The Very Hungry Transaction

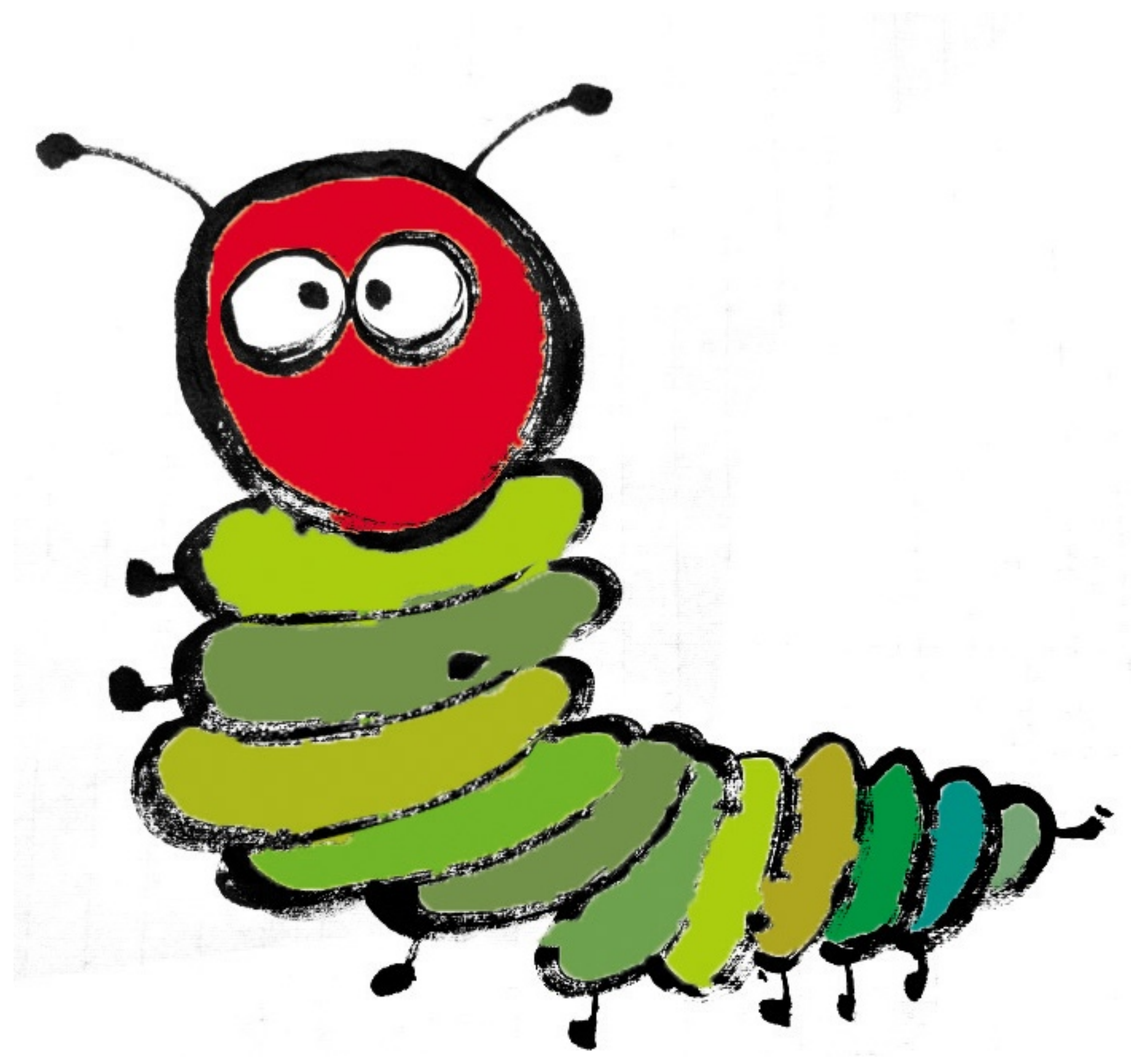
DANIEL COLSON

Senior Software Engineer

GitHub

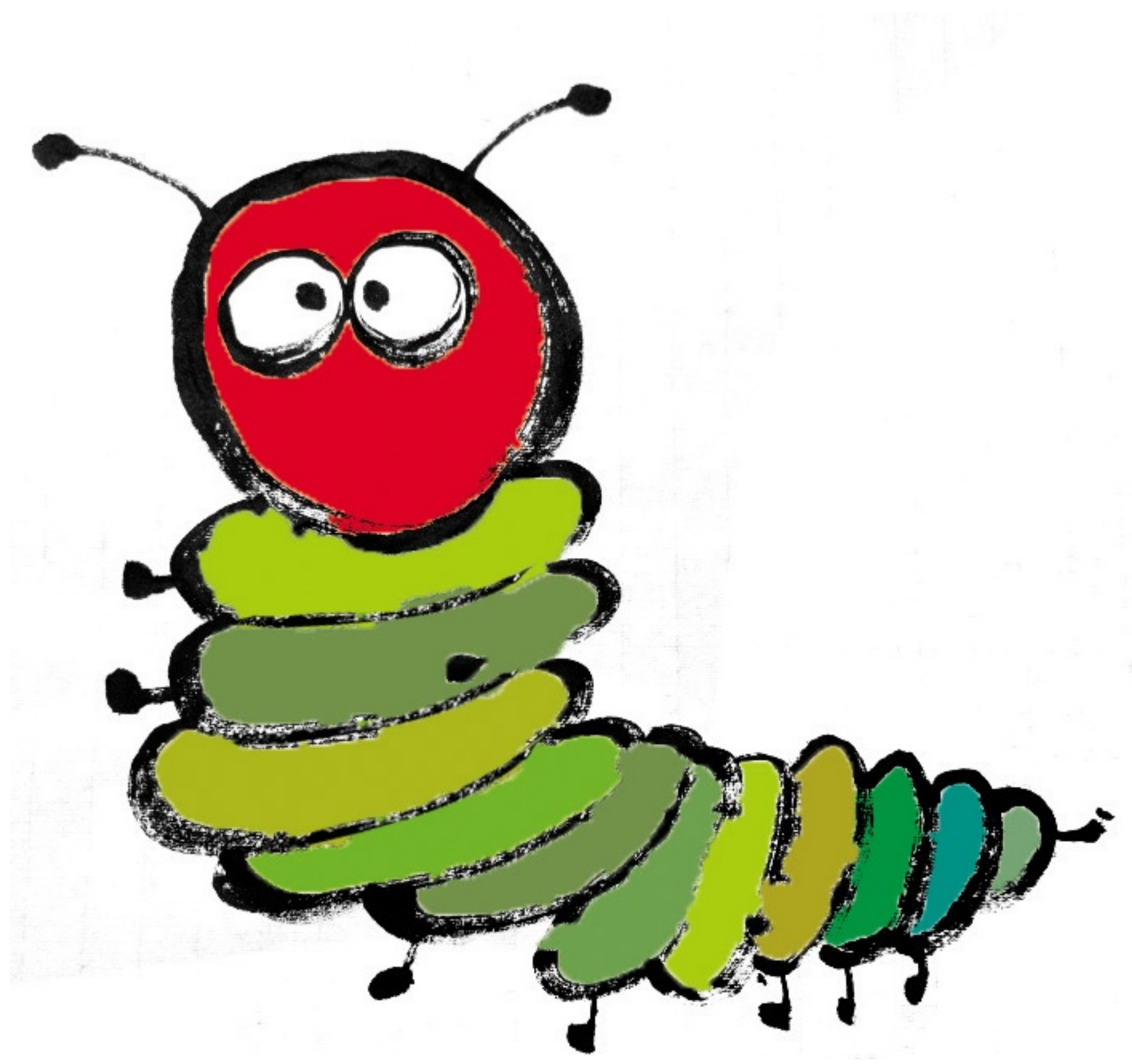
Cat R. Pillar

- Job — Developer at BugHub
- Dislikes — Birds, Software Bugs
- Likes — Leaves, Actual Bugs

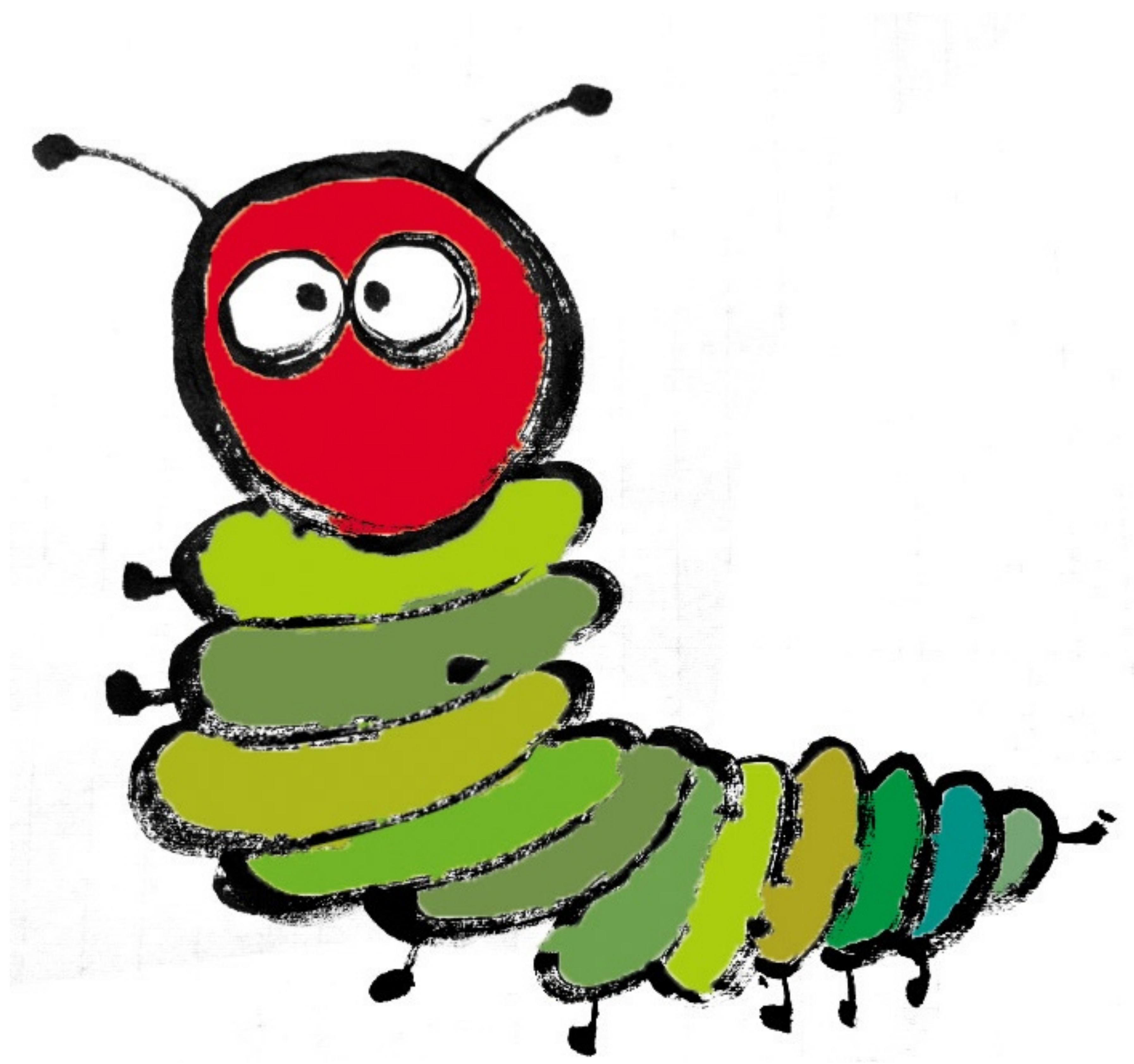


BugHub

- Large Online Community of Bugs
- More Bugs Than Any Other Site



```
transaction do
  ...
end
```

