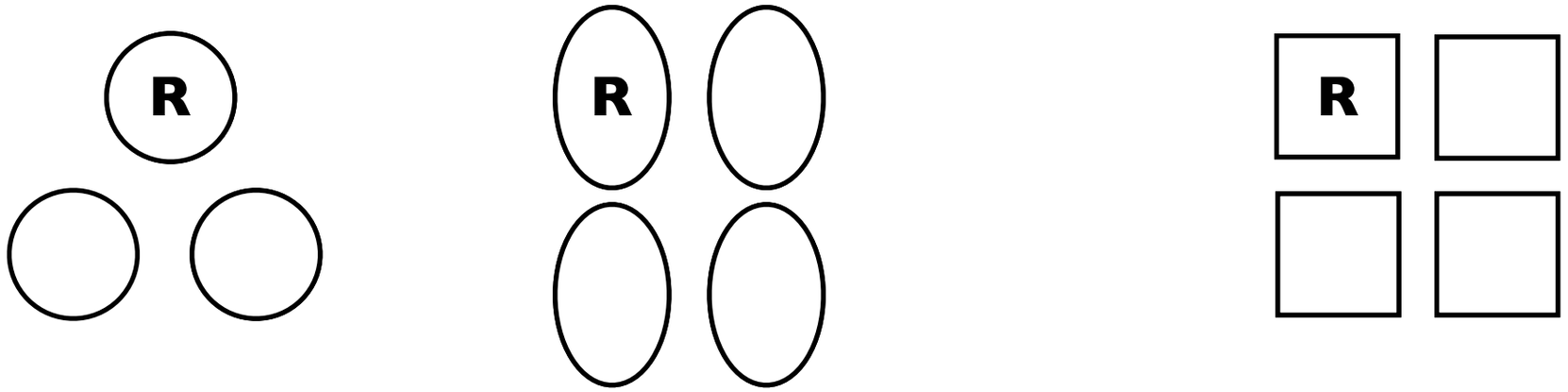


Staged deployment in Mirage

R: representatives

OUTSIDE WORLD





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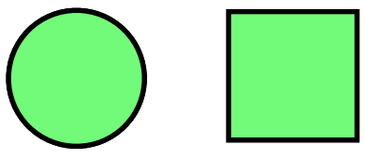

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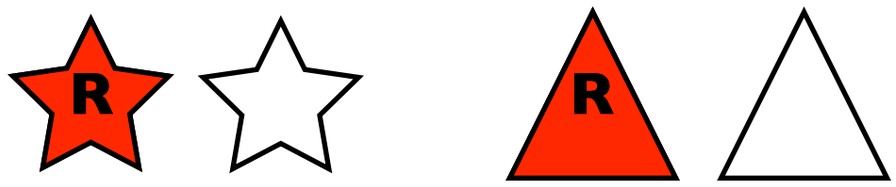

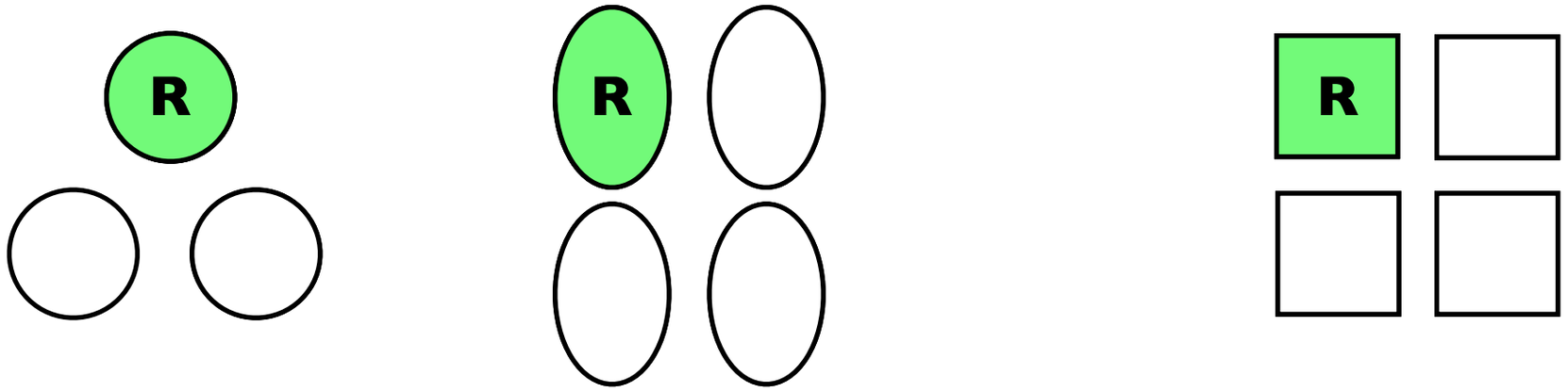

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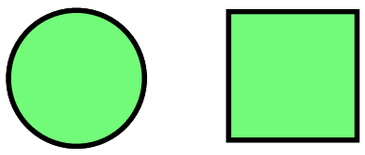

Staged deployment in Mirage

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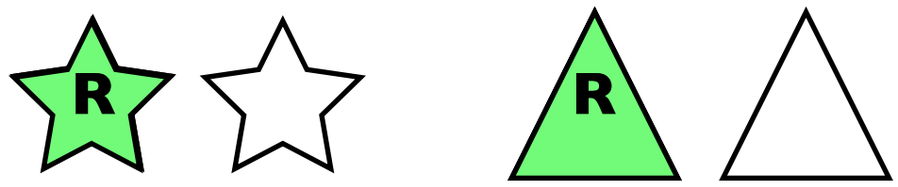

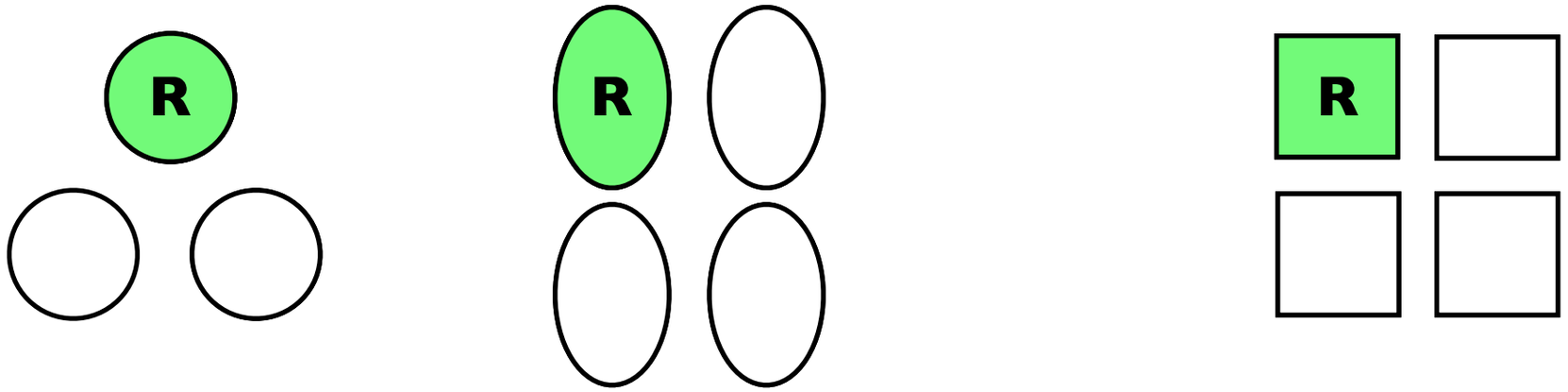

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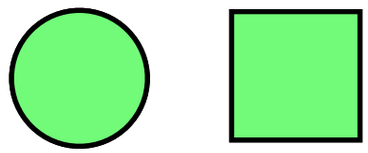

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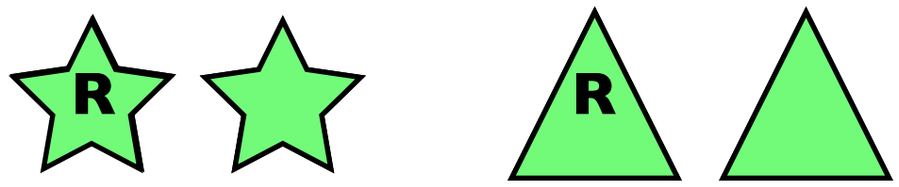

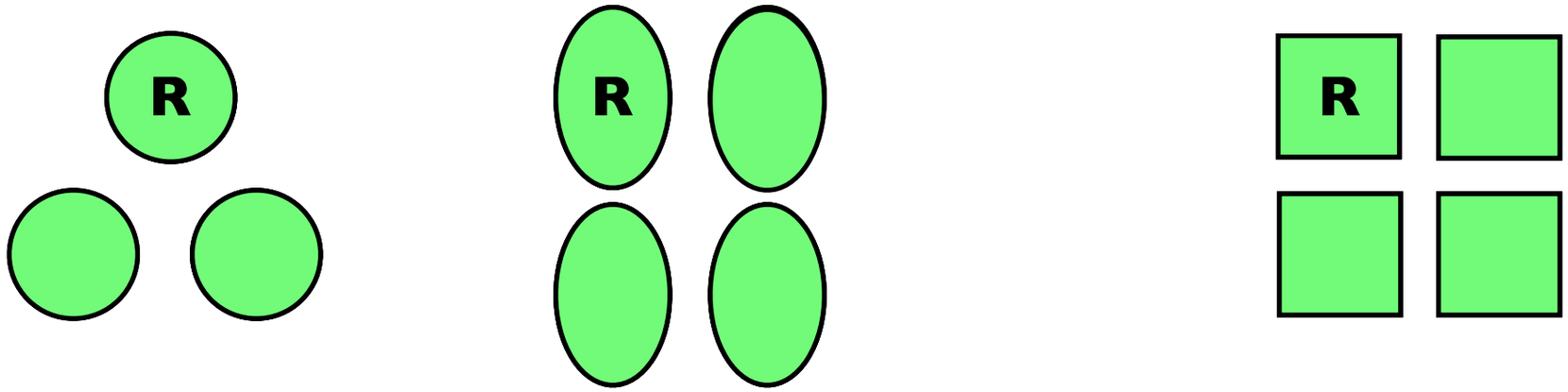

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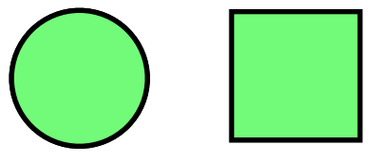
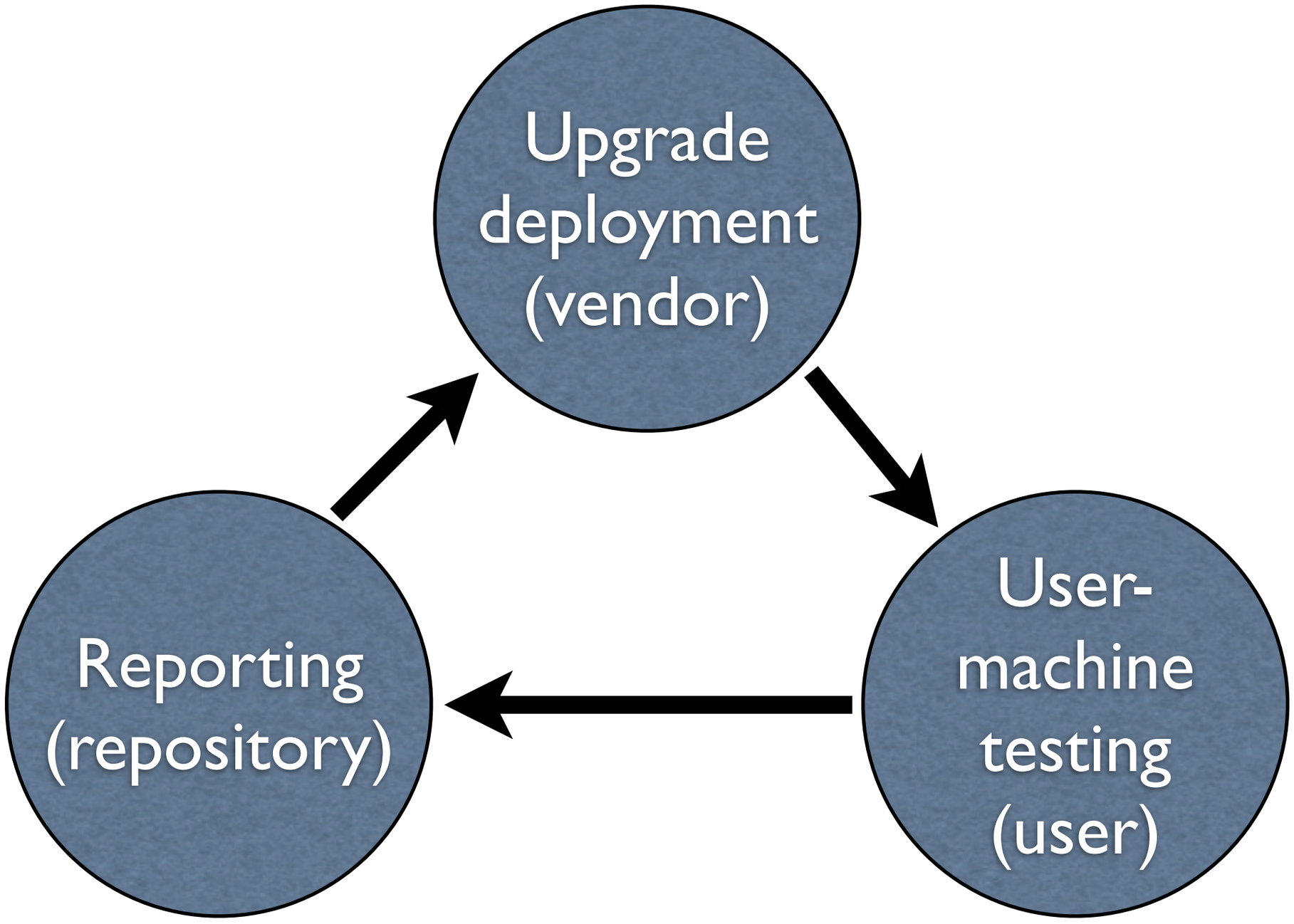


