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Caching and Performance Deep Dive

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Overview

Overview

About me

- Fabian Franz

- VP of Software Engineering @ Tag1 Consulting

- Co-Author of BigPipe and the Drupal 8/9 Caching system + D7 core maintainer + subsystems ...

=> **Motivation: Teach you all I know about Caching!**

Overview

What to expect: Educational Session

- Disclaimer: Absolute beginner session!
- Some concepts from a different angle however.
- Roughly three parts with 10 min each and 5 min for Questions in between parts

Overview

What to expect

- Part 1: General caching and cache invalidation strategies (cache items, cache max-age and tags)

- Part 2: Cache variation, cache hit ratio, placeholders and uncacheable things

Part 3: Caching layers + Common Caching Pitfalls

1. What is Caching?

> In computing, a cache is a hardware or software component that stores data so that future requests for that data can be served faster; the data stored in a cache might be the result of an earlier computation or a copy of data stored elsewhere.

Wikipedia

What is Caching?

Sooo much theory ...

- Example: We have a restaurant and we prepare meals (pages)
- Pizza takes 10 min to prepare
- Takeaway => Pizza is wrapped and given out

What is Caching?

Sooo much theory ...

- Example: We have a restaurant and we prepare meals (pages)
- Pizza takes 10 min to prepare
- Takeaway => Pizza is wrapped and given out -----> THAT IS CACHING!

What is Caching?

Sooo much theory ...

- That’s a cache, performance of pizza delivery is improved
- Finite numbers of pizzas?

What is Caching?

Sooo much theory ...

- We have a magic replicator!
- Customer comes, we replicate the Pizza that we prepared earlier, and give it away

What is Caching?

Sooo much theory ...

- Every item that we cache gets a name: Cache item name or cache address
- In Drupal this is a cache ID or later this is also called “cache keys”
- Cache keys sample -- [‘pizza’, ‘margherita’] => pizza:margherita

Let’s make Pizza! :D

How to cache?

Examples for you :)

```php
$pizza = \Drupal::cache('pizzas')->get('pizza:margherita');
if ($pizza) {
  return $pizza;
}

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')->set('margherita', $pizza);

return $pizza;
```

Who sees the bug?

How to cache?

Fixed example!

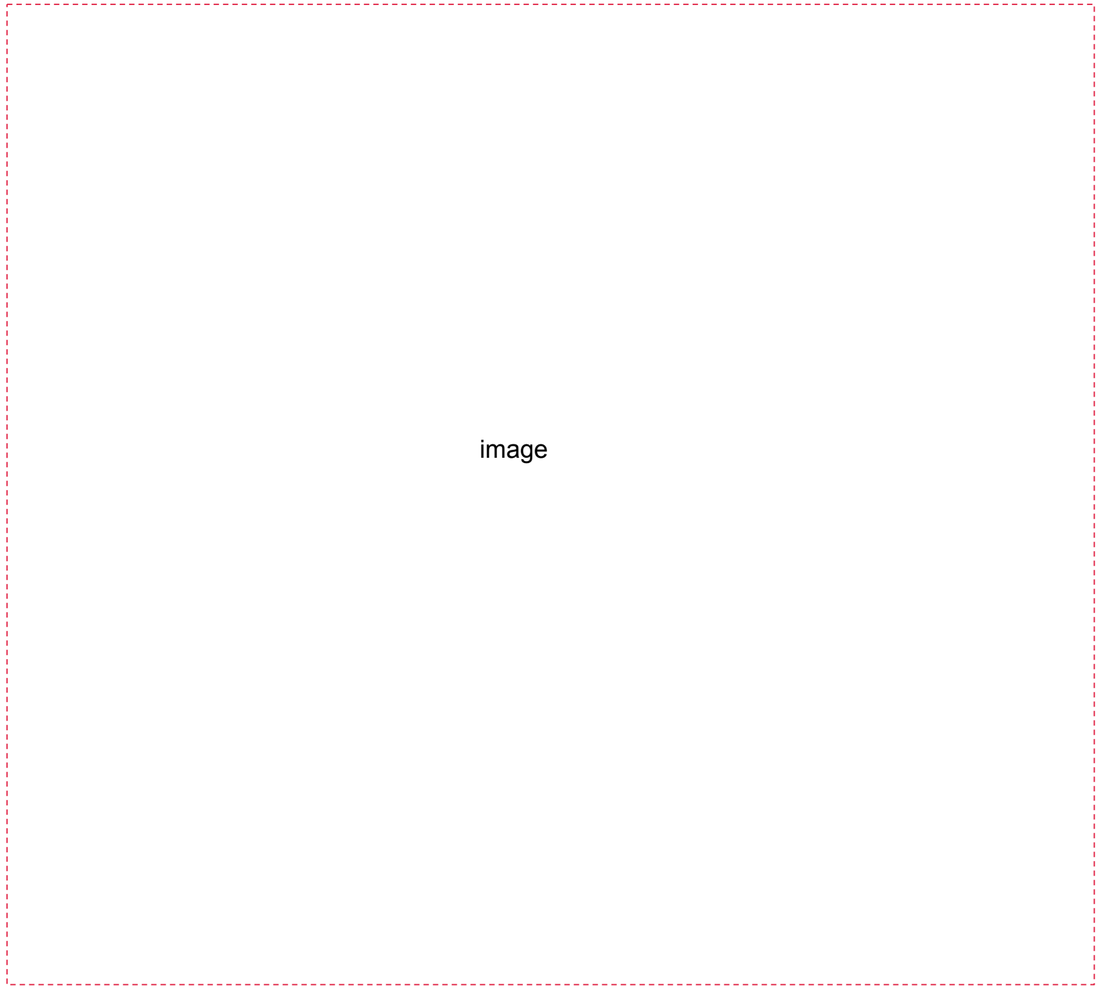
```php
$cid = 'pizza:margherita'; // Cache ID
$pizza = \Drupal::cache('pizzas')->get($cid);
if ($pizza) {
  return $pizza;
}

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')->set($cid, $pizza);

return $pizza;
```

How long is a product valid?