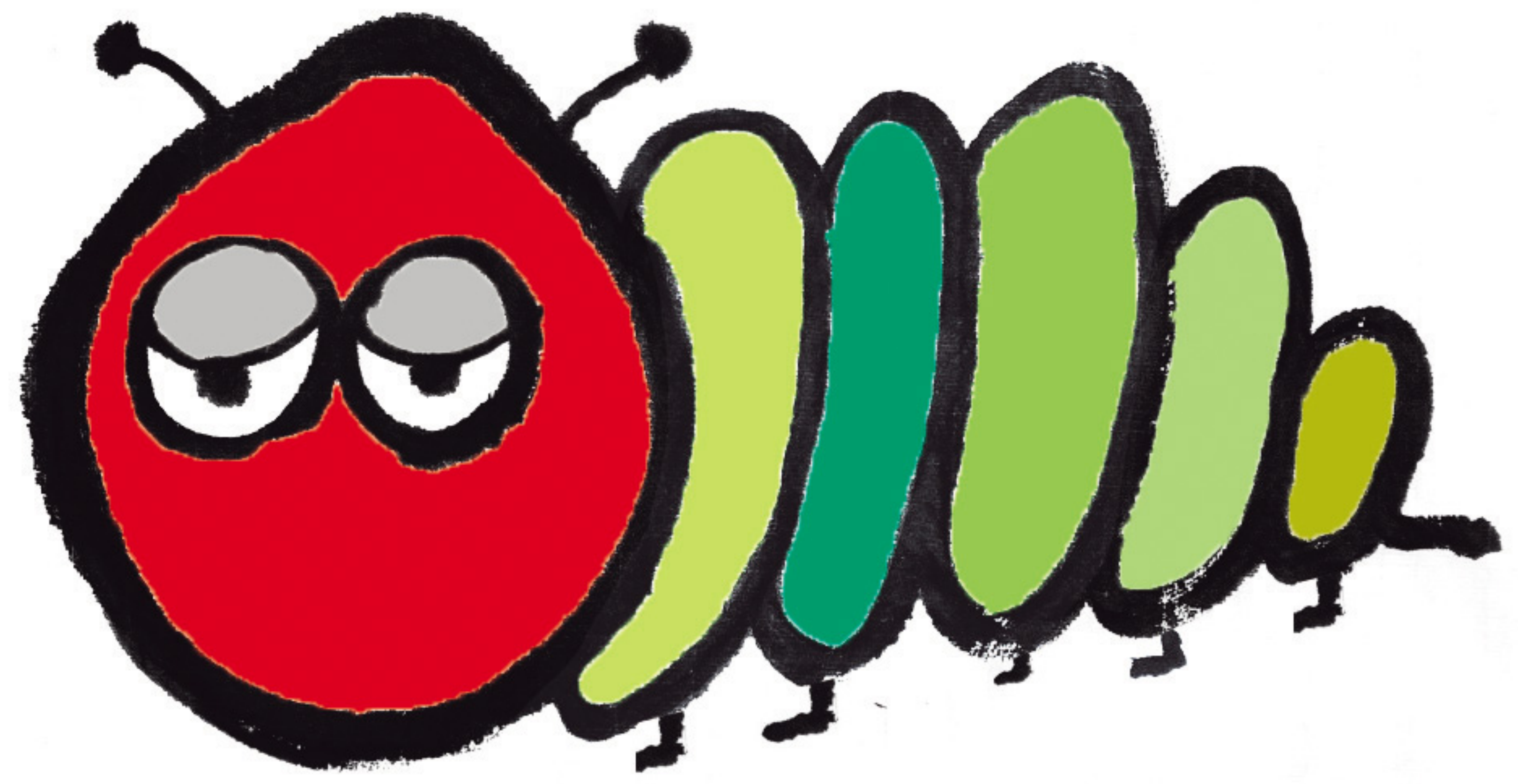


Monday

A Transaction is Born

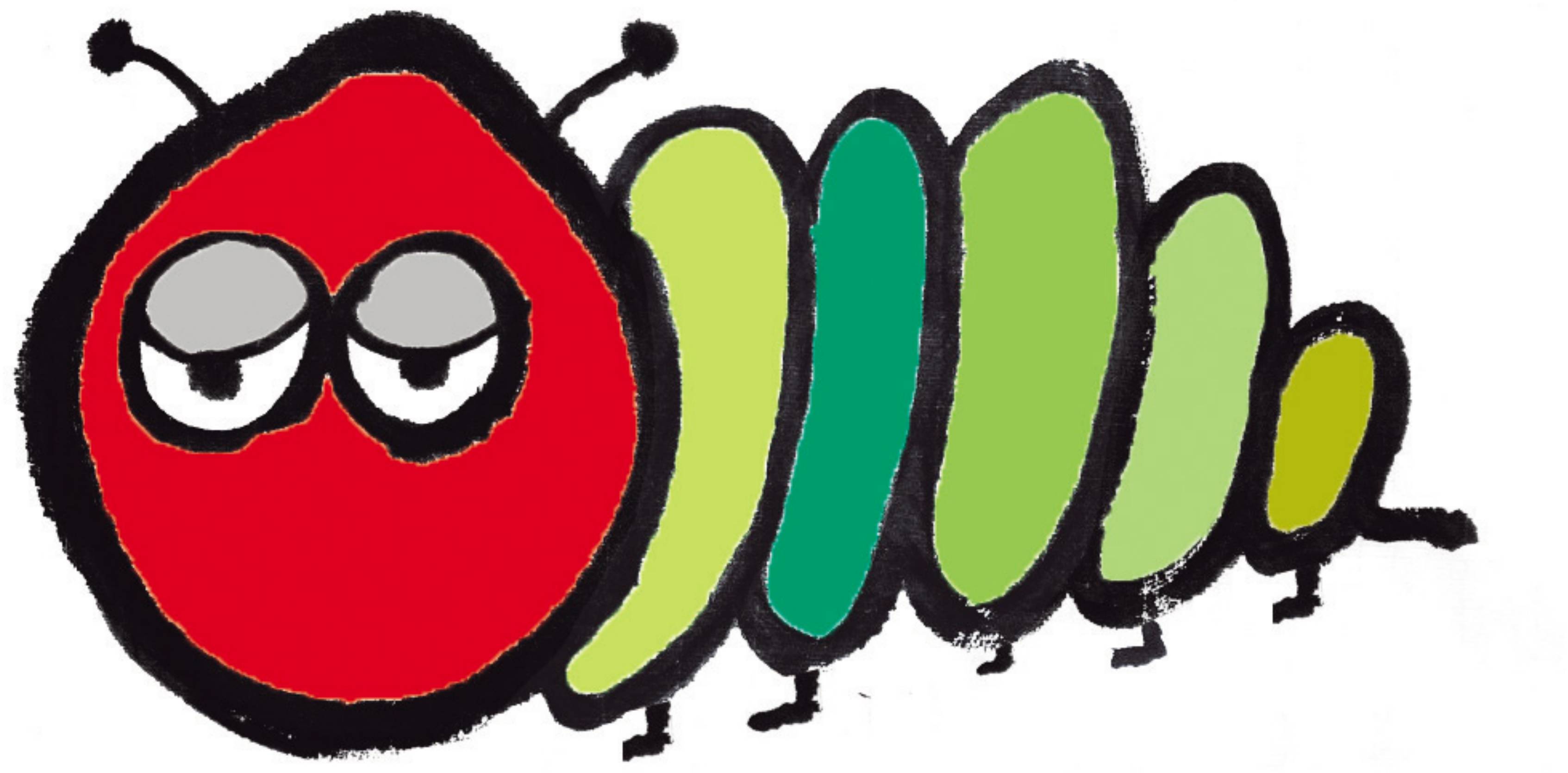
Monday

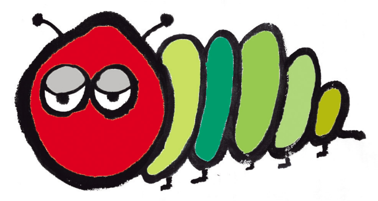
A Transaction is Born



“

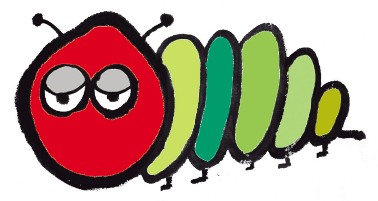
I’m very hungry. I want groceries delivered to my chrysalis.

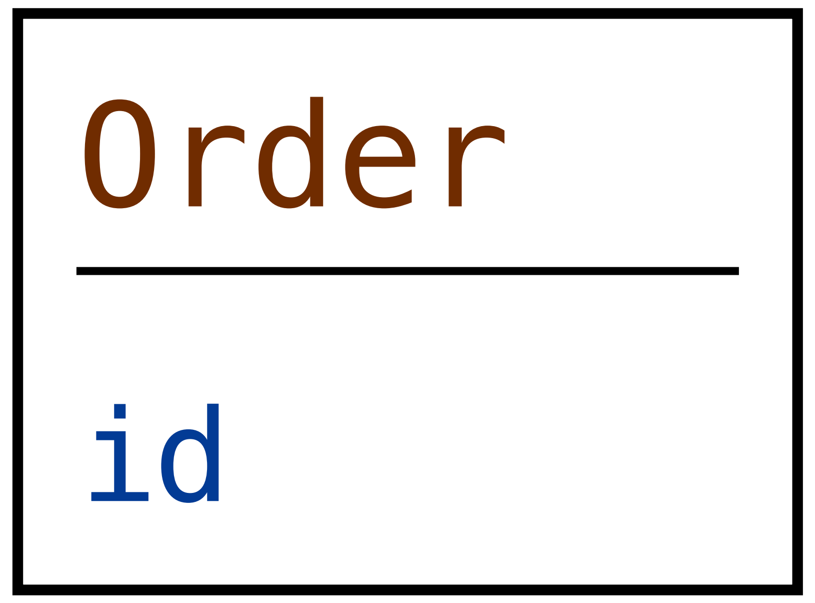


Monday 

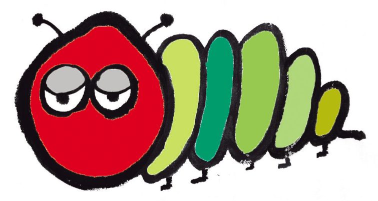
```ruby
def submit
  @order.save!
end
```

