SymfonyCon
LISBON 2018
DECEMBER 6-8

Knowing your State Machines

Tobias Nyholm

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happyr

What?

a way of thinking

Why state machines?

- Separates business logic from your models
- Makes the code more:
  - Reusable
  - Maintainable
  - Readable

Tobias Nyholm

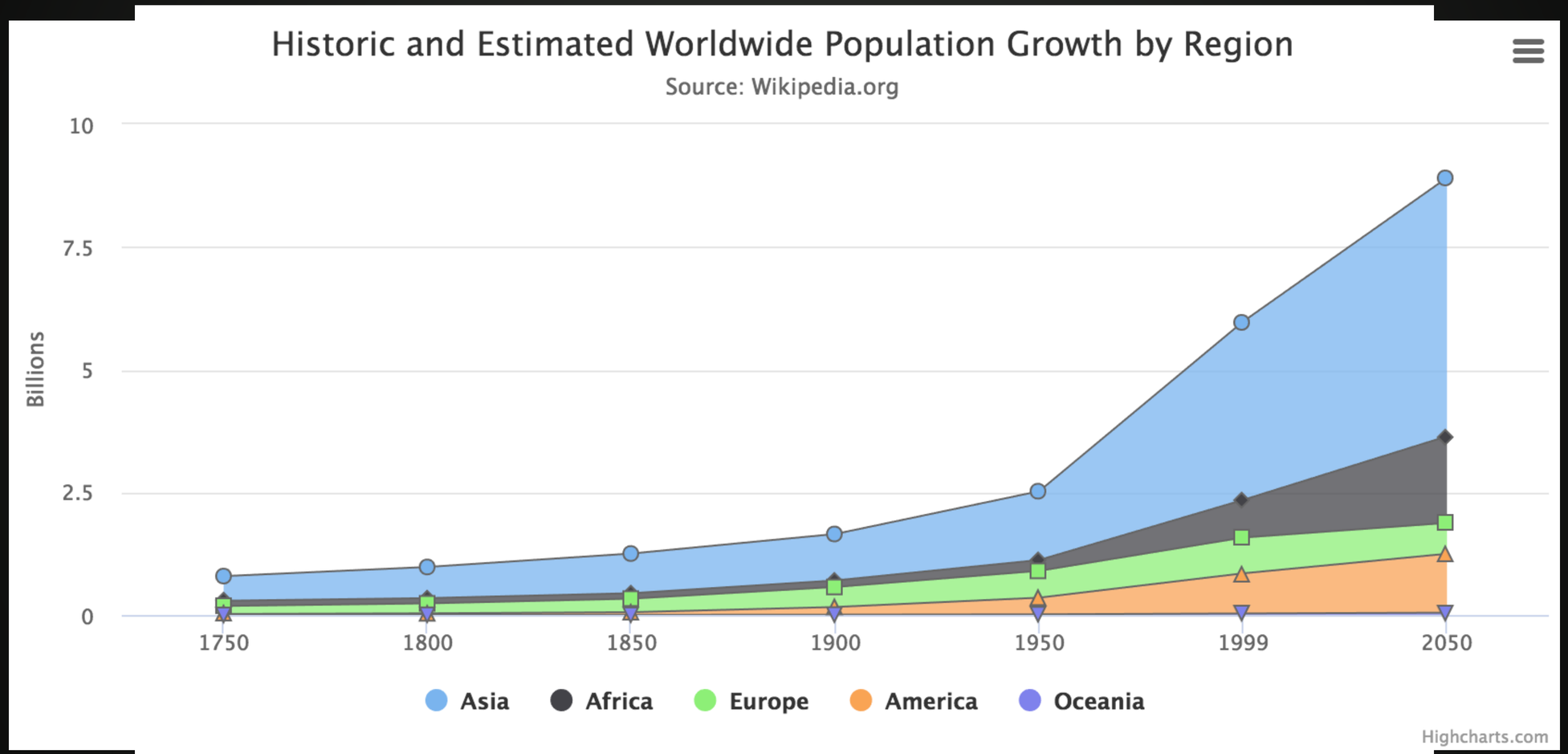
- Full stack unicorn on Happyr.com
- Certified Symfony developer
- Symfony core member
- PHP-Stockholm
- Open source

Open source

Assert
Neo4j
FriendsOfApi/boilerplate
Guzzle
Buzz
Backup-manager/symfony
nyholm/effective-interest-rate
Puli
Swap
LinkedIn API client
NSA
php-http/discovery
PHP-cache
PHP-Translation
PSR7
CacheBundle
league/geotools
Mailgun
KNP Github API
happyr/normal-distribution-bundle
HTTPlug
Stampie
SymfonyBundleTest
MailgunBundle
php-http/httplug-bundle
php-http/multipart-stream
SimpleBus integrations
PHP-Geocoder
PSR HTTP clients
BazingaGeocoderBundle

So how?