How long is a product valid?



- Supermarket: Best before [DATE]
- Pizza after a while looks like this =>

  Don’t want to eat it anymore …
- Solution: Expiration date

Best before:
09/2022

```php
$cid = 'pizza:margherita'; // Cache ID
$time_to_live = 10*60; // 10 min valid

$pizza = \Drupal::service('pizza.oven')->make('margherita');
\Drupal::cache('pizzas')->set($cid, $pizza, $time_to_live);

return $pizza;
```

Best before: 09/2022

- Page cache in Drupal 3-6
- Still a perfect pattern => EASY!
- Cache for 10 min unconditionally, great for high traffic sites

Weekend - let’s clean up!

Weekend!

Let’s clean-up!

```php
$cid = 'pizza:margherita'; // Cache ID
\Drupal::cache('pizzas')->delete($cid);
```

Let’s offer Frozen Margherita!

- Dough with 00-flour, pint of salt + water
- Custom made Tomato Sauce
- Mozzarella
- Basil

Let's keep it for longer

```php
$cid = 'pizza:margherita'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')->makeFrozen('margherita');
\Drupal::cache($bin)->set($cid, $pizza, $time_to_live);

return $pizza;
```

Recap - How our Shop works!

Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita]
- [Waiter] gets the [Pizza] from the fridge at the counter
- [Waiter] checks the expiration date, if it’s expired he gets one from central storage in the cellar
- [Waiter] replicates and delivers the pizza to the customer

Let’s offer Marinara as well!

- Dough with 00-flour, pint of salt + water
- Custom made Tomato Sauce
- Extra virgin olive oil
- Oregano + Garlic

It’s a vegan pizza!

Mooore Pizza!

Completely new pizza! Not a variation. Now on offer!

```php
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, $time_to_live);

return $pizza;
```

Success! We are growing!

A better recipe for the dough!

After super-secret expedition to Italy!

Pizza-Dough 2.0

Pizza-Dough 2.0

We are lovin’ it!

- Invalidate all the (cached) old pizzas
- Not wait for 30 days
- How do we know if they are new or old?

Pizza-Dough 2.0

Naive solution

```
$pizza = \Drupal::cache('frozen_pizzas')->get('pizza:margherita:dough_version=2');
if ($pizza) {
  return $pizza;
}
```

- This does not scale :(
- All old versions are kept around

pizza:marinara:dough_version=10

pizza:marinara:dough_version=4

pizza:margherita:dough_version=4

What a Mess!

pizza:margherita:dough_version=10

pizza:marinara:dough_version=2

pizza:marinara:dough_version=3

pizza:margherita:dough_version=3

pizza:marinara:dough_version=10

Pizza-Dough 2.0

Let’s tag it!

```
name: Margherita
expires: 08/2020
tags:
  - dough_version: 2
```

```
name: Marinara
expires: 08/2020
tags:
  - dough_version: 2
```

Pizza-Dough 2.0

Let’s tag it!

```php
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, $time_to_live, ['dough_version']);
```

Pizza-Dough 2.0

Let's tag it!

```php
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!
$cache_tags = ['dough_version'];

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, $time_to_live, $cache_tags);
```

Release a new dough version, do that:

```php
\Drupal::cache($bin)->invalidateTags(['dough_version']);
```

Pizza-Dough 2.0

Tagging is versioning!

- Drupal versions the tags automatically
- cachetags table: `tag, invalidations`
- It’s a version number conceptually!

Pizza-Dough 2.0

Ways of Tagging

- v3.1.0 (versions)
- 2020-07-15 (timestamps)
- Snow Leopard (names)
- 1..10000 (counters)

Pizza-Dough 2.0

This ain’t easy

- node:1 is saved and cache tag is invalidated (v42 -> v43)
- node:1 cache tag now SHOULD BE v43
- Anything tagged with node:1 must have value of v43, else it’s invalid

Pizza-Dough 2.0

This ain’t easy

- Complex, but once mastered this is so powerful:

  Cache Item = {Name, tag=v42}

  Canonical Store = {Current Version of tag = v43}

Pizza-Dough 2.0

This ain’t easy

Hint: **Everything in the same request always uses the same current version.**

In other words: The waiter just checks the list of dough versions e.g. once a day and not every minute.

Recap - How our Shop works - now with tagging!

Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita]
- [Waiter] gets the [Pizza] from the fridge at the counter
- [Waiter] checks the expiration date and tags
- [Waiter] marks the pizza as valid or invalid
- If the pizza is not valid, he gets one from central storage in the cellar
- [Waiter] replicates and delivers the pizza to the customer

Recap

All that we learned so far!

We now know how to:

- Get an item from the cache
- Set an item into the cache

Recap

Three ways to expire the cache! *sing*

- Direct deletion / invalidation by name of item [cache id - name]
- Time based (TTL - time to live) invalidation [cache - max-age]
- Tag based invalidation [cache - tags]

Recap

Core is cheating :p

We also implicitly created a new cache:

- The list of versions for the tags (we store it for the time of the request)

Hence: Cache tags DON’T solve the problem of cache invalidation, they just move it to somewhere else.