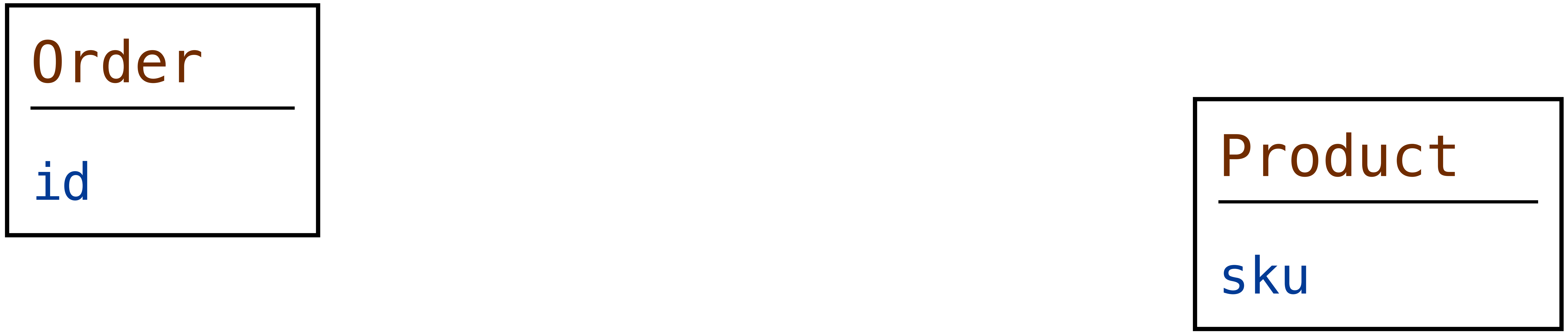
Monday



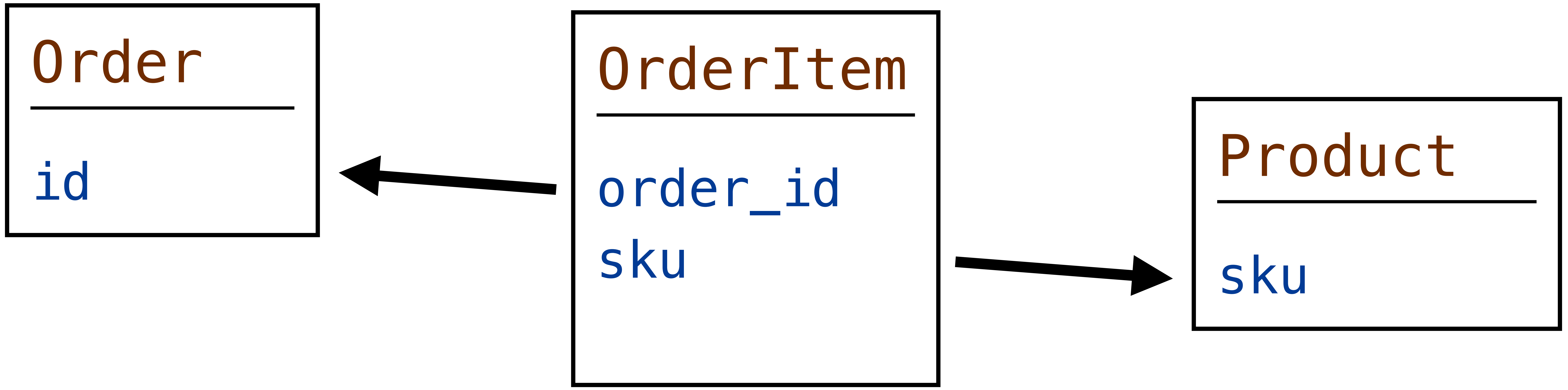


Monday

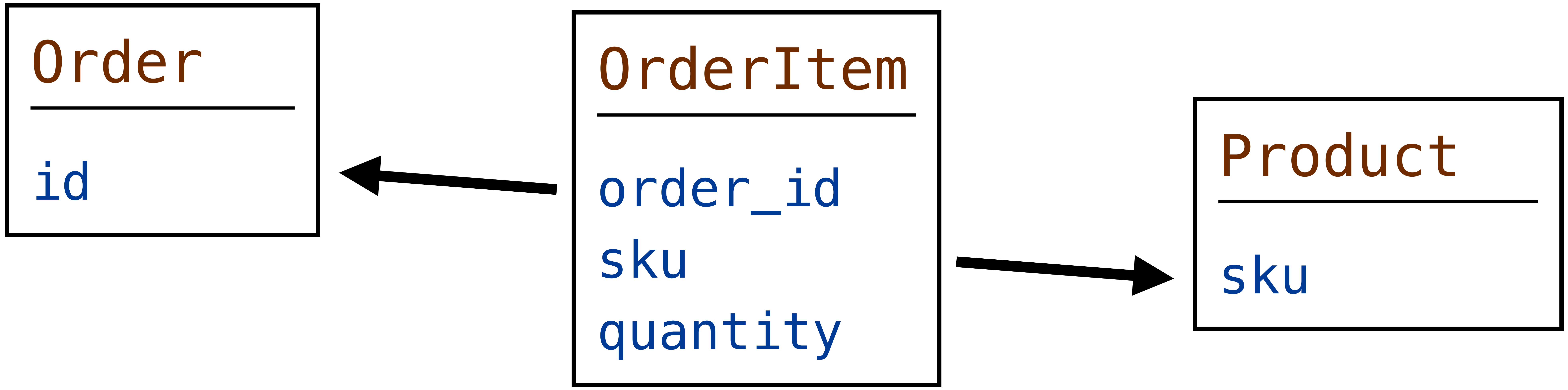




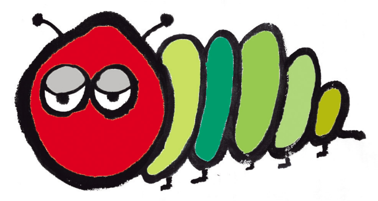
Monday



Monday

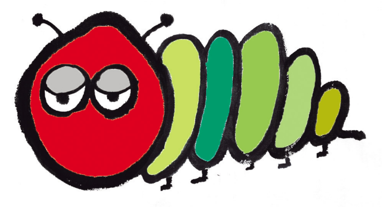


Monday

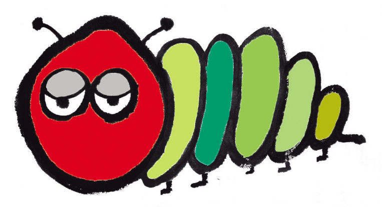


```
def submit
  @order.save!
end
```

Monday

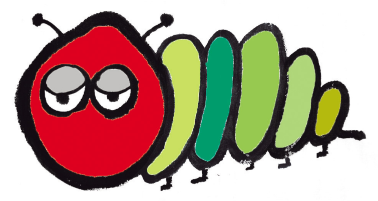


```
def submit
  @order.save!
end

=> BEGIN
```

Monday 

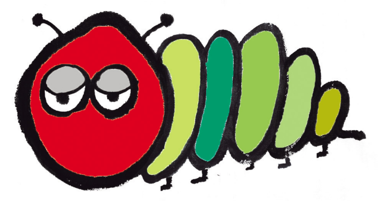
```
def submit
  @order.save!
end

=> BEGIN
=> INSERT INTO orders ...
```

Monday



```
def submit
  @order.save!
end

=> BEGIN
=> INSERT INTO orders ...
=> INSERT INTO order_items ...
=> INSERT INTO order_items ...
   ...
```

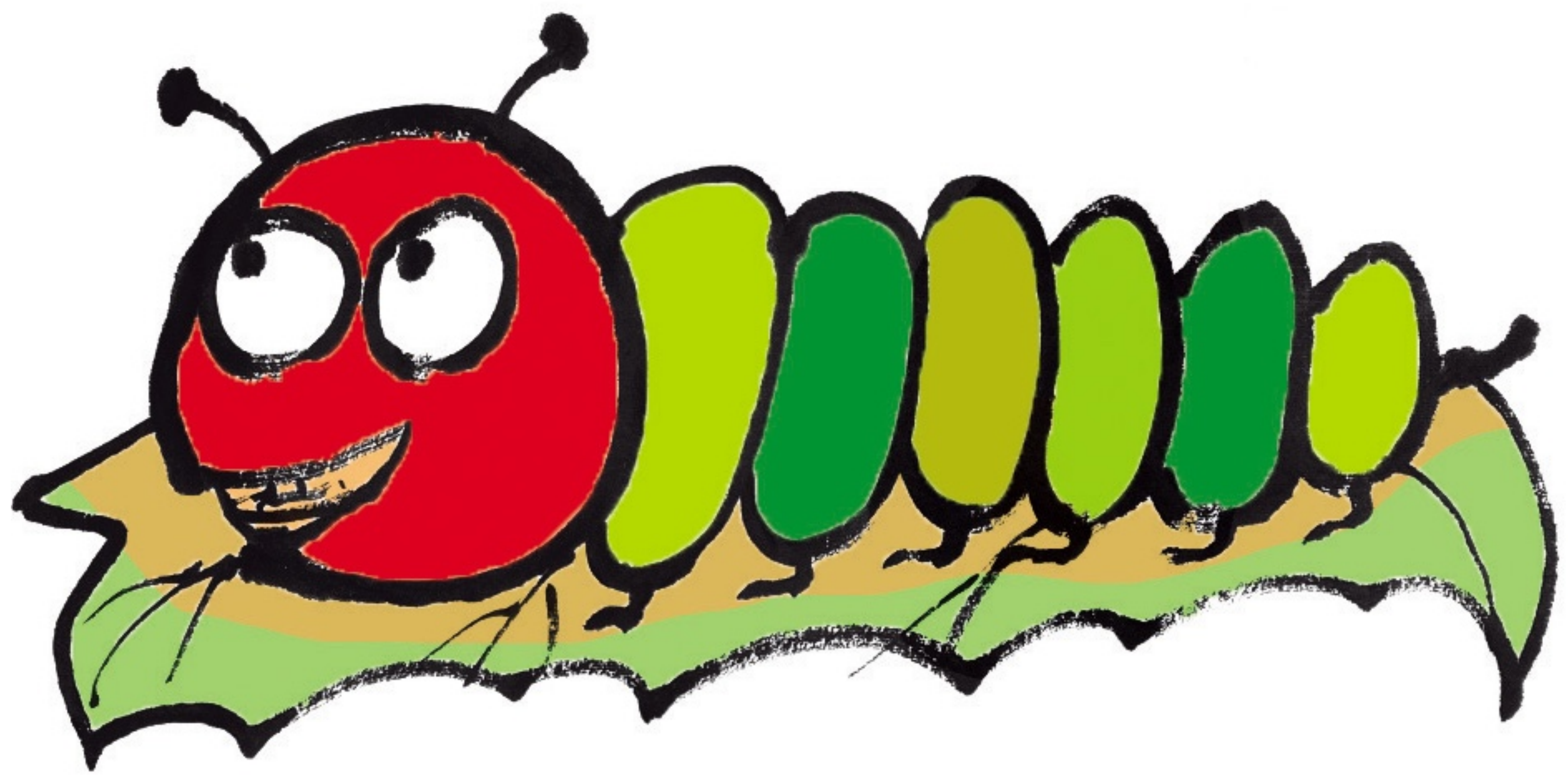
Monday



```
def submit
  @order.save!
end

=> BEGIN
=> INSERT INTO orders ...
=> INSERT INTO order_items ...
=> INSERT INTO order_items ...
   ...
=> COMMIT / ROLLBACK
```