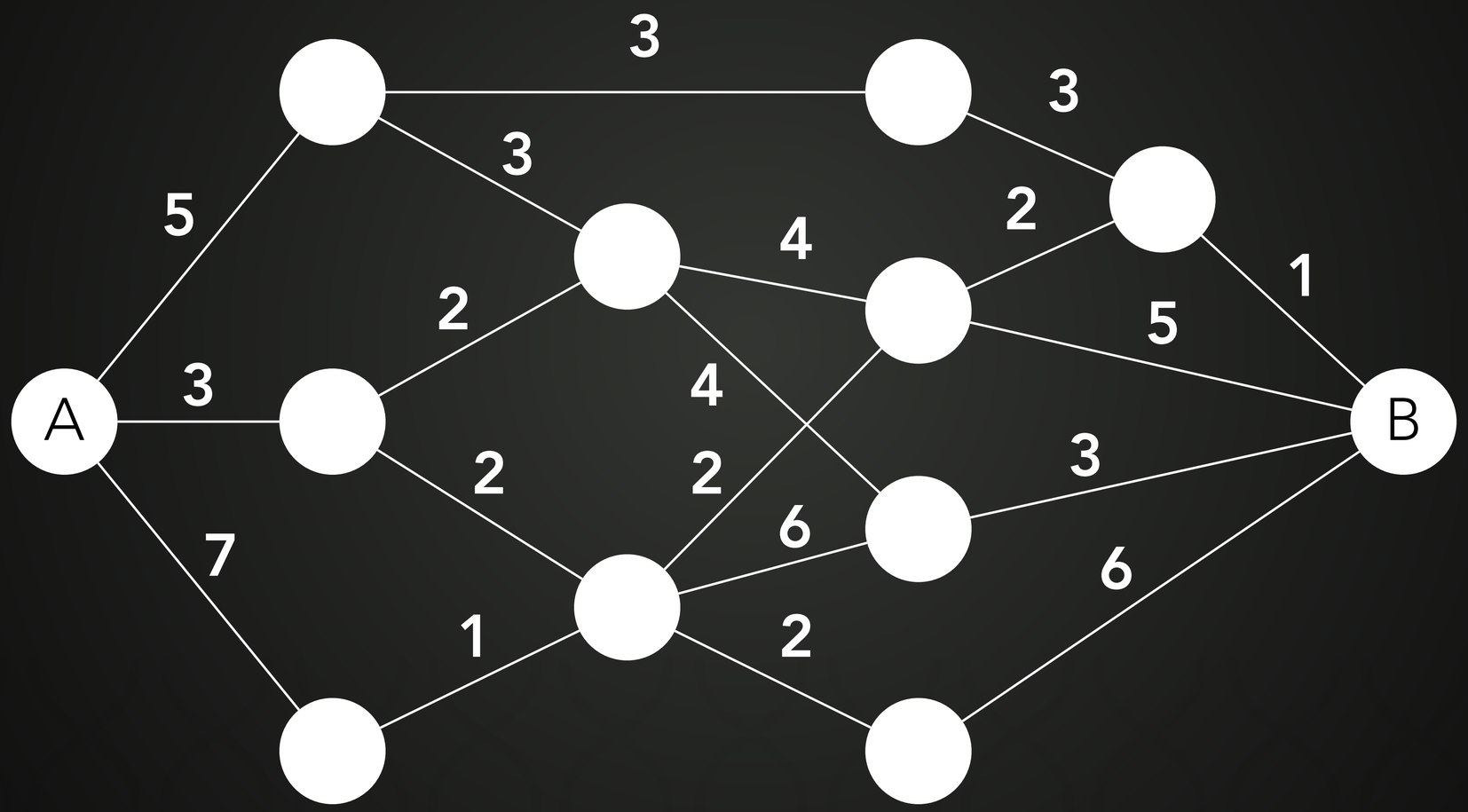
Graph theory



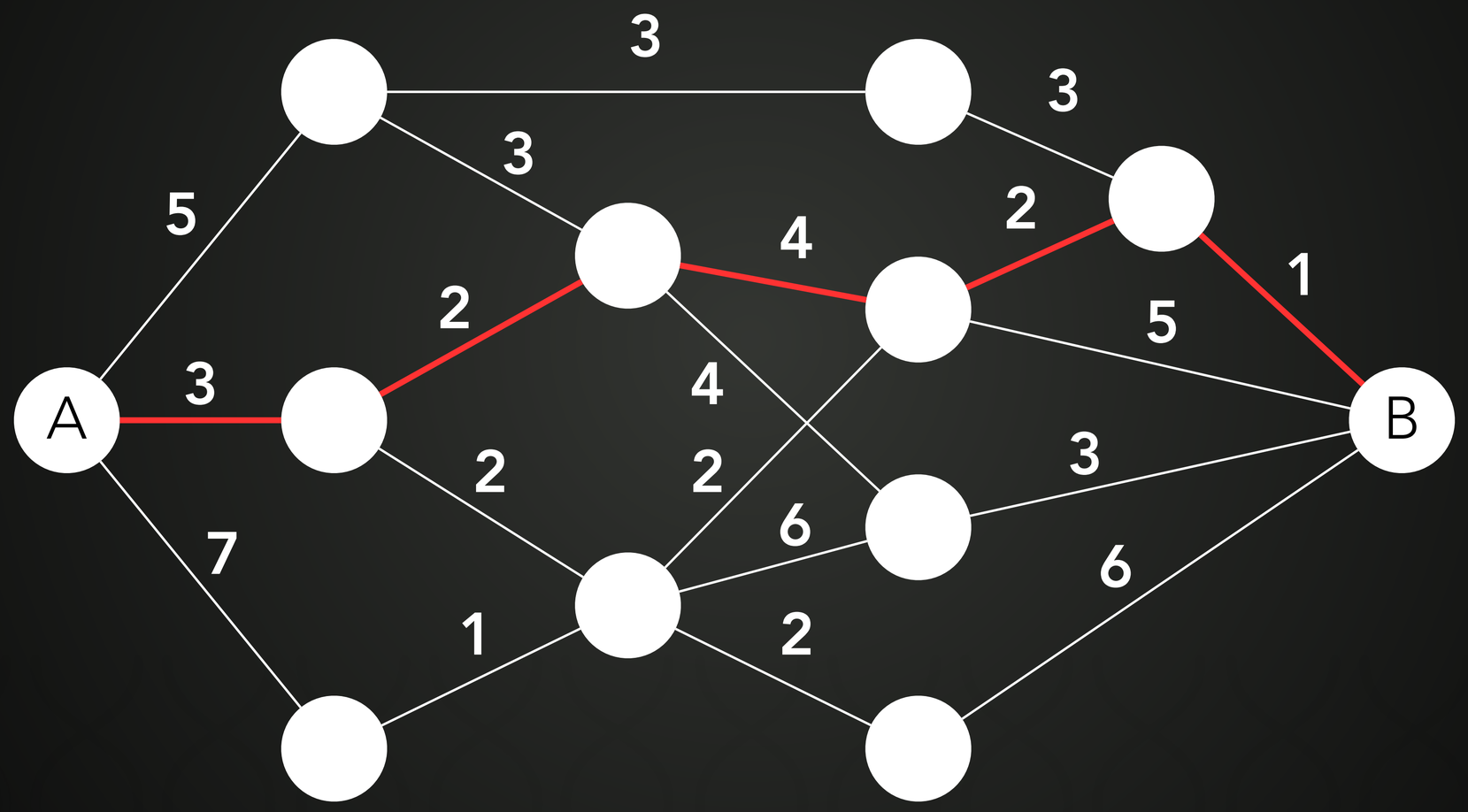
Highcharts.com

Graph theory

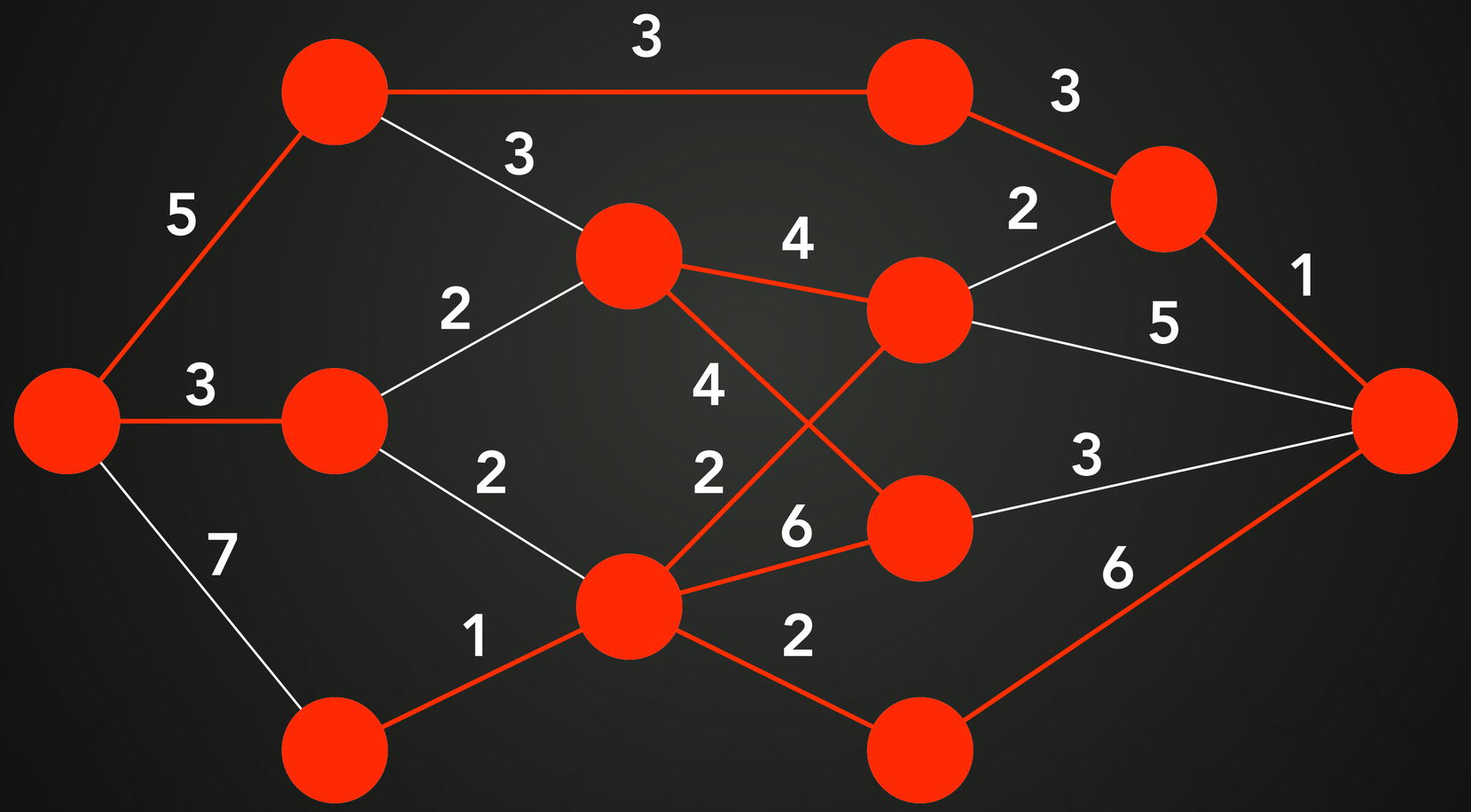
Graph theory



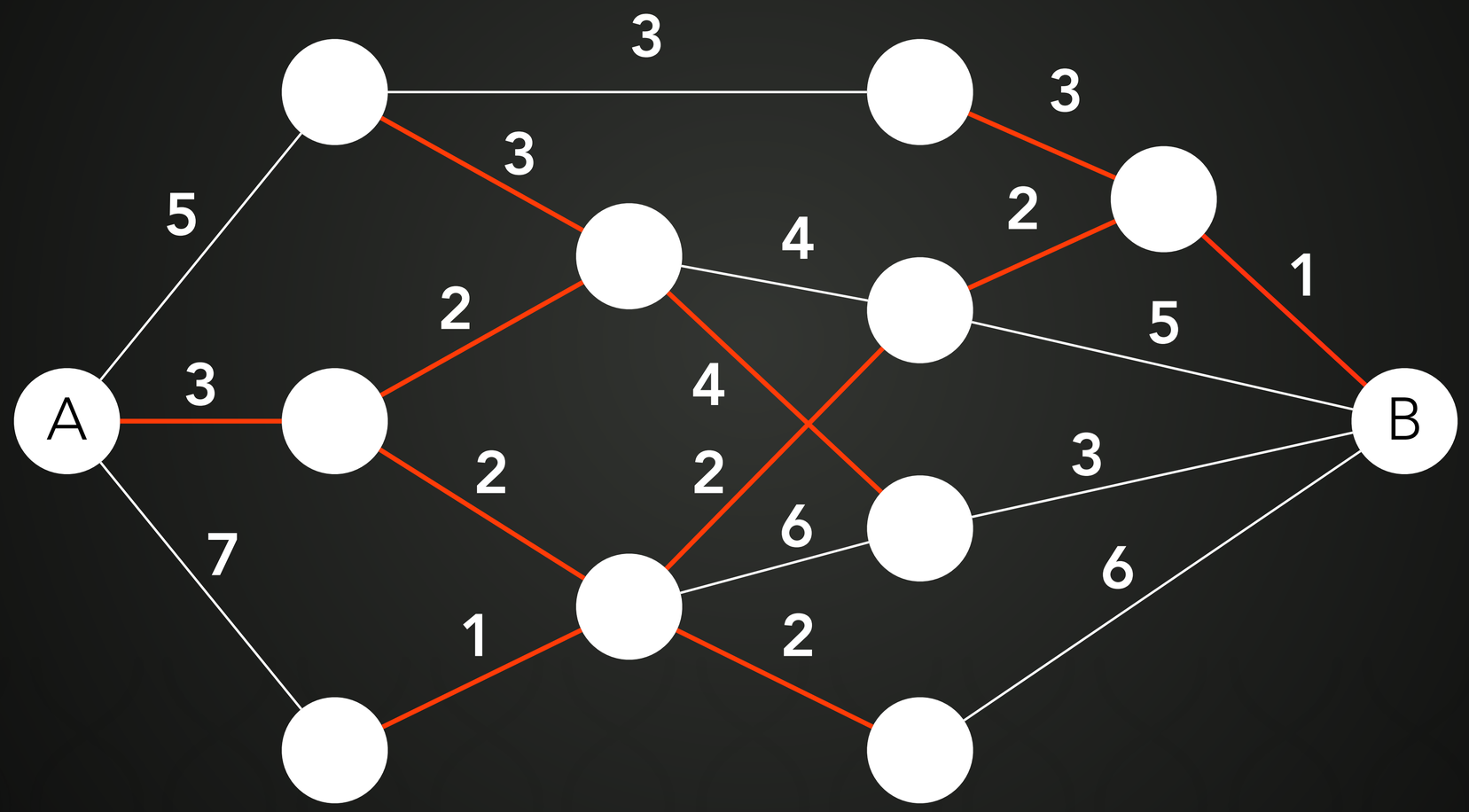
Graph theory



Graph theory



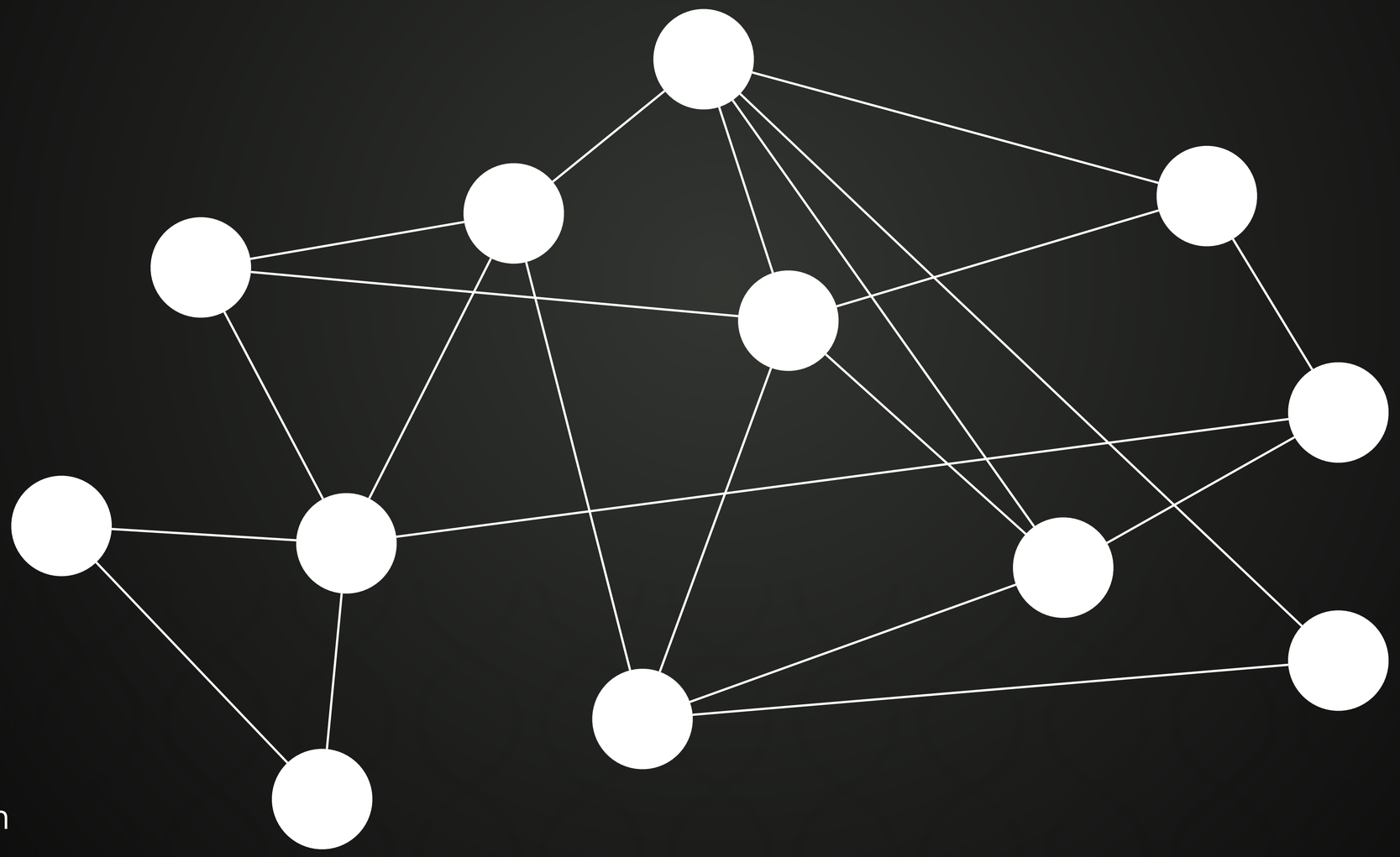
Graph theory



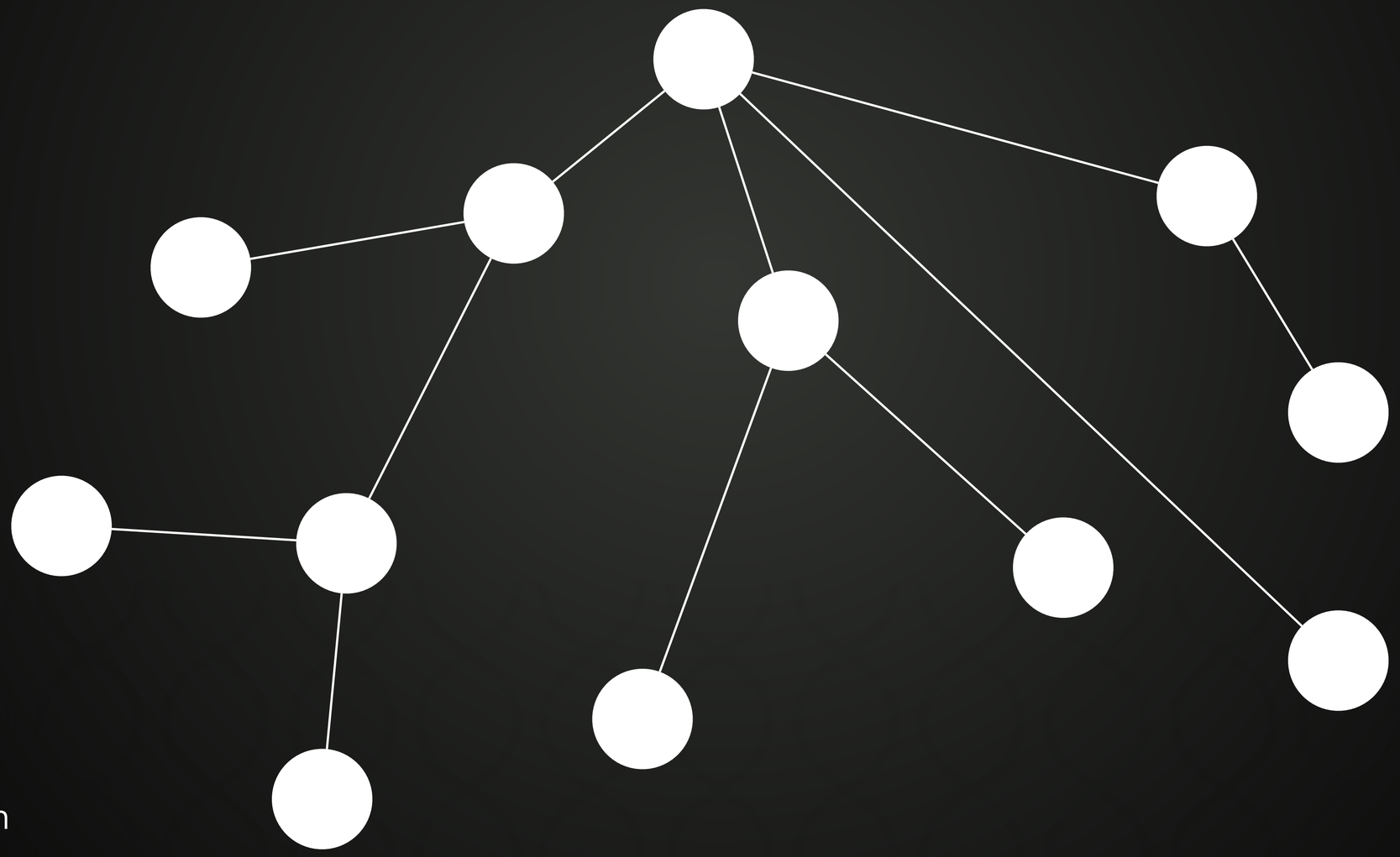
Theory

Graph

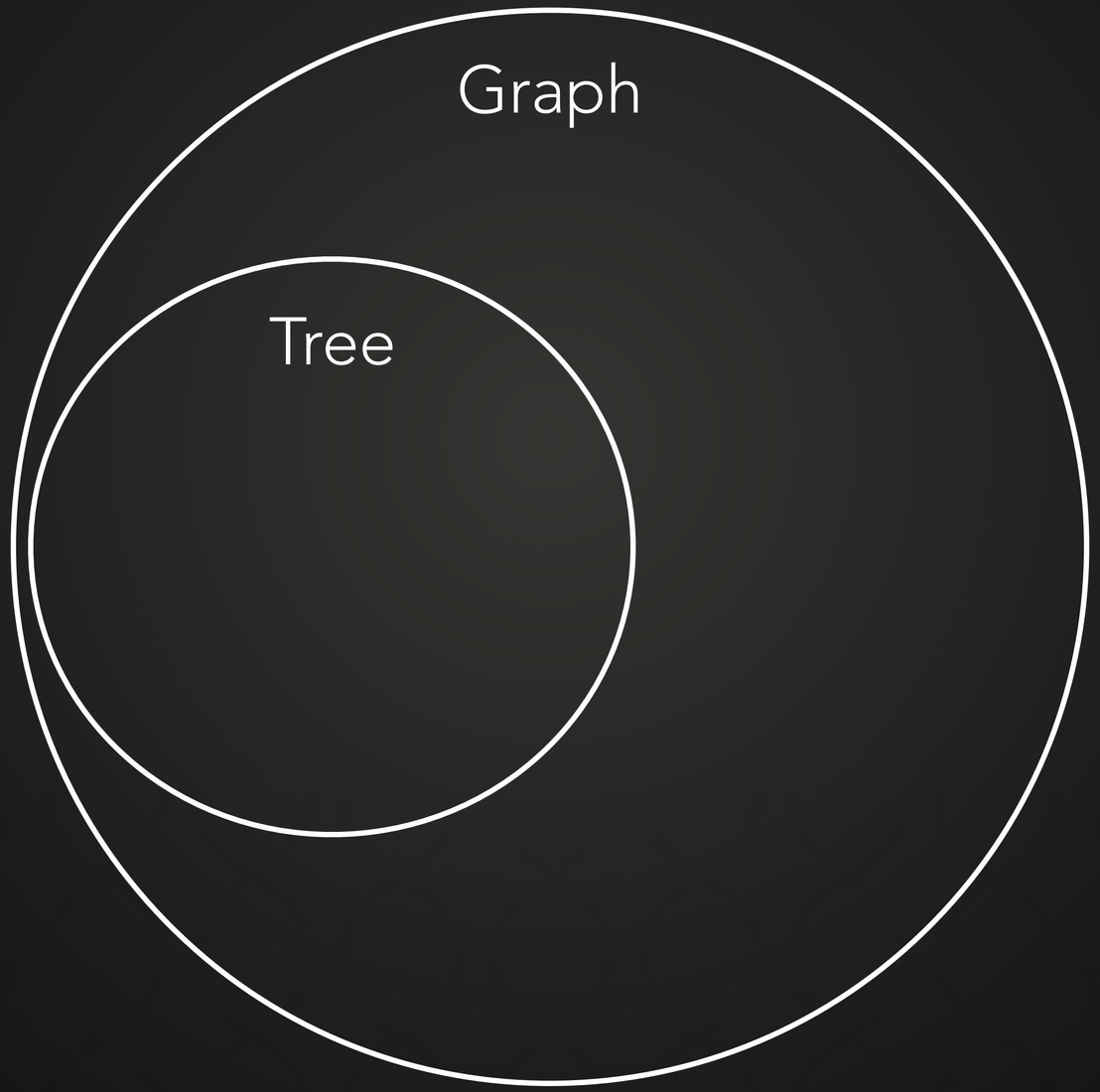
Graph theory



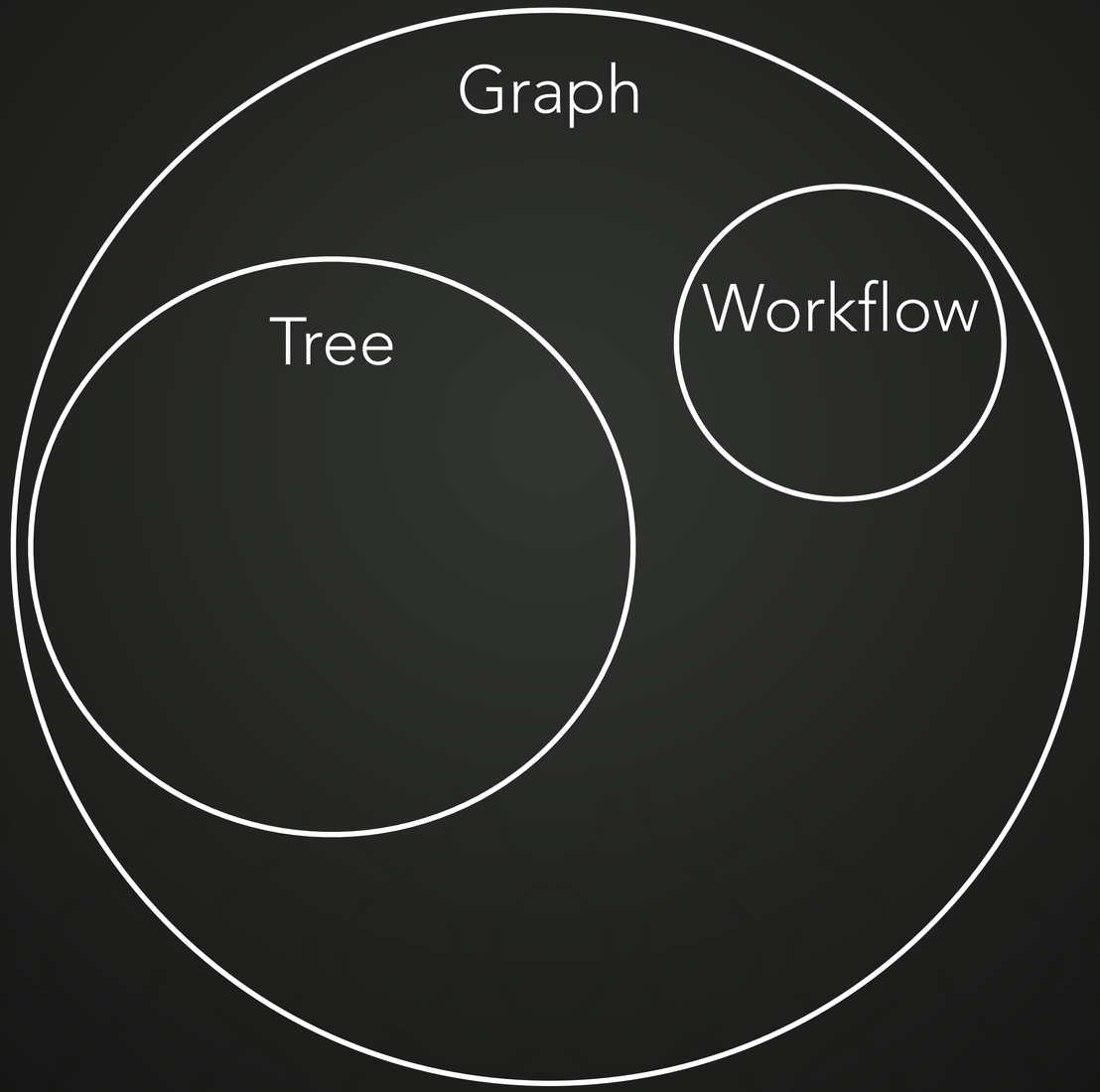
Graph theory



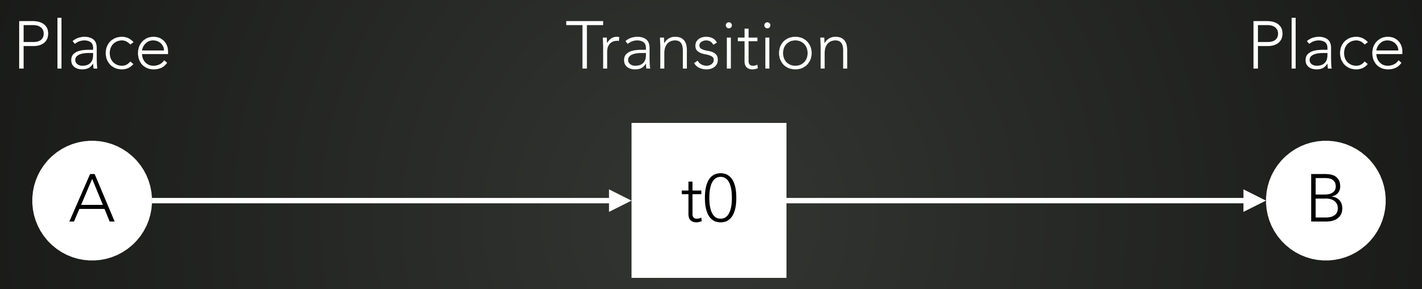
Theory



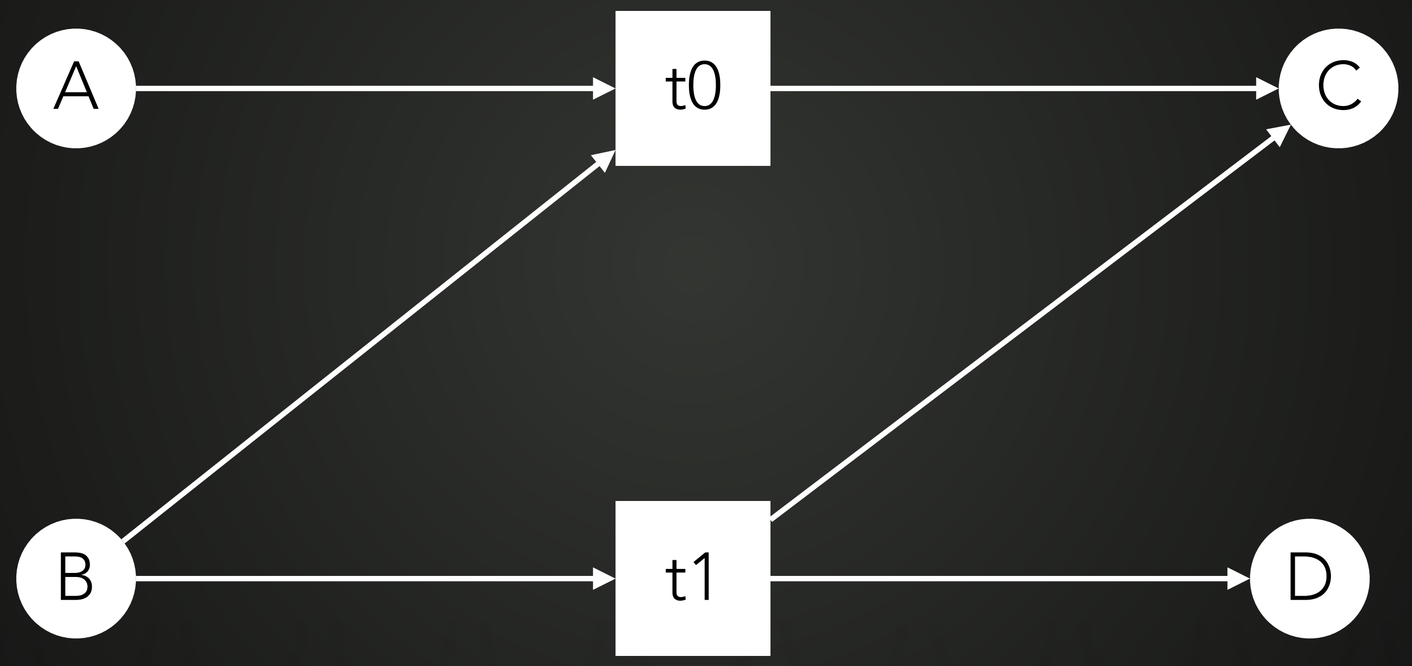