1. What is Caching?

Question Time!

2. What should you cache?

2 years later

Grown even more!

Success is great!

Ready for new products!

Pizza-Shop 2.0

Gluten-free dough, vegan mozzarella, pizza spinacci, ...

- New pizza variations
- Gluten free offering
- Vegan Margherita offering (Marinara was always vegan!)

Quick Recap
(now with 100% more variation)

Recap (Slides)

- [Customer] comes and orders a pizza
- [Waiter] asks for the preferences (vegan/gluten free) (cache context)
- [Waiter] checks the fridge for the wanted variation
- [Waiter] gives the wanted variation to the customer (cache hit) or produces it (cache miss) and then stores it in the fridge

Pizza-Shop 2.0

Let’s add it to the name (again?!)

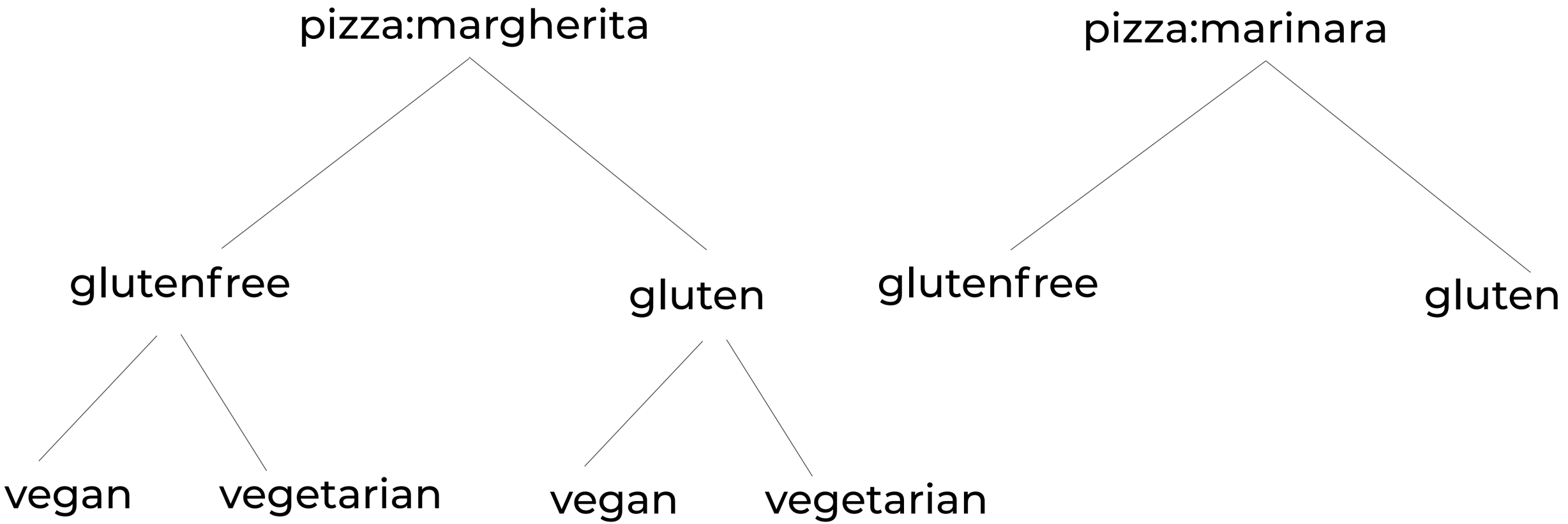
- - pizza:margherita:vegan:glutenfree
- - pizza:margherita:vegan:gluten
- - pizza:margherita:vegetarian:glutenfree
- - pizza:margherita:vegetarian:gluten
- - pizza:marinara:vegan:glutenfree
- - pizza:marinara:vegan:gluten

Hmm, nope!

- - pizza:marinara:vegetarian:glutenfree
- - pizza:marinara:vegetarian:gluten

Pizza-Shop 2.0

What we would like:



Cache Contexts

Vary me if you can!

- … are used for variation in Drupal 8/9
- … are computed on demand
- … internally adds the cache context values to the Cache ID name

Cache Contexts

Pizza-Shop 2.0

Name: pizza:margherita

Cache Contexts:

- vegan=yes|no
- gluten_free=yes|no

Name: pizza:margherita:vegan=yes|no:glutenfree=yes|no

Expires: 09/2020

Tag:

- dough_version=2

Cache Contexts

Pizza-Shop 2.0

Name: pizza:marinara

Cache Contexts:

- gluten_free=yes|no

Name: pizza:marinara:glutenfree=yes|no

Expires: 09/2020

Tag:

- dough_version=2

Quick Recap
(now with intelligent variation)

Recap (Slides)

- [Customer] drives to our Pizza Shop
- [Customer] orders a frozen [Pizza Margherita] (Cache ID)
- **[Waiter] looks at the [Pizza] variations for Margherita (Cache Context Router)**
- **[Waiter] asks the [Customer] for his preferences (vegan and/or gluten-free?) (Cache Context Execution)**
- [Waiter] gets the preferred [Pizza] from the fridge at the counter (Cache Retrieval)
- [Waiter] checks the expiration date and tags (Cache validation)
- [Waiter] marks the pizza as valid or invalid
- If the pizza is not valid, he gets one from central storage in the cellar (Cache miss)
- [Waiter] replicates and delivers the pizza to the customer (Cache hit)