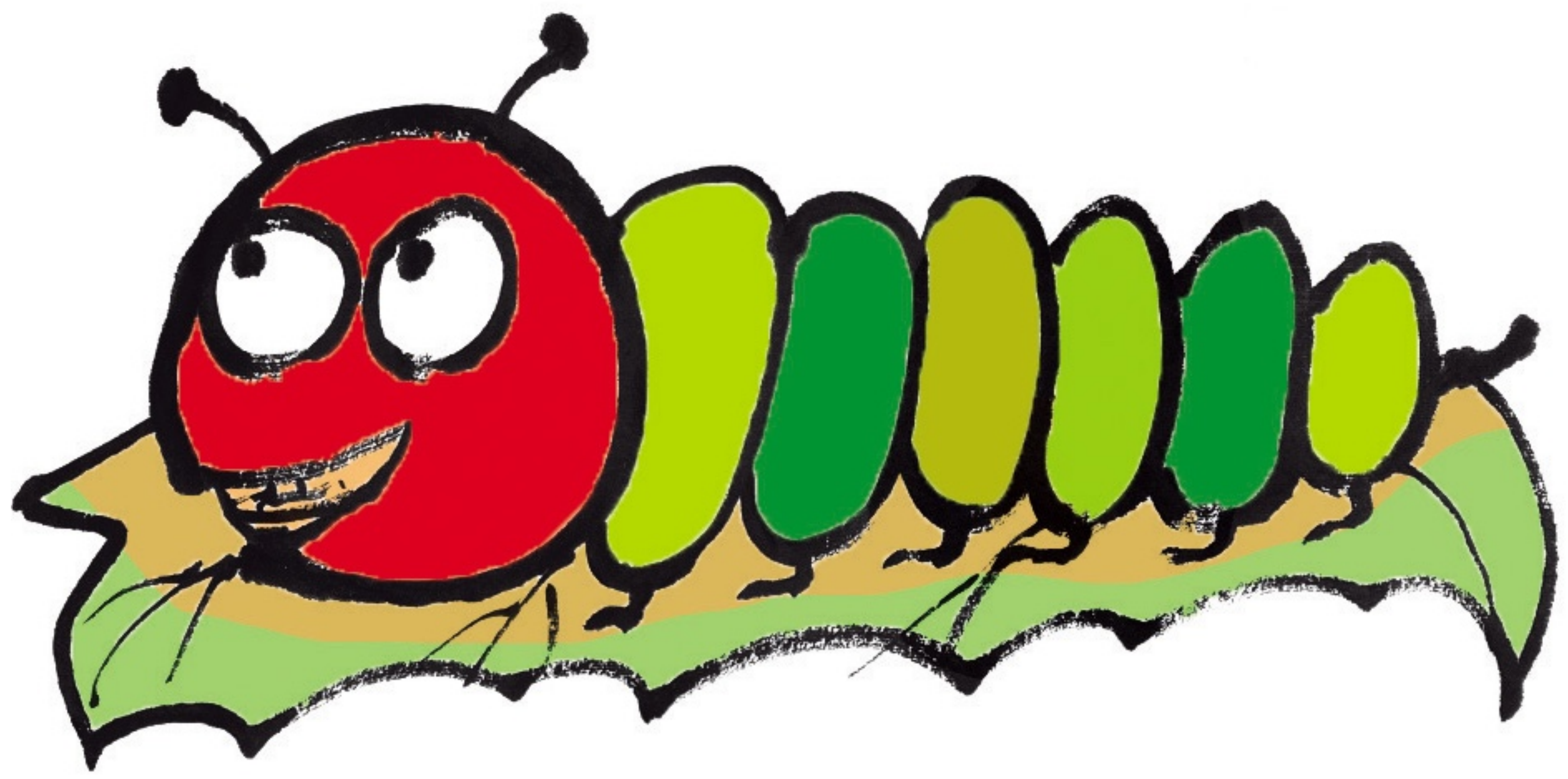
Tuesday

Slow Transactions

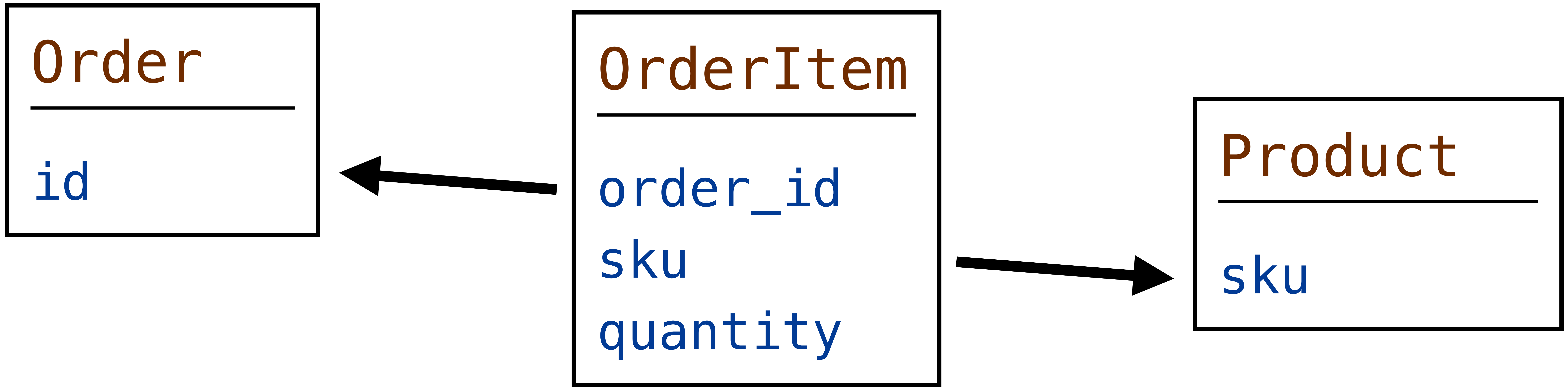


“

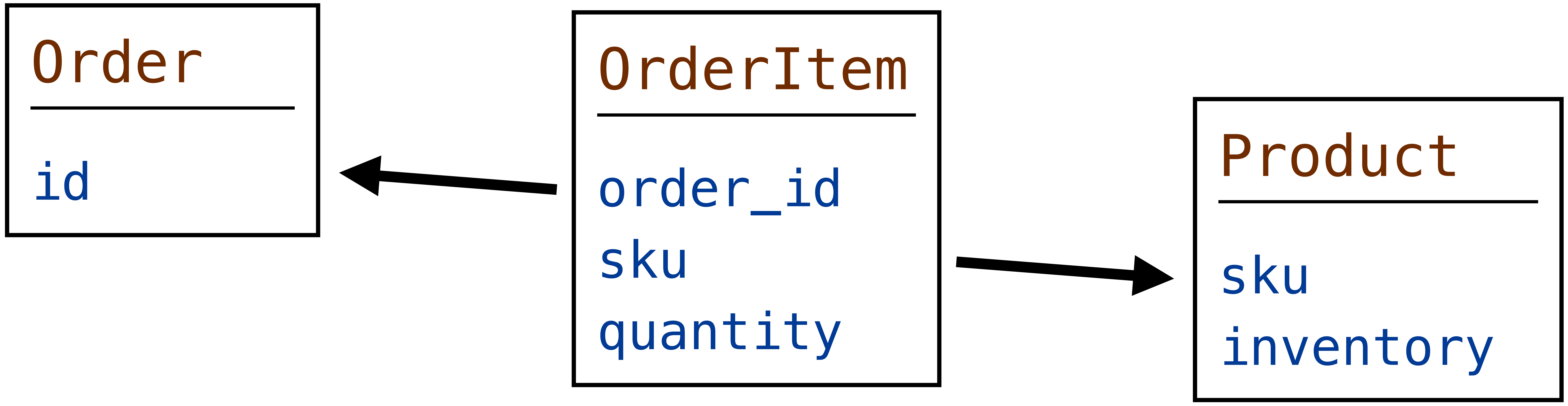
I was so excited about my order, but it was canceled and now the items are not available.



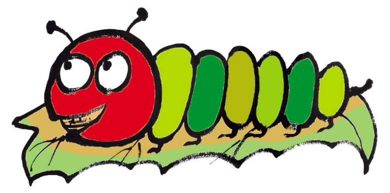
Tuesday



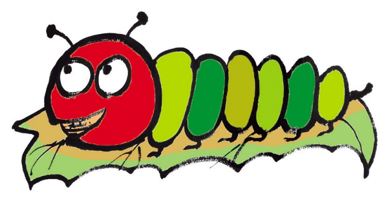
Tuesday


Order
id
OrderItem
order_id
sku
quantity
Product
sku
inventory

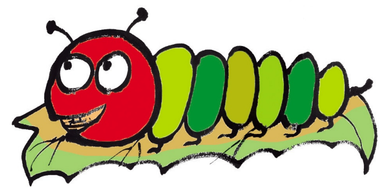
Tuesday



```
def submit
  @order.save!
end
```

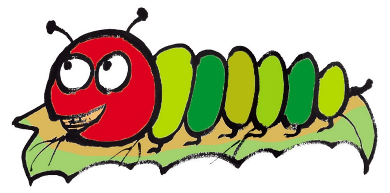
Tuesday 

```
def submit
  @order.save!
  @order.update_product_inventory
end
```

Tuesday 

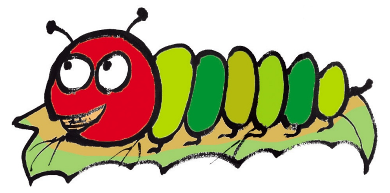
```
=> UPDATE products
```

Tuesday

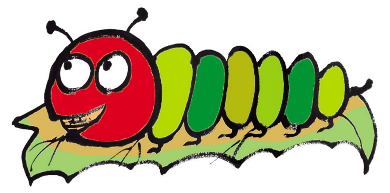


```
=> UPDATE products
   SET inventory = inventory - :order_item_quantity
```

Tuesday

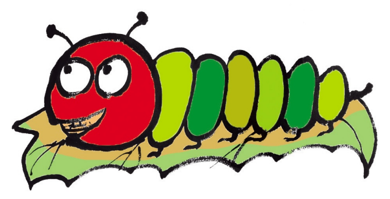


```
=> UPDATE products
   SET inventory = inventory - :order_item_quantity
   WHERE sku = :order_item_sku
```

Tuesday 

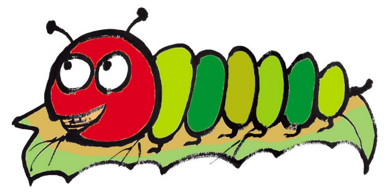
```
=> UPDATE products
   SET inventory = inventory - :order_item_quantity
   WHERE sku = :order_item_sku

=> UPDATE products ...
```

Tuesday



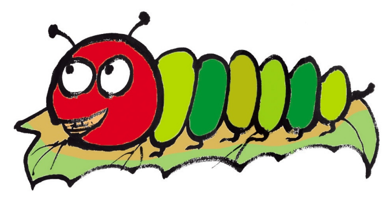
```
=> UPDATE products
   SET inventory = inventory - :order_item_quantity
   WHERE sku = :order_item_sku

=> UPDATE products ...

=> UPDATE products ...
```

Tuesday



```
=> UPDATE products
   SET inventory = inventory - :order_item_quantity
   WHERE sku = :order_item_sku

=> UPDATE products ...

=> UPDATE products ...

=> UPDATE products ...
```

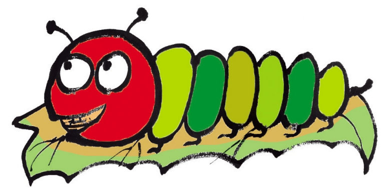
Tuesday



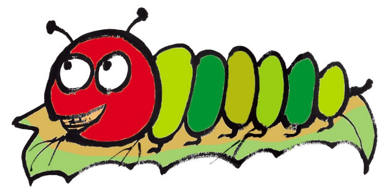
```
def submit
  @order.save!
  @order.update_product_inventory
end
```

Should be Atomic

Tuesday



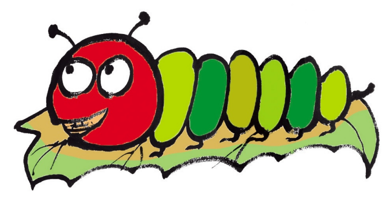
```
def submit
  Order.transaction do
    @order.save!
    @order.update_product_inventory
  end
end
```

Tuesday 

```
=> BEGIN
=> INSERT INTO orders ...
=> INSERT INTO order_items ...
=> INSERT INTO order_items ...
   ...
=> UPDATE products ...
=> UPDATE products ...
   ...
=> COMMIT
```

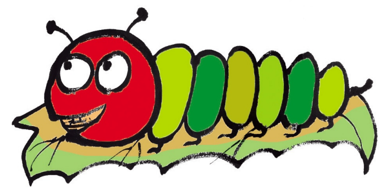
🚨Bug Report

Increased 500 responses for placing orders

Tuesday 

Lock Contention 🔒🤼

Tuesday



Lock Contention 🔒🤼

Bug 1

Bug 2

Tuesday 🐛

Lock Contention 🔒🤼

Bug 1

```
=> BEGIN
```

Bug 2

```
=> BEGIN
```

Tuesday

Lock Contention 🔒🤼

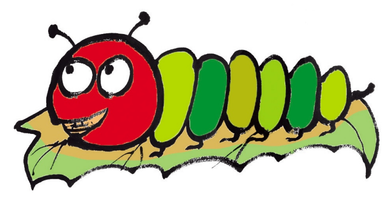
Bug 1

```
=> BEGIN
=> UPDATE ... sku = APL1
```

Bug 2

```
=> BEGIN
=> UPDATE ... sku = APL1
```

Tuesday



Lock Contention 🔒🤼

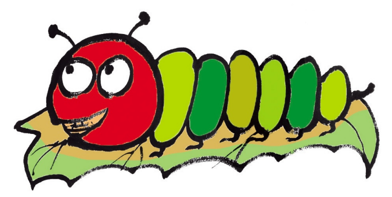
Bug 1

```
=> BEGIN
=> UPDATE ... sku = APL1
   🔒Row locked ...
```

Bug 2

```
=> BEGIN
=> UPDATE ... sku = APL1
   Waiting ...
```

Tuesday



Lock Contention 🔒🤼

Bug 1

```
=> BEGIN
=> UPDATE ... sku = APL1
```

🔒Row locked ...