Theory



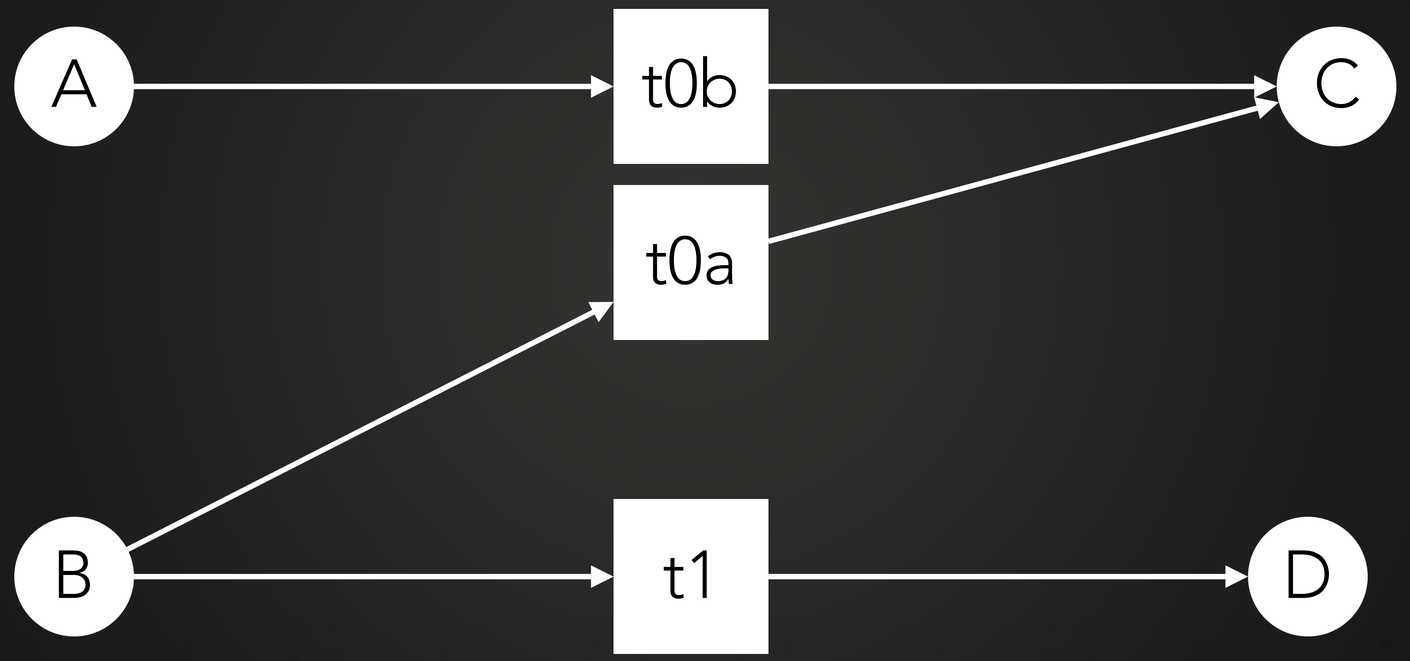
Workflow



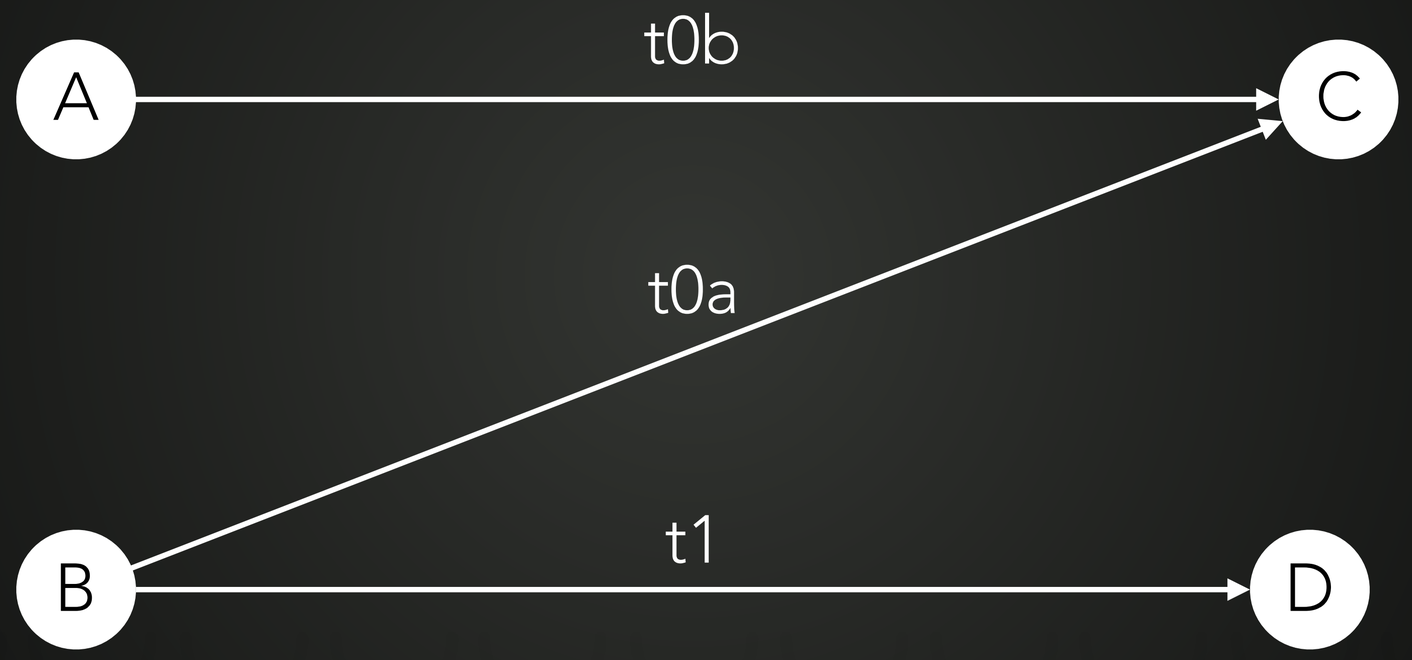
Workflow



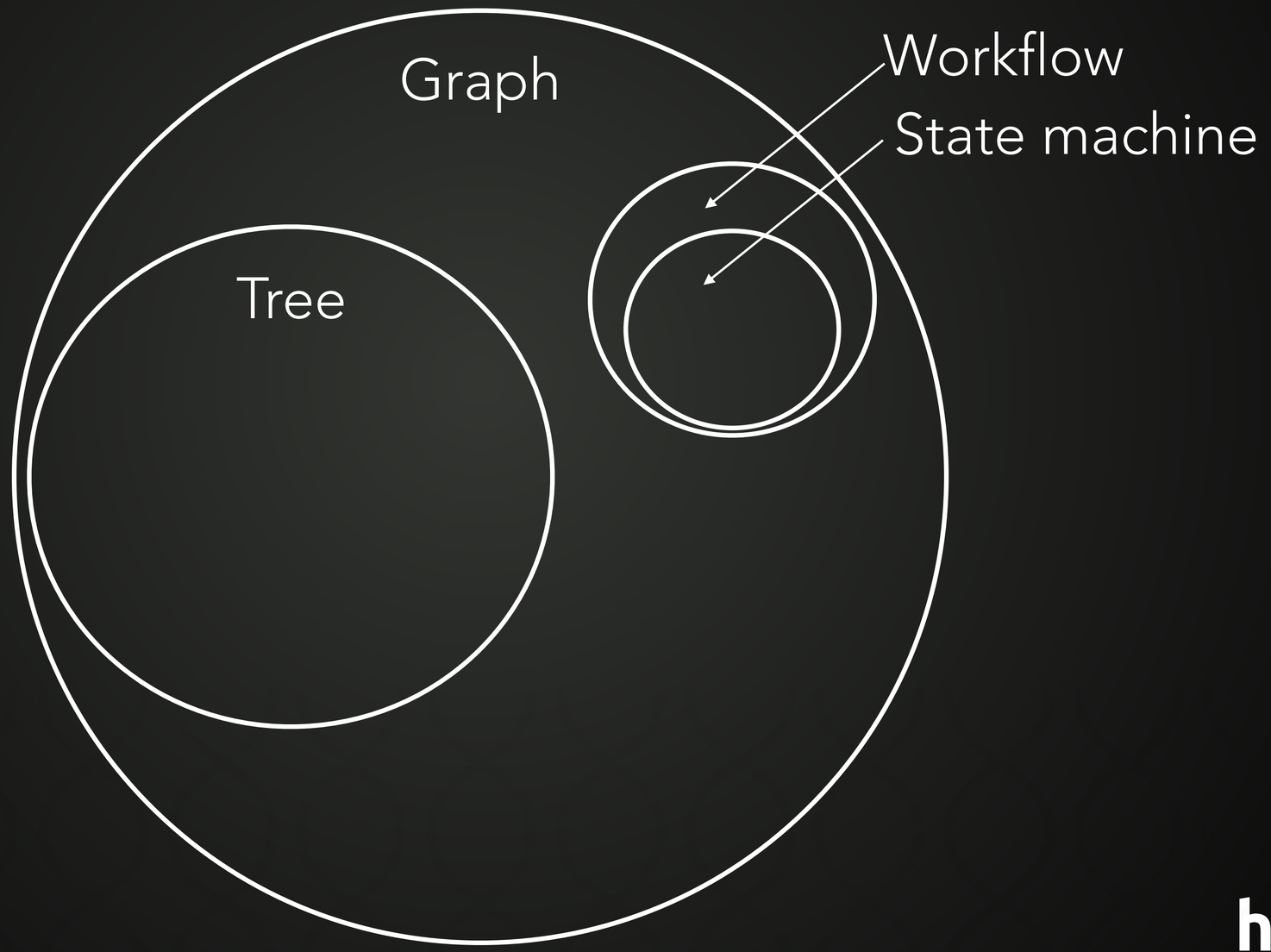
State Machine



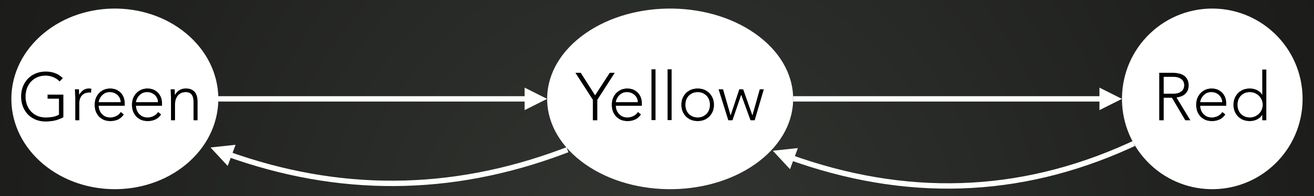
State Machine



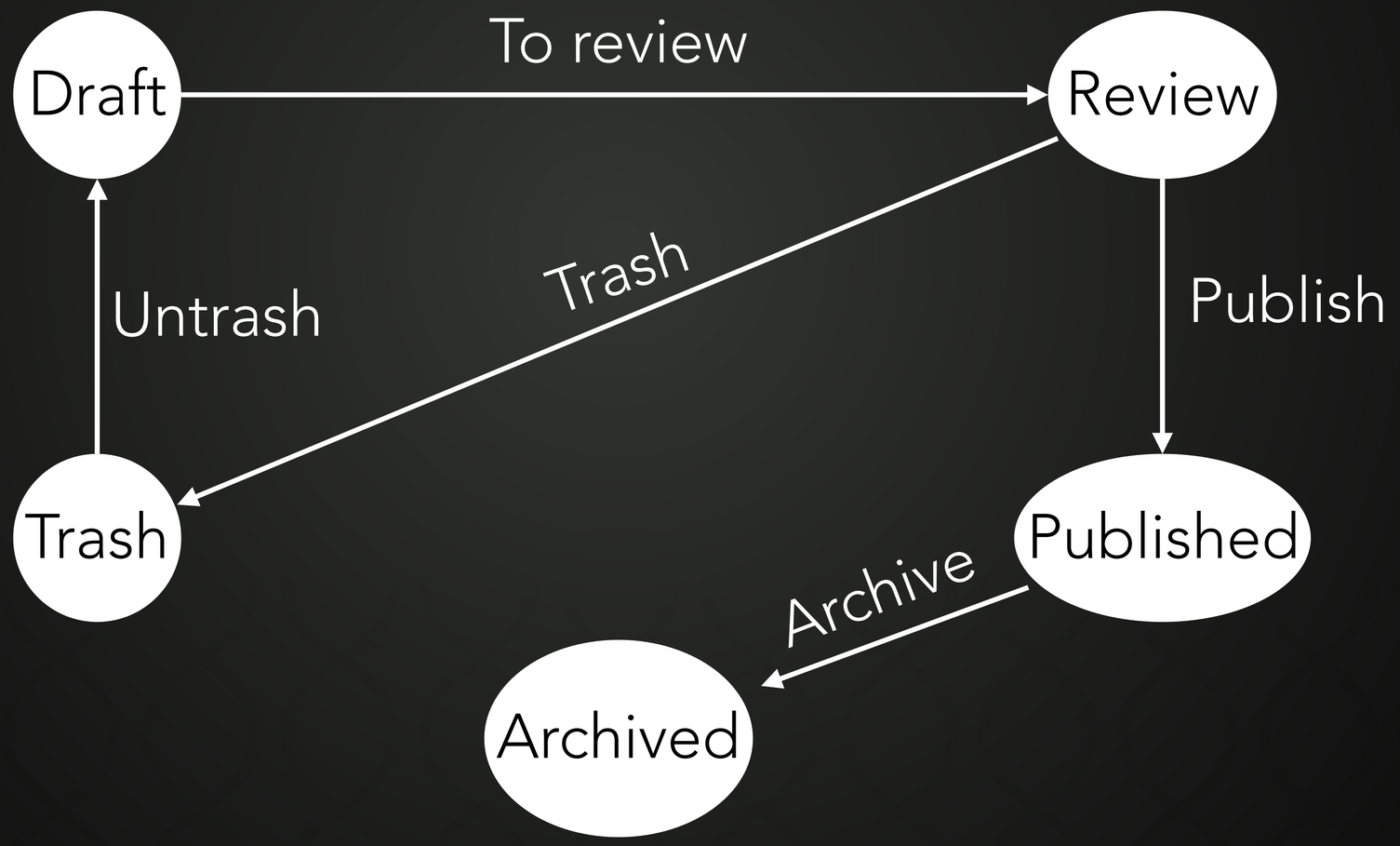
Theory



Traffic Light



Job advert


Draft
To review
Review
Trash
Untrash
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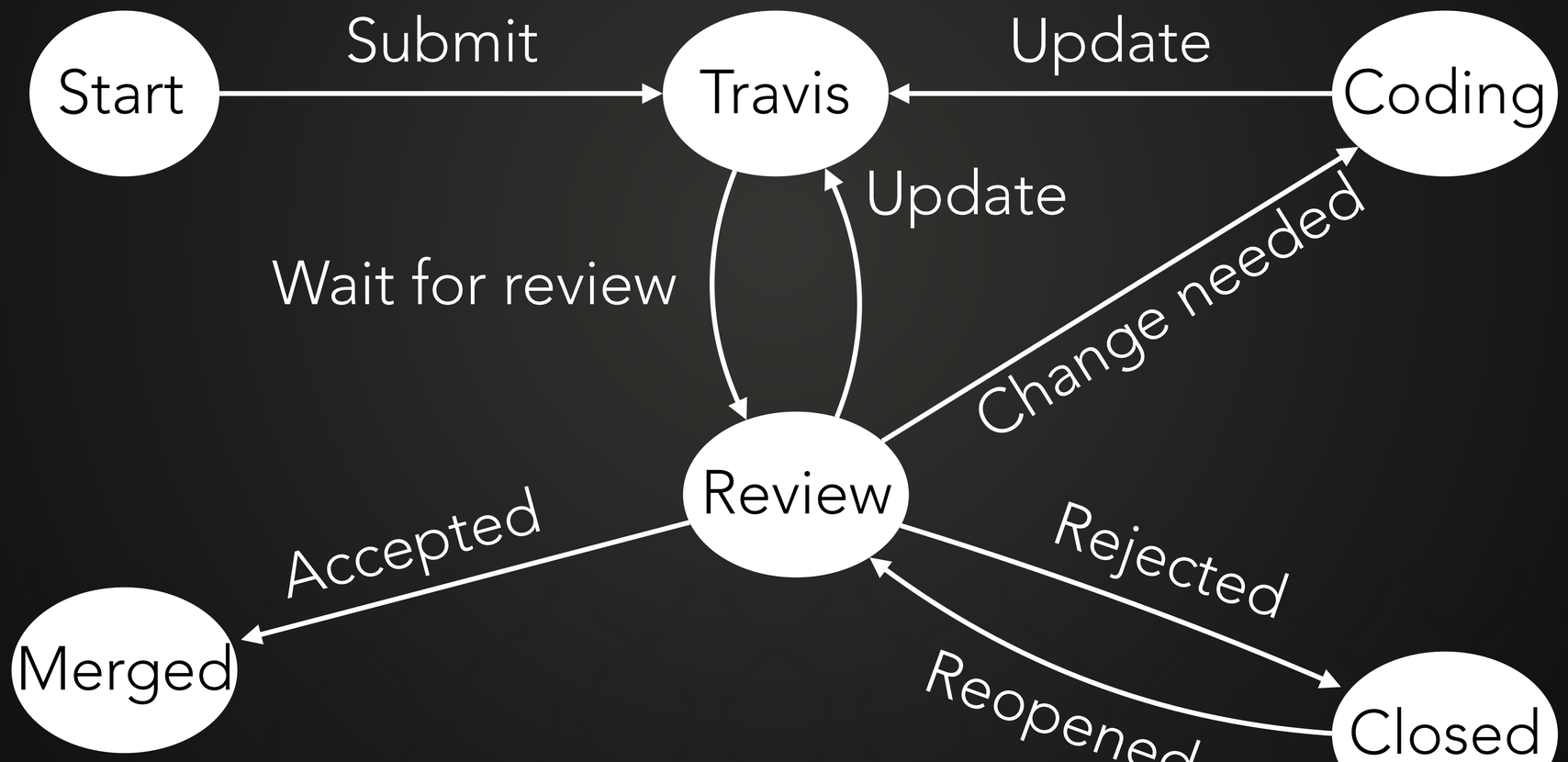
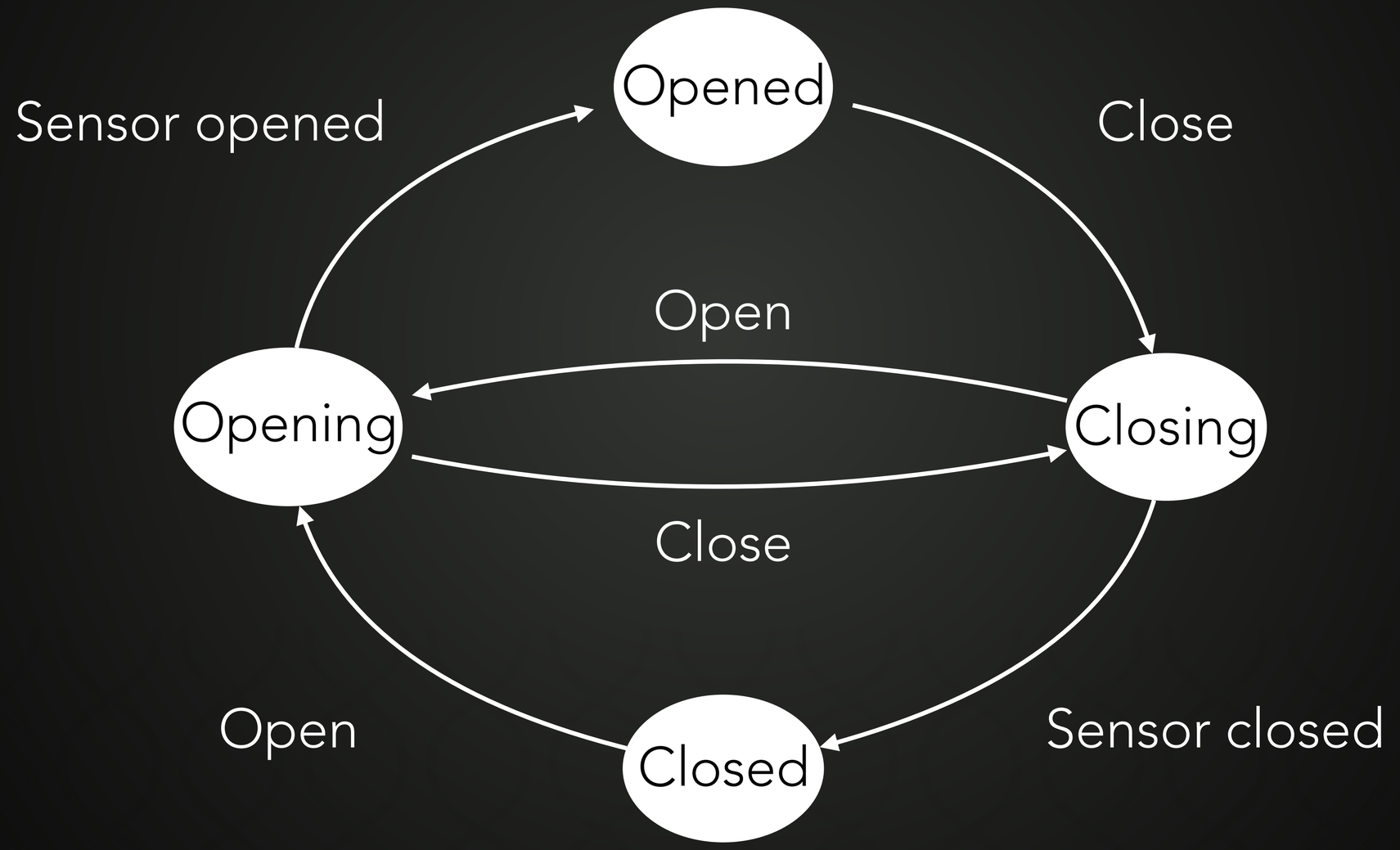
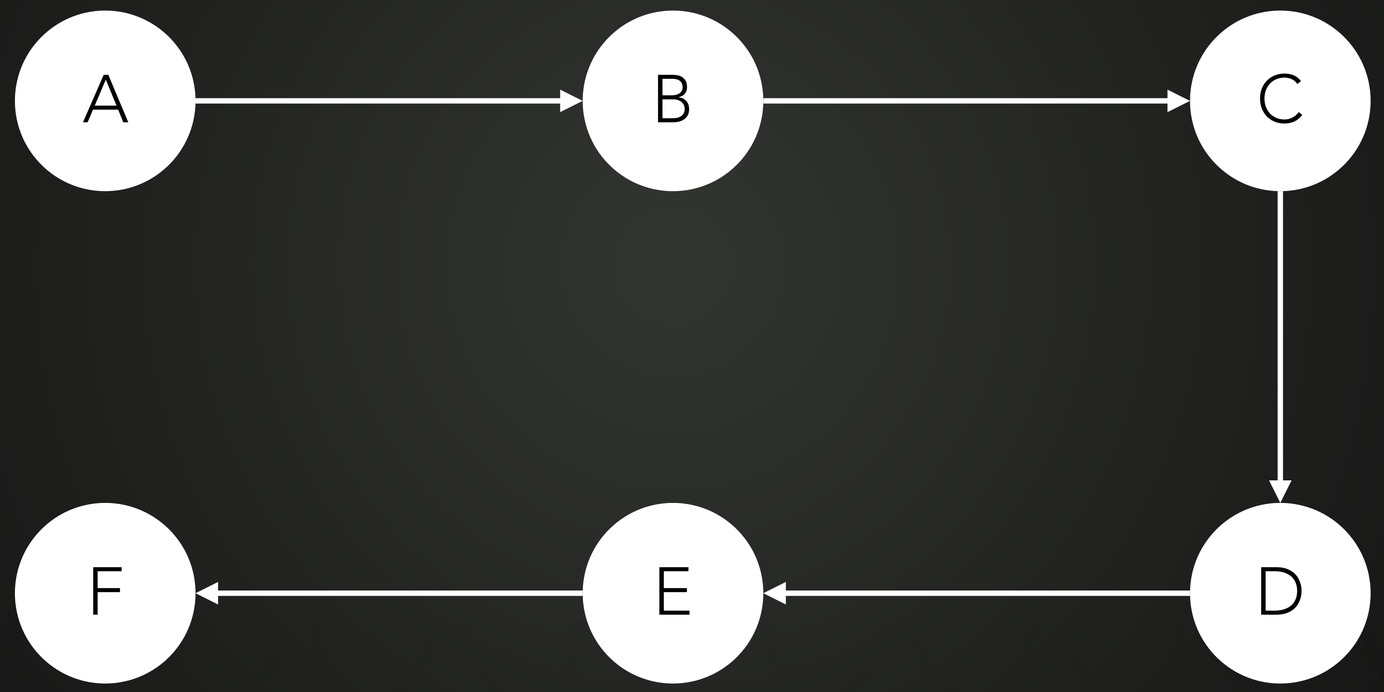
Pull Request