Cache Contexts

Practical Example

- Only works with Render Arrays
- Took us quite some time to understand in depth
- RenderCache could provide it as Service in the future

Cache Contexts

Direct vs. Render Array - Compare:

```php
$cid = 'pizza:marinara'; // Cache ID
$bin = 'frozen_pizzas';
$time_to_live = 30*24*60*60; // 30 days valid!
$cache_tags = ['dough_version'];

$pizza = \Drupal::service('pizza.maker')->makeFrozen('marinara');
\Drupal::cache($bin)->set($cid, $pizza, $time_to_live, $cache_tags);
```

Cache Contexts

Direct vs. **Render Array** - Compare:

```php
$build = [
  '#cache' => [
    'bin' => 'frozen_pizzas',
    'keys' => ['pizza','marinara'],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];

$build['#pre_render'][] = function($elements) {
  $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen('marinara');
  return $elements;
};
```

Cache Contexts

Practical Example using Render Array

- Provide the Cache metadata via #cache
- Provide the Cache miss function (#pre_render)

Cache Contexts

Render Array with Cache Contexts added

```
$build = [
  '#cache' => [
    'contexts' => ['user.vegan', 'user.glutenfree'],
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];

$build['#pre_render'][] = function($elements) use ($pizza_name) {
  $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
  return $elements;
};
```

Cache Contexts

Render Array with Cache Contexts added

```php
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];

$build['#pre_render'][] = function($elements) use ($pizza_name) {
  $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
  return $elements;
};

$build['#cache']['contexts'] = ['user.vegan', 'user.glutenfree'];
```

Cache Contexts

Render Array with dynamic cache contexts

```php
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];

$build['#pre_render'][] = function($elements) use ($pizza_name) {
  $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);

  $elements['#cache']['contexts'][] = 'user.glutenfree';
  if ($pizza_name == 'margherita') {
    $elements['#cache']['contexts'][] = 'user.vegan';
  }
  return $elements;
};
```

Cache Contexts

Creating a Cache Context: src/UserVeganCacheContext.php

```
class UserVeganCacheContext extends UserCacheContext {

  /**
   * {@inheritdoc}
   */
  public static function getLabel() {
    return t('Vegan User');
  }

  /**
   * {@inheritdoc}
   */
  public function getContext() {
    return $this->user
      ->field_vegan
      ->value() ? 'yes' : 'no';
  }

}
```

Cache Contexts

Creating a Cache Context: pizza.services.yml

```
services:
  cache_context.user.vegan:
    class: Drupal\pizza\UserVeganCacheContext
    arguments: ['@current_user']
    tags:
      - { name: cache.context}
```

TADA! That works great!

Alert: Fridge is full!

So many variations ...

Help!

Soooo many variations ...

- Pizza Spinacci is bought way less
- Custom pizza is “uncacheable”
- Check your cache hit ratio and invalidations: https://www.drupal.org/project/cache_metrics

Help!

Soooo many variations ...

- Let’s disable the cache
- Easiest: Not cache at all

Disable cache

Max-Age = 0

```
$build['#cache']['max-age'] = 0;
```

Disable cache

For cacheable objects

```
$cacheable_object->setCacheMaxAge(0);
```

Disable Cache

Full example

```php
<?php

$build['#pre_render'][] = function($elements) use ($pizza_name, $ingredients) {
  if ($pizza_name == 'custom') {
    $pizza = \Drupal::service('pizza.maker')->makeCustomPizza($ingredients);
    $elements['#cache']['max-age'] = 0;
    return $elements; // We early return ...
  }

  if ($pizza_name == 'spinacci') {
    $elements['#cache']['max-age'] = 0; // We fall through ...
  }

  // [...] The rest of the callback

  return $elements;
};
```

Disable Cache

Practical Example using Render Array

- Cache max-age=0 set after function has been rendered

- **Pitfall**: Clear your cache (drush cr) after making such a change during local development

  -> Happened to me more often than I'd like to admit ...

Disable Cache

Practical Example using Render Array

- **Pitfall**: Clear your cache (drush cr) after making such a change during local development

- 3 ways:
  - `drupal cache:tag:invalidate rendered`
  - `drush cache:tag rendered`
  - `\Drupal\Core\Cache::invalidateTags(['rendered']);`

Disable Cache

Before it is retrieved from the Cache

```
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $tags,
  ],
  '#pizza_name' => $pizza_name,
  '#pre_render' => [$this, 'makePizza'],
];

if (in_array($pizza_name, ['custom', 'spinacci'])) {
  $build['#cache']['max-age'] = 0;
}
```

Disable Cache

Practical Example using Render Array

- It’s always more efficient to disable the cache before the item is retrieved from the Cache
- Similar to: Request based Cache Policy

Cache Chains

No Pizza-Shop creates the Pizza always from Scratch

Pizza is made from pre-prepared things:

Dough (12-24 hrs till ready), Tomato sauce, Ingredients

Composing Sites

Pages consist of different cached and uncached parts

- Main page response (need to custom cache)

- Blocks, Menus, Header, Footer, ...

  [Decoration around the main page response]

Pizza Funghi

2 ways to create a Pizza with Mushrooms!

- Start with the empty pan, add the dough, add the tomato sauce add the mozzarella cheese and then add the mushrooms.

- Start with a finished pizza margherita and just add the mushrooms.