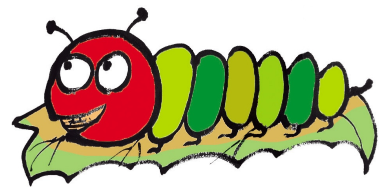
🔒Row locked ...

Bug 2

```
=> BEGIN
=> UPDATE ... sku = APL1
```

Waiting ...

Waiting ...

Tuesday 

Lock Contention 🔒🤼

<u>Bug 1</u>

```
=> BEGIN
=> UPDATE ... sku = APL1
```

🔒Row locked ...

🔒Row locked ...

🔒Row locked ...

<u>Bug 2</u>

```
=> BEGIN
=> UPDATE ... sku = APL1
```

Waiting ...

Waiting ...

Waiting ...

Tuesday

Lock Contention 🔒🤼

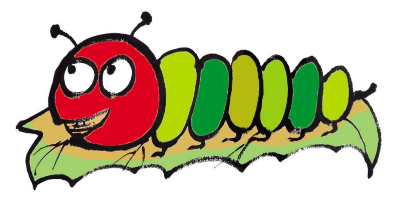
<u>Bug 1</u>

```
=> BEGIN
=> UPDATE ... sku = APL1
     🔒Row locked ...
     🔒Row locked ...
     🔒Row locked ...
=> COMMIT
```

<u>Bug 2</u>

```
=> BEGIN
=> UPDATE ... sku = APL1
     Waiting ...
     Waiting ...
     Waiting ...
     🔒Row locked ...
```

Tuesday

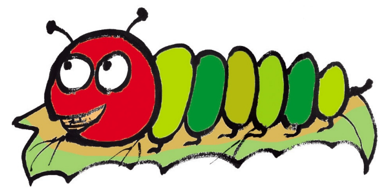


Little Opportunity for Contention

```
=> BEGIN
=> UPDATE products ... WHERE sku = APL1
=> UPDATE products ... WHERE sku = ORG5
=> COMMIT
```

< 1 millisecond

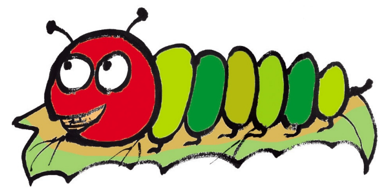
Tuesday



Large Opportunity for Contention

```
=> BEGIN
=> UPDATE products ... WHERE sku = APL1


=> UPDATE products ... WHERE sku = ORG5


=> COMMIT
```

> 1 second

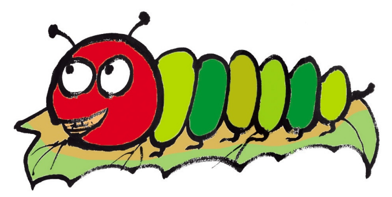
Tuesday 

Large Opportunity for Contention

```
=> BEGIN
=> UPDATE products ... WHERE sku = APL1


=> UPDATE products ... WHERE sku = ORG5



=> COMMIT
```

Slow Queries

Tuesday



Large Opportunity for Contention

```
=> BEGIN
=> UPDATE products ... WHERE sku = APL1
=> UPDATE products ... WHERE sku = PLM3
=> UPDATE products ... WHERE sku = BRY4
=> UPDATE products ... WHERE sku = PER2
                   ... (hundreds more)
=> UPDATE products ... WHERE sku = ORG5
=> COMMIT
```

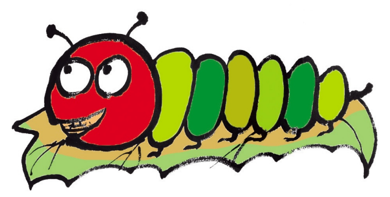
Too Many Queries

Tuesday

Large Opportunity for Contention

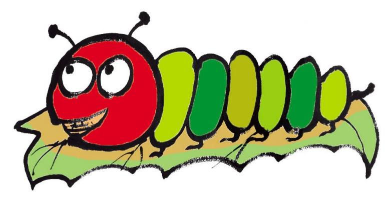
```
=> BEGIN
=> UPDATE products ... WHERE sku = APL1
=> UPDATE products ... WHERE sku = PLM3
=> UPDATE products ... WHERE sku = BRY4
=> UPDATE products ... WHERE sku = PER2
                   ... (hundreds more)
=> UPDATE products ... WHERE sku = ORG5
=> COMMIT
```

Waiting on Locks

Tuesday 

```
def submit
  Order.transaction do
    @order.save!
    @order.update_product_inventory
  end
end
```

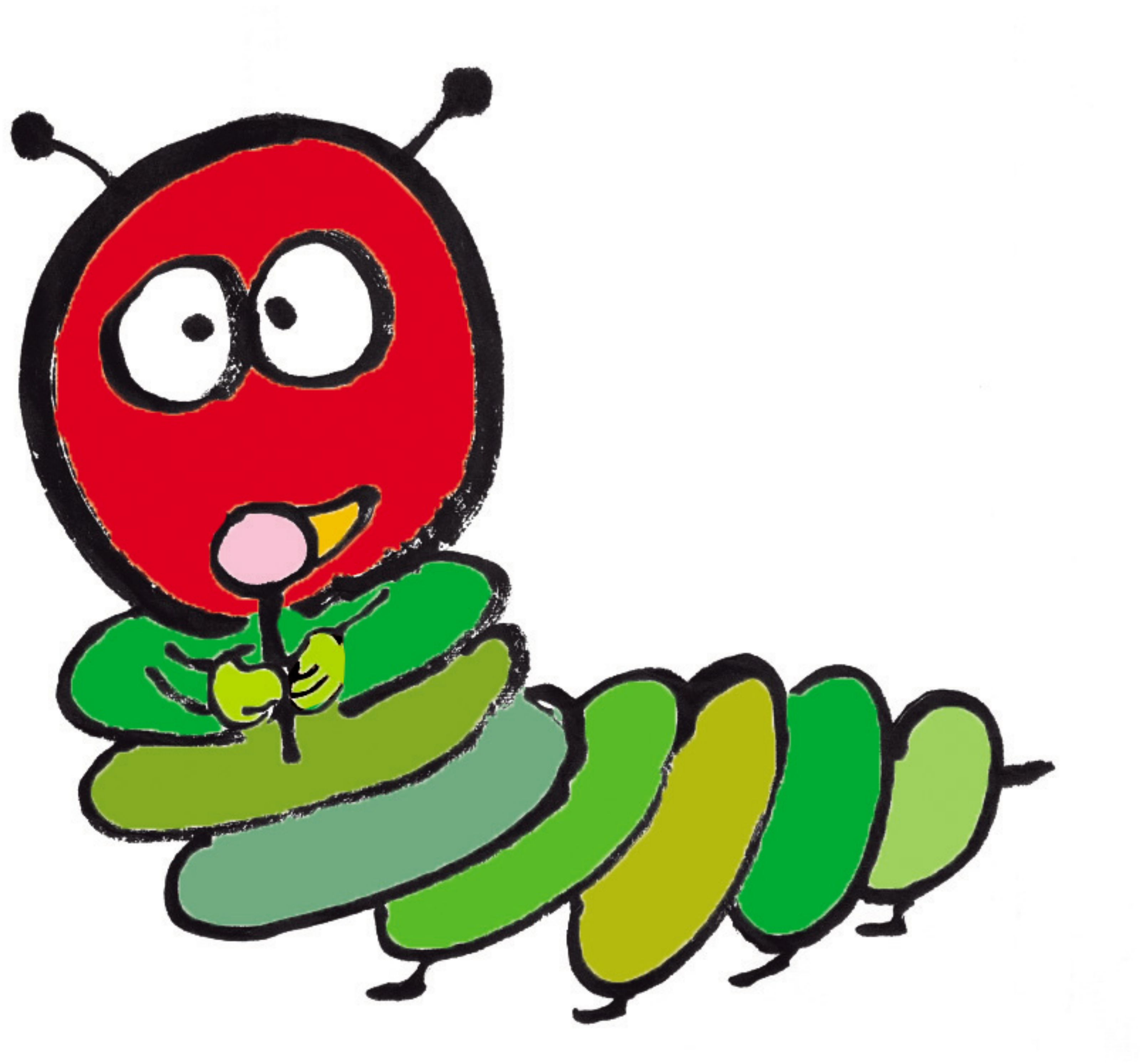
Tuesday



```
def submit
  Order.transaction do
    @order.save!
    ~~@order.update_product_inventory~~
  end
end
```

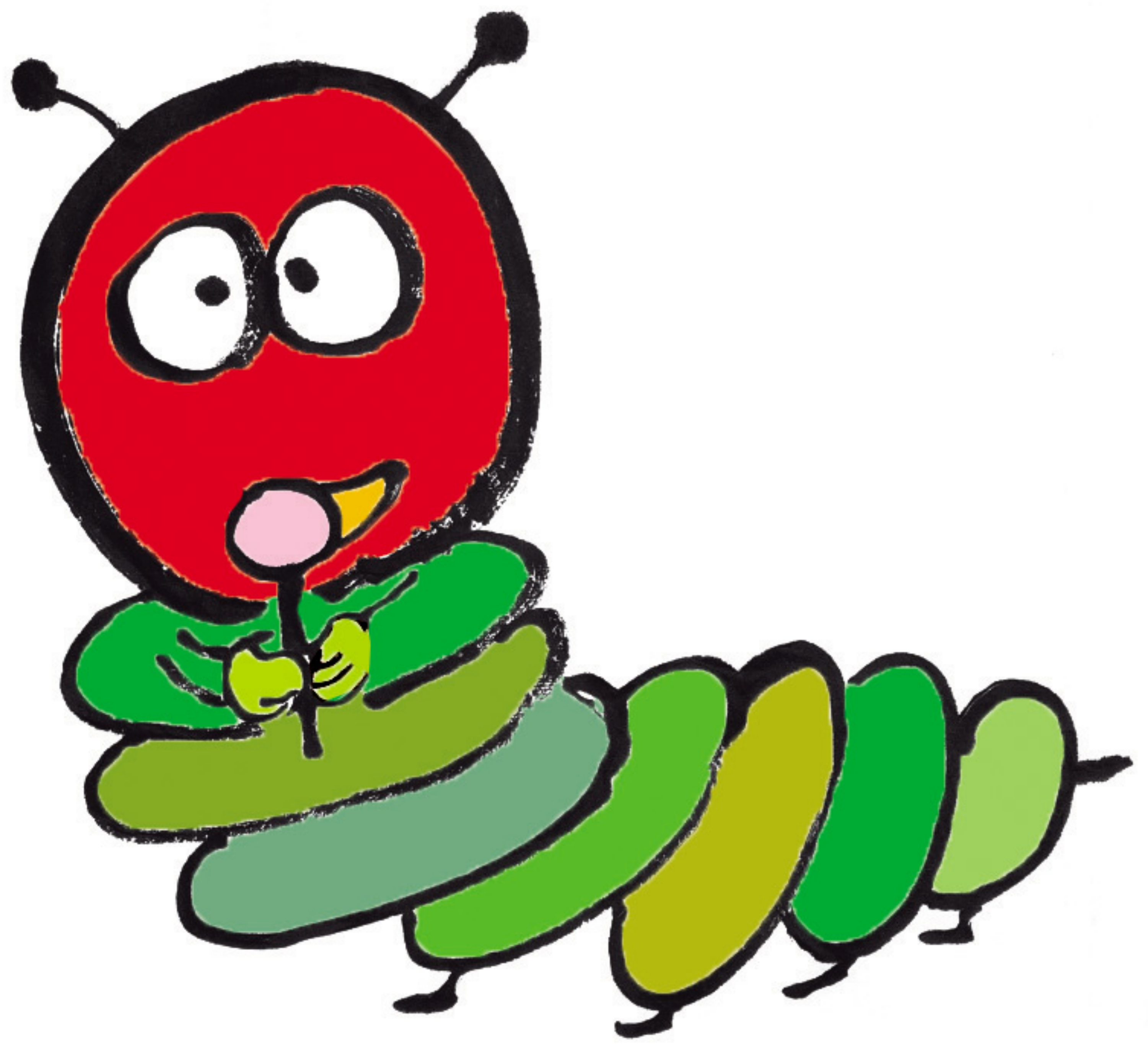
Wednesday

Background Jobs

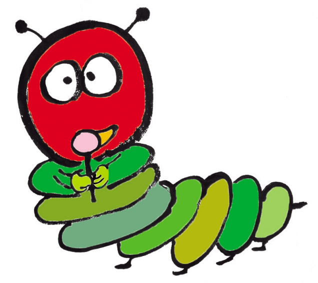


“

I don’t have time to waste. I want my orders to submit without delay.