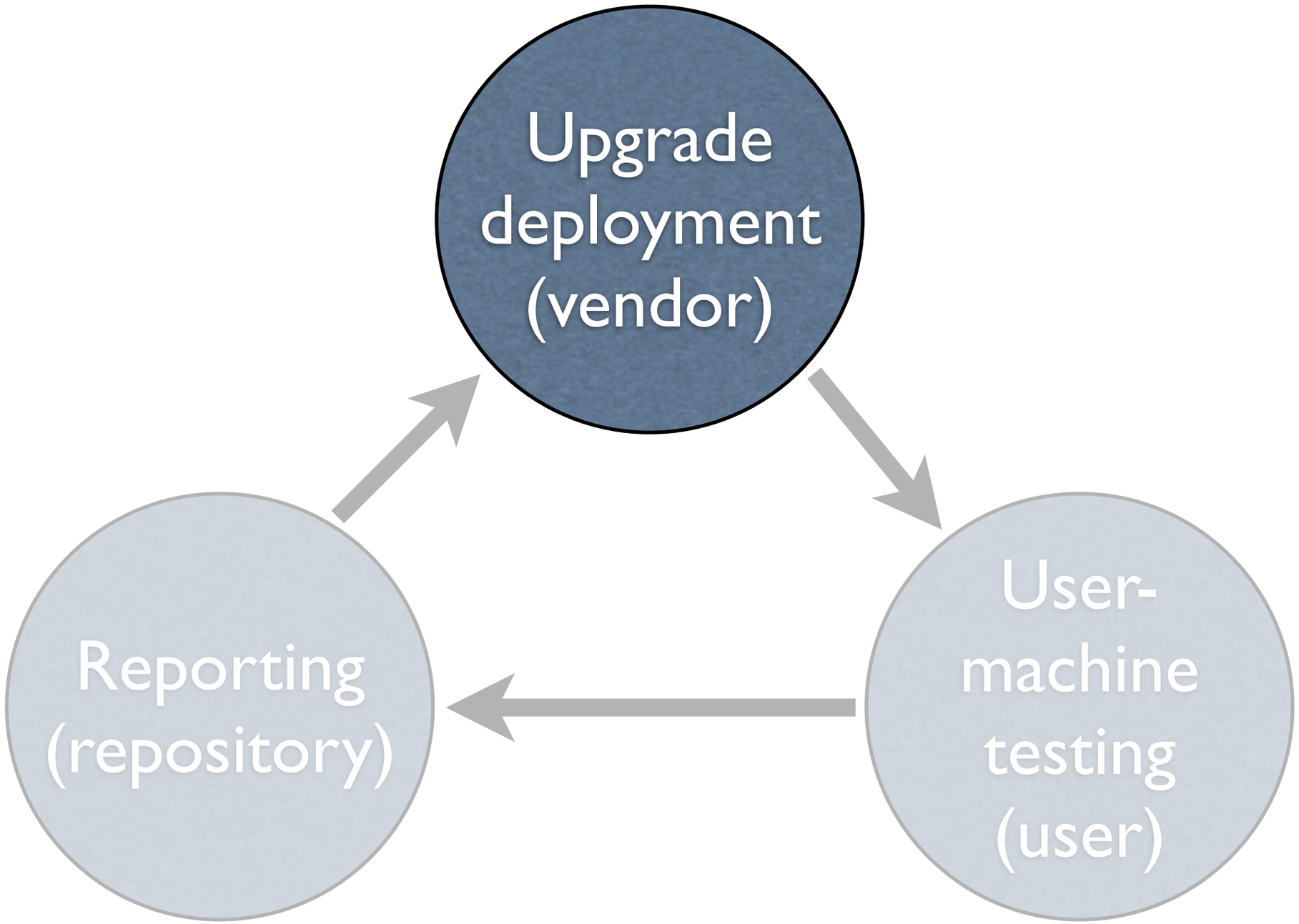
Key idea

- Leverage information about the environment:
  - ✦ better testing coverage
  - ✦ reduced upgrade overhead

Mirage


Upgrade deployment (vendor)
User-machine testing (user)
Reporting (repository)

Mirage


Upgrade deployment (vendor)
User-machine testing (user)
Reporting (repository)

Challenges

- Clustering machines
  - ✦ identify the environment
  - ✦ fingerprint environmental resources
  - ✦ cluster
- Deployment

Goal of clustering

- All machines in a cluster behave identically with respect to an upgrade

Benefit of clustering

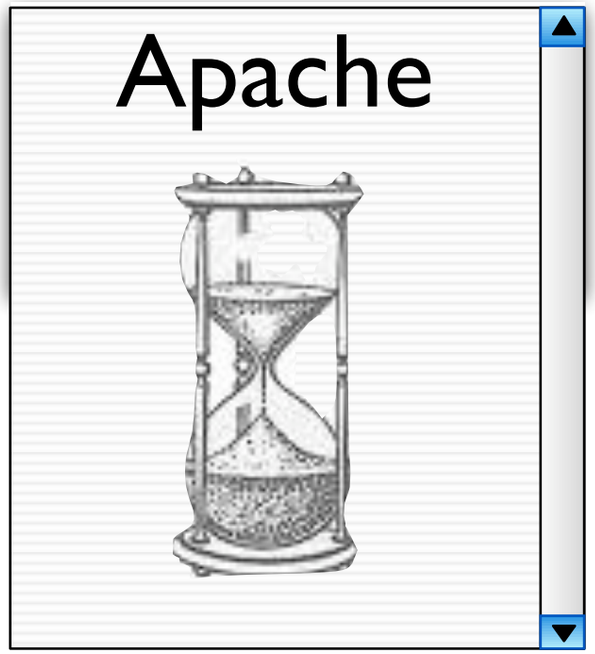
- Testing at a representative provides information about an entire cluster

Extent of the benefit

- Depends on:
  - quality of clustering
  - quality of testing

Clustering machines

Identification — Fingerprinting — Clustering



Clustering machines

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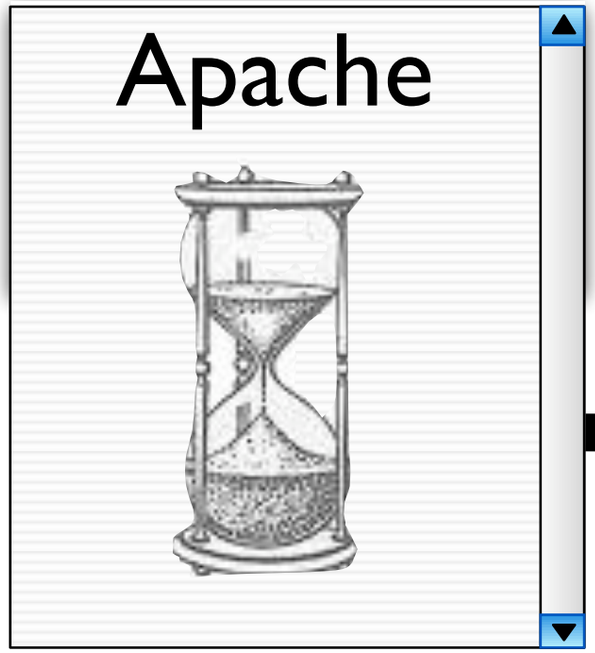
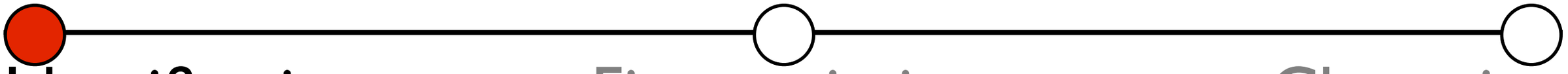


Instrumentation

```
libc-2.4.so
$PATH
httpd.conf
access_log
/tmp/xyz
index.html
Tomcat
```

Clustering machines



Libraries: `libc-2.4.so`

Environment variables: `$PATH`

Configuration files: `httpd.conf`

Log files: `access_log`

Temporary files: `/tmp/xyz`

Data files: `index.html`

Dependent Applications: `Tomcat`

Clustering machines

Identification — Fingerprinting — Clustering

Libraries:

Environment variables:

Configuration files:

Log files: `access_log`

Temporary files: `/tmp/xyz`

Data files: `index.html`

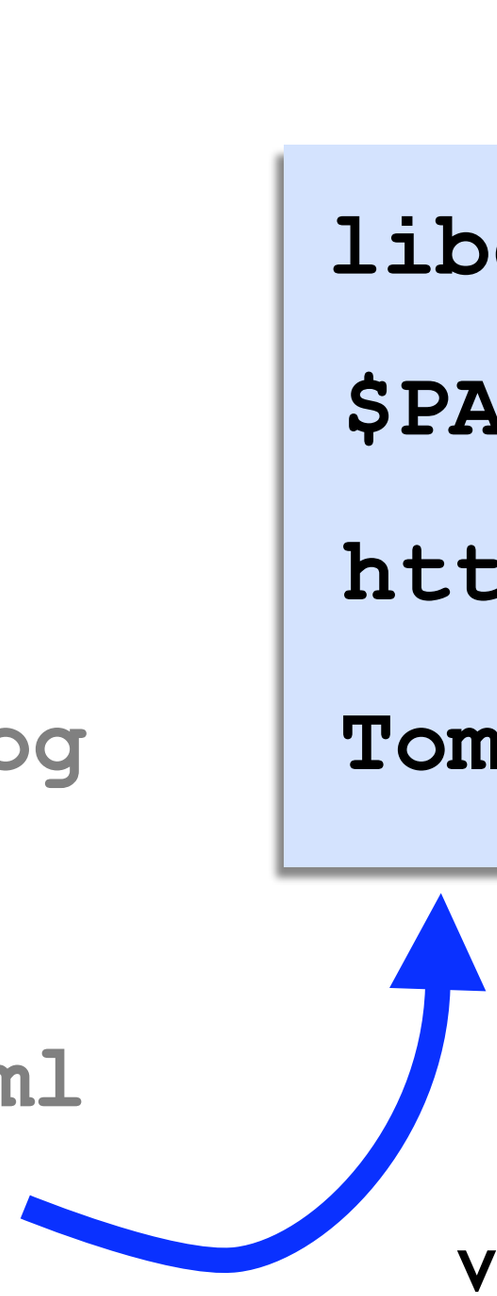
Dependent Applications:

`libc-2.4.so`

`$PATH`

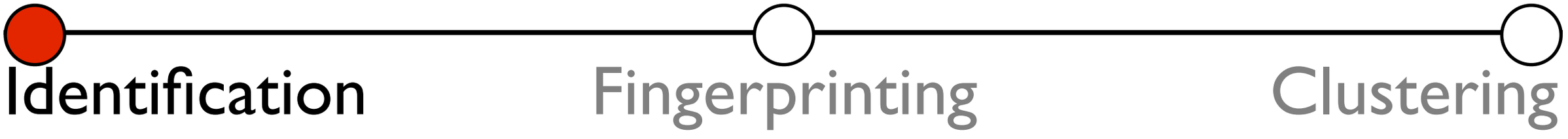
`httpd.conf`

`Tomcat`



heuristic + vendor rules

Clustering machines



Libraries:

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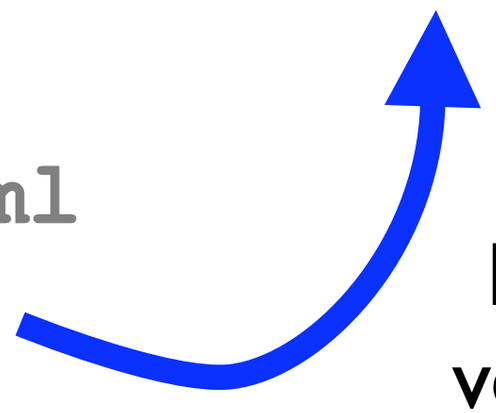

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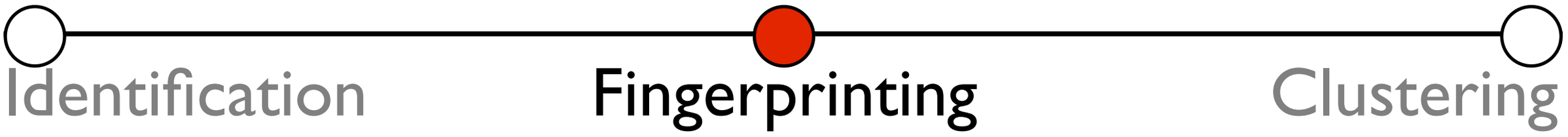