Pizza Funghi

+ Dynamic Page Cache

That is what the true power of dynamic page cache is:

- We cache the response
- We add flavor / placeholders afterwards

Pizza Funghi

+ Dynamic Page Cache

Drupal 8+9 with two ways for really dynamic things:

- Disable the (dynamic) page cache; just cache all the inner parts (blank pan, create from scratch)

- Cache the whole response in dynamic page cache and just add some placeholders for dynamic data

Pizza Funghi

+ Dynamic Page Cache

- Glutenfree cannot be a placeholder

- It’s the foundation of our pizza

- Both are needed:

  - Variation (varies all cache entries)

  - Placeholders (out of band)

  => Decide case-by-case

Placeholders

Pizza M+X

Margherita + Placeholders

- A placeholder in Drupal: Can be independently rendered. Must not depend on anything that has been executed before.

For example:

- It’s not possible to add more wheat to the dough after the pizza is finished already.

Pizza M+X

Classified - Top Secret - Placeholders internal structure

```
$elem['#attached']['placeholders']['%%ingredients_placeholder%%'] = $build;
$elem['#markup'] = '%%ingredients_placeholder%%';
```

Pizza M+X

+ Placeholders

Contract:

- Executed after all other parts have been rendered
- #pre_render => #lazy_builder (stronger contract)

Placeholders

LazyBuilder vs. **#pre_render**

```php
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];
$build['#pre_render'][] = function($elements) use ($pizza_name) {
  $elements['pizza'] = \Drupal::service('pizza.maker')->makeFrozen($pizza_name);
  return $elements;
};
```

Code

Lazy Builder - Auto Placeholdering

```
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];
$build['#lazy_builder'] = [
  '\Drupal\pizza\PizzaLazyBuilder::build',
  [$pizza_name],
];
```

Code

Lazy Builder - Explicit Placeholder

```
$build = [
  '#cache' => [
    'keys' => ['pizza', $pizza_name],
    'max-age' => $time_to_live,
    'tags' => $cache_tags,
  ],
];
$build['#lazy_builder'] = [
  '\Drupal\pizza\PizzaLazyBuilder::build',
  [$pizza_name],
];


$build['#create_placeholder'] = TRUE;
```

Pizza M+X

+ LBs + Placeholders - Pitfalls (!)

Lazy Builders:

- Must not contain complex data (enforced!)
- Must not depend on the main page request

Pizza M+X

+ LBs + Placeholders

Lazy Builders + Placeholders allows to:

- Use **big_pipe** (in Core, enable and good to go!)
- Cache the uncacheable
- Break up variation: per-page/per-user => per-page + per-user

2. What should you cache?

Question Time!

3. Where should you cache?

Shop is even more successful!

But Customers
need to drive to us :(

Many drive for 2 hours and more

Can’t we do something about that?

Solution: We offer our pizza in supermarkets around the world!

Solution:

Content Delivery Network (CDN)

CDN

Pizza Delivery Network (PDN!)

Drupal 8/9 makes it easy:

- Choose CDN (Akamai, Cloudflare, Fastly) or Varnish
- Enable module
- Profit!

CDN

Pizza Delivery Network (PDN!)

CDN does the checks:

- Has the pizza expired?
- Is the dough_version still matching?
- dough_version changes => Give CDN a heads up!

CDN

Pizza Delivery Network (PDN!)

See headers for yourself:

- X-Drupal-Cache-Tags
- Debug option

Code

Title

```
parameters:
  # Cacheability debugging:
  #
  # Responses with cacheability metadata (CacheableResponseInterface instances)
  # get X-Drupal-Cache-Tags and X-Drupal-Cache-Contexts headers.
  #
  # For more information about debugging cacheable responses, see
  # https://www.drupal.org/developing/api/8/response/cacheable-response-interface
  #
  # Not recommended in production environments
  # @default false
  http.response.debug_cacheability_headers: true
```

CDN

Pizza Delivery Network (PDN!)

And this is the result:

- X-Drupal-Cache-Tags: dough_version
- Expires: 09/2022

Great - but what about the dough itself?

Need to get it from warehouse 10 miles away.

Let’s put it in a fridge under the counter

Efficiency 3.0

Dough near the counter

Drupal has ChainedFast:

- ACPu (shared memory within PHP process)

Main rule of thumb:

- **If you have things that are seldom changing, put it into a special bin and connect that bin to “chained fast”. (mostly read only cache traffic)**

Efficiency 3.0

The dough is always near the counter - yeah!

```
$settings['cache']['bins']['pizza_dough'] = 'cache.backend.chainedfast';
```

No Efficiency 3.0

The custom made pizzas should NOT be stored near the counter

Second rule:

Never put chained fast on things that are often changing or have lots of variations:

- You can get serious write lock problems and performance will decrease!
- If the cache is full it can lead to lock-ups as a full garbage collection needs to be performed.

Efficiency 3.0

APCu is really cool :D

APCu is ideal (and used in Drupal) for:

- FileCache (depends only if the file has changed)
- ClassCache (depends only on where the class sits on the filesystem)
- Config cache (is invalidated only if config changes)

This shows now also the importance of ‘bins’ as those can have different cache backends associated with them.

Don’t forget Redis / Memcached

Efficiency 4.0

Memcached/Redis is also cool

- MySQL is a warehouse that’s across the street
- Memcached / Redis is a fridge that is in the room next door
- ACPu is the fridge below the counter.

Efficiency 4.0

Advantages and Disadvantages, hmmm - what to do ...