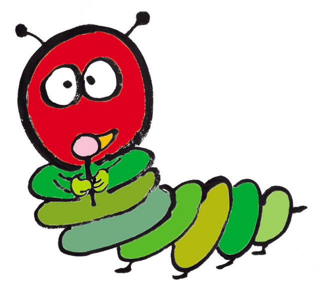


Wednesday



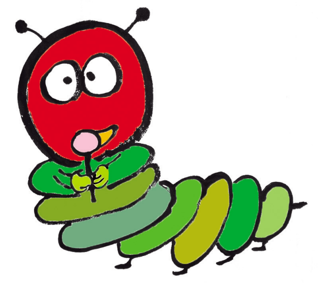
```
class Order < ApplicationRecord
  after_create :finalize_order
end
```

Wednesday



```
class Order < ApplicationRecord
  after_create :finalize_order

  def finalize_order
    # Sync with billing platform
    # Send confirmation email
    # etc.
  end
end
```

Wednesday

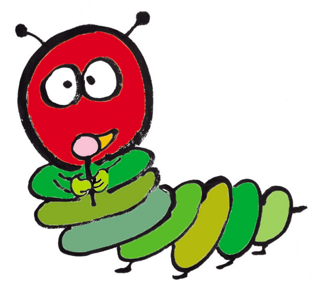


```
class Order < ApplicationRecord
  after_create :finalize_order

  def finalize_order
    OrderFinalizationJob.perform_later
  end
end
```

🚨Bug Report

Confirmation emails delayed by minutes

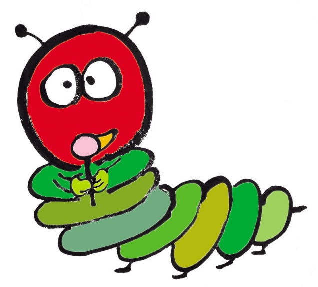
Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
```

=> Enqueue Job

Wednesday

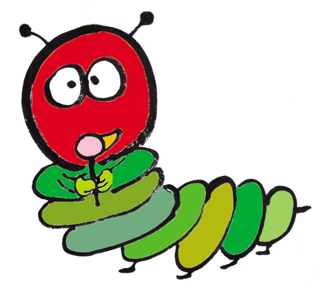


```
=> BEGIN
=> INSERT INTO orders ...
```

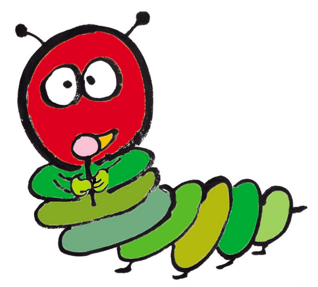
=> Enqueue Job

=> Job Executes and Fails

Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
                                   =>  Enqueue Job
                                   =>  Job Executes and Fails
=> UPDATE products ...
```

Wednesday 

```
=> BEGIN
=> INSERT INTO orders ...
```

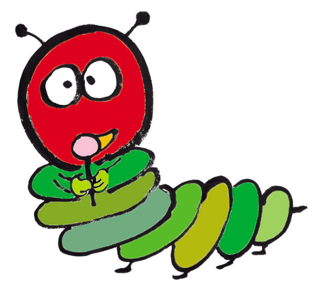
=> Enqueue Job

=> Job Executes and Fails

```
=> UPDATE products ...
```

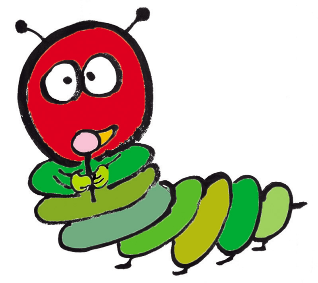
=> Job Retries and Fails

Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
                                   =>  Enqueue Job
                                   =>  Job Executes and Fails
=> UPDATE products ...
                                   =>  Job Retries and Fails
=> COMMIT
```

Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
```

=> Enqueue Job

=> Job Executes and Fails

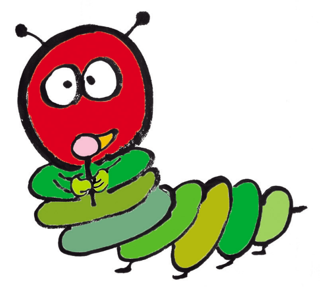
```
=> UPDATE products ...
```

=> Job Retries and Fails

```
=> COMMIT
```

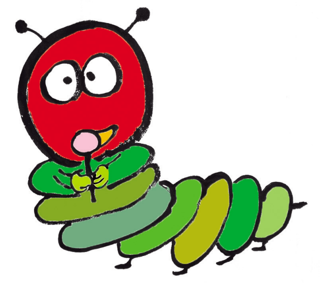
=> Job Retries and Succeeds

Wednesday



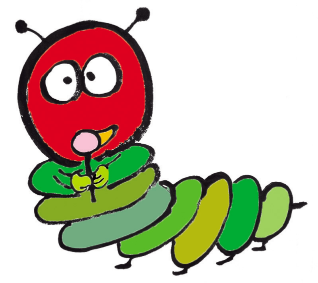
```
=> BEGIN
=> INSERT INTO orders ...
                                       =>  Enqueue Job
                                       =>  Job Executes and Fails
=> UPDATE products ...
                                       =>  Job Retries and Fails
=> ROLLBACK
```

Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
                                        =>  Enqueue Job
                                        =>  Job Executes and Fails
=> UPDATE products ...
                                        =>  Job Retries and Fails
=> ROLLBACK
                                        =>  Job Retries and Fails
```

Wednesday



```
=> BEGIN
=> INSERT INTO orders ...
```

=> Enqueue Job

=> Job Executes and Fails

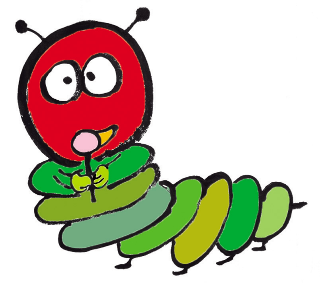
```
=> UPDATE products ...
```

=> Job Retries and Fails

```
=> ROLLBACK
```

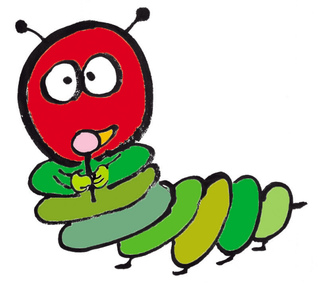
=> Job Retries and Fails

=> Job Retries and Fails

Wednesday 

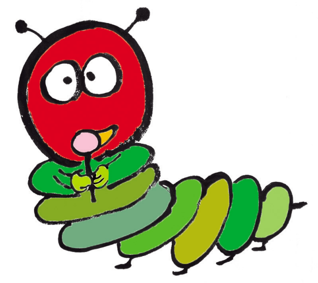
```
class Order < ApplicationRecord
  after_create :finalize_order

  def finalize_order
    OrderFinalizationJob.perform_later
  end
end
```

Wednesday