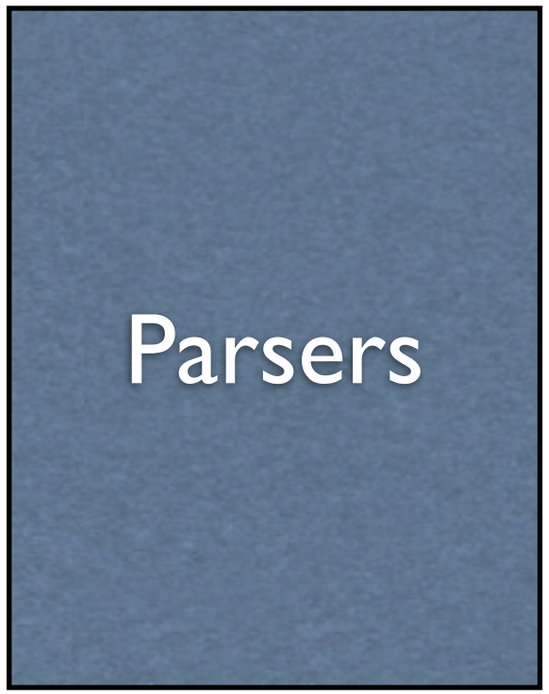

Clustering machines

Identification — Fingerprinting — Clustering

```
libc-2.4.so

$PATH

httpd.conf

Tomcat
```

Parsers

Clustering machines

Identification — Fingerprinting — Clustering

`$PATH`

`httpd.conf`

`Tomcat`

Parsers

`libc.2.4.hash`

Clustering machines

Identification — Fingerprinting — Clustering

httpd.conf

Tomcat

Parsers

libc.2.4.hash

$PATH.hash

Clustering machines

Identification — Fingerprinting — Clustering

Tomcat

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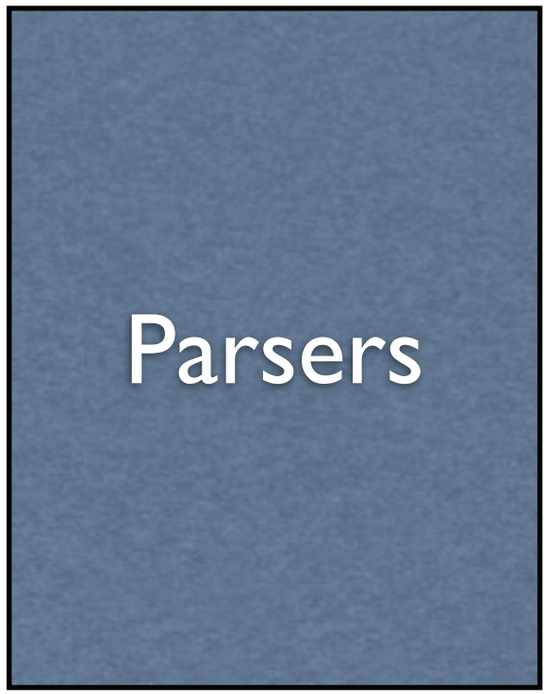
```
libc.2.4.hash

$PATH.hash

httpd.conf.listen.hash
httpd.conf.mod_php.hash
httpd.conf.mod_cgi.hash
```

Clustering machines

Identification — Fingerprinting — Clustering




```
libc.2.4.hash

$PATH.hash

httpd.conf.listen.hash
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Tomcat.5.5
```
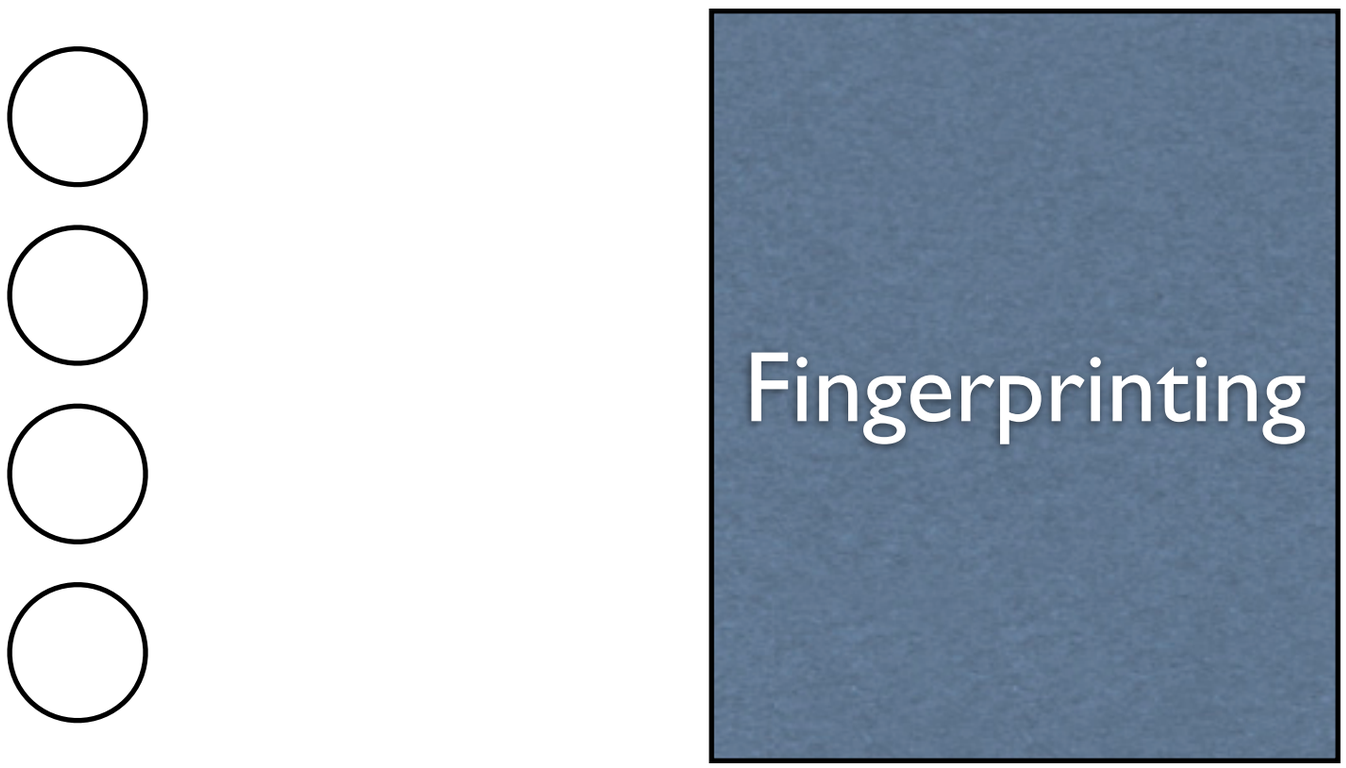

Clustering machines

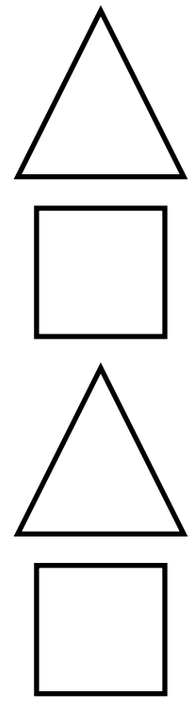
Identification — Fingerprinting — Clustering



Clustering machines

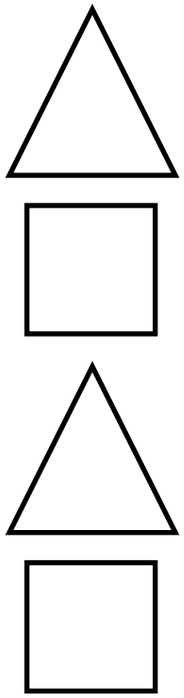
Identification — **Fingerprinting** — Clustering

Fingerprinting



Clustering machines

Identification — Fingerprinting — **Clustering**



Clustering machines

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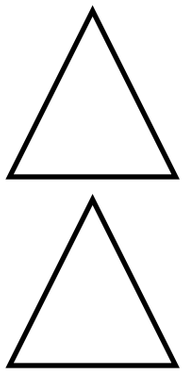

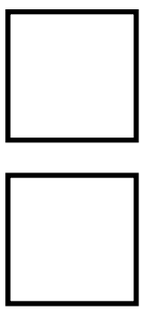

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Deployment goals

- Low upgrade overhead
- Fast deployment

Deployment goals

- Low upgrade overhead
- Fast deployment

There is a tradeoff !

Controlling the tradeoff

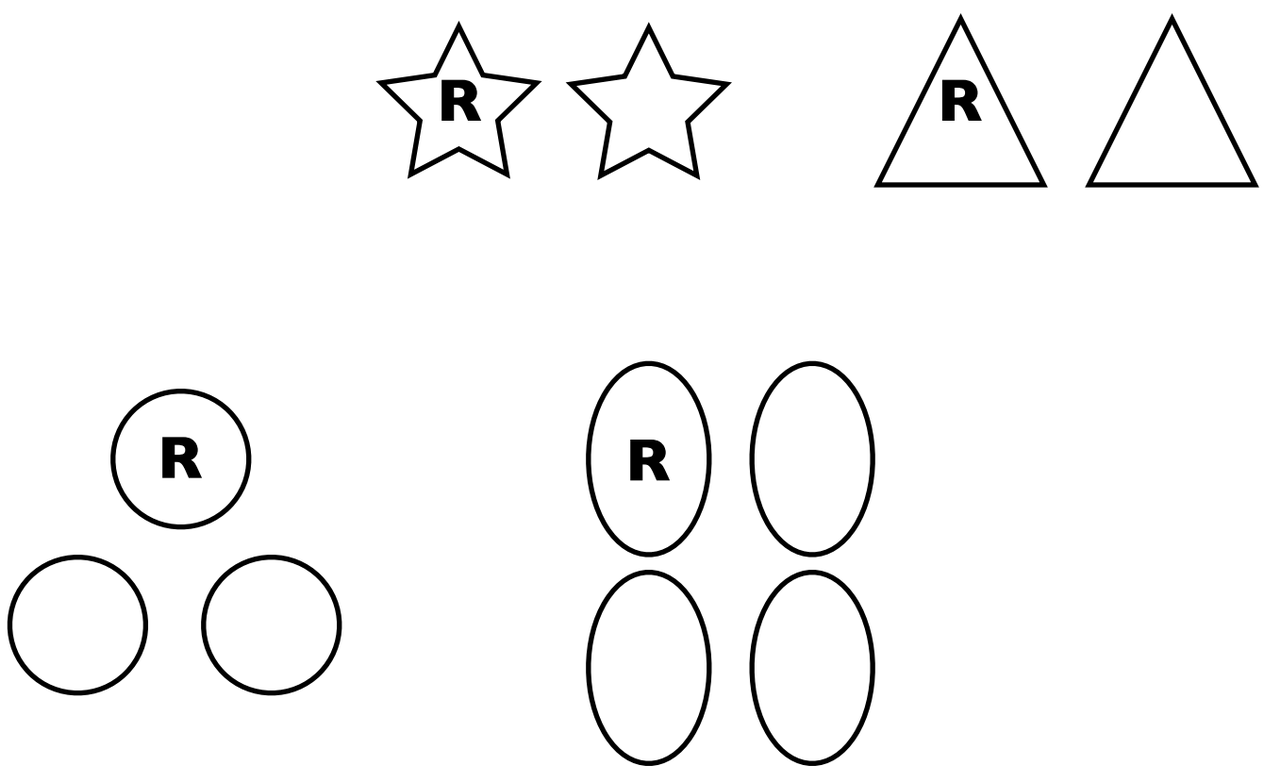
- Leverage clusters for staging
- Deploy in parallel or in sequential stages