- MySQL: Large Storage space / Slow: 2-5 ms response times usually
- Memcached / Redis: Medium storage space / Fast: 0.5 - 1 ms response times usually
- APCu: Small storage space / Fastest: 0.05 ms usually

Efficiency 4.0

Create Pizza + Deliver Pizza are different cache paths

It is important to distinguish two cases:

- Caches used for creating the pizza (MySQL, APCu, Memcached) [from parts]

- Caches used for delivering the pizza to the customer (MySQL, Memcached, CDN, Browser Cache)

Lot’s of customers at once

=> Pizza with Spring Onions

Spring Onions

Only seconds TTL

- The spring onions can only be cached for a very short while (micro-caching)
- Potential bottleneck

  => Stampede protection (build into most CDNs)

  SHIELD!

Stampede Protection

Microcaching + Stampede Protection

- Inefficient: Prepare lot’s of pizzas in parallel
- Instead: Prepare one spring onion pizza and then just replicate it.

Stampede Protection

```php
public function stampedeProtect($cid) {
  $item = $this->cache->get($cid);
  if ($item) {
    return $item;
  }

  $acquired_lock = $this->lock->acquire('stampede:' . $cid);
  if (!$acquired_lock) {
    sleep(1);
    return $this->stampedeProtect($cid); // Let's try that again.
  }

  // Rebuild cache
  $item = $this->rebuild();

  $this->cache->set($cid, $item, 30); // Cache for only 30 seconds
  $this->lock->release($acquired_lock);

  return $item;
}
```

Common Caching Pitfalls

Common Caching Pitfalls

Planning to fail is better than failing to plan

Plan your caching strategy:

- Know what depends on what
- Known when something needs to be invalidated
- https://drupal.org/project/renderviz module can be a really nice help here.

Have fun and I'll
make a Pizza now ;)

yummy

The End!

More Questions?

Follow me: @fabianfranz

Code

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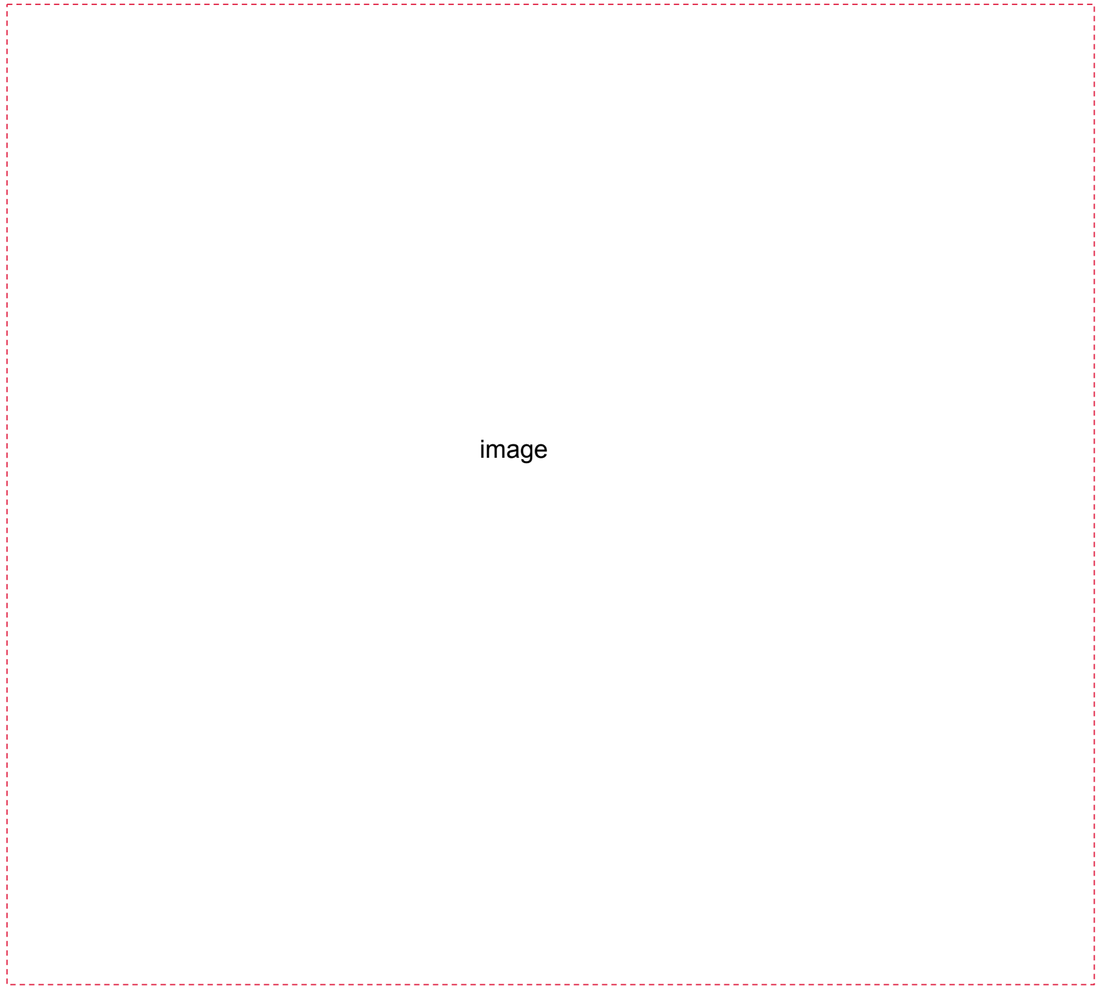