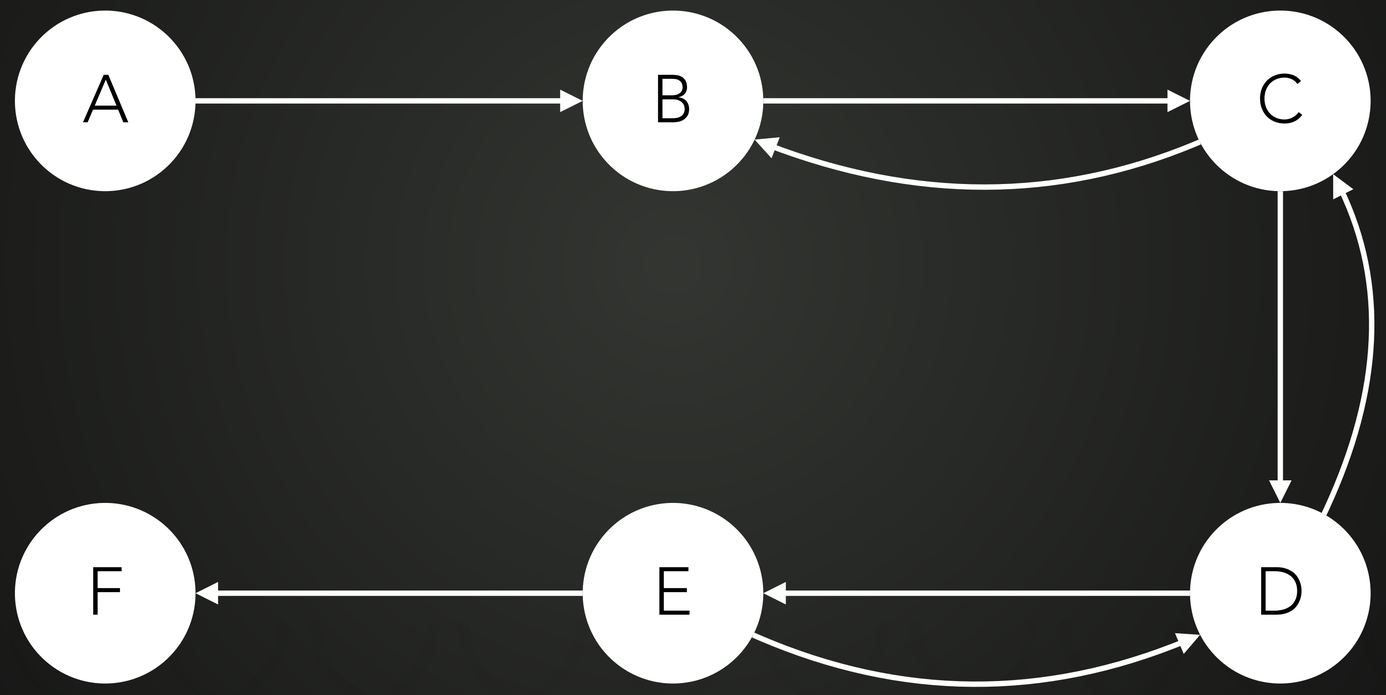
Elevator doors



Multi step form



Multi step form

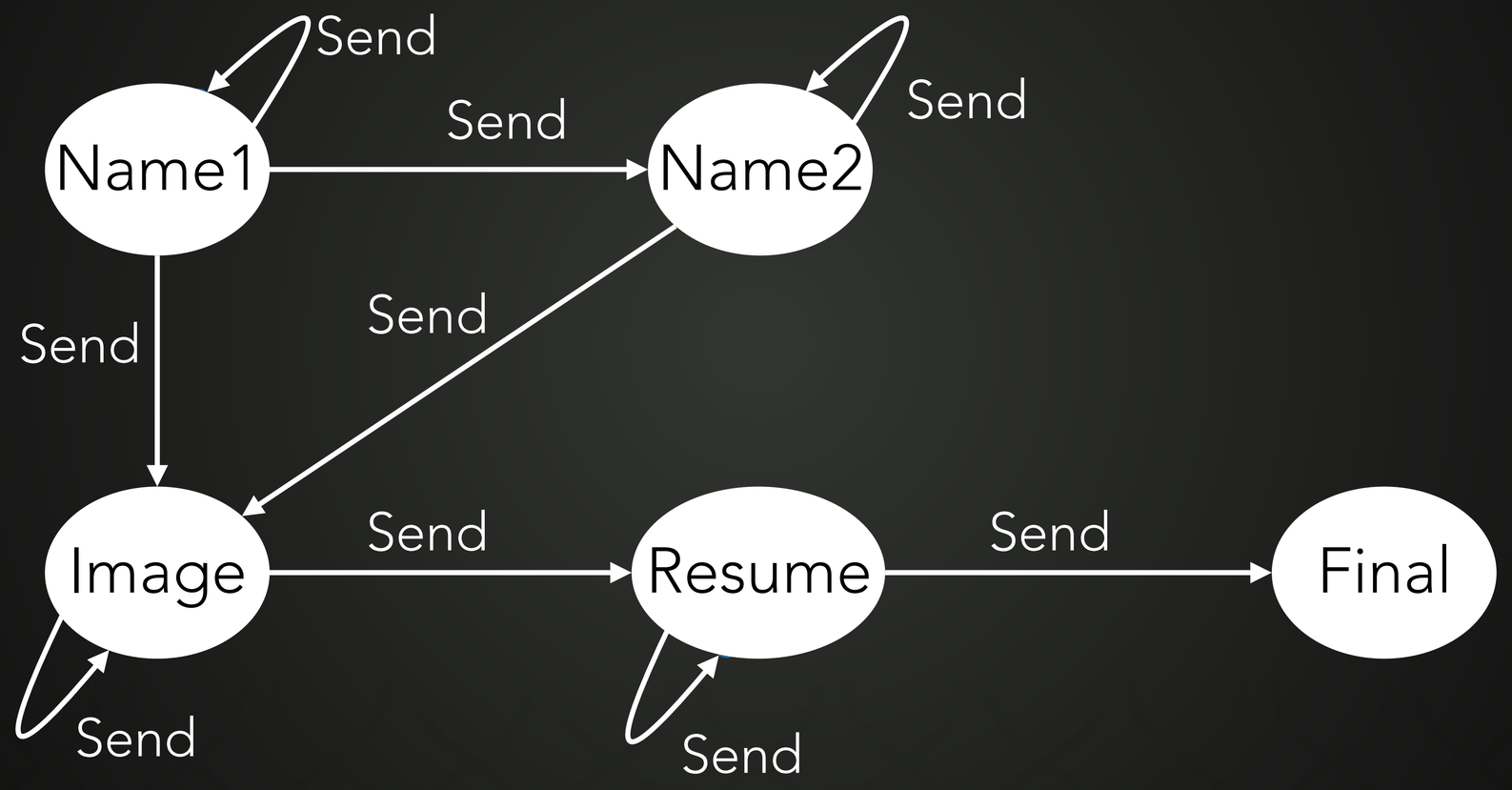


Two Implementations

State Pattern

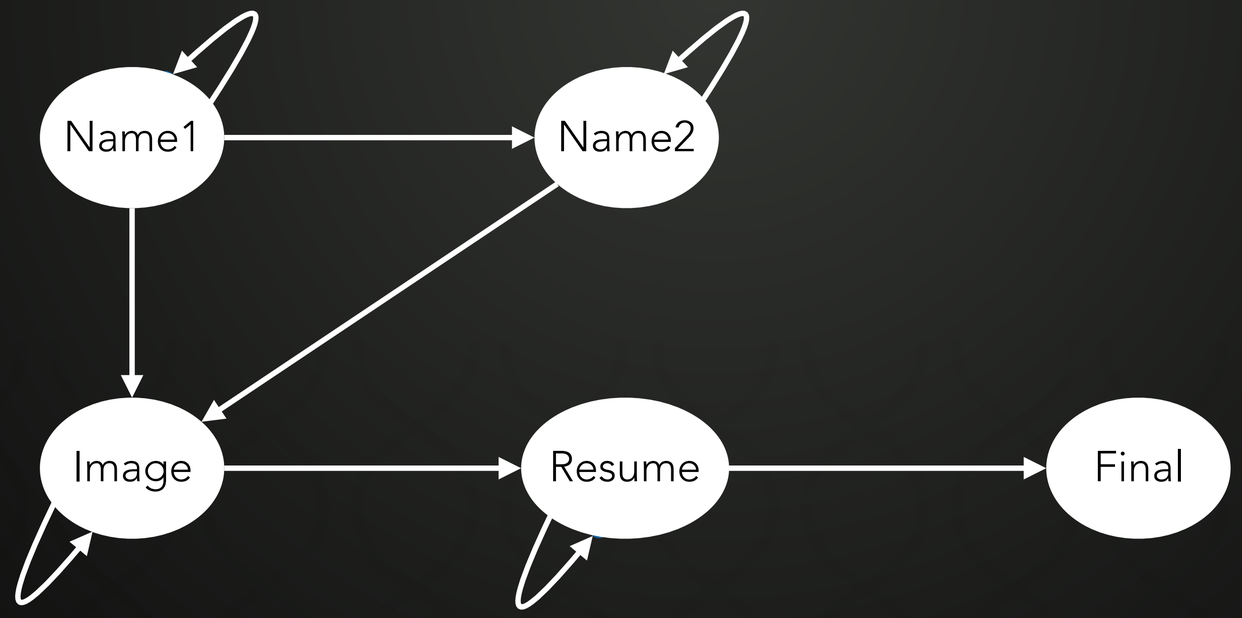
Moore

Complete Profile Reminder



```php
class Worker
{
    // Call daily
    public function sendReminders()
    {
        $stateMachines = ...;// Fetch from database

        /** @var ProfileReminder $profileReminder */
        foreach ($stateMachines as $stateMachine) {
            $ended = $stateMachine->start($this->emailService);
            if ($ended === true) {
                // Remove $profileReminder from database
            }
        }
    }
}
```



```php
class CompleteYourProfileReminderStateMachine {
    private $user; /** @var User */
    private $state; /** @var ProfileReminderState */

    public function __construct(User $user) {
        $this->user = $user;
        $this->state = new AddYourNameFirst();
    }

    /**
     * @param AnyEmailService $emailService
     *
     * @return bool true if this state machine has come to an end.
     */
    public function start(AnyEmailService $emailService) {
        while (true !== $this->state->send($this, $emailService)) {
            // Looping through states.
        }

        return $this->state instanceof FinalState;
    }

    public function getUser(){
        return $this->user;
    }

    public function setState(ProfileReminderState $state) {
        $this->state = $state;
    }
}
```

```
class AnyStep implements ProfileReminderState
{

    public function send(Compl…StateMachine $stateMachine, $emailService)
    {

        // Send email and set next state
        $emailService->send(
            'Mail\AddYourNameFirst.html.twig',
            ['user' => $stateMachine->getUser()]
        );

        $stateMachine->setState(new AddYourNameSecondReminder));

        return false;
    }
}
```

```php
class AnyStep implements ProfileReminderState
{

    public function send(Compl…StateMachine $stateMachine, $emailService)
    {
        // If [precondition] send to other state.
        if ($stateMachine->getUser()->hasName()) {
            $stateMachine->setState(new AddYourImage());
            return false;
        }

        // Send email and set next state
        $emailService->send(
            'Mail\AddYourNameFirst.html.twig',
            ['user' => $stateMachine->getUser()]
        );

        $stateMachine->setState(new AddYourNameSecondReminder));

        return false;
    }
}
```

```php
class AnyStep implements ProfileReminderState
{
    private $createdAt;
    public function __construct() {
        $this->createdAt = new \DateTime();
    }

    public function send(Compl…StateMachine $stateMachine, $emailService)
    {
        // If [precondition] send to other state.
        if ($stateMachine->getUser()->hasName()) {
            $stateMachine->setState(new AddYourImage());
            return false;
        }

        // If we have been at this step for less than seven days. Do nothing
        if ($this->createdAt > new \DateTime('-7days')) {
            return true;
        }

        // Send email and set next state
        $emailService->send(
            'Mail\AddYourNameFirst.html.twig',
            ['user' => $stateMachine->getUser()]
        );
        $stateMachine->setState(new AddYourNameSecondReminder));
        return false;
    }
}
```

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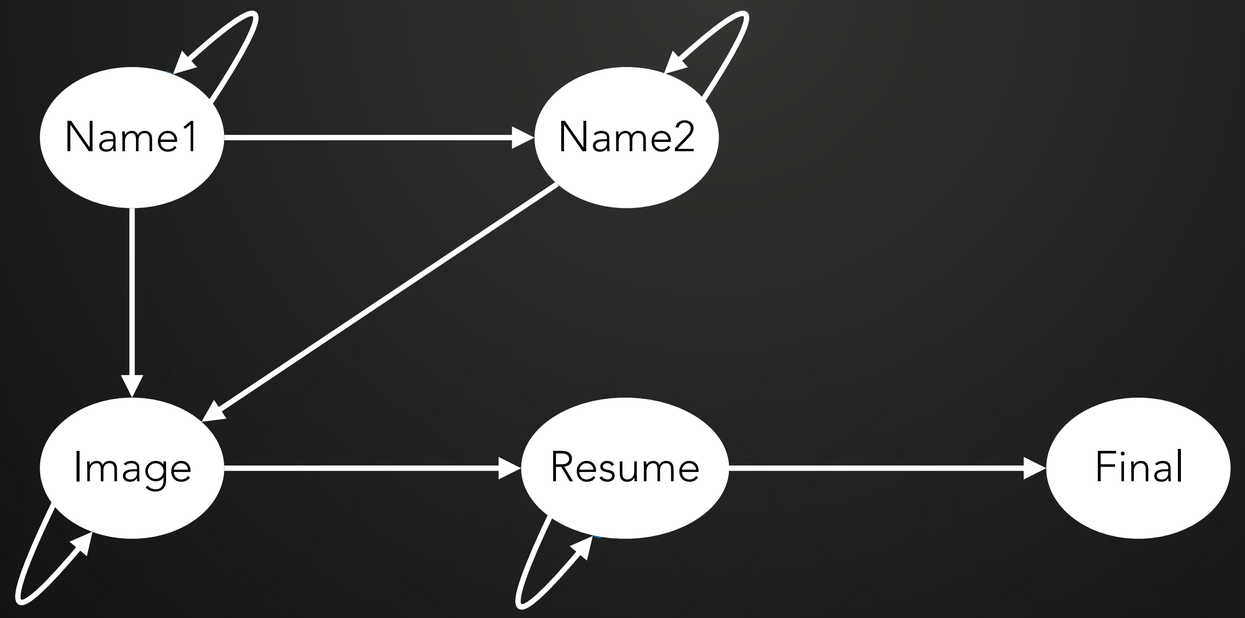
@tobiasnyholm

happyr

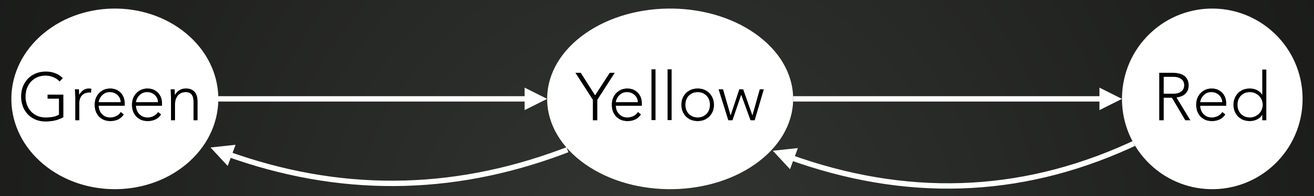
```
src/App/StatePattern/
- Worker.php
- Email/
-   - AddYourImage.php
-   - AddYourNameFirstReminder.php
-   - AddYourNameSecondReminder.php
-   - AddYourResume.php
-   - CompleteYourProfileReminderStateMachine.php
-   - FinalState.php
-   - ProfileReminderState.php
```

```php
class Worker
{
    // Call daily
    public function sendReminders()
    {
        $stateMachines = ...;// Fetch from database

        /** @var ProfileReminder $profileReminder */
        foreach ($stateMachines as $stateMachine) {
            $ended = $stateMachine->start($this->emailService);
            if ($ended === true) {
                // Remove $profileReminder from database
            }
        }
    }
}
```



Mealy State Machine

Traffic Light



```php
namespace App;

class StateMachine
{
    const STATE_GREEN = 0;
    const STATE_YELLOW = 1;
    const STATE_RED = 2;

    private $state;

    public function can($transition) {
        switch ($this->state) {
            case self::STATE_GREEN:
                return ($transition === 'to_yellow');
            case self::STATE_YELLOW:
                return ($transition === 'to_green' || $transition === 'to_red');
            case self::STATE_RED:
                return ($transition === 'to_yellow');
            default:
                return false;
        }
    }
    // ..
}
```

```php
namespace App;

class StateMachine
{
    // ..

    public function apply($transition) {
        if (!$this->can($transition)) {
            throw new \InvalidArgumentException('Invalid transition');
        }

        switch ($this->state) {
            case self::STATE_GREEN && ($transition === 'to_yellow'):
                $this->state = self::STATE_YELLOW;
                break;
            case self::STATE_YELLOW && ($transition === 'to_green'):
                $this->state = self::STATE_GREEN;
                break;
            case self::STATE_YELLOW && ($transition === 'to_red'):
                $this->state = self::STATE_RED;
                break;
            case self::STATE_RED && ($transition === 'to_yellow'):
                $this->state = self::STATE_YELLOW;
                break;
        }
    }
}
```

```php
namespace App;

class StateMachine
{
    const STATE_GREEN = 0;
    const STATE_YELLOW = 1;
    const STATE_RED = 2;

    public function can(TrafficLight $trafficLight, $transition) {
        $state = $trafficLight->getCurrentState();

        switch ($state) {
            case self::STATE_GREEN:
                return ($transition === 'to_yellow');
            case self::STATE_YELLOW:
                return ($transition === 'to_green' || $transition === 'to_red');
            case self::STATE_RED:
                return ($transition === 'to_yellow');
            default:
                return false;
        }
    }

    // ..
}
```

```php
namespace App;

class StateMachine
{
    // ..
    public function apply(TrafficLight $trafficLight, $transition) {
        if (!$this->can($trafficLight, $transition)) {
            throw new \InvalidArgumentException('Invalid transition');
        }

        $state = $trafficLight->getCurrentState();

        switch ($state) {
            case self::STATE_GREEN && ($transition === 'to_yellow'):
                $trafficLight->setState(self::STATE_YELLOW);
                break;
            case self::STATE_YELLOW && ($transition === 'to_green'):
                $trafficLight->setState(self::STATE_GREEN);
                break;
            case self::STATE_YELLOW && ($transition === 'to_red'):
                $trafficLight->setState(self::STATE_RED);
                break;
            case self::STATE_RED && ($transition === 'to_yellow'):
                $trafficLight->setState(self::STATE_YELLOW);
                break;
        }
    }
}
```

```php
namespace App;

class StateMachine
{

    // ...

    public function allowTraffic(TrafficLight $trafficLight)
    {
        if ($this->can($trafficLight, 'to_green')) {
            $this->apply($trafficLight, 'to_green');
        } elseif ($this->can($trafficLight, 'to_yellow')) {
            $this->apply($trafficLight, 'to_yellow');
        }
    }

    public function stopTraffic(TrafficLight $trafficLight)
    {
        if ($this->can($trafficLight, 'to_red')) {
            $this->apply($trafficLight, 'to_red');
        } elseif ($this->can($trafficLight, 'to_yellow')) {
            $this->apply($trafficLight, 'to_yellow');
        }
    }
}
```

```php
namespace App;

class StateMachine
{

    // ...

    public function allowTraffic(TrafficLight $trafficLight)
    {
        if ($this->can($trafficLight, 'to_green')) {
            $this->apply($trafficLight, 'to_green');
        } elseif ($this->can($trafficLight, 'to_yellow')) {
            $this->apply($trafficLight, 'to_yellow');
        }
    }

    public function stopTraffic(TrafficLight $trafficLight)
    {
        if ($this->can($trafficLight, 'to_red')) {
            $this->apply($trafficLight, 'to_red');
        } elseif ($this->can($trafficLight, 'to_yellow')) {
            $this->apply($trafficLight, 'to_yellow');
        }
    }
}
```

```php
namespace App;

class StateMachine{
    const STATE_GREEN = 0;
    const STATE_YELLOW = 1;
    const STATE_RED = 2;
    private $states = [
        self::STATE_GREEN => [
            'to_yellow' =>  self::STATE_YELLOW,
        ],
        self::STATE_YELLOW => [
            'to_green' => self::STATE_GREEN,
            'to_red' => self::STATE_RED,
        ],
        self::STATE_RED => [
            'to_yellow' =>  self::STATE_YELLOW,
        ],
    ];

    public function can(TrafficLight $trafficLight, $transition) {
        $state = $trafficLight->getCurrentState();

        return isset($this->states[$state][$transition]);
    }

    public function apply(TrafficLight $trafficLight, $transition) {
        if (!$this->can($trafficLight, $transition)) {
            throw new \InvalidArgumentException('Invalid transition');
        }
```

```php
namespace App;

class StateMachine{

    private $states;

    public function __construct(array $states) {
        $this->states = $states;
    }

    public function can(TrafficLight $trafficLight, $transition) {
        $state = $trafficLight->getCurrentState();

        return isset($this->states[$state][$transition]);
    }

    public function apply(TrafficLight $trafficLight, $transition) {
        if (!$this->can($trafficLight, $transition)) {
            throw new \InvalidArgumentException('Invalid transition');
        }

        $state = $trafficLight->getCurrentState();
        $newState = $this->states[$state][$transition];
        $trafficLight->setState($newState);
    }
    // ...
}
```

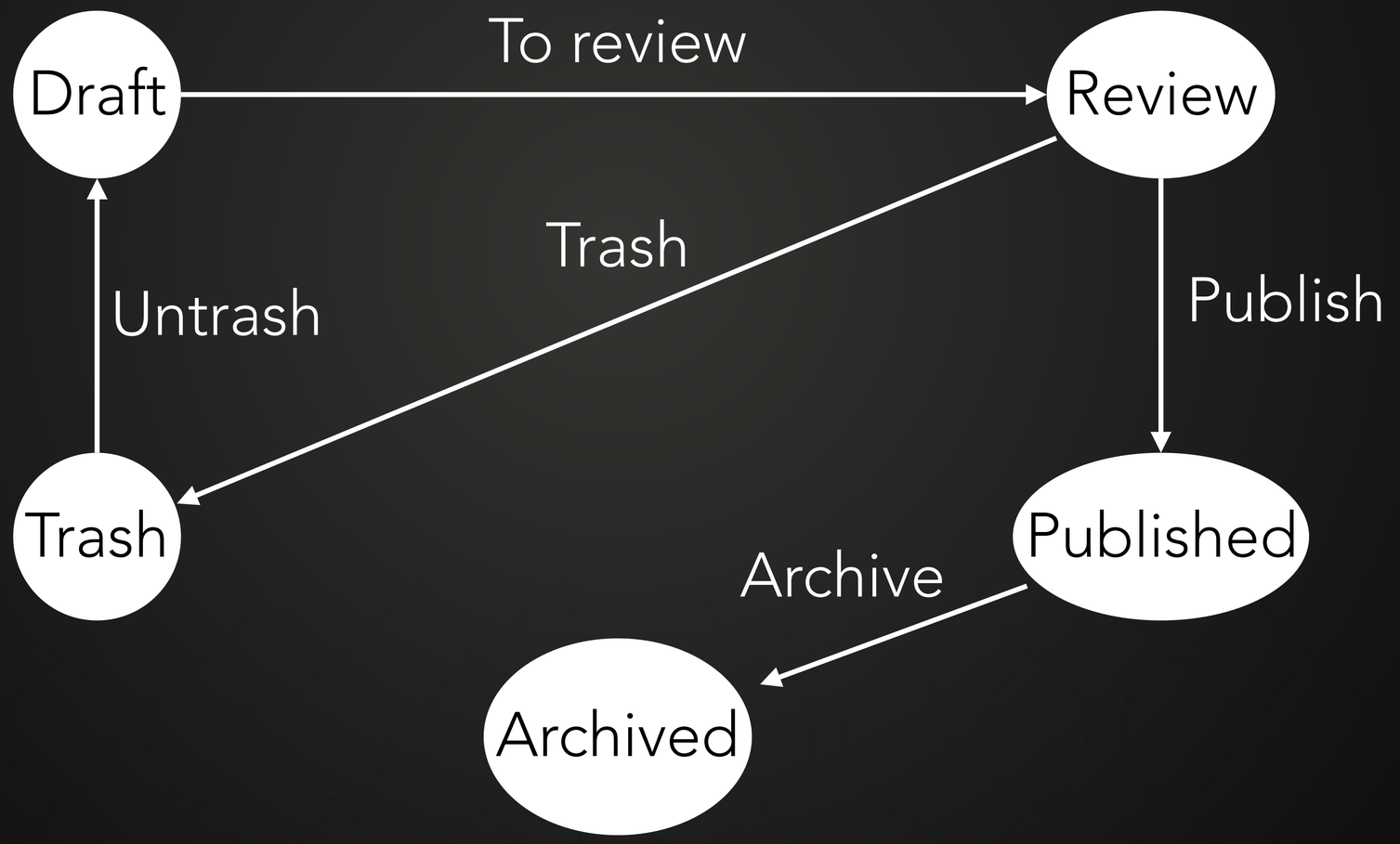
```php
namespace App;

class StateMachine{

    private $states;

    public function __construct(array $states) {
        $this->states = $states;
    }

    public function can(StateAwareInterface $object, $transition) {
        $state = $object->getCurrentState();

        return isset($this->states[$state][$transition]);
    }

    public function apply(StateAwareInterface $object, $transition) {
        if (!$this->can($object, $transition)) {
            throw new \InvalidArgumentException('Invalid transition');
        }

        $state = $trafficLight->getCurrentState();
        $newState = $this->states[$state][$transition];
        $trafficLight->setState($newState);
    }

    // ...
}
```

Workflow component

Functions

- Can we do [transition]?
- Apply [transition]
- What state are we in?
- Which are my valid transitions?