	parallel	sequential
speed of deployment	✓	✖
upgrade overhead	✖	✓

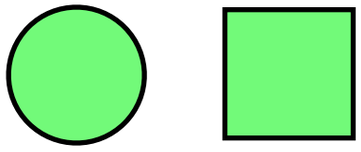
Representatives first, in parallel

R: representatives

OUTSIDE WORLD



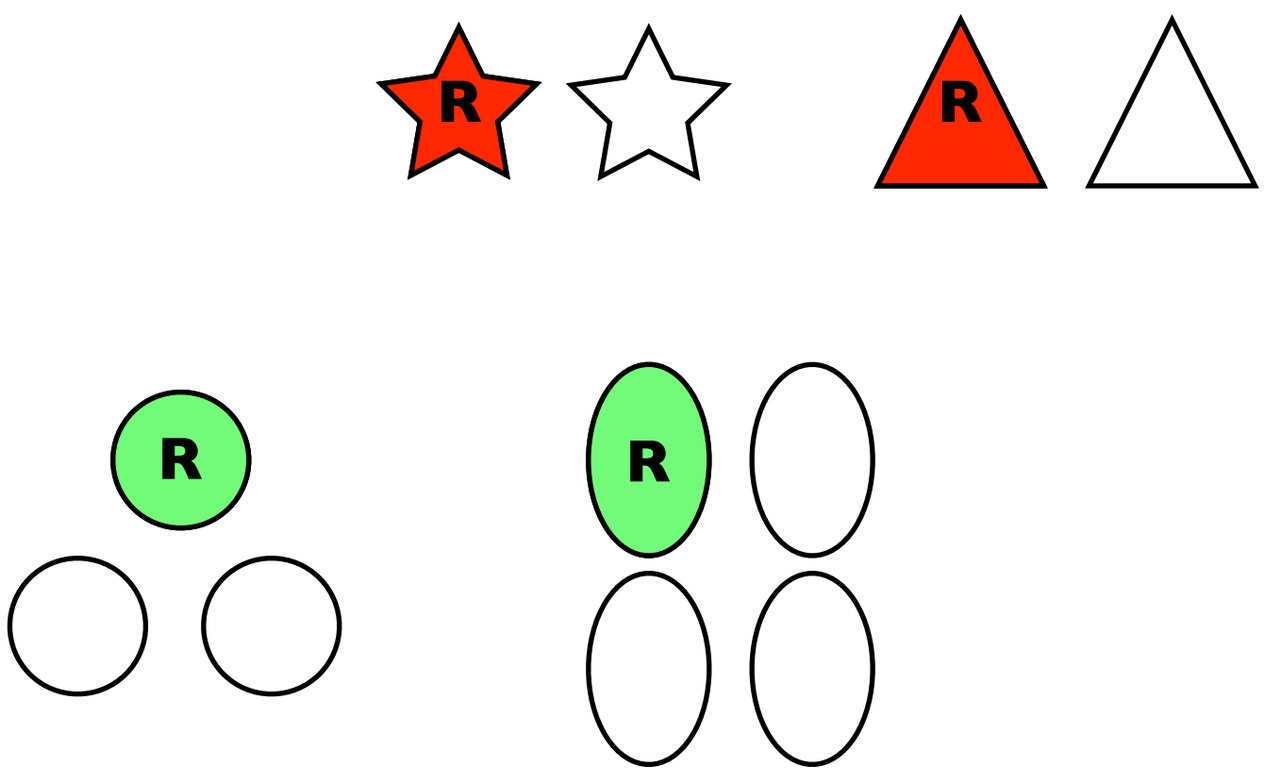
VENDOR



Representatives first, in parallel

R: representatives

OUTSIDE WORLD



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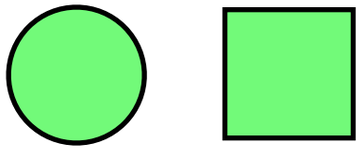
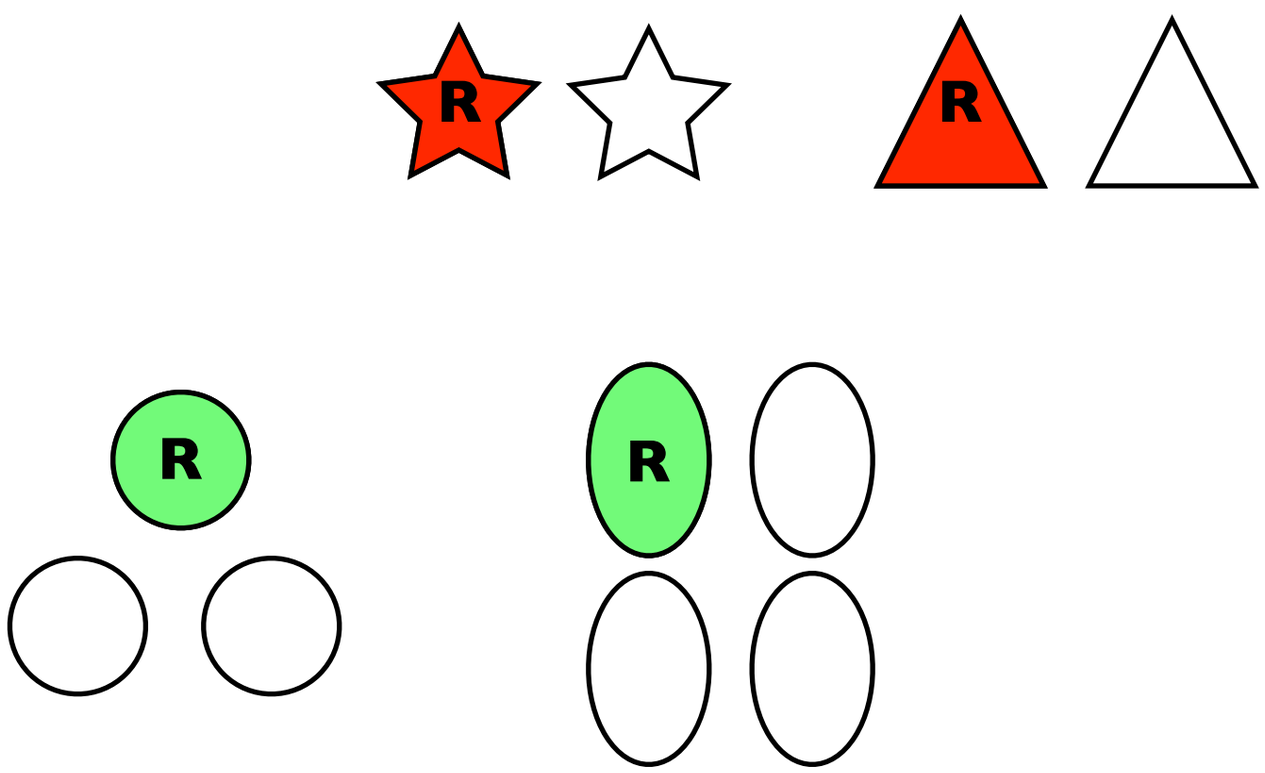


Representatives first, in parallel

R: representatives

OUTSIDE WORLD



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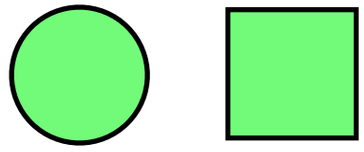
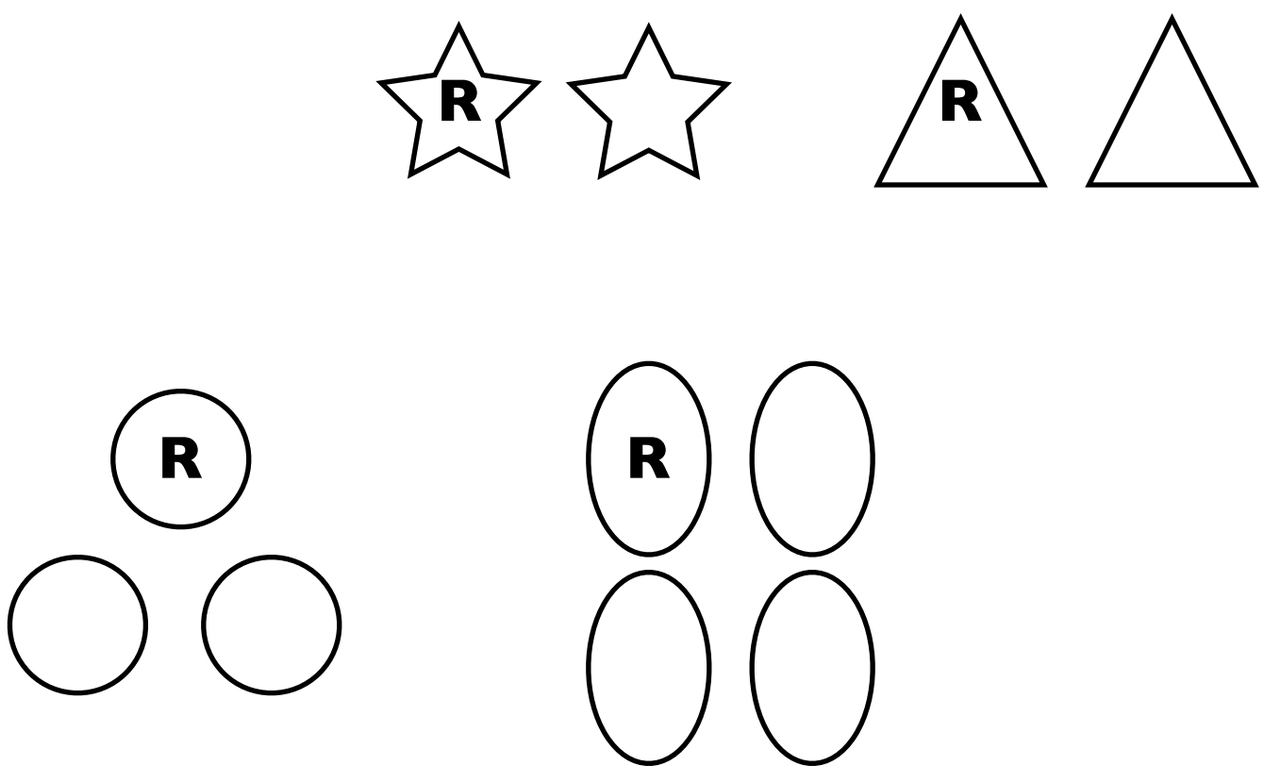


Upgrade overhead: 2

Representatives first, in sequence

R: representatives

OUTSIDE WORLD



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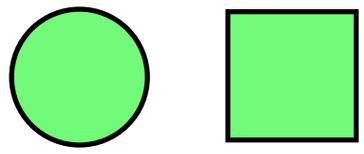
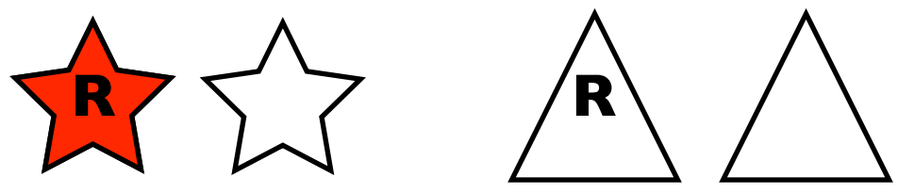
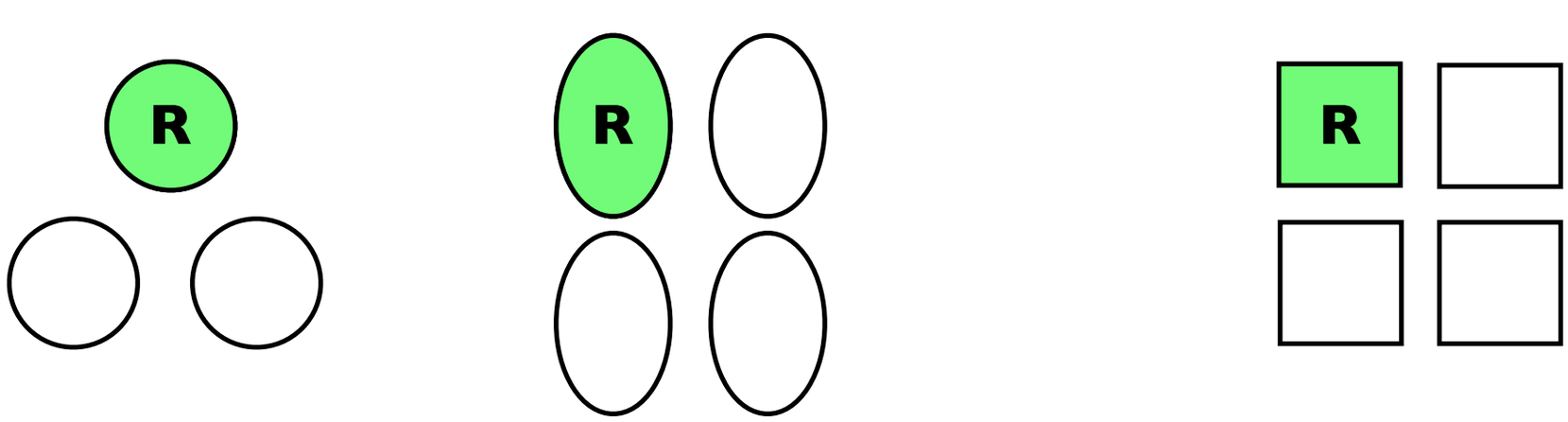