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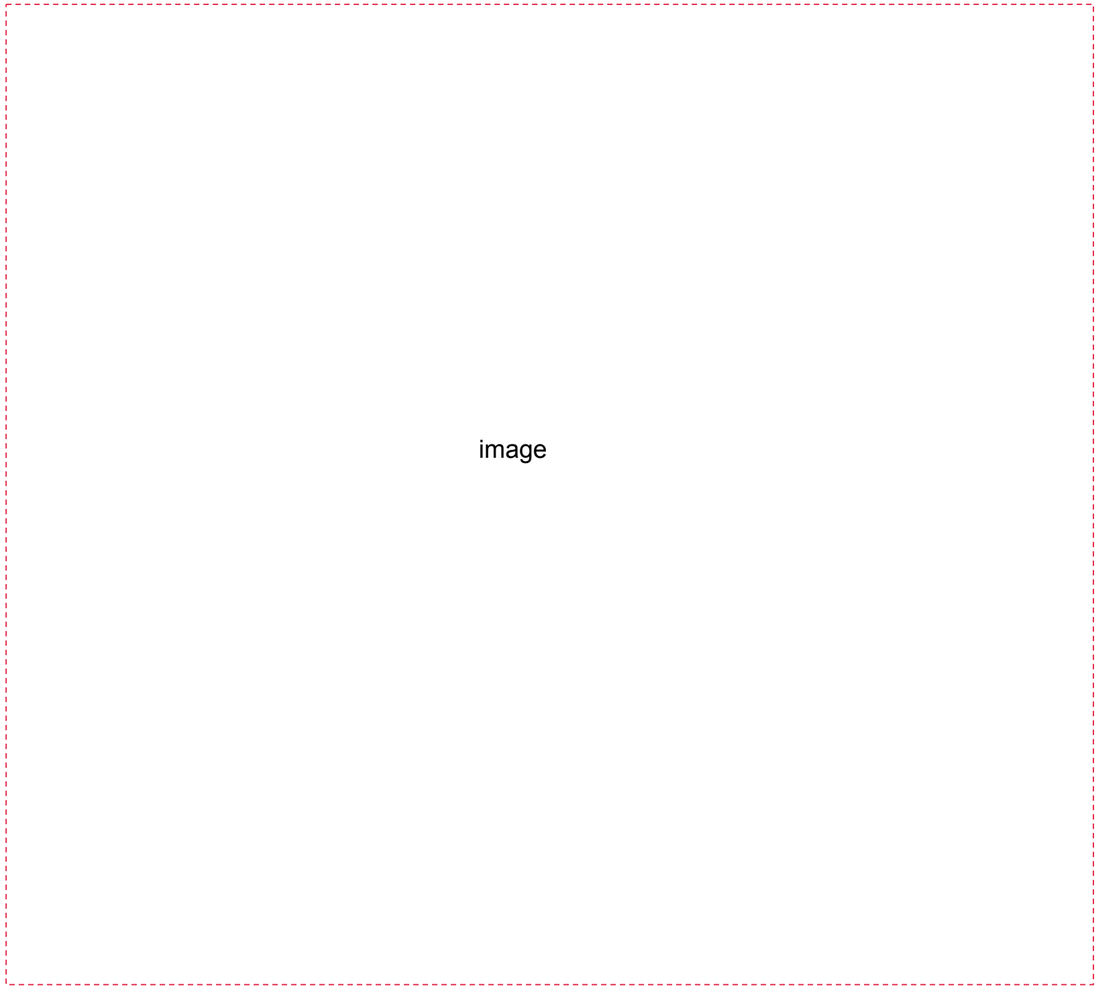

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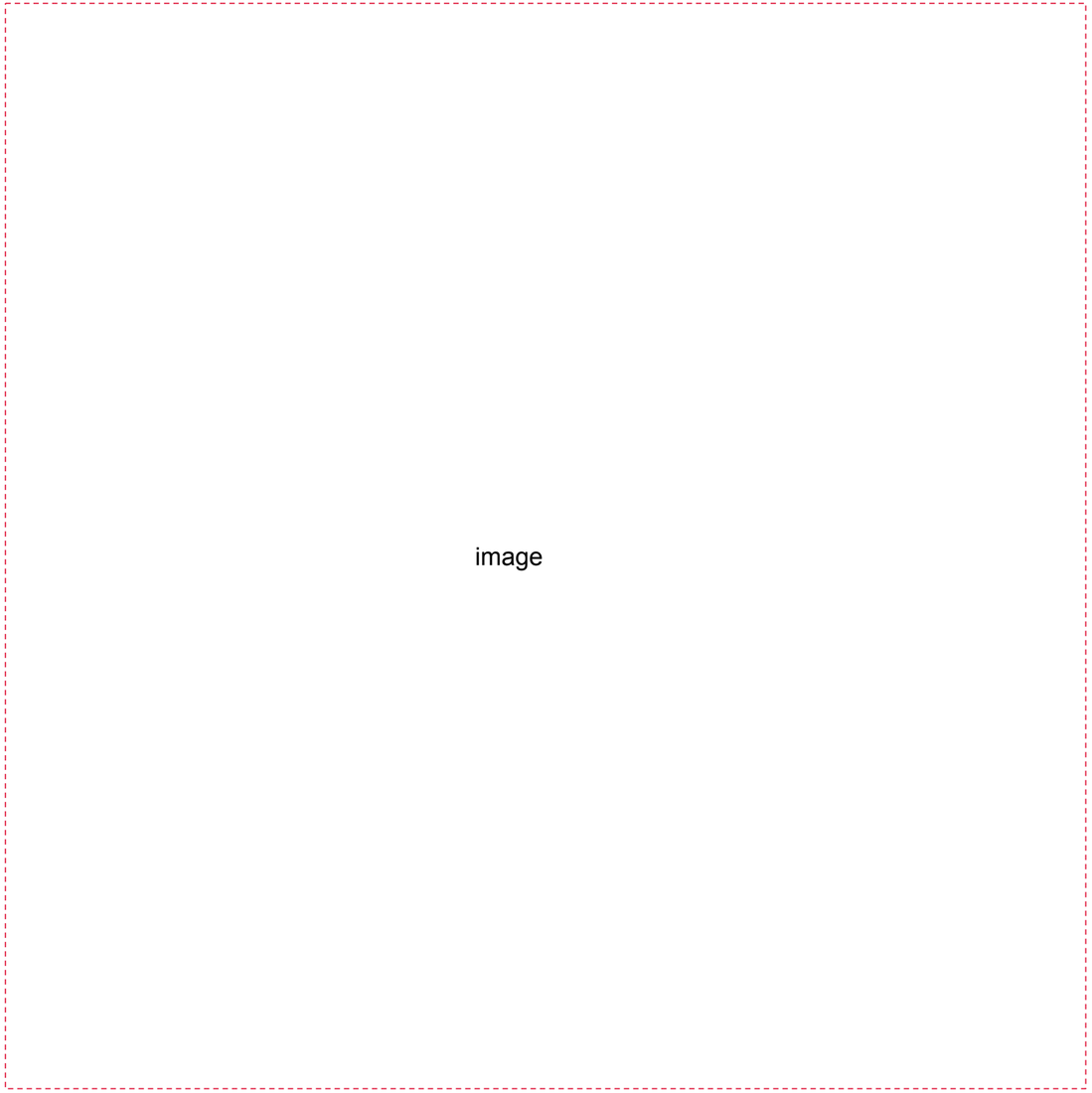