Job advert


Draft
To review
Review
Trash
Untrash
Publish
Trash
Published
Archive
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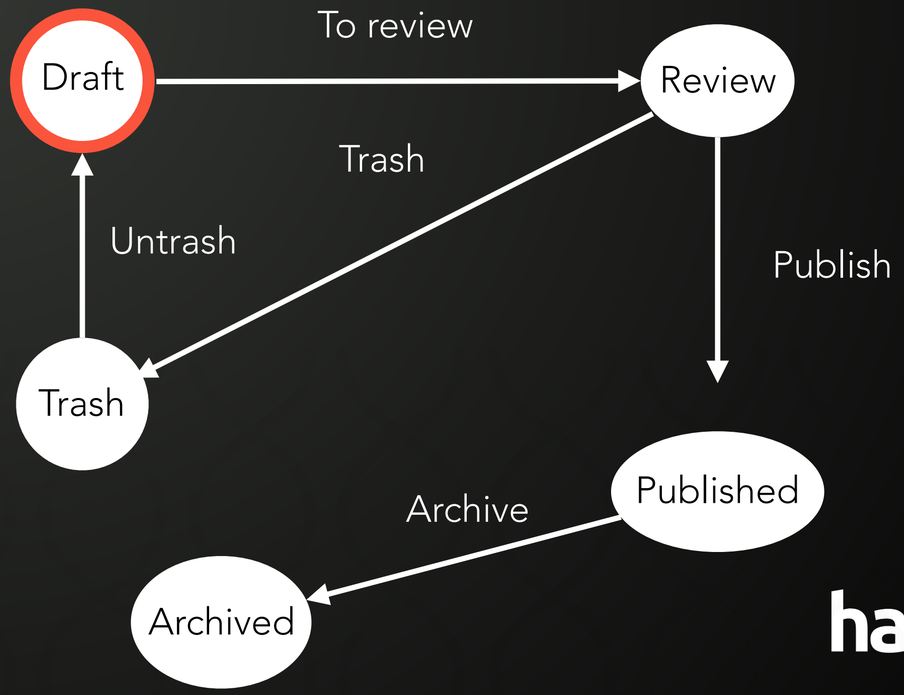
Examples


Draft
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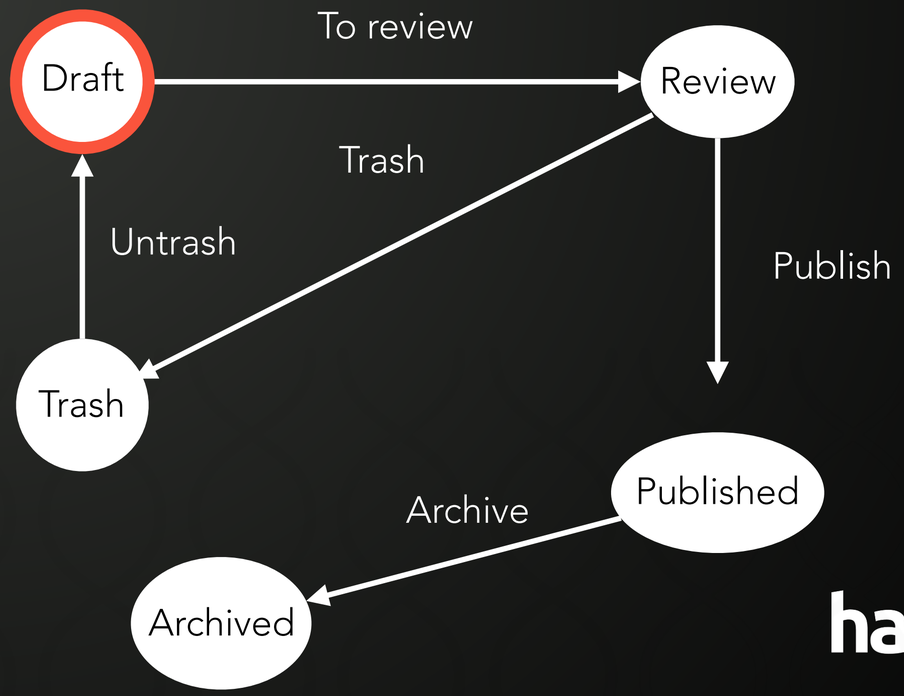
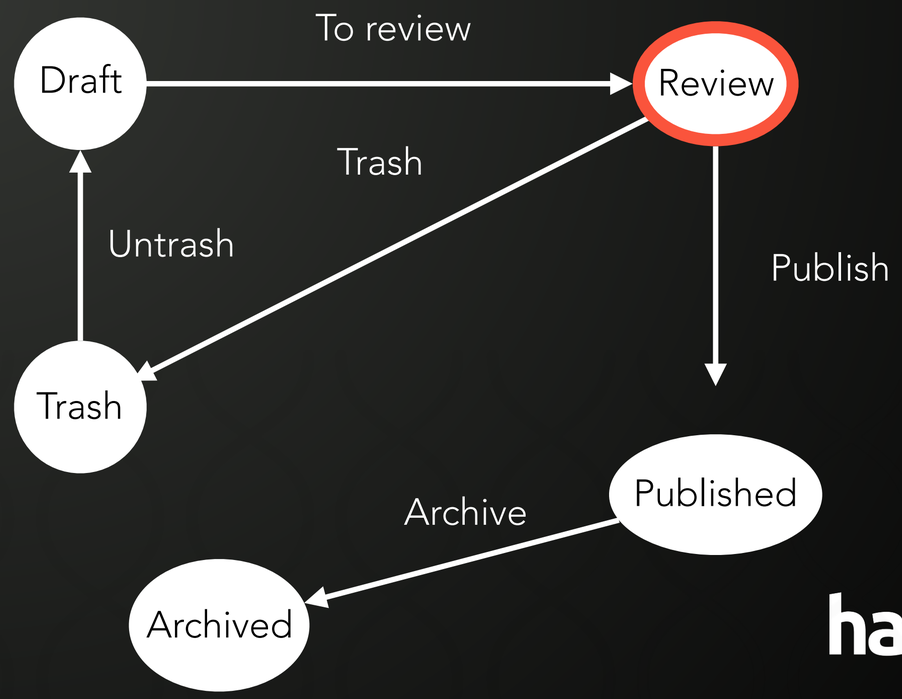
Published
Archive
Archived

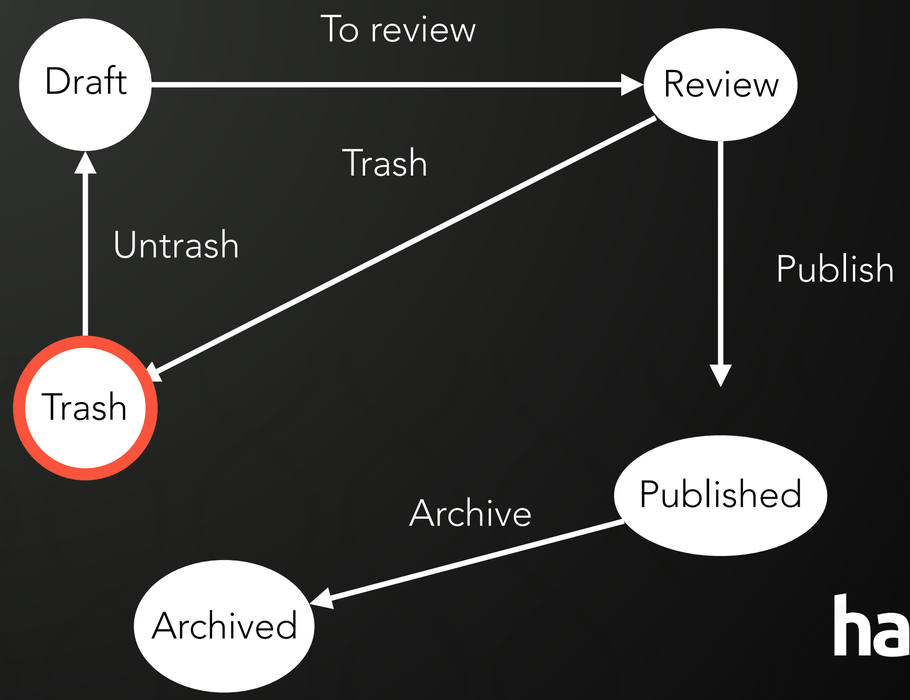
```
$stateMachine = $this->get('state_machine.job_advert');
$places = $stateMachine->getMarking($advert)->getPlaces();
var_dump($places);

// array (size=1)
// 'draft' => int 1

$stateMachine->can($advert, 'publish'); // false
$stateMachine->can($advert, 'to_review'); // true

$stateMachine->apply($advert, 'to_review');
```



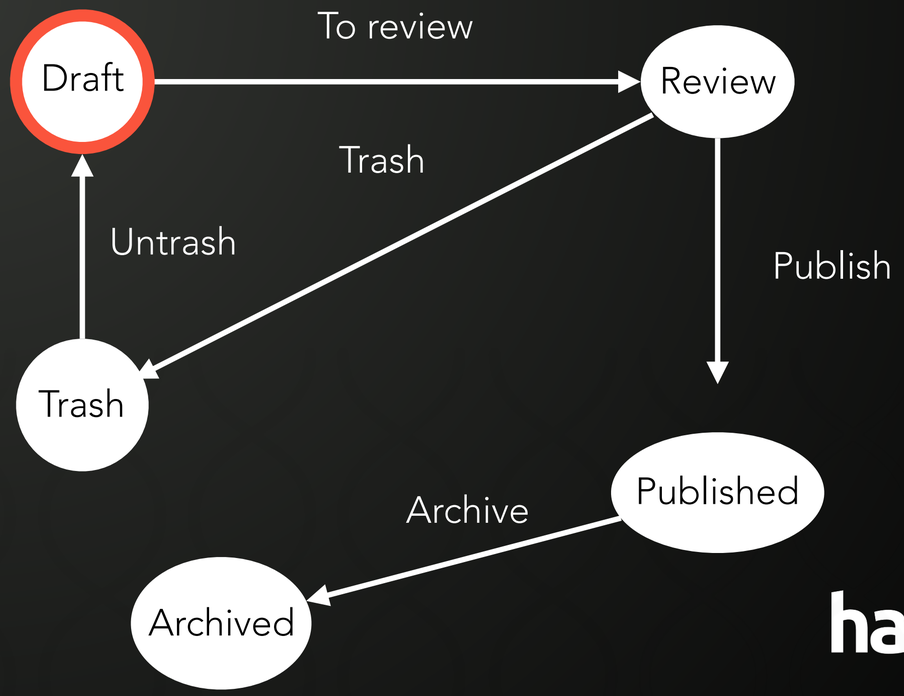
```
$stateMachine->can($advert, 'publish'); // false
$stateMachine->can($advert, 'to_review'); // true

$stateMachine->apply($advert, 'to_review');
```



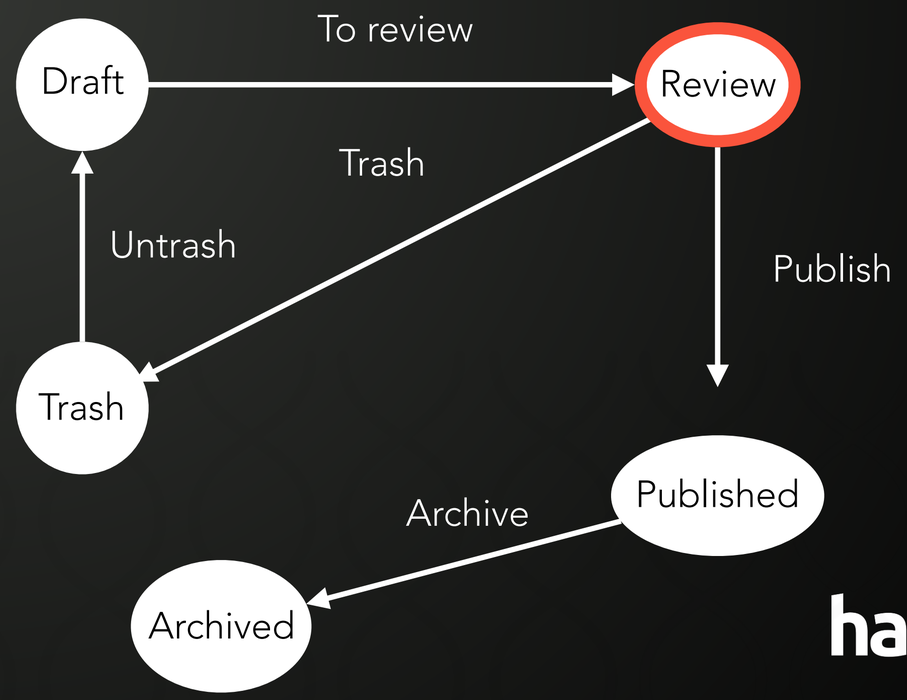
```
$stateMachine->can($advert, 'publish'); // false
$stateMachine->can($advert, 'to_review'); // true

$stateMachine->apply($advert, 'to_review');
$stateMachine->apply($advert, 'trash');
```



```
$stateMachine->can($advert, 'publish'); // false
$stateMachine->can($advert, 'to_review'); // true

$stateMachine->apply($advert, 'to_review');
$stateMachine->apply($advert, 'trash');
$stateMachine->apply($advert, 'untrash');
```



```
$stateMachine->can($advert, 'publish'); // false
$stateMachine->can($advert, 'to_review'); // true

$stateMachine->apply($advert, 'to_review');
$stateMachine->apply($advert, 'trash');
$stateMachine->apply($advert, 'untrash');
$stateMachine->apply($advert, 'to_review');

$transitions = $stateMachine->getEnabledTransitions($advert);
foreach ($transitions as $transition) {
  echo $transition->getName();
}

// publish
// trash
```



Twig examples

```
<h4>Sidebar actions</h4>
{% if workflow_can(advert, 'to_review') %}
    <a href="{{ path('advert_to_review', {id:advert.id}) }}”>
    Send to review</a><br>
{% endif %}

{% if workflow_can(advert, 'publish') %}
    <a href="{{ path('advert_publish', {id:advert.id}) }}”>
    Publish advert</a><br>
{% endif %}

{% if workflow_can(advert, 'archive') %}
    <a href="{{ path('advert_archive', {id:advert.id}) }}”>
    Archive</a><br>
{% endif %}

{% if workflow_can(advert, 'trash') %}
    <a href="{{ path('advert_trash', {id:advert.id}) }}”>
    Trash</a><br>
{% endif %}

{% if workflow_can(advert, 'untrash') %}
    <a href="{{ path('advert_untrash', {id:advert.id}) }}”>
    Restore for trash</a><br>
{% endif %}
```

Twig examples

Sidebar actions

Send to review

Sidebar actions

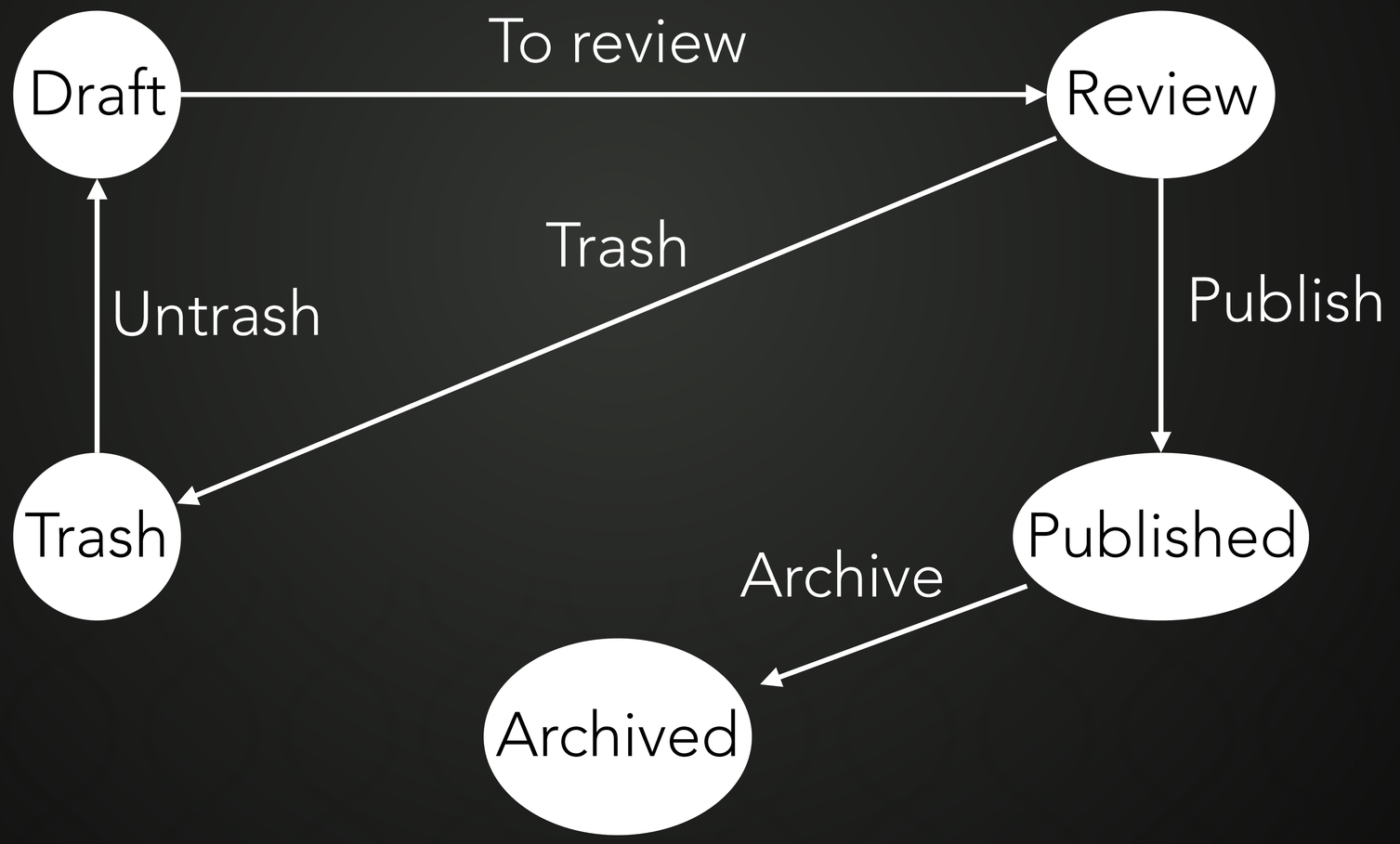
Publish advert

Trash

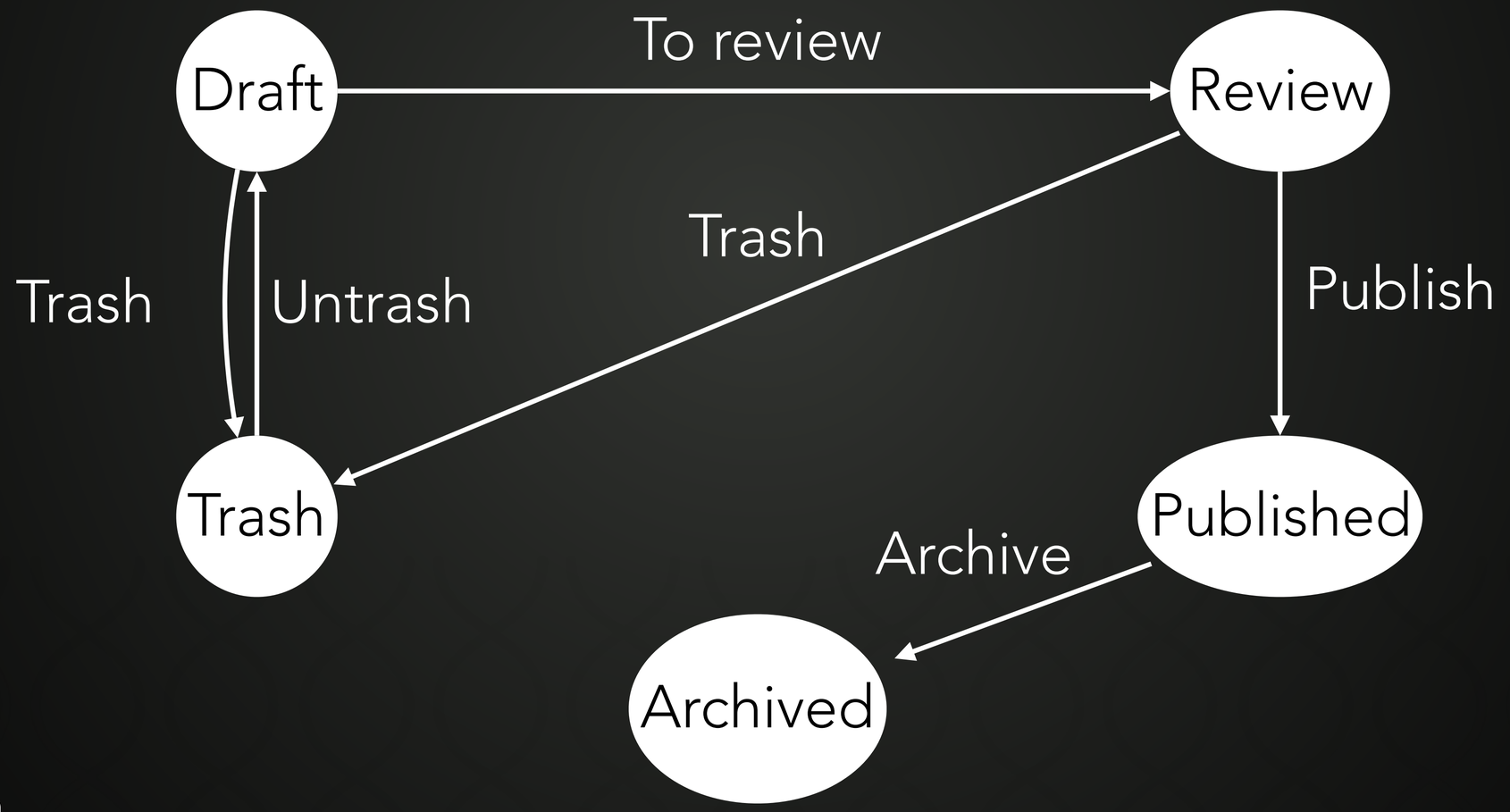
Twig examples

```
<h4>Sidebar actions</h4>
{% for transition in workflow_transitions(advert) %}
  <a href="{{ path('advert_'~transition.name,
{id:advert.id}) }}">
    {{ transition.name|humanize }}
  </a><br />
{% else %}
  No actions available for this advert.
{% endfor %}
```

Job advert


Draft
To review
Review
Trash
Untrash
Publish
Trash
Published
Archive
Archived

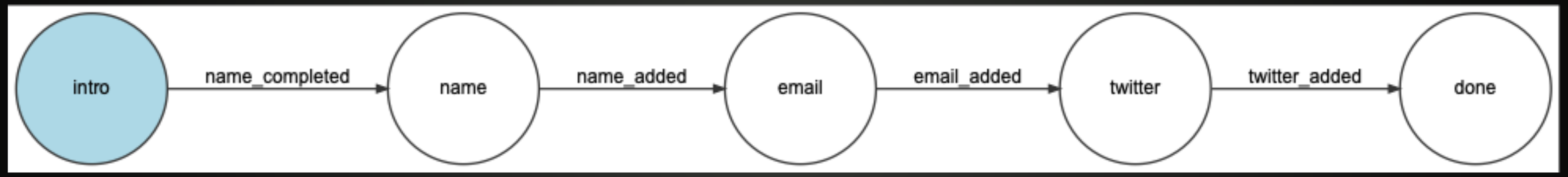
Job advert


Draft
To review
Review
Trash
Untrash
Trash
Publish
Trash
Published
Archive
Archived

Configuration

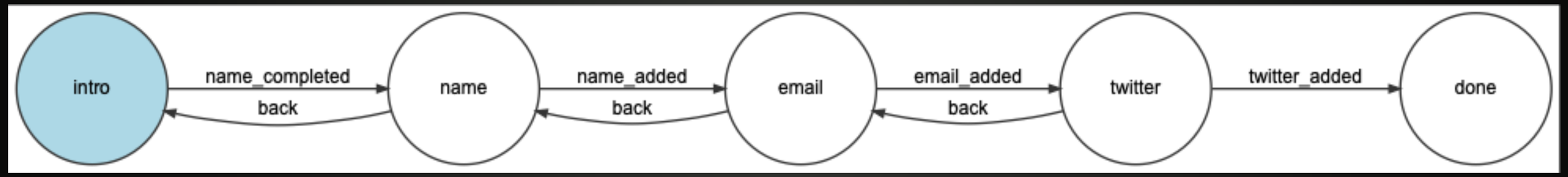
```yaml
framework:
    workflows:
        job_advert:
            type: 'state_machine'
            supports:
                - AppBundle\Entity\Advert
            places:
                - draft
                - review
                - published
                - trash
                - archived
            transitions:
                to_review:
                    from: draft
                    to: review
                publish:
                    from: review
                    to: published
                trash:
                    from: [draft, review]
                    to: trash
                archive:
                    from: published
                    to: archived
                untrash:
                    from: trash
                    to: draft
```

Multi step form



```yaml
framework:
    workflows:
        signup:
            type: 'state_machine'
            marking_store:
                type: 'single_state'
            places:
                - intro
                - name
                - email
                - twitter
                - done
            transitions:
                name_completed:
                    from: intro
                    to: name
                name_added:
                    from: name
                    to: email
                email_added:
                    from: email
                    to: twitter
                twitter_added:
                    from: twitter
                    to: done
```