Representatives first, in sequence

R: representatives

OUTSIDE WORLD





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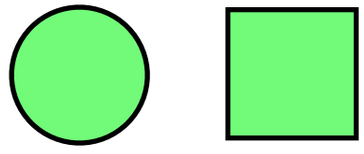
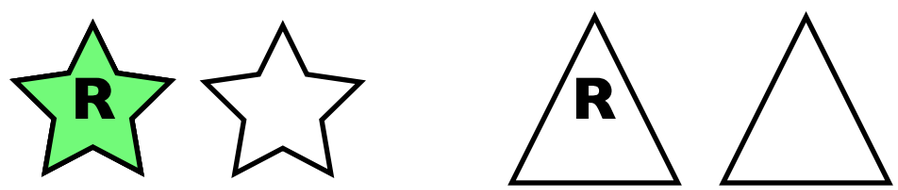
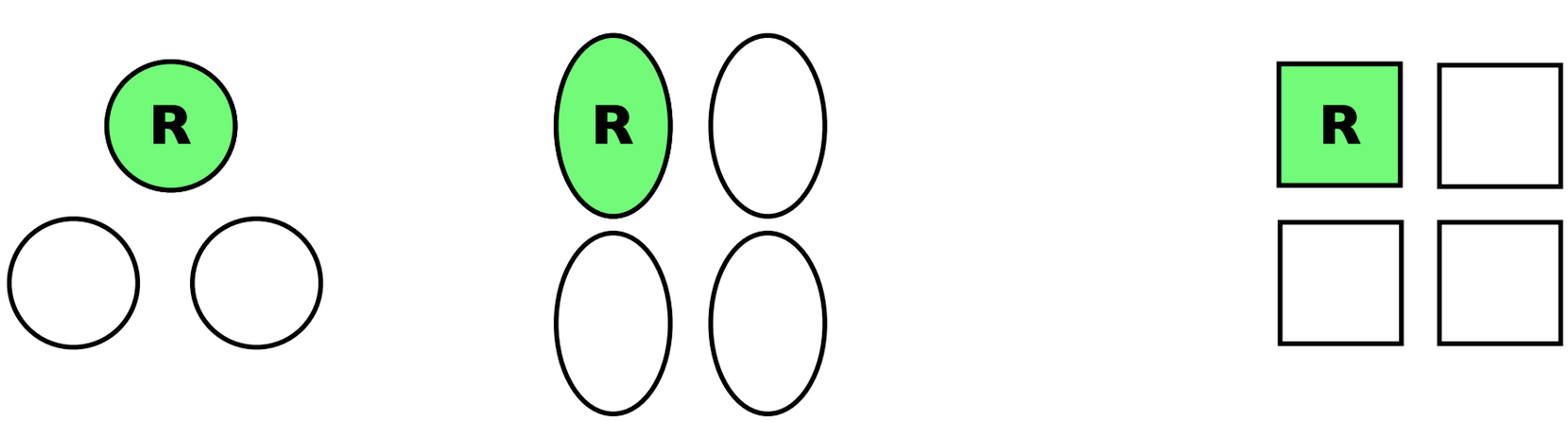


Representatives first, in sequence

R: representatives

OUTSIDE WORLD





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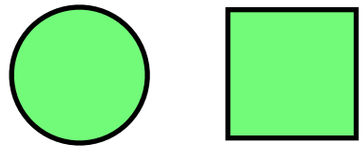

Representatives first, in sequence

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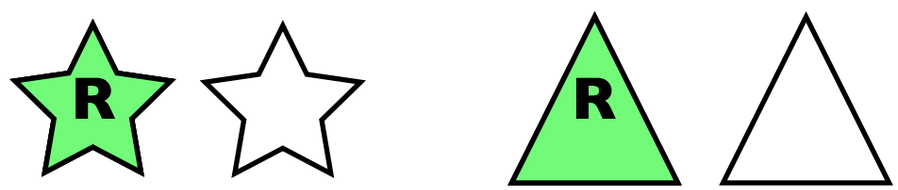

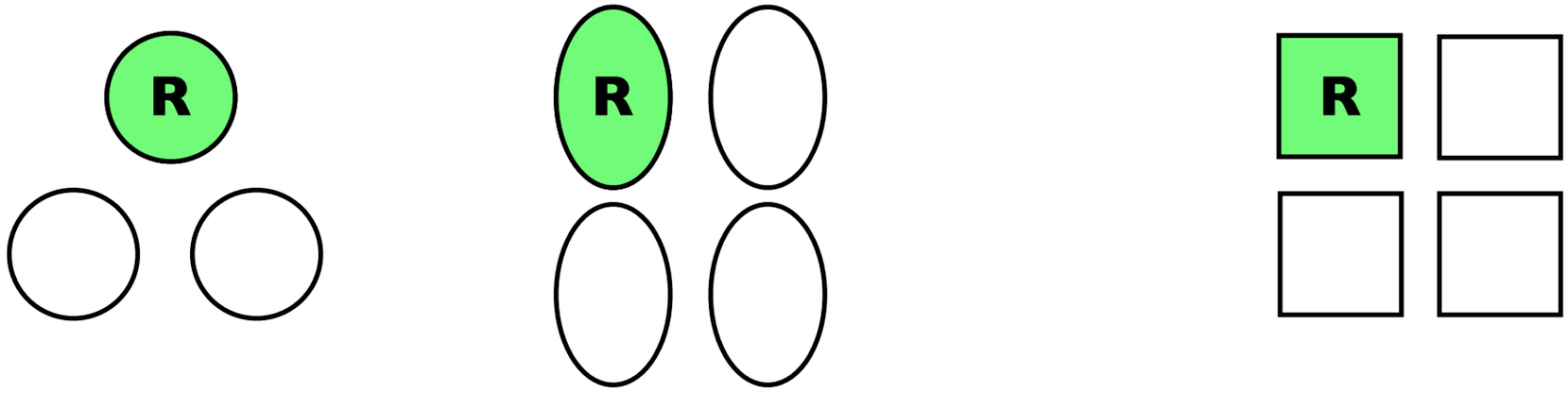

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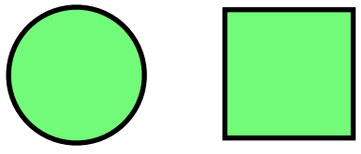
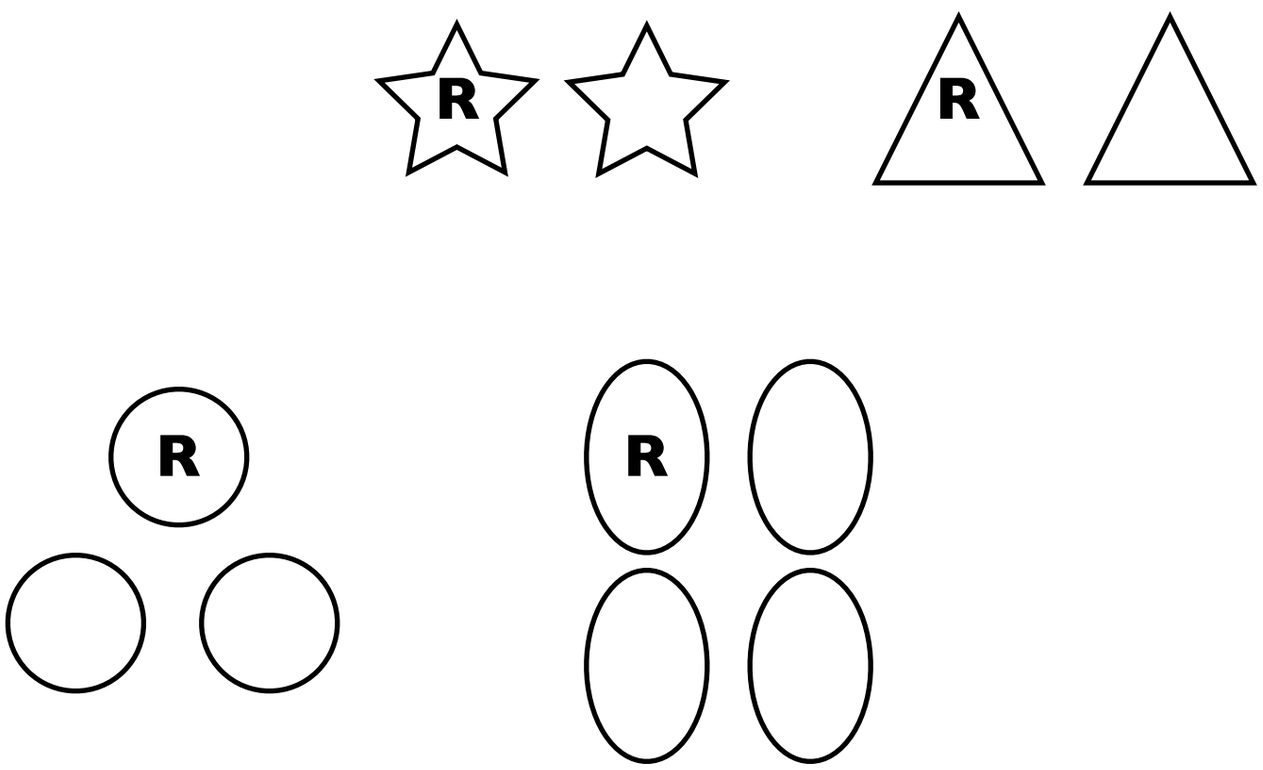


Upgrade overhead: 1

Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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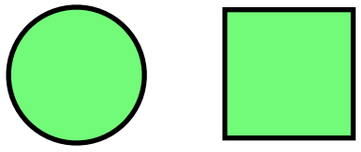
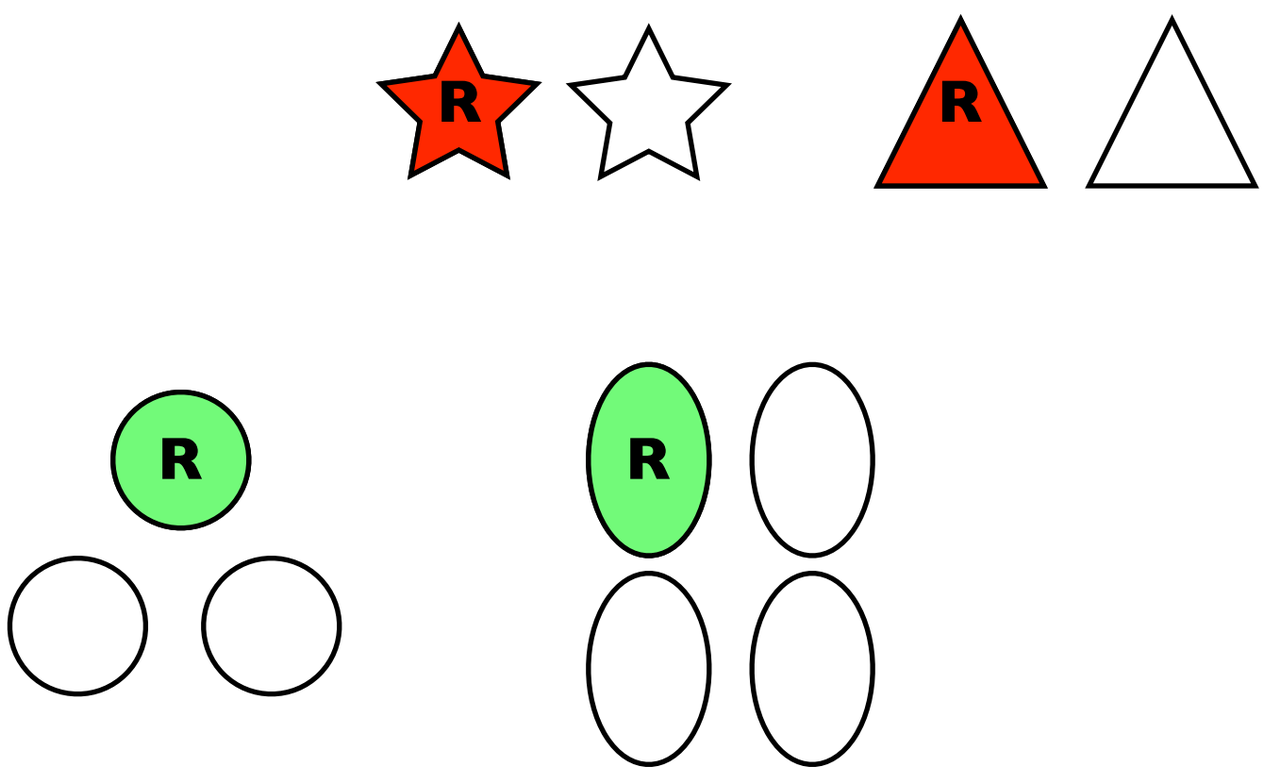


Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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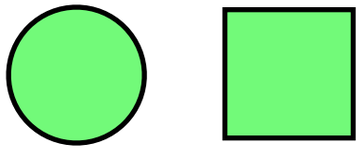
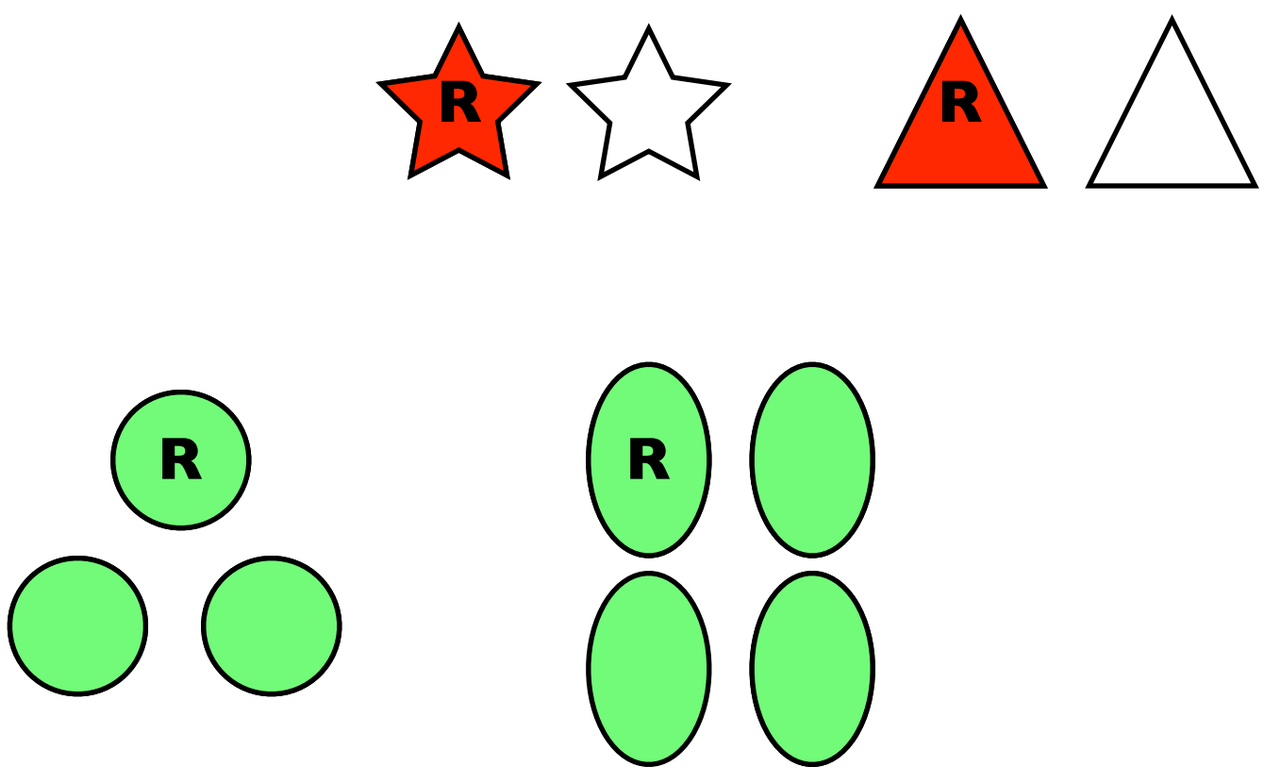


Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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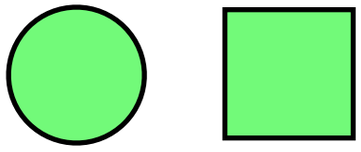
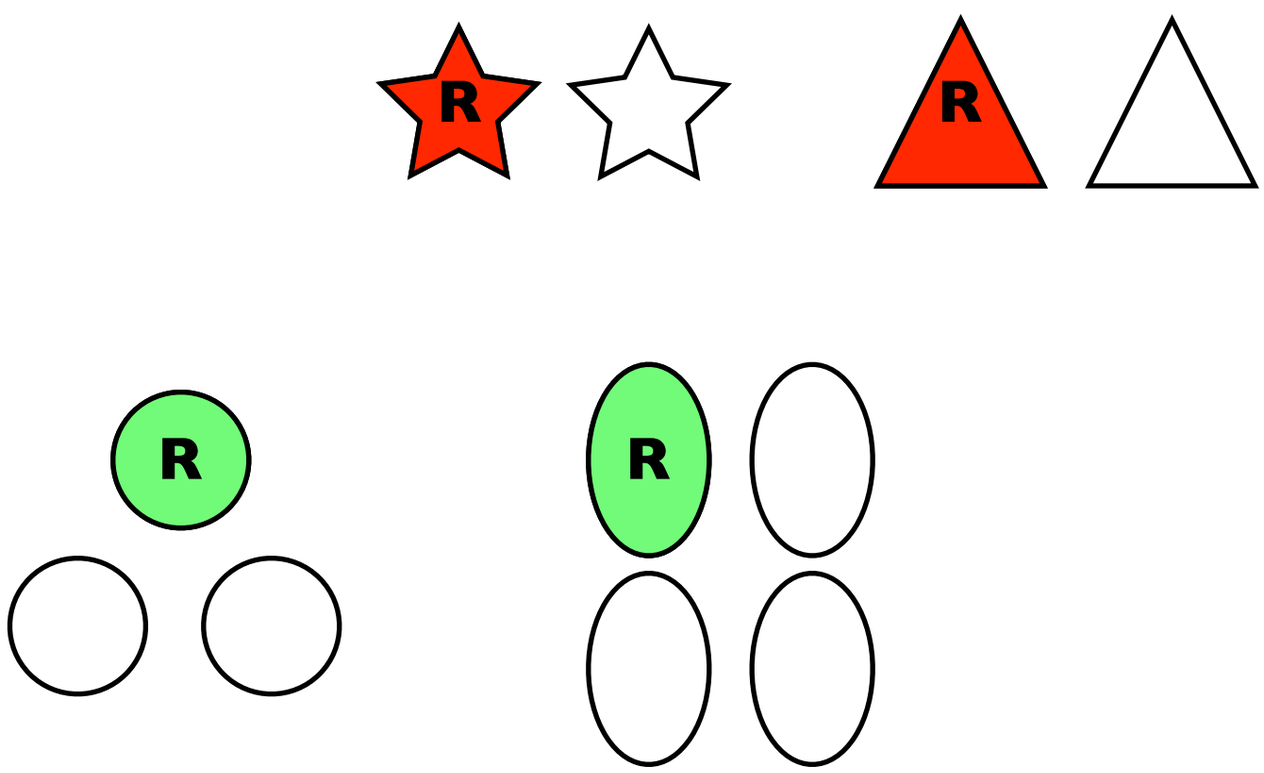


Upgrade overhead: 2

Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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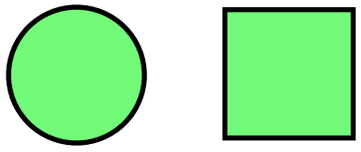


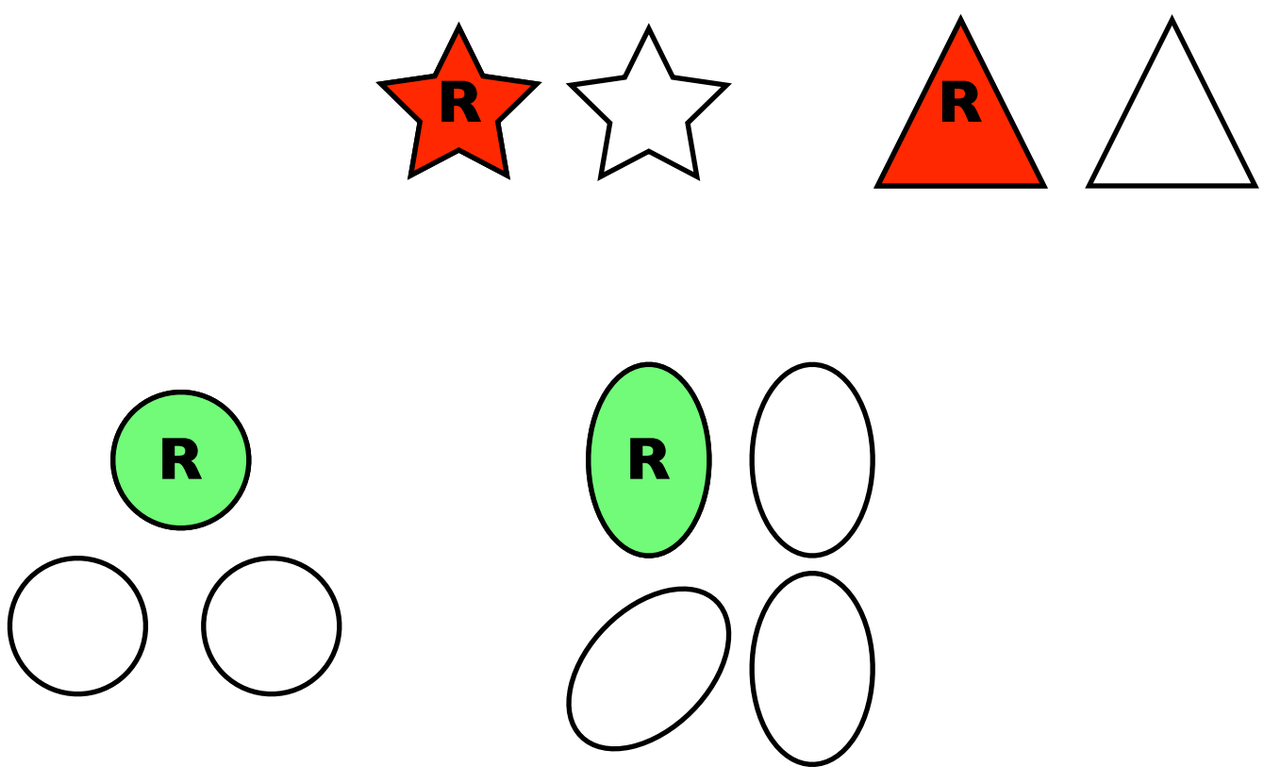
ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

RUTGERS

Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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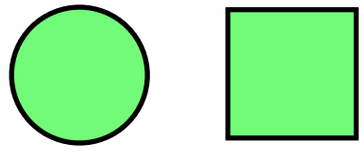
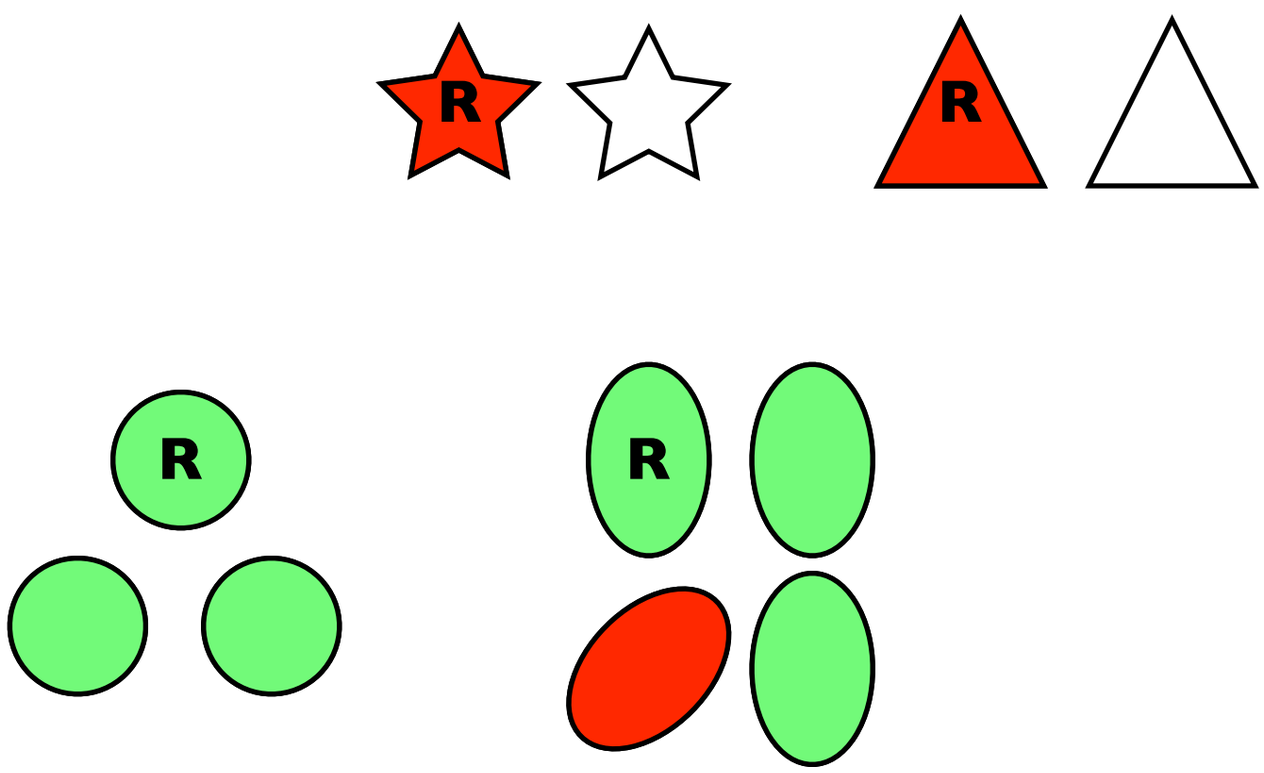