```
class Order < ApplicationRecord
  after_create_commit :finalize_order

  def finalize_order
    OrderFinalizationJob.perform_later
  end
end
```

Wednesday



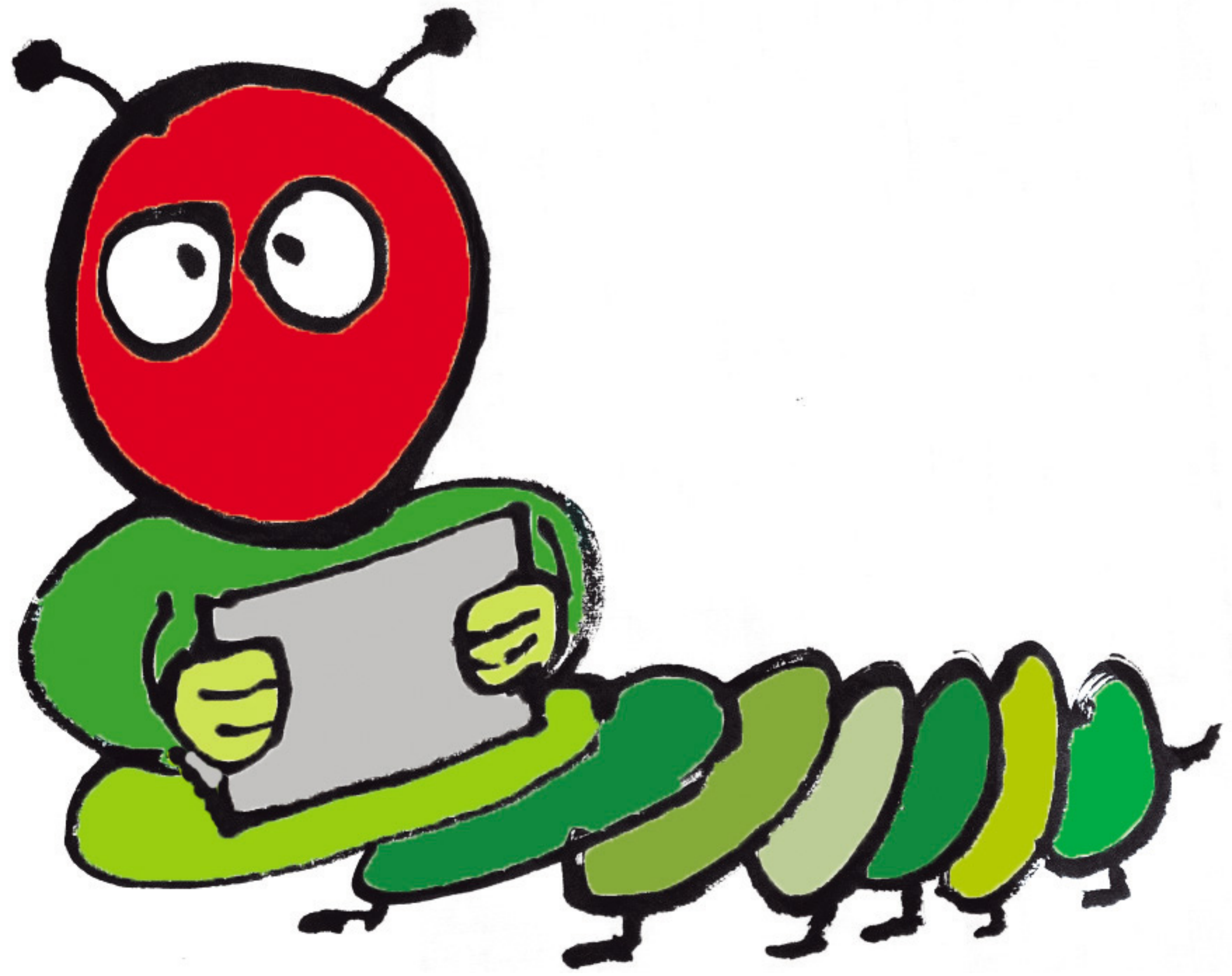
```
=> BEGIN
=> INSERT INTO orders ...
=> UPDATE products ...
=> COMMIT
```

=> Enqueue Job

=> Job Executes and Succeeds

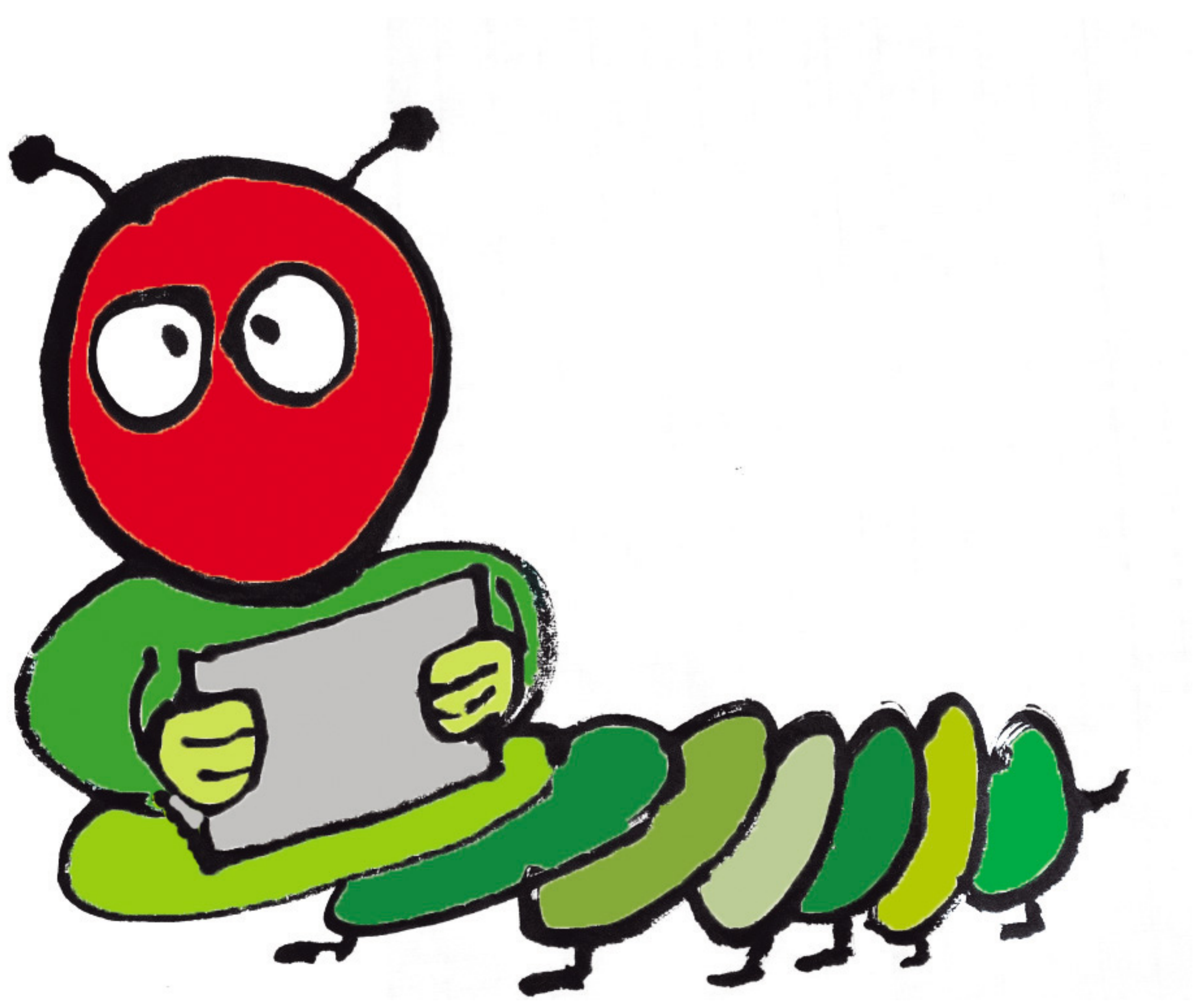
Thursday

External Services

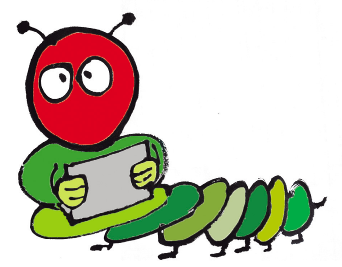


“

I want my orders fulfilled quickly and accurately.

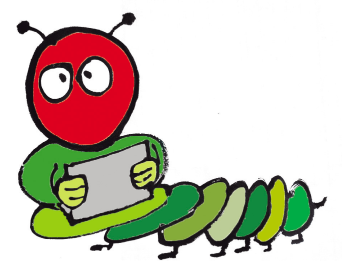


Thursday



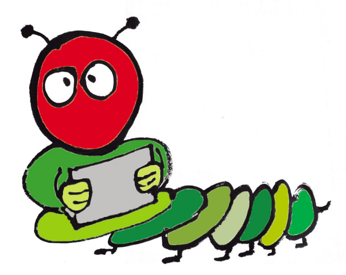
```
def submit
  Order.transaction do
    @order.save!
    @order.update_product_inventory
  end
end
```

Thursday



```
def submit
  Order.transaction do
    @order.save!
    FulfillmentClient.submit_order(@order)
    @order.update_product_inventory
  end
end
```

Thursday



```
=> BEGIN
=> INSERT INTO orders ...
                                   =>  External Call
=> UPDATE products ...
=> COMMIT
```

🚨 Bug Report

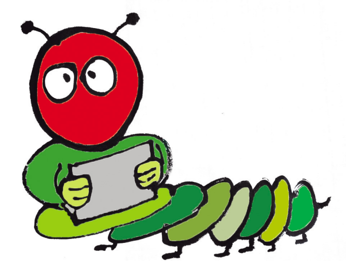
Site-wide failure

Thursday

```
def submit
  Order.transaction do
    @order.save!
    FulfillmentClient.submit_order(@order)
    @order.update_product_inventory
  end
end
```

Responding Slowly

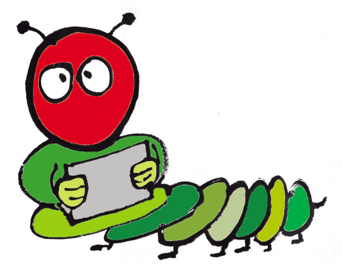
Thursday



```
=> BEGIN
=> INSERT INTO orders ...



=> UPDATE products ...
=> COMMIT / ROLLBACK
```

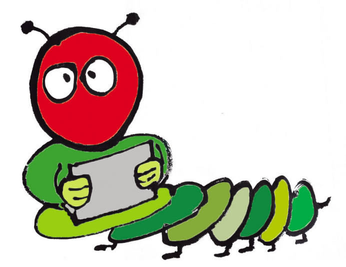
Slow External Call

Thursday

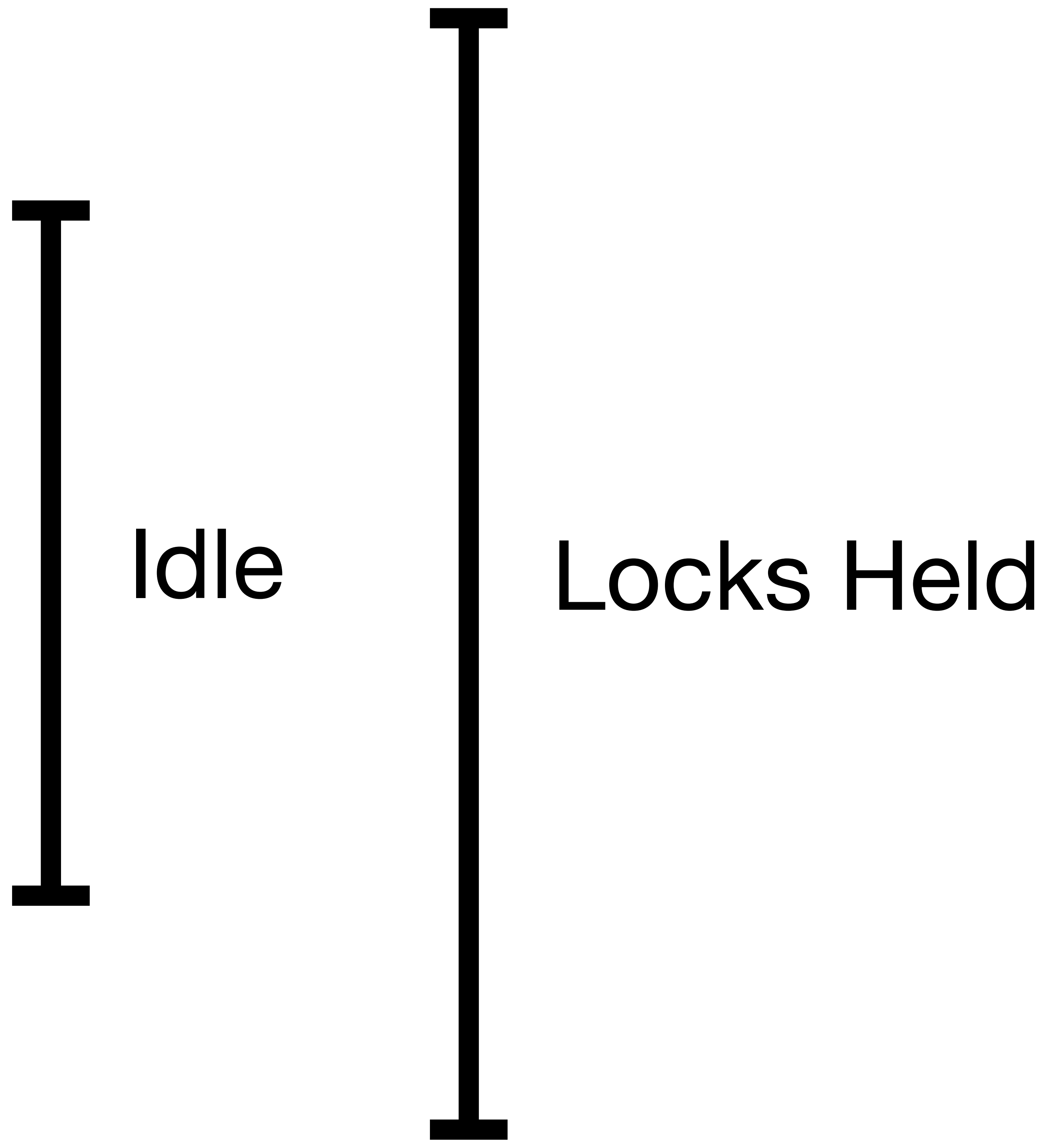