Multi step form



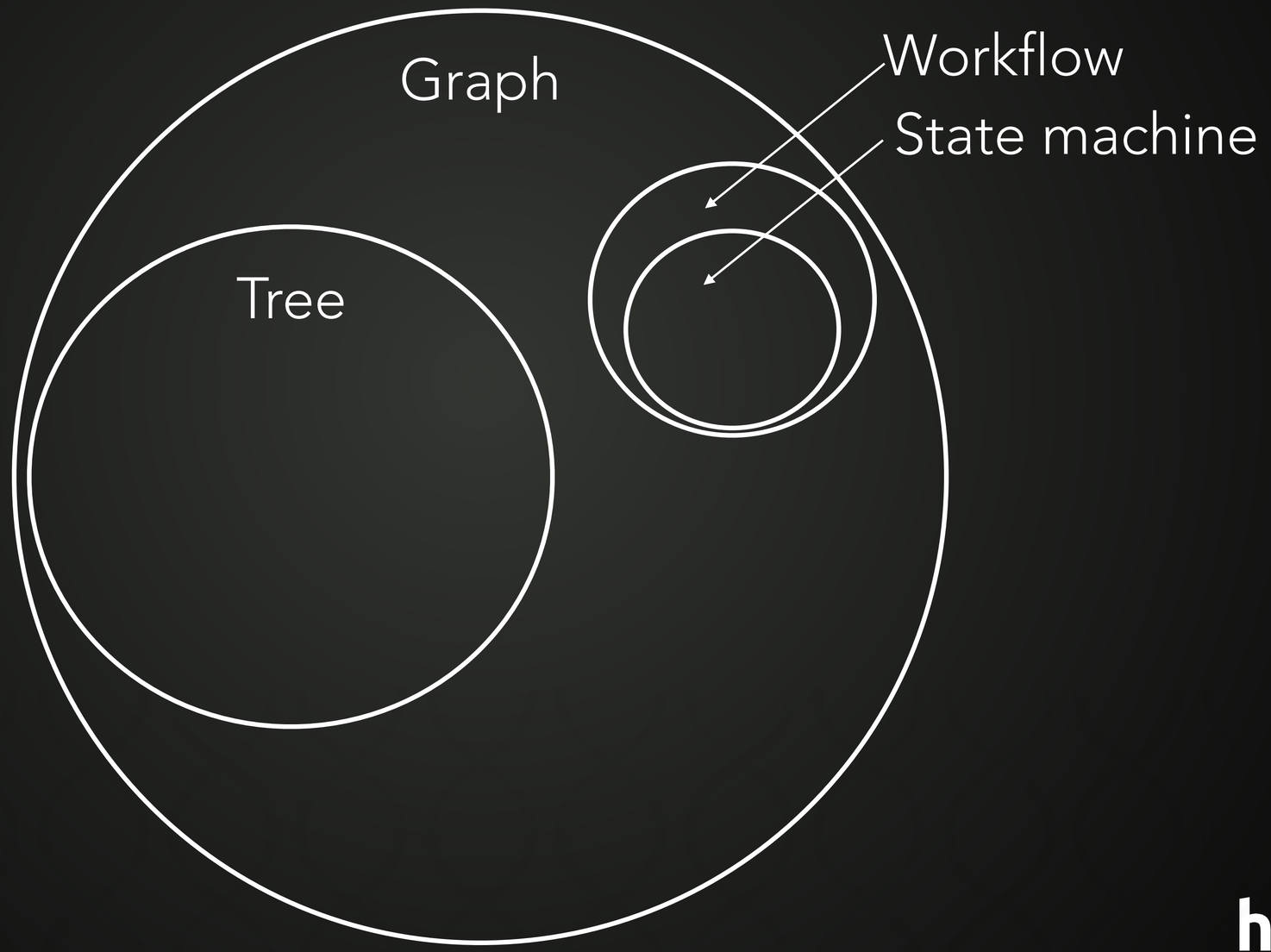
```yaml
framework:
    workflows:
        signup:
            type: 'state_machine'
            marking_store:
                type: 'single_state'
            places:
                - intro
                - name
                - email
                - twitter
                - done
            transitions:
                name_completed:
                    from: intro
                    to: name
                name_added:
                    from: name
                    to: email
                email_added:
                    from: email
                    to: twitter
                twitter_added:
                    from: twitter
                    to: done
                back:
                    from: twitter
                    to: email
```

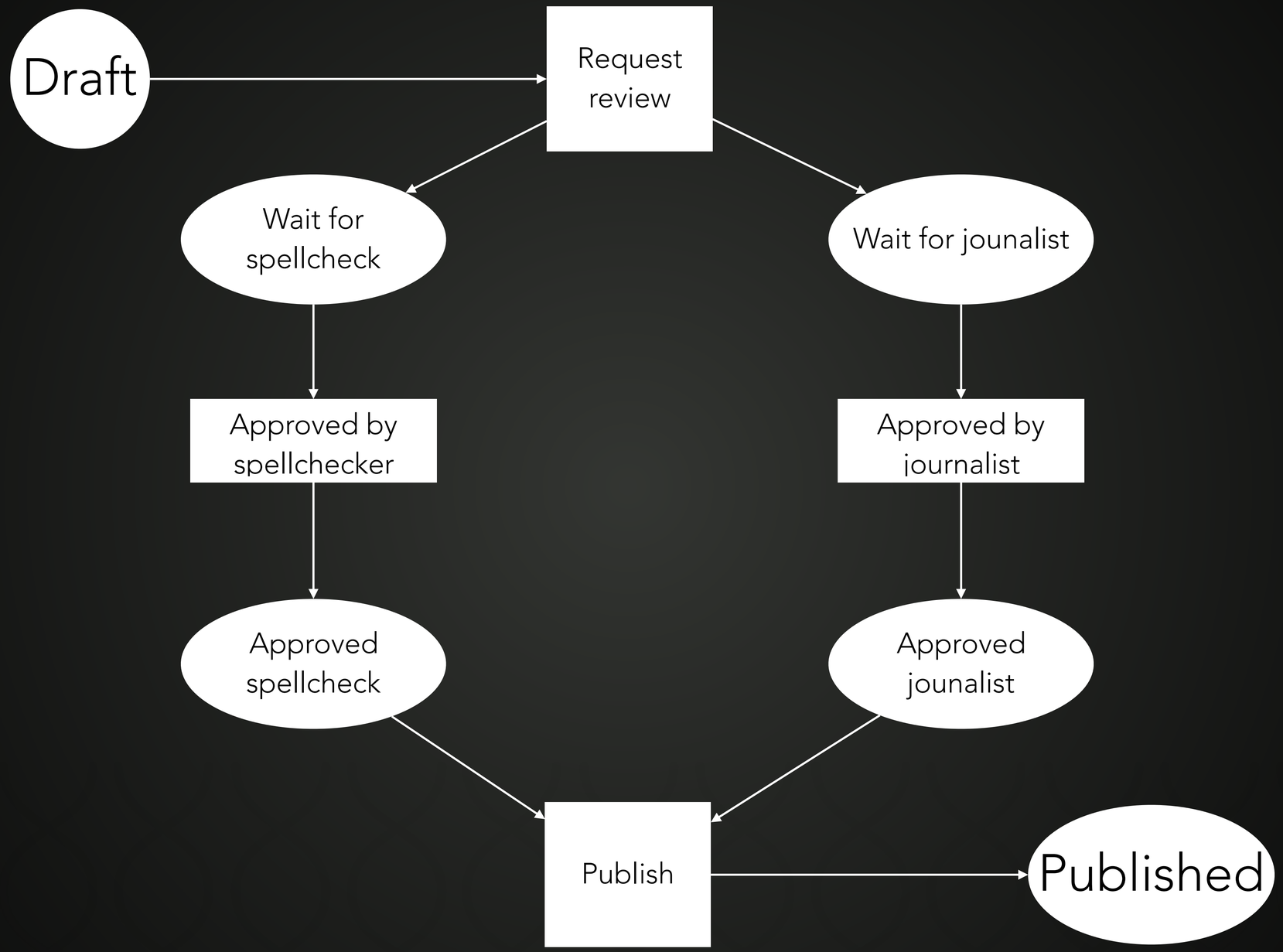
```yaml
framework:
    workflows:
        signup:
            type: 'state_machine'
            marking_store:
                type: 'single_state'
            places:
                - intro
                - name
                - email
                - twitter
                - done
            transitions:
                name_completed:
                    from: intro
                    to: name
                name_added:
                    from: name
                    to: email
                email_added:
                    from: email
                    to: twitter
                twitter_added:
                    from: twitter
                    to: done
                back_0:
                    name: back
                    from: twitter
```

```yaml
        - done
    transitions:
        name_completed:
            from: intro
            to: name
        name_added:
            from: name
            to: email
        email_added:
            from: email
            to: twitter
        twitter_added:
            from: twitter
            to: done
        back_0:
            name: back
            from: twitter
            to email
        back_1:
            name: back
            from: email
            to: name
        back_foobar:
            name: back
            from: name
            to: intro
```

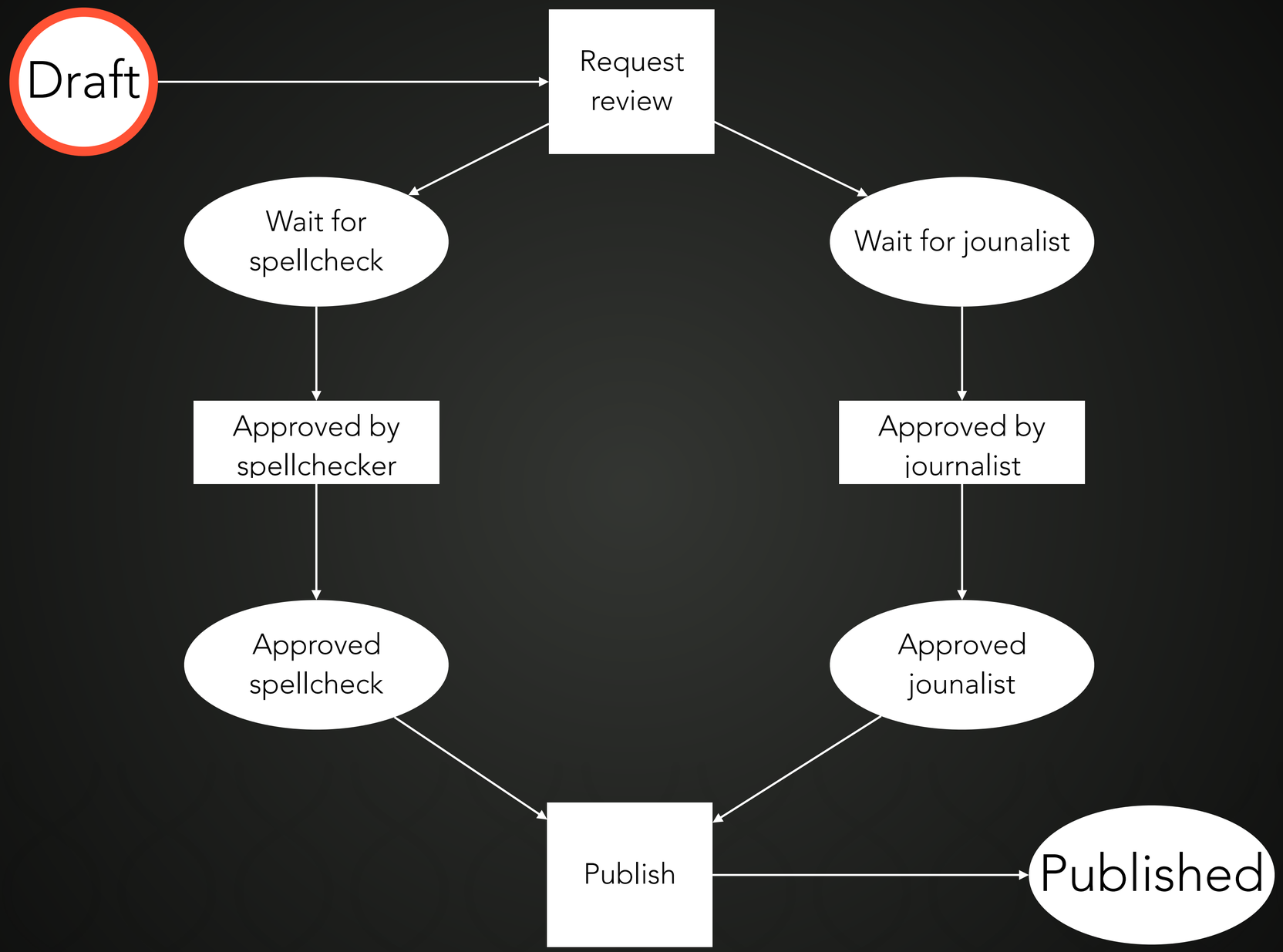
```
        - done
    transitions:
        name_completed:
            from: intro
            to: name
        name_added:
            from: name
            to: email
        email_added:
            from: email
            to: twitter
        twitter_added:
            from: twitter
            to: done
        back_0:
            name: back
            from: twitter
            to email
        back_1:
            name: back
            from: email
            to: name
        back_foobar:
            name: back
            from: name
            to: intro
```