Representatives and other machines in parallel

R: representatives

OUTSIDE WORLD



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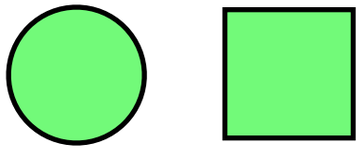
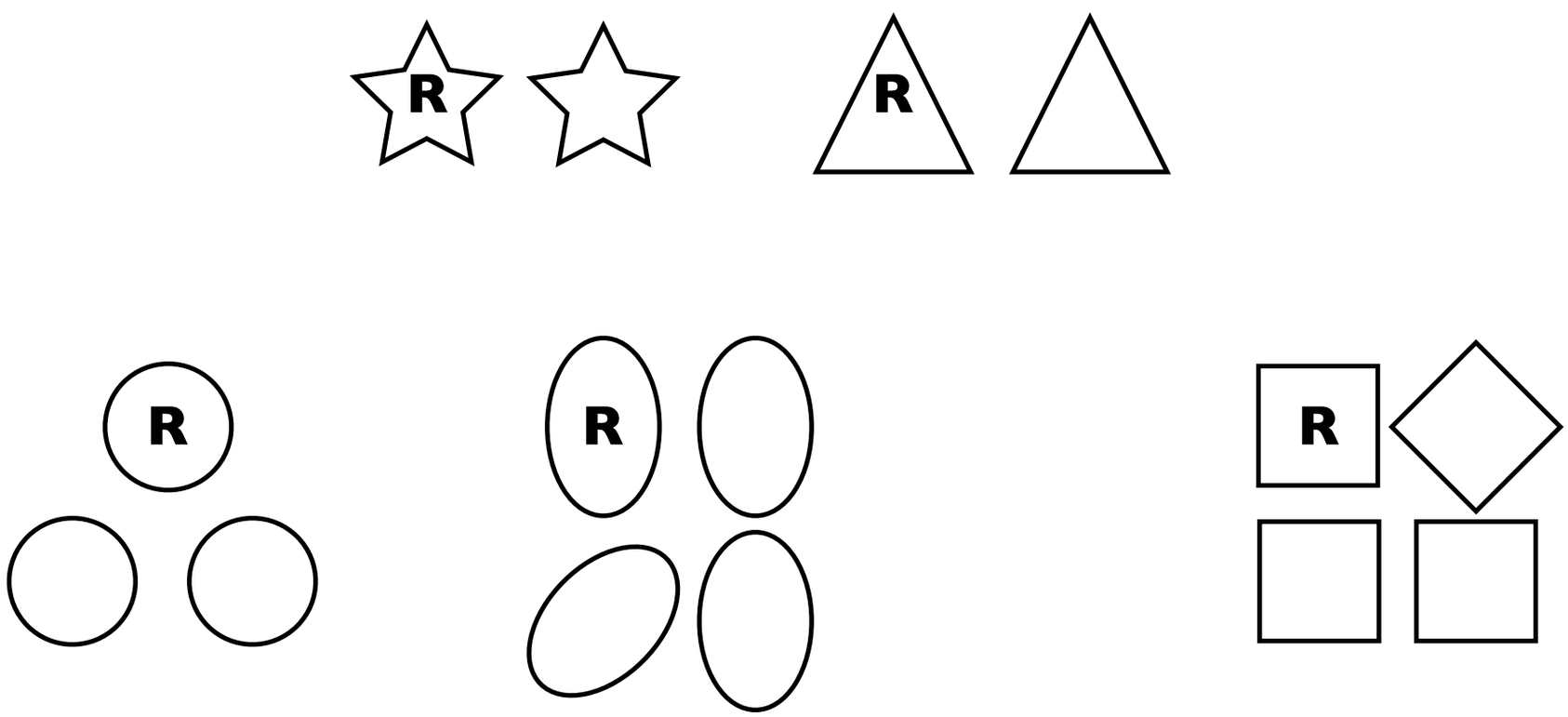


Upgrade overhead: 4

Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD



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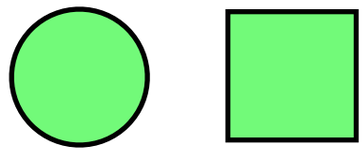
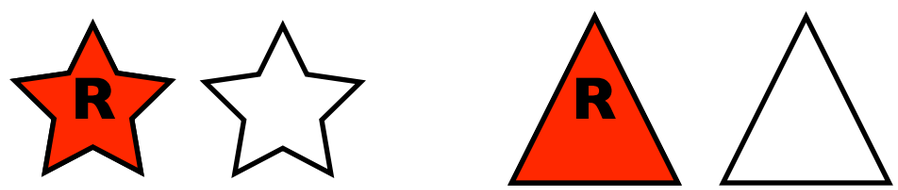
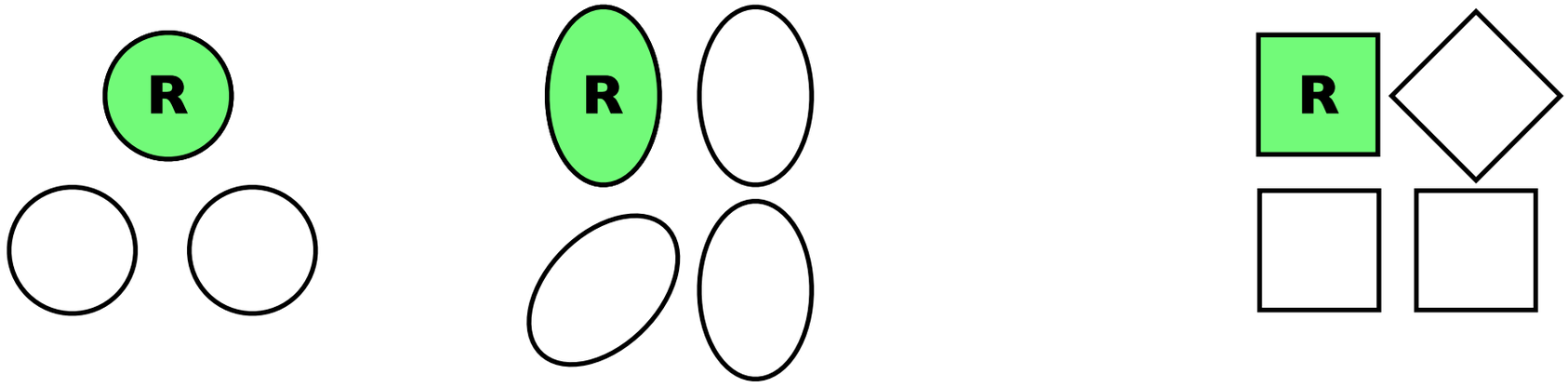


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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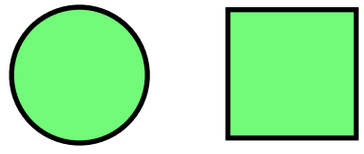
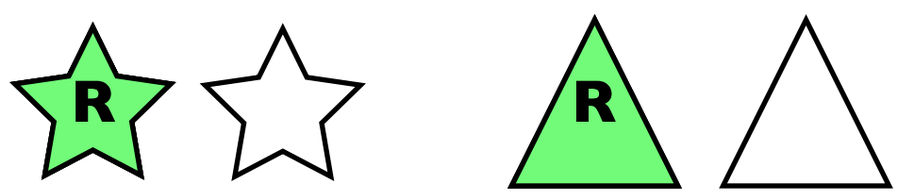
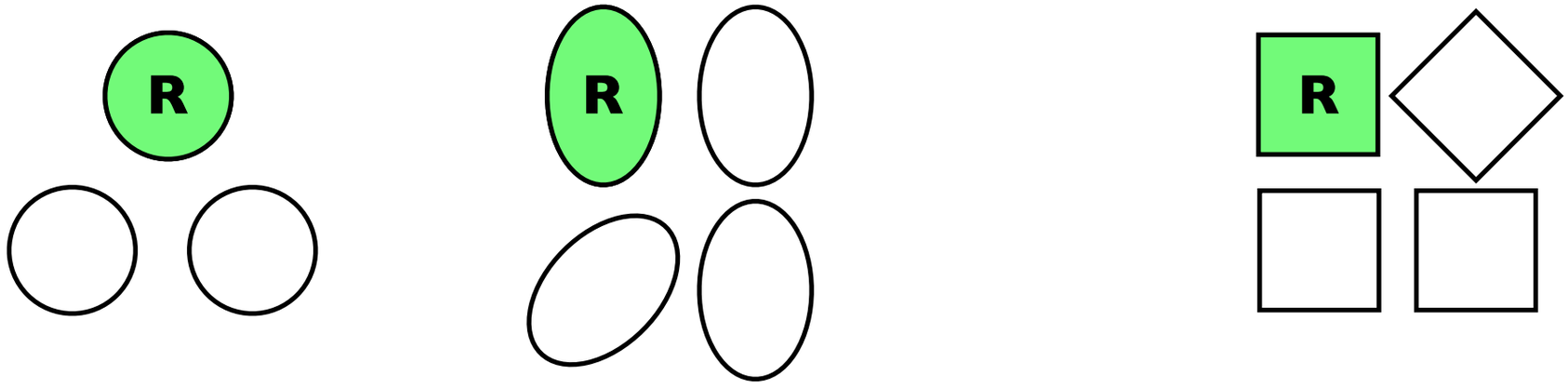


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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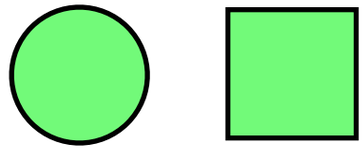
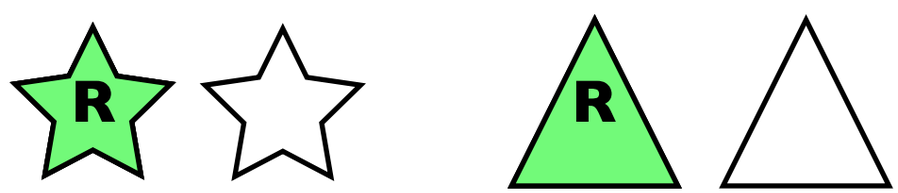
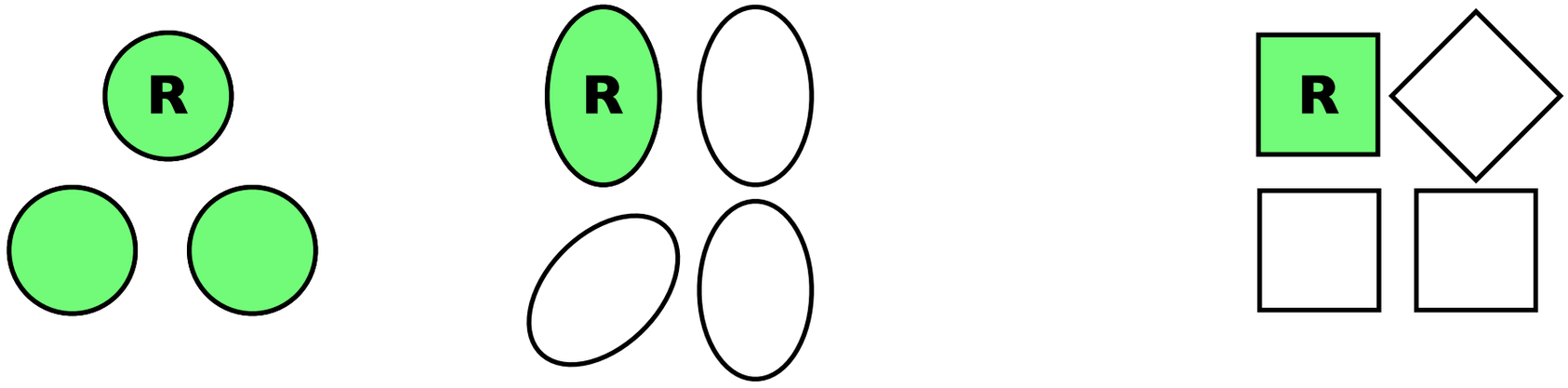


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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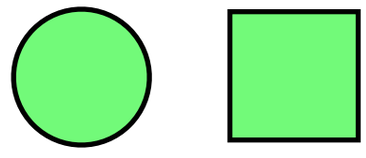
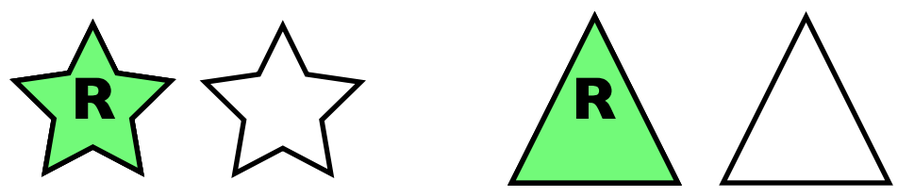
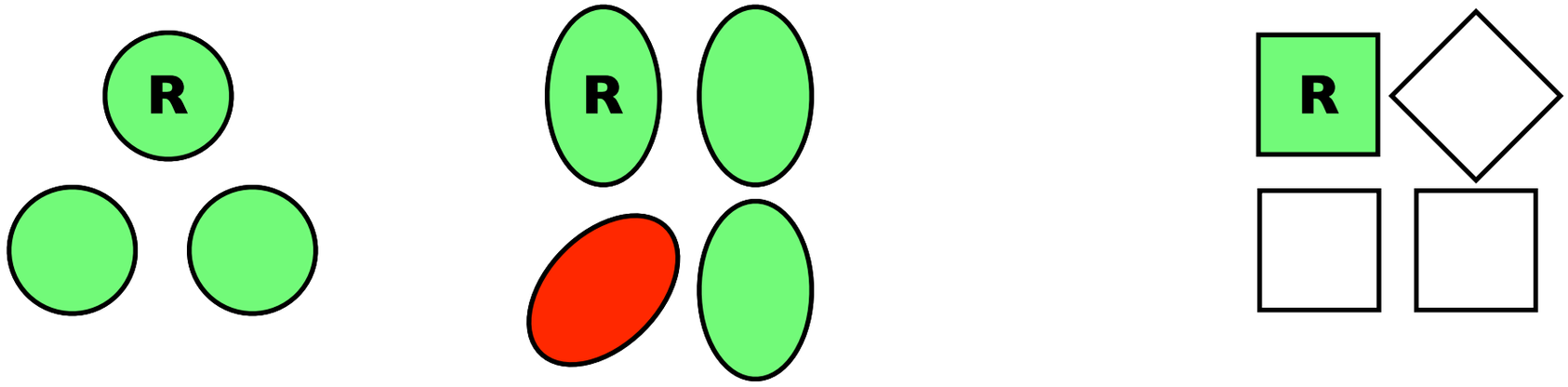