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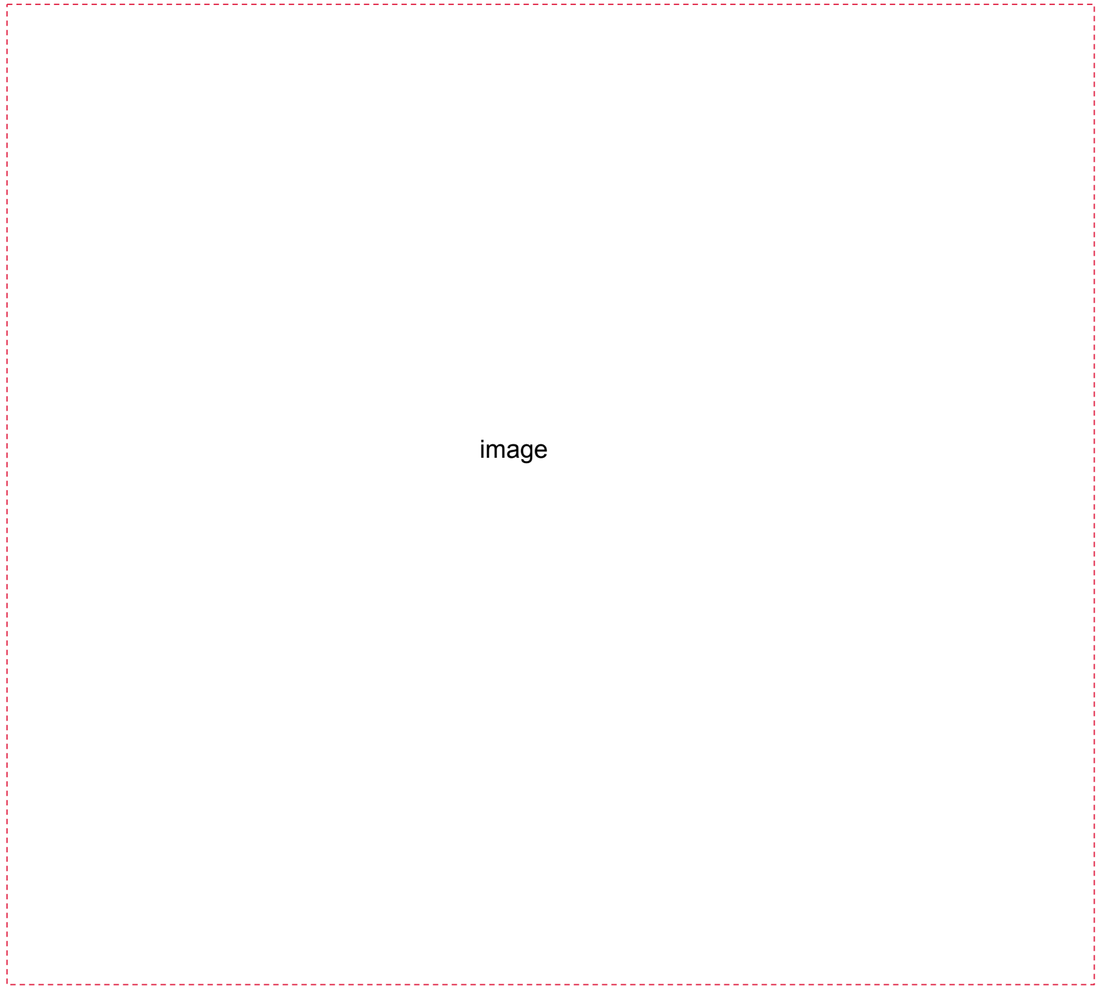

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“

This will be a quote about something or someone

”

AUTHOR


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