Theory

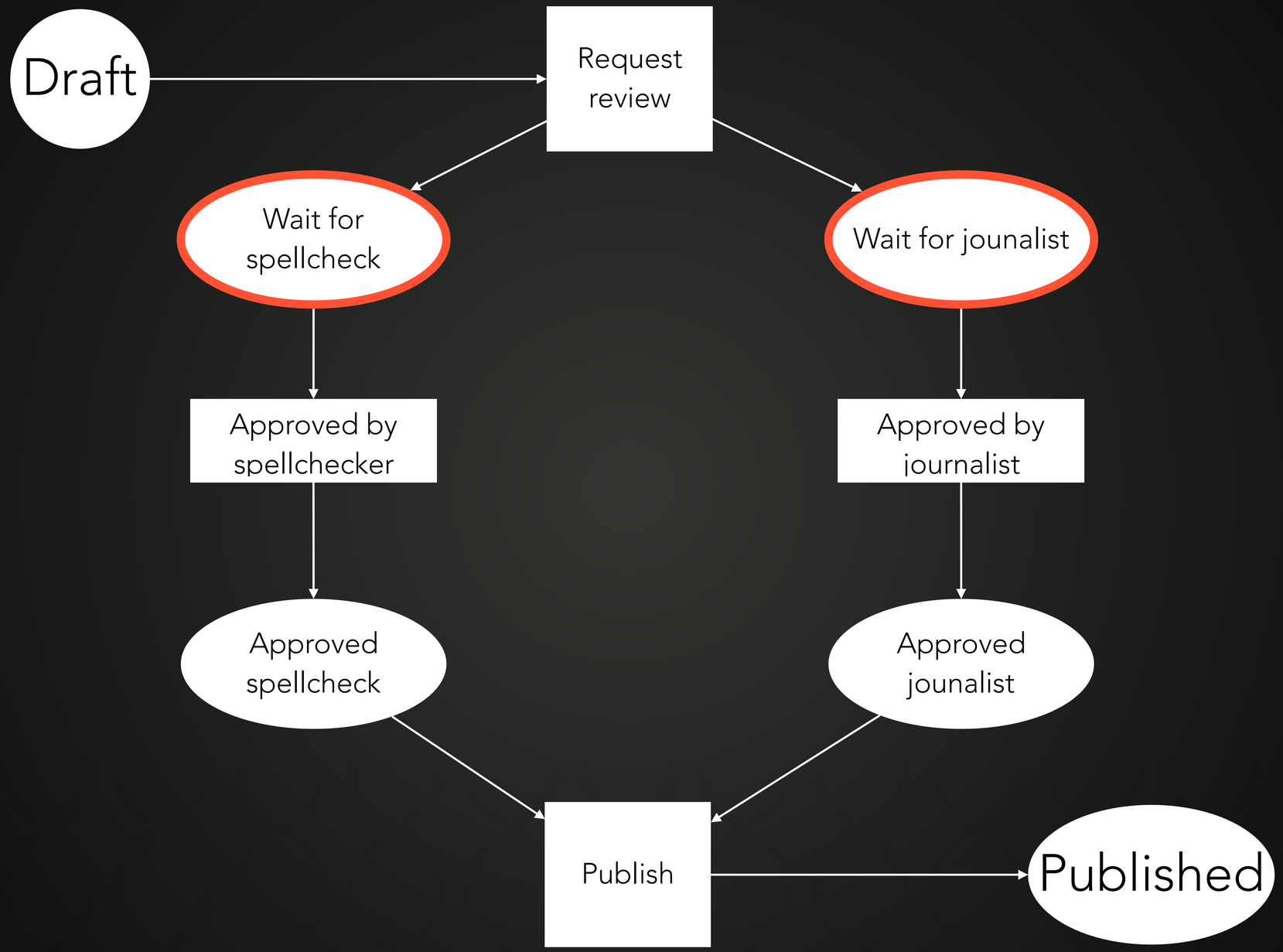




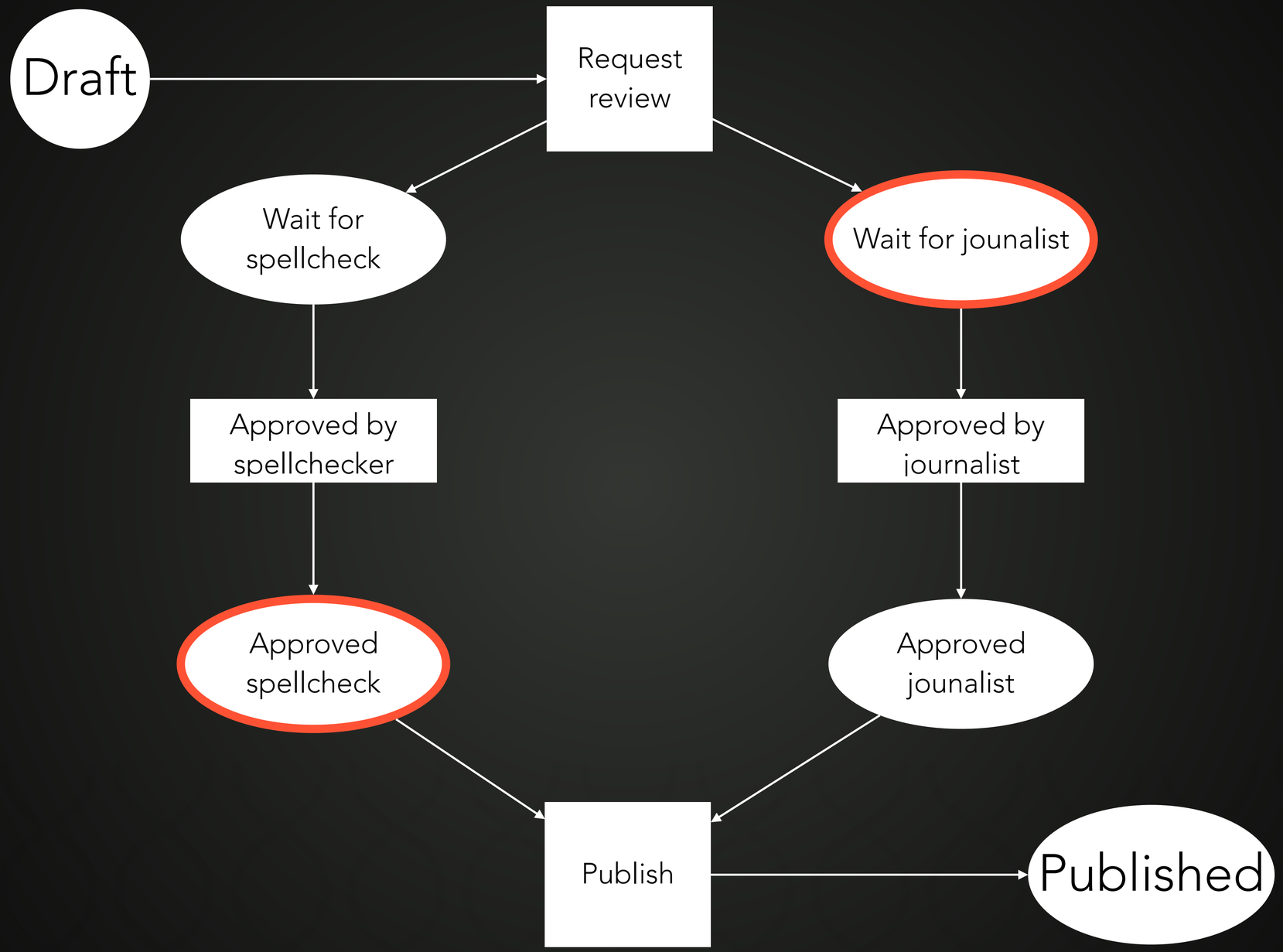
Example by Grégoire Pineau



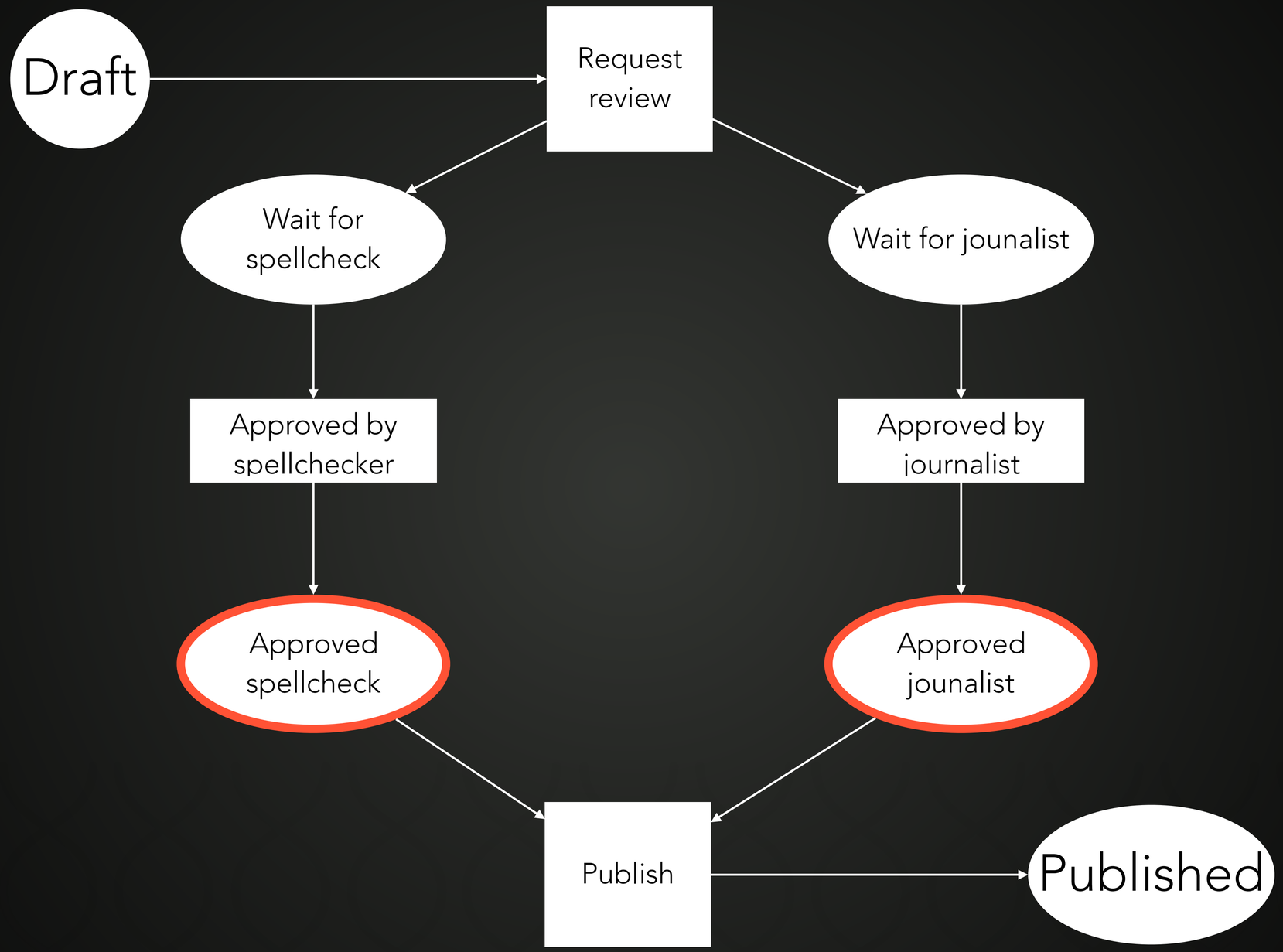
Example by Grégoire Pineau



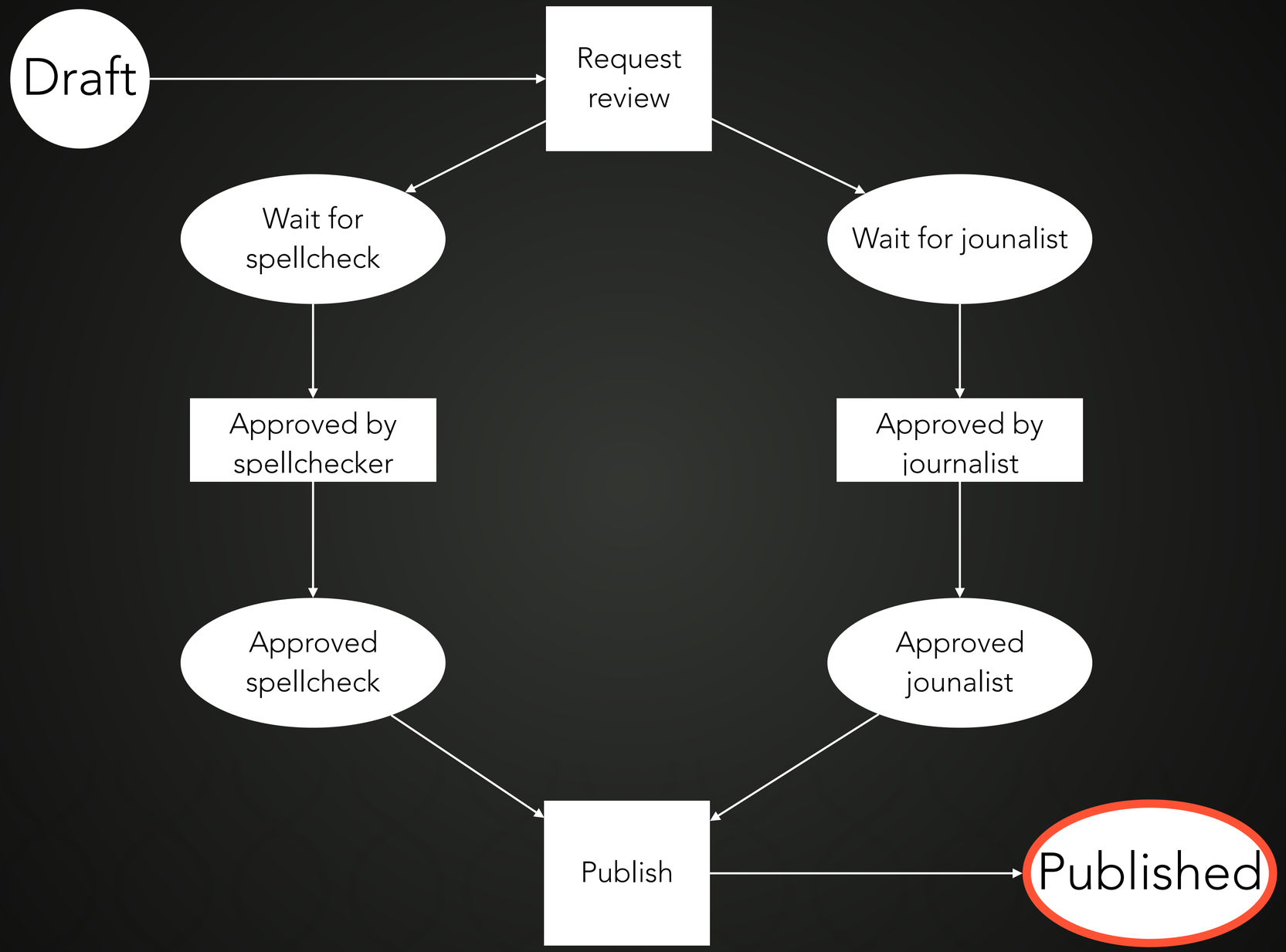
Example by Grégoire Pineau



Example by Grégoire Pineau



Example by Grégoire Pineau



Example by Grégoire Pineau

Events

workflow.leave
workflow.[*job_advert*].leave
workflow.[*job_advert*].leave.[*draft*]

workflow.transition
workflow.[*job_advert*].transition
workflow.[*job_advert*].transition.[*to_review*]

workflow.enter
workflow.entered
workflow.completed
workflow.announce

Guard

```
use Symfony\Component\EventDispatcher\EventSubscriberInterface;
use Symfony\Component\Security\Core\Authorization\AuthorizationCheckerInterface;
use Symfony\Component\Workflow\Event\GuardEvent;

class GuardListener implements EventSubscriberInterface
{
    public function __construct(AuthorizationCheckerInterface $checker) {
        $this->checker = $checker;
    }

    public function guardPublish(GuardEvent $event) {
        if (!$this->checker->isGranted('ROLE_PUBLISHER')) {
            $event->setBlocked(true);
        }
    }

    public static function getSubscribedEvents() {
        return array(
            'workflow.job_advert.guard.publish' => 'guardPublish',
        );
    }
}
```

```php
use Psr\Log\LoggerInterface;
use Symfony\Component\EventDispatcher\EventSubscriberInterface;
use Symfony\Component\Workflow\Event\Event;

class WorkflowLogger implements EventSubscriberInterface
{
    public function __construct(LoggerInterface $logger) {
        $this->logger = $logger;
    }

    public function onLeave(Event $event) {
        $this->logger->alert(sprintf(
            'Advert (id: "%s") preformed transition "%s" from "%s" to "%s"',
            $event->getSubject()->getId(),
            $event->getTransition()->getName(),
            implode(', ', array_keys($event->getMarking()->getPlaces())),
            implode(', ', $event->getTransition()->getTos())
        ));
    }

    public static function getSubscribedEvents() {
        return array(
            'workflow.job_advert.leave' => 'onLeave',
        );
    }
}
```

Security voters

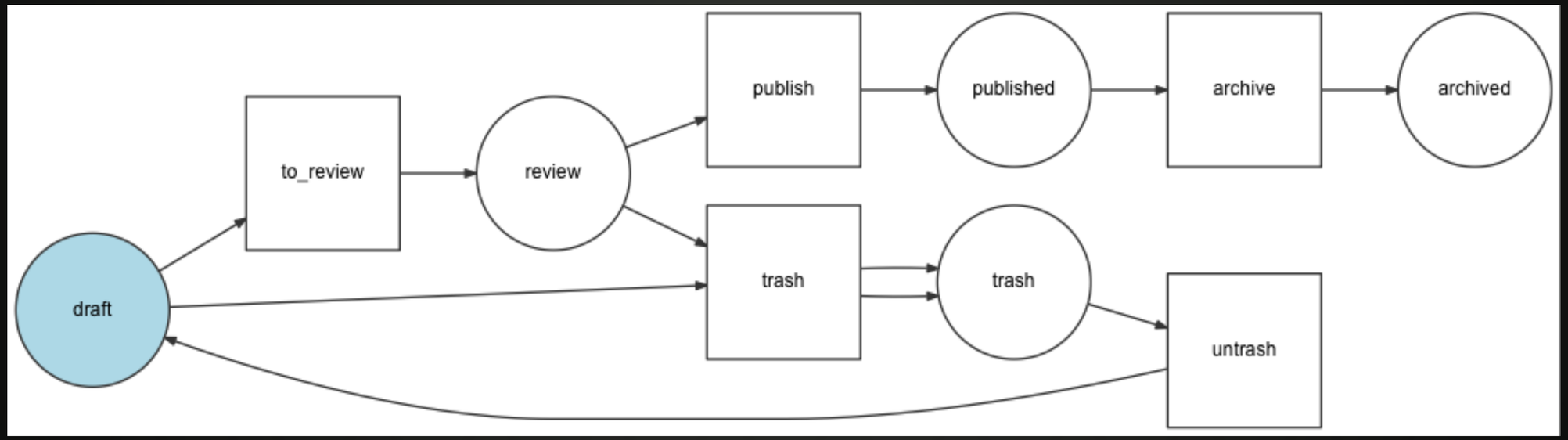
```
class AdvertVoter extends Voter
{
    const VIEW = 'VIEW';
    const EDIT = 'EDIT';
    // ...
    protected function supports($attribute, $subject)
    {
        $attribute = strtoupper($attribute);
        return $subject instanceof Advert &&
                 in_array($attribute, [self::VIEW, self::EDIT]);
    }

    protected function voteOnAttribute($attribute, $advert, TokenInterface $token)
    {
        $attribute = strtoupper($attribute);
        $this->currentToken = $token;
        switch ($attribute) {
            case self::VIEW:
                return $this->stateMachine->getMarking($advert)->has('published');
            case self::EDIT:
                // ...
        }

        return false;
    }
}
```

Events

```
use AppBundle\Service\EmailService;
use Symfony\Component\EventDispatcher\EventSubscriberInterface;
use Symfony\Component\Workflow\Event\Event;

class PublishListener implements EventSubscriberInterface
{
    public function __construct(EmailService $mailer)
    {
        $this->mailer = $mailer;
    }

    public function onPublished(Event $event)
    {
        $this->mailer->emailAllUsers($event->getSubject());
    }

    public static function getSubscribedEvents()
    {
        return array(
            'workflow.job_advert.enter.published' => 'onPublished',
        );
    }
}
```

Debug

```
php bin/console workflow:dump job_advert | dot -Tpng -o out.png
```




STATE MACHINES ARE GREAT
TO BAD I CANT APPLY THEM
imgflip.com

Identify state machines

```
class Quotation
{
  const STATUS_SENT = 0;
  const STATUS_NEGOTIATION = 1;
  const STATUS_WON = 2;
  const STATUS_LOST = 3;

  /**
   * @var int status
   *
   * @ORM\Column(type="integer")
   * @Assert\NotBlank()
   */
  private $status;

  // ...
}
```

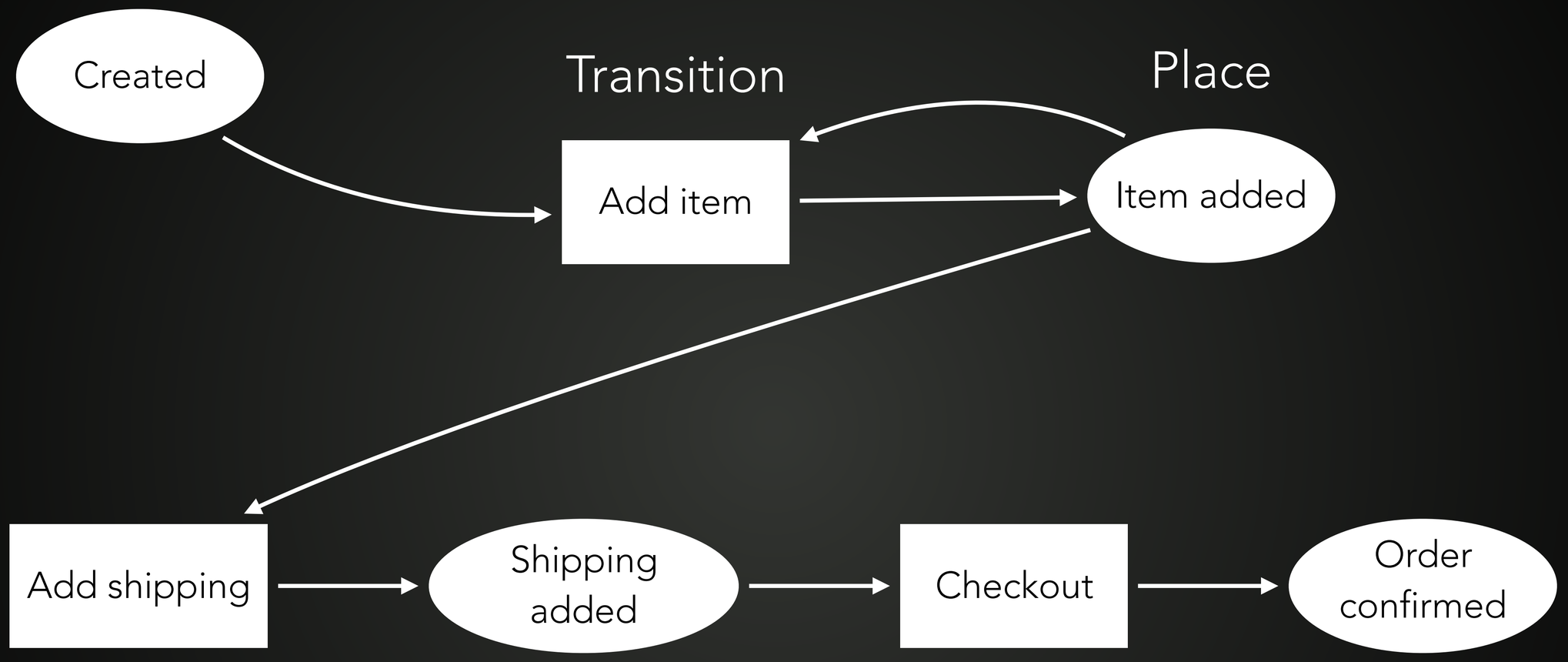
Search: id IN 62,63,99,585

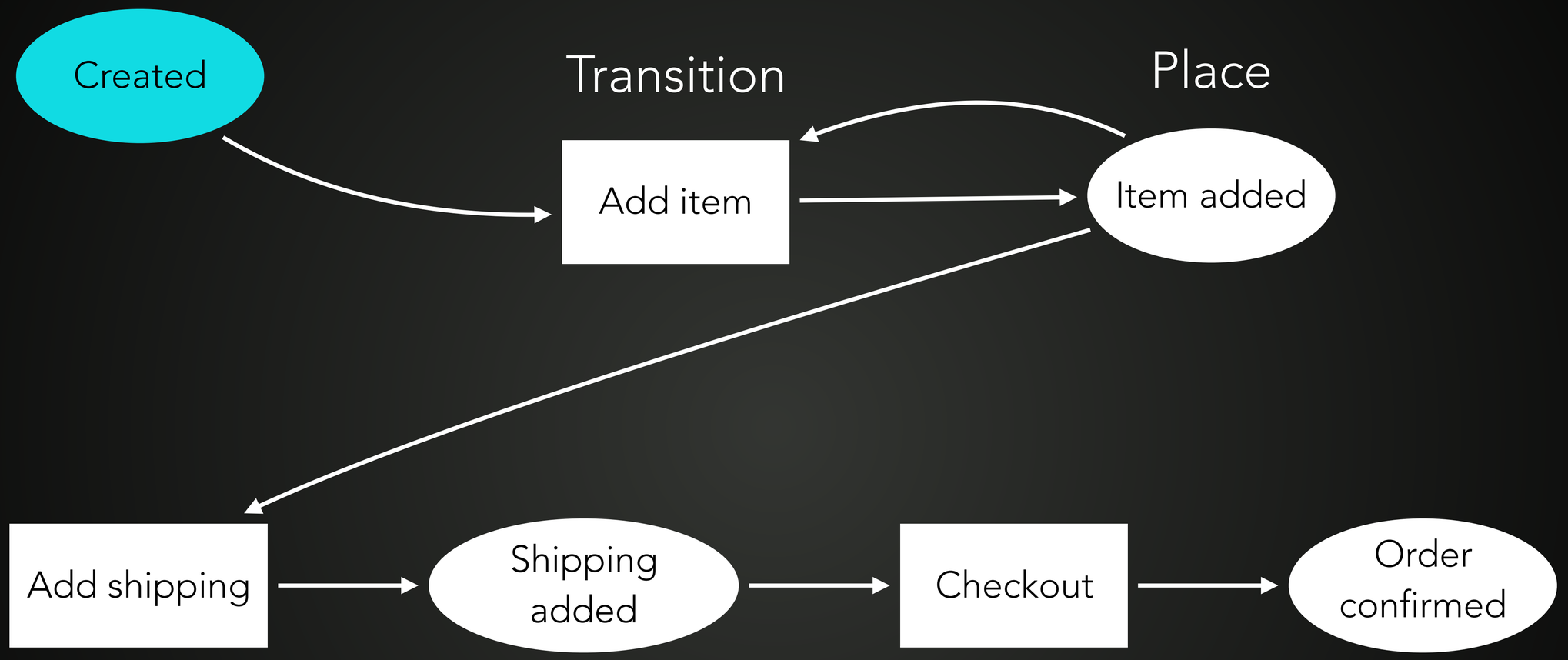
id	position_id	active	ended	closed	createdAt	u
62	119	0	1	1	2014-07-28 16:01:55	2
63	120	0	1	1	2014-07-28 16:02:17	2
99	204	0	1	1	2014-08-06 13:42:27	2
585	597	0	1	1	2015-03-19 09:51:49	2
586	386	0	1	1	2015-03-19 11:41:27	2
587	389	0	1	1	2015-03-19 11:42:22	2
614	82	0	1	1	2015-04-03 07:44:26	2
620	134	0	1	1	2015-04-04 13:36:20	2
880	1006	0	1	1	2015-07-03 14:47:19	2
4343	8968	0	1	1	2016-06-22 09:28:50	2
4344	23740	0	1	1	2016-06-22 09:35:33	2

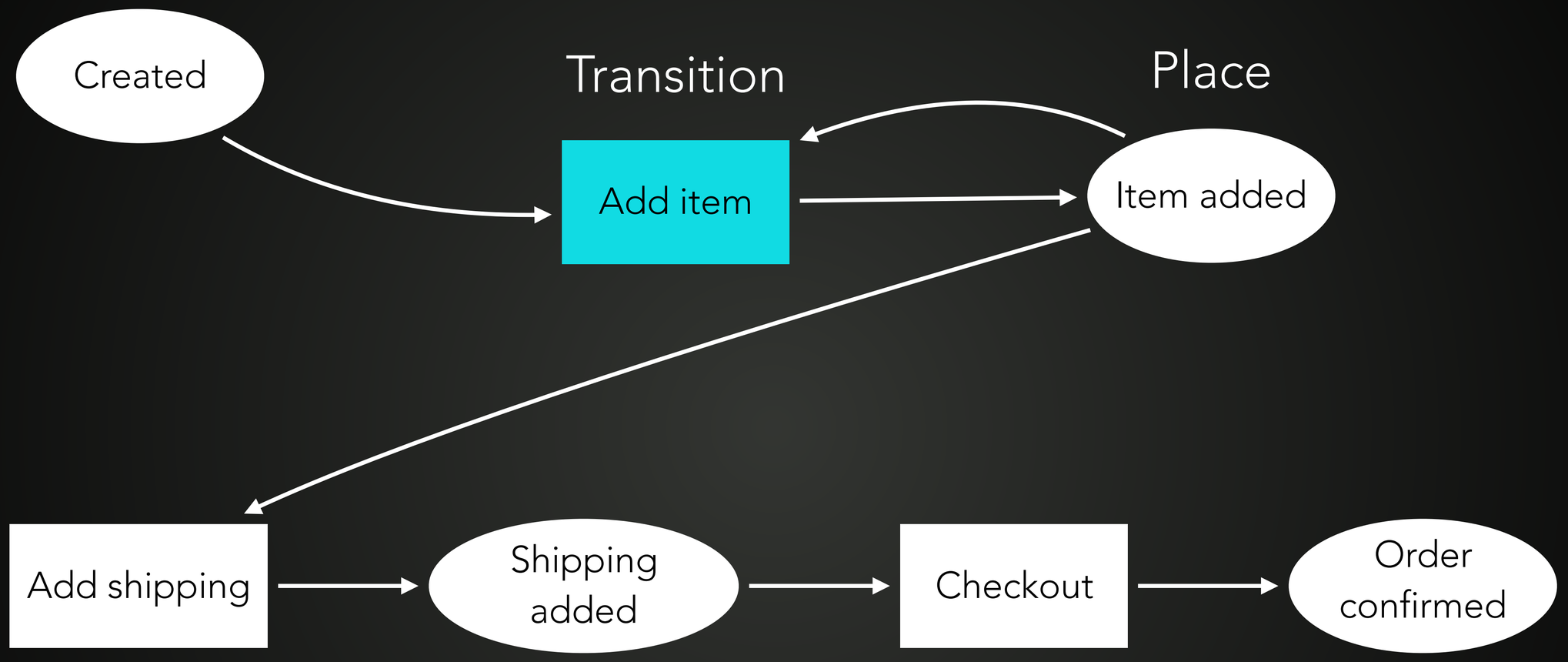
How about processes?

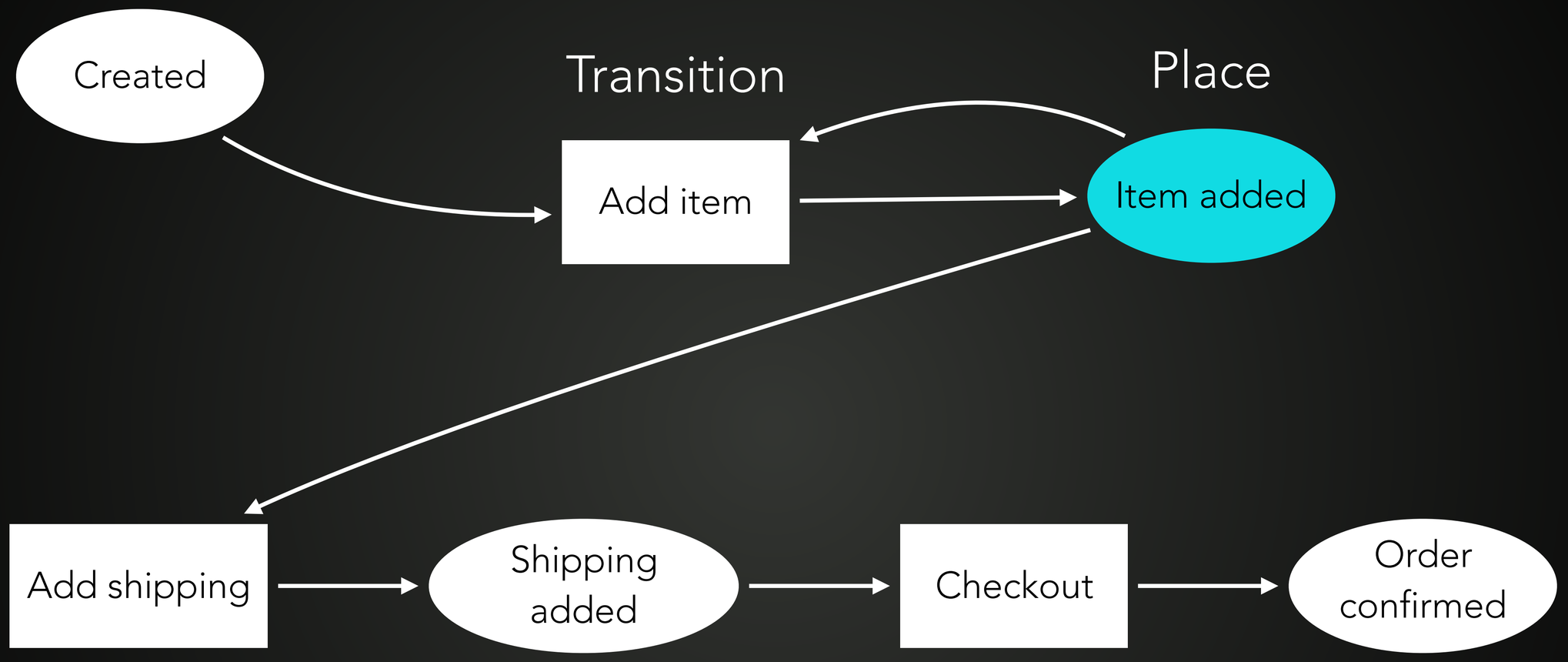
E-commerce

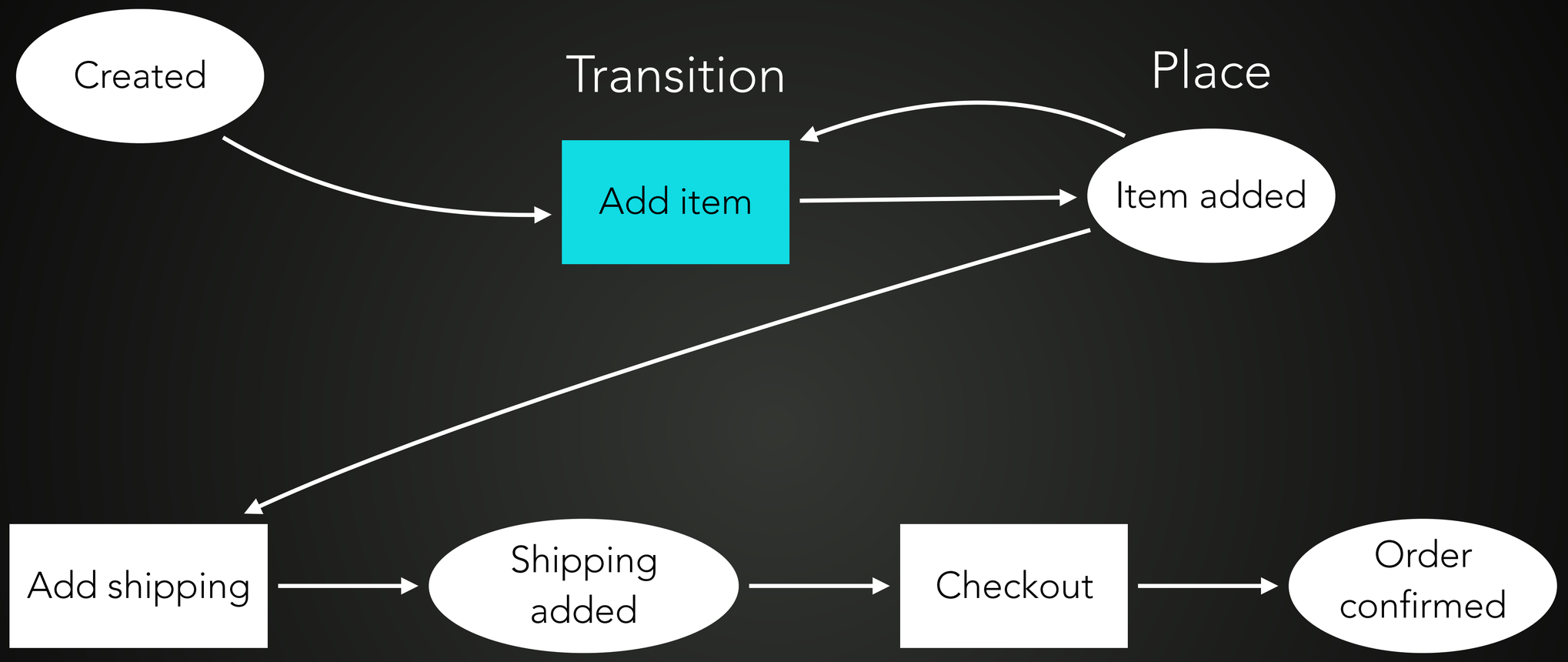
1. An order is created
2. Items are added to order
3. Users sets delivery address
4. User goes to checkout and enters their payment
5. Delivery people gets a notification