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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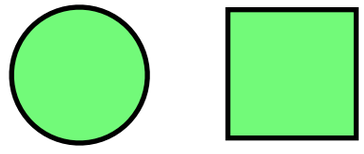

Representatives in parallel, other machines in sequence

R: representatives

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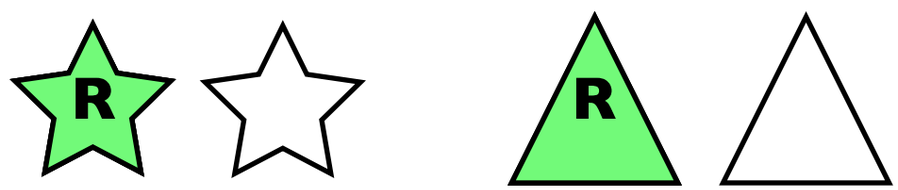

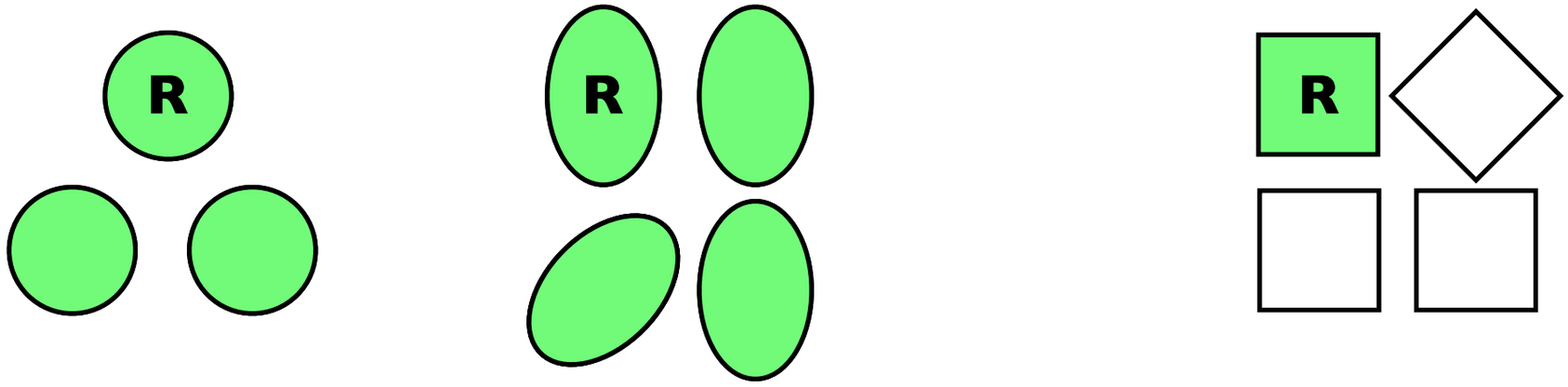

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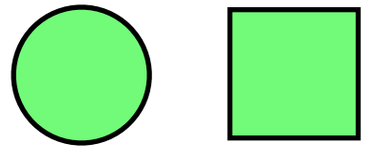
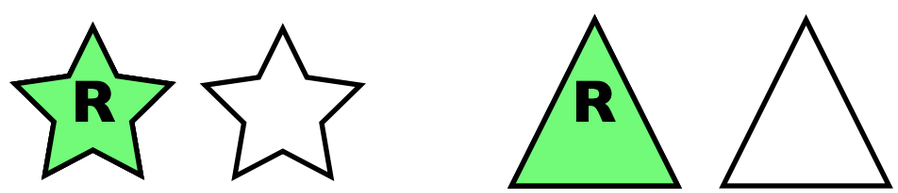
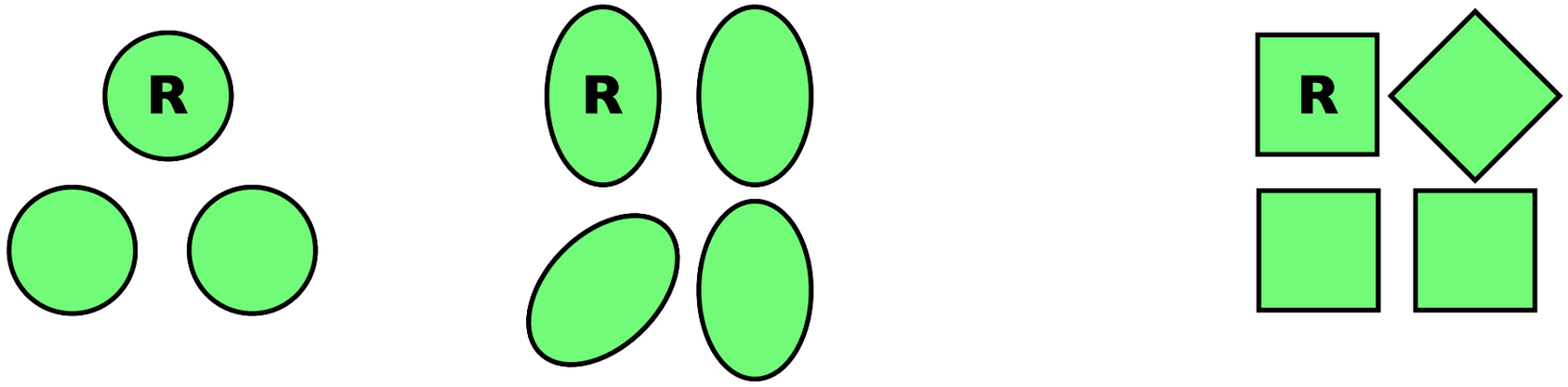


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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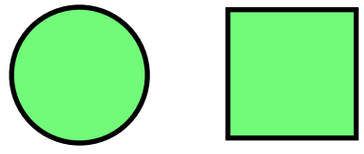

Representatives in parallel, other machines in sequence

R: representatives

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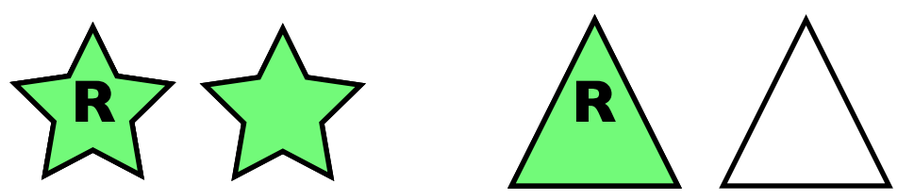

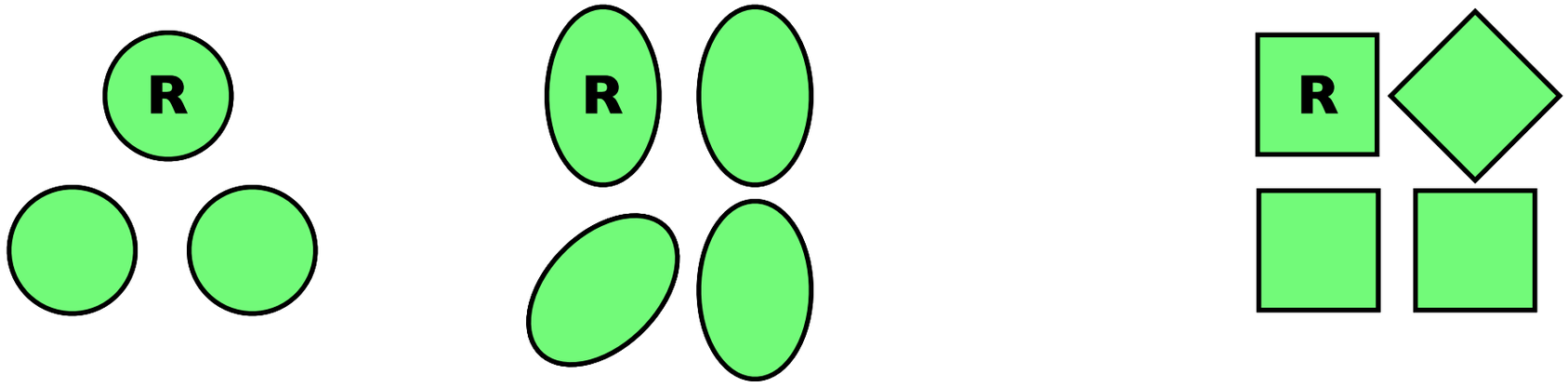

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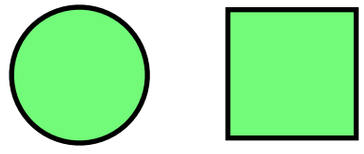
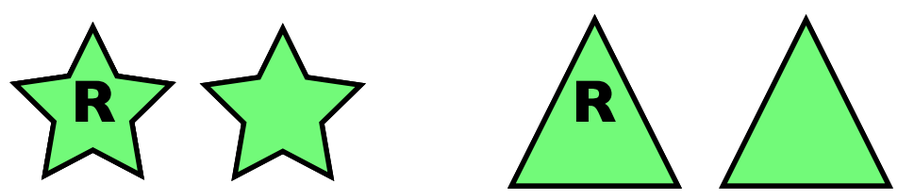
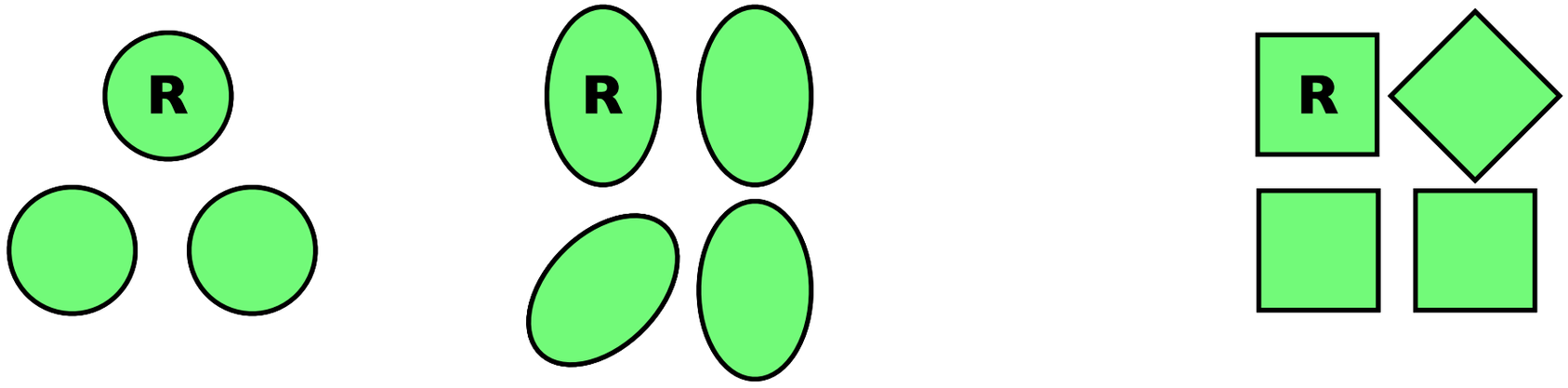


Representatives in parallel, other machines in sequence

R: representatives

OUTSIDE WORLD





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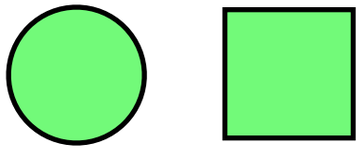

Upgrade overhead: 3

Evaluation

- Quality of clustering:
  - ✦ accuracy of identification of env. resources
  - ✦ accuracy of the clustering algorithm
- Staged deployment:
  - ✦ control upgrade overhead and deployment speed

Can we accurately identify environmental resources ?

App.	# env. resources	# vendor rules	#errors
firefox	839	7	0
apache	251	2	0
php	206	0	0
mysql	250	1	0

Can we accurately identify environmental resources ?

App.	# env. resources	# vendor rules	#errors
firefox	839	7	0
apache	251	2	0
php	206	0	0
mysql	250	1	0

Example: Apache

- Files initially misclassified:
  - `index.html`
  - `access_log`
- Vendor rules needed:
  - *exclude* `*.html`
  - *exclude* `access_log`

Can we accurately cluster machines?

- 21 MySQL environments
  - 2 distributions of linux
  - PHP and Apache
  - various MySQL configurations
- 2 real upgrade problems

Can we accurately cluster machines?

- 0 misplaced machines
  - ✦ optimal for reducing upgrade overhead by testing at representatives
- 15 clusters
  - ✦ artefact of the experiment
  - ✦ number of clusters can be reduced by increasing the fingerprinting granularity

Controlling the tradeoff

- Experimental setup:
  - Event-driven simulator
  - 100’000 machines
  - 3 problems
  - 2 staging protocols, plus NoStaging

Controlling the tradeoff

- Upgrade overhead reduced very significantly
- Deployment completes 25% later than NoStaging in the worst case

Related work

- Package management systems
- Patch management systems
  - Strider, Microsoft ACT
  - No other work considered clustering and staged deployment

Conclusion

- Staged deployment in Mirage
  - machines can be clustered based on their environment
  - significantly reduce upgrade overhead

Thank you for your attention !

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