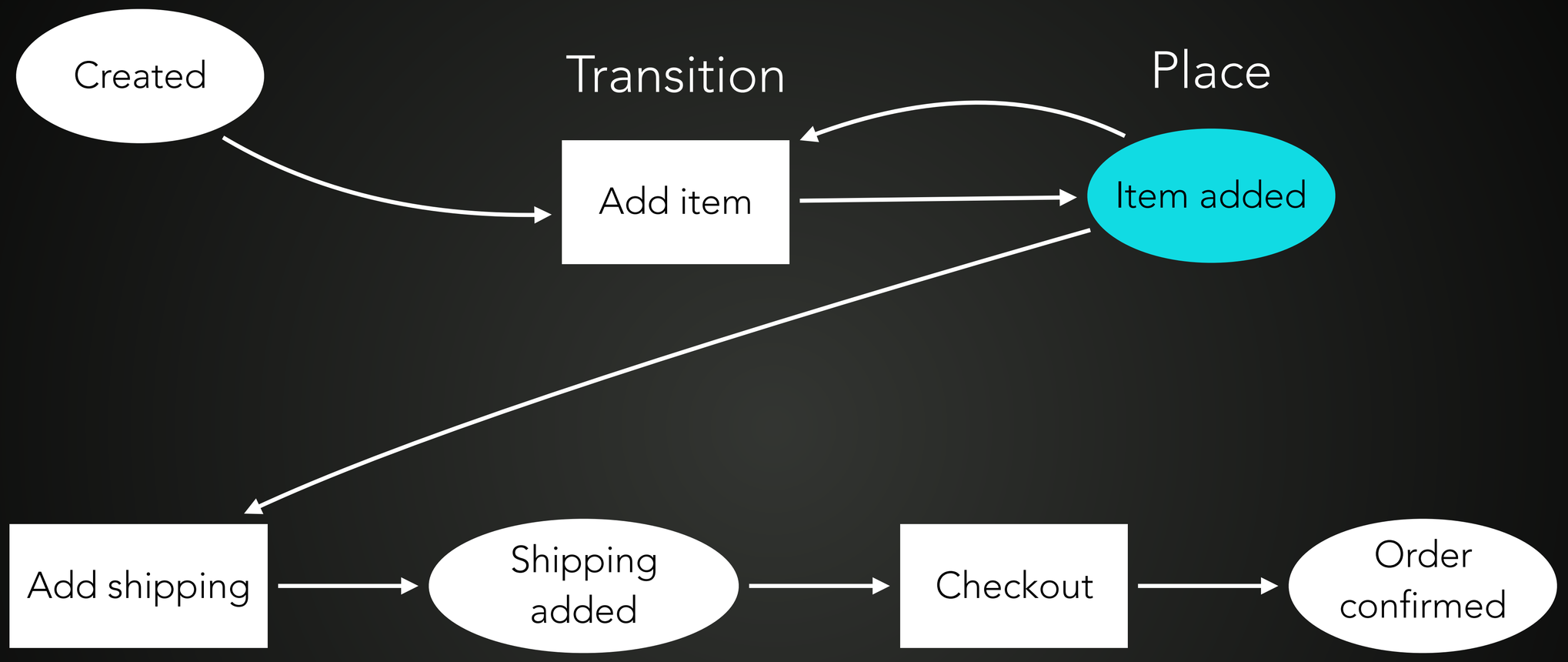

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

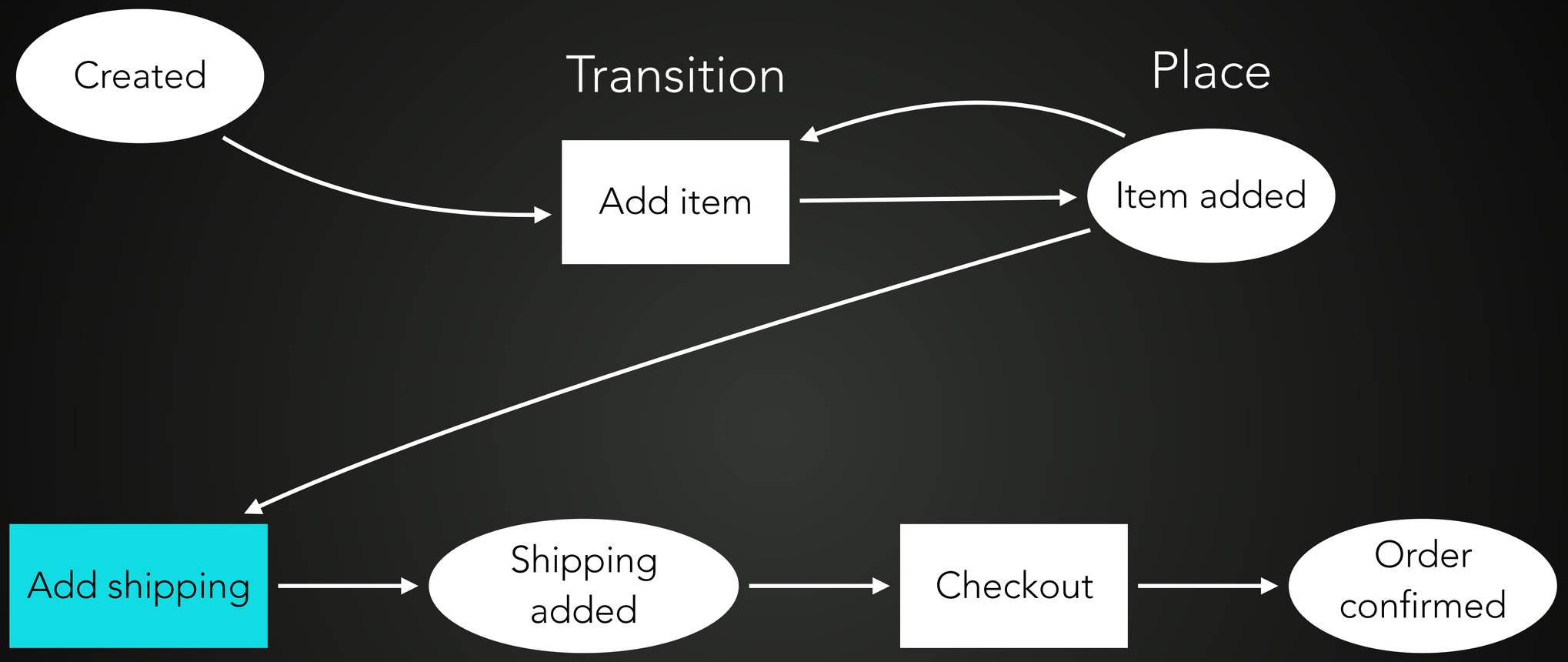

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

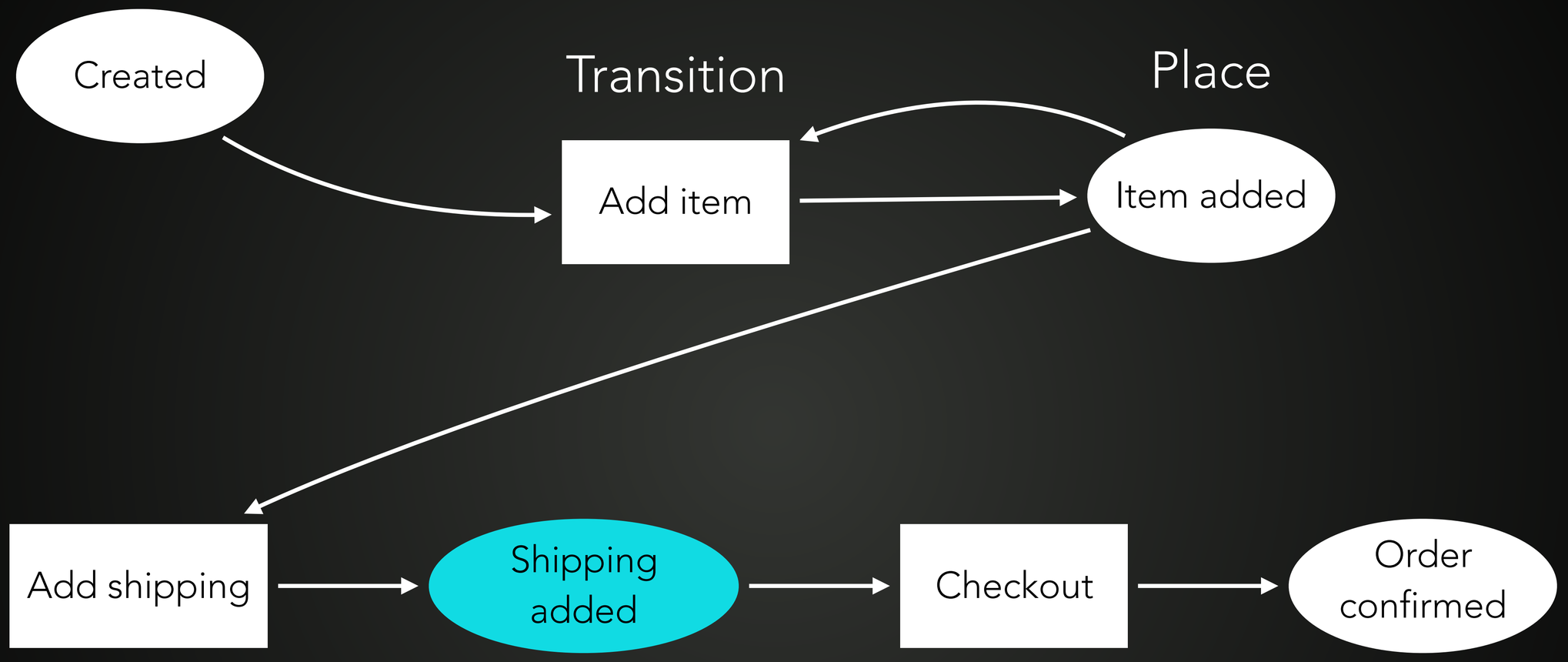

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

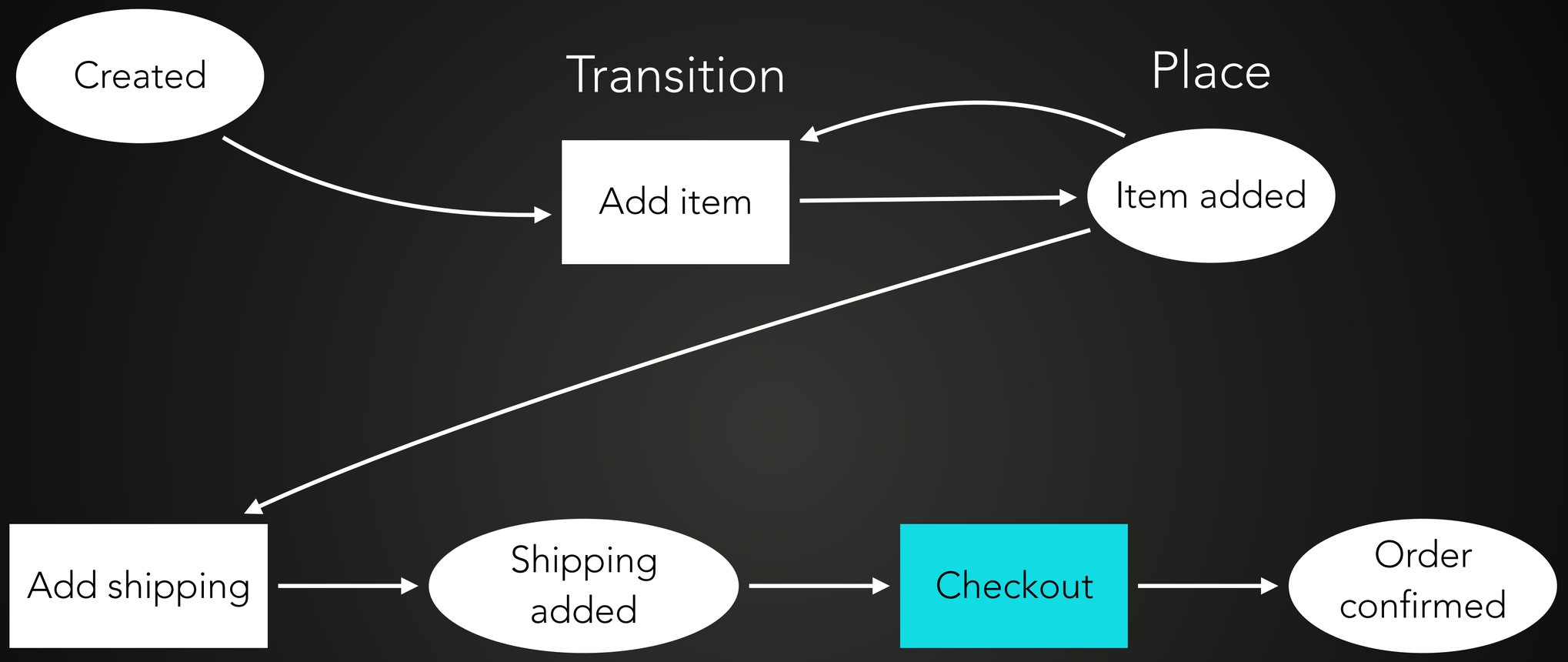

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

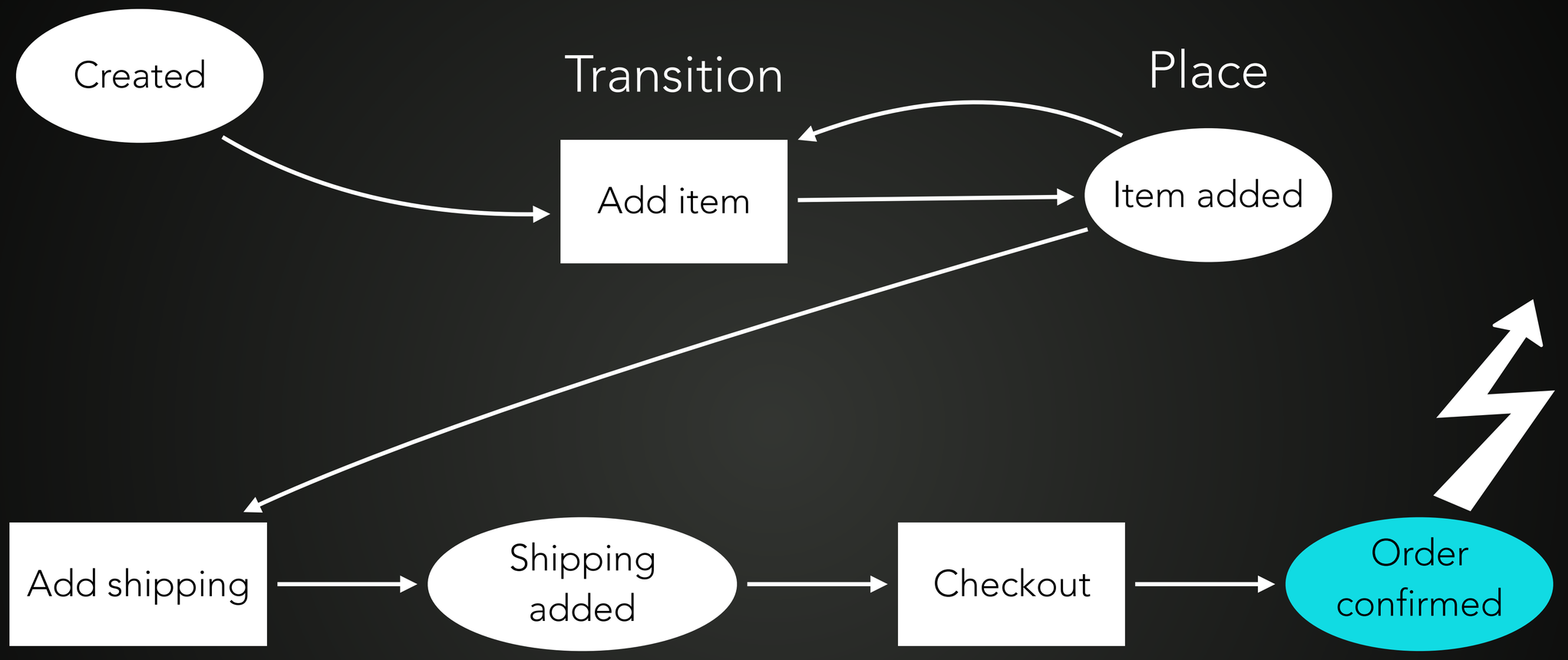

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed


Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

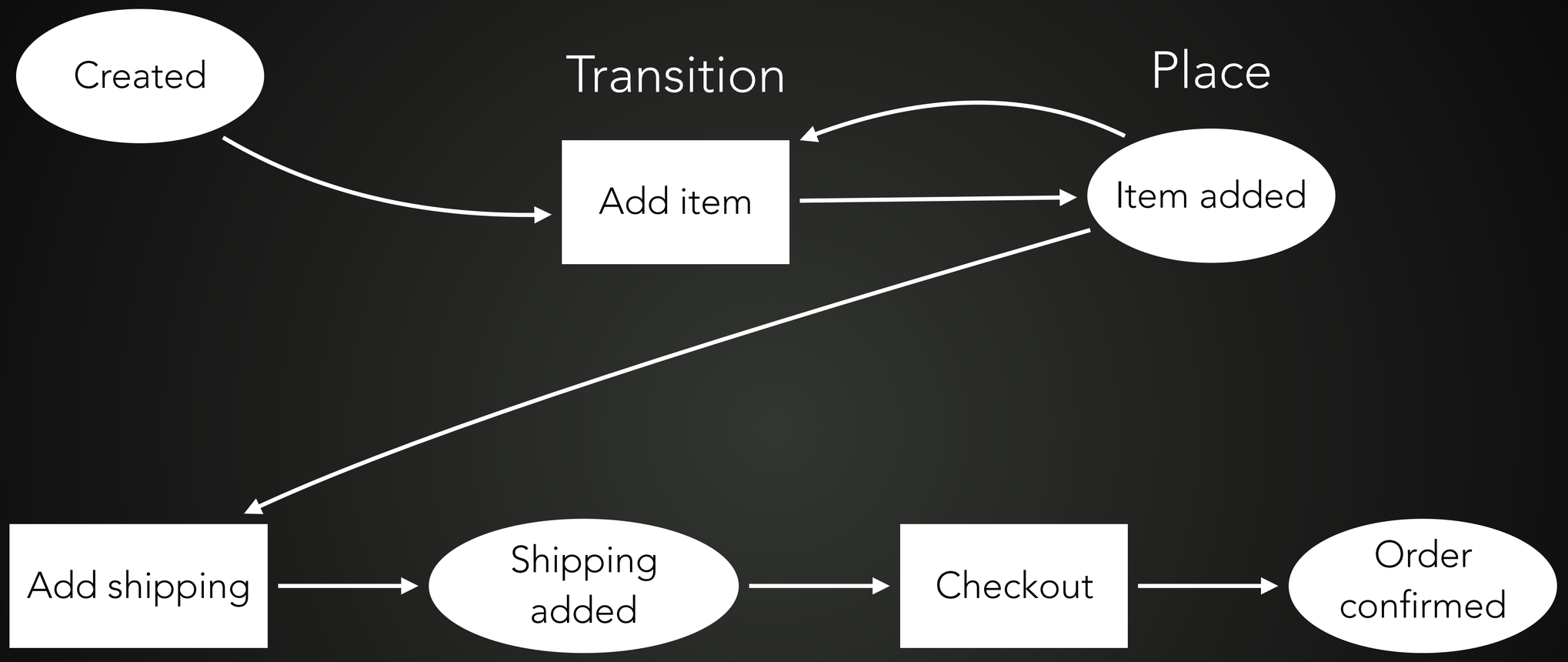

Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed


Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed


Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed


Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

```php
namespace App\Workflow\Checkout\EventSubscriber;

use Symfony\Component\EventDispatcher\EventSubscriberInterface;
use Symfony\Component\Workflow\Event\Event;

class WorkflowLogger implements EventSubscriberInterface
{
    public function __construct(DeliveryService $deliveryService)
    {
        $this->deliveryService = $deliveryService;
    }

    public function onOrderConfirmed(Event $event)
    {
        $this->deliveryService->takeCareOfOrder($event->getSubject());
    }

    public static function getSubscribedEvents()
    {
        return array(
            'workflow.checkout.order_confirmed.announce' => 'onOrderConfirmed',
        );
    }
}
```


Created
Transition
Place
Add item
Item added
Add shipping
Shipping added
Checkout
Order confirmed

Using Symfony Workflow component you will write

fewer bugs

a way of thinking