```
=> BEGIN
=> INSERT INTO orders ...
                              Idle
=> UPDATE products ...
=> COMMIT / ROLLBACK
```

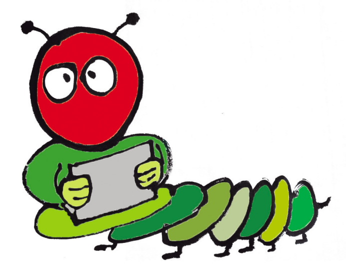
Thursday



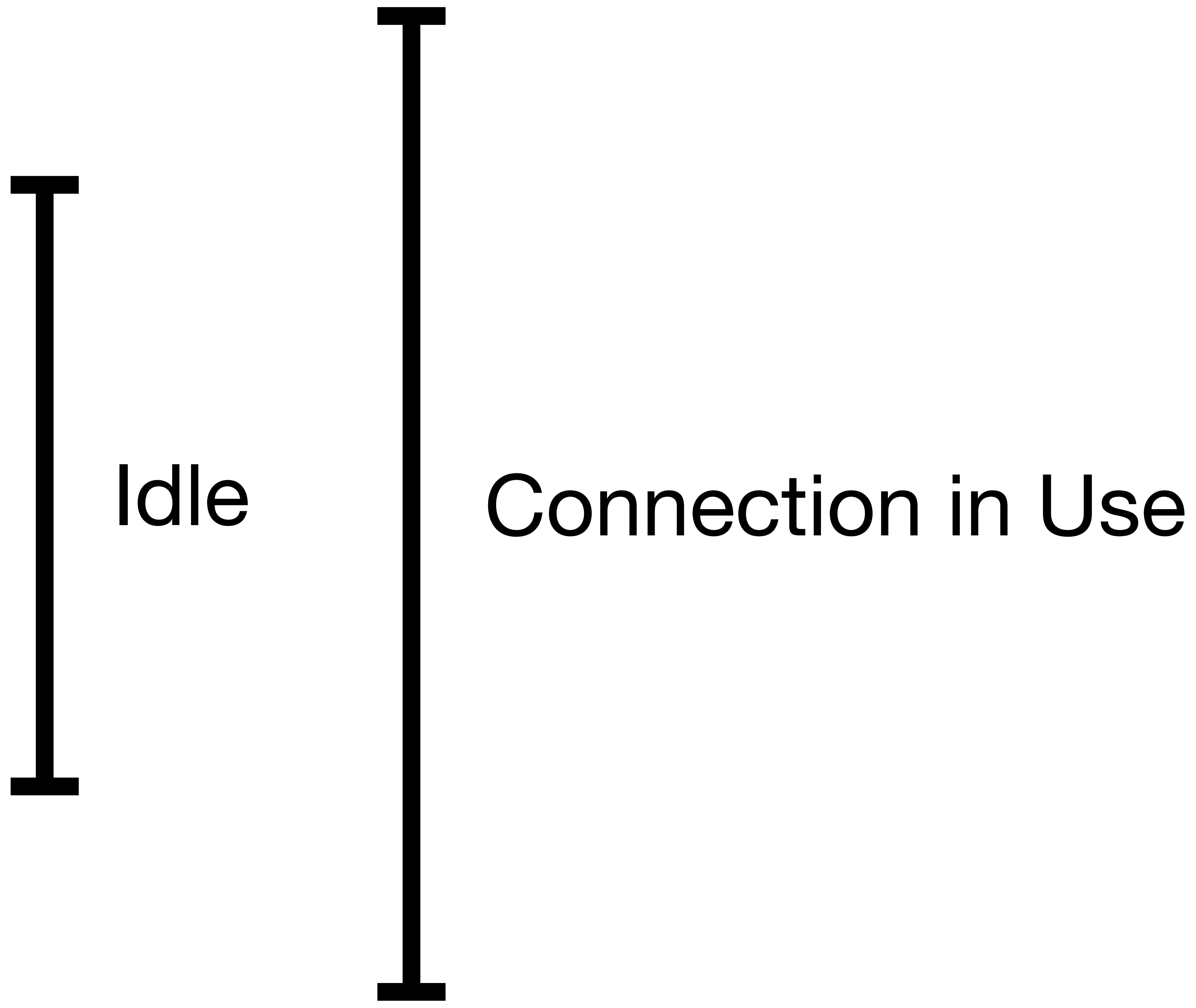
```
=> BEGIN
=> INSERT INTO orders ...



=> UPDATE products ...
=> COMMIT / ROLLBACK
```



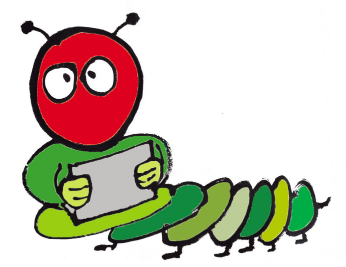
Thursday



```
=> BEGIN
=> INSERT INTO orders ...




=> UPDATE products ...
=> COMMIT / ROLLBACK
```

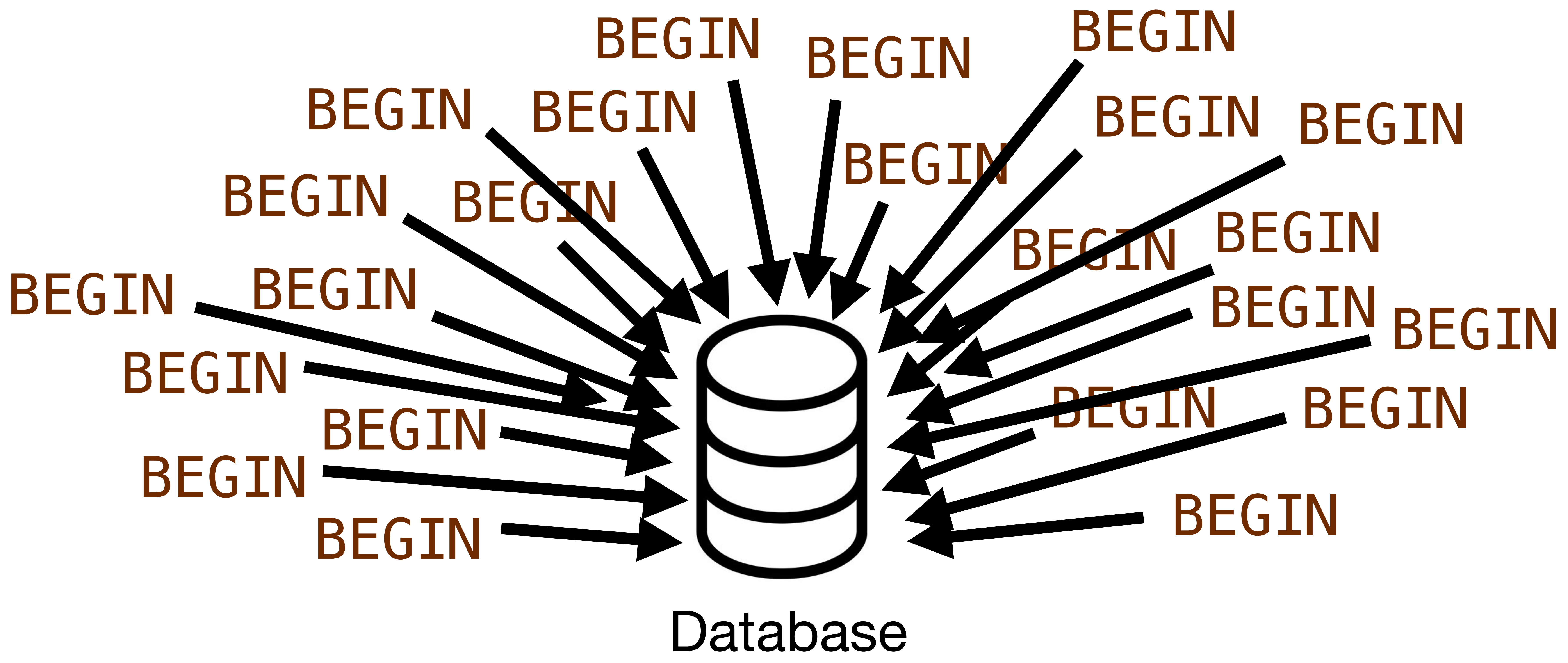


Thursday



Database

Thursday


BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
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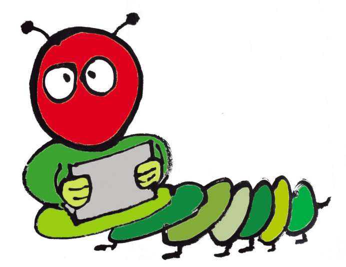
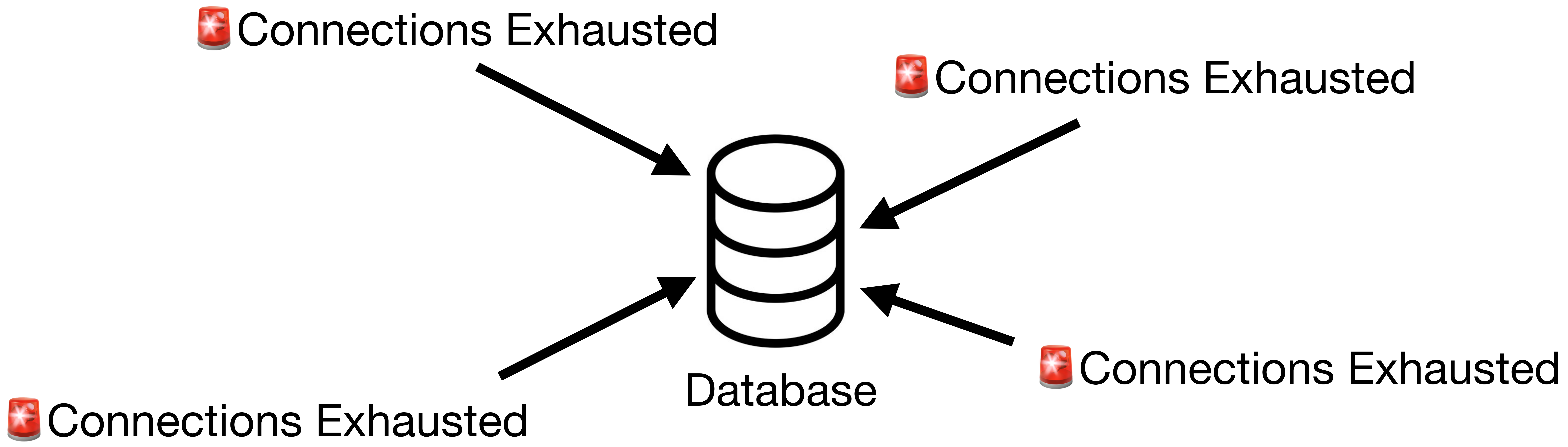
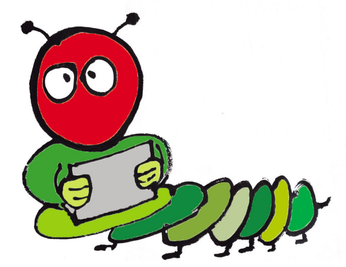
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
BEGIN
Database

Thursday 

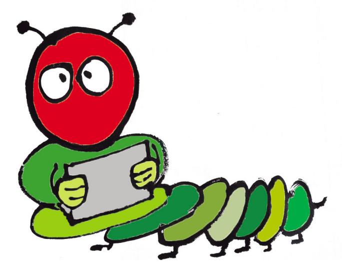

🚨Connections Exhausted
🚨Connections Exhausted
🚨Connections Exhausted
🚨Connections Exhausted
Database

Thursday



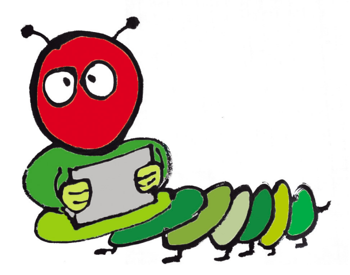
Configure Timeout

```
def submit
  Order.transaction do
    @order.save!
    FulfillmentClient.submit_order(@order)
    @order.update_product_inventory
  end
end
```

Thursday 

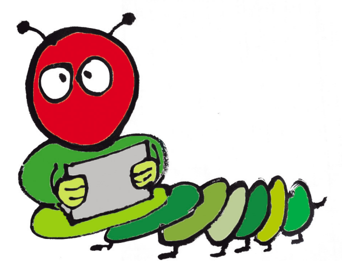
```
def submit
  FulfillmentClient.submit_order(@order)

  Order.transaction do
    @order.save!
    ~~FulfillmentClient.submit_order(@order)~~
    @order.update_product_inventory
  end
end
```

Thursday



```
def submit
  Order.transaction do
    @order.save!
    ~~FulfillmentClient.submit_order(@order)~~
    @order.update_product_inventory
  end

  FulfillmentClient.submit_order(@order)
end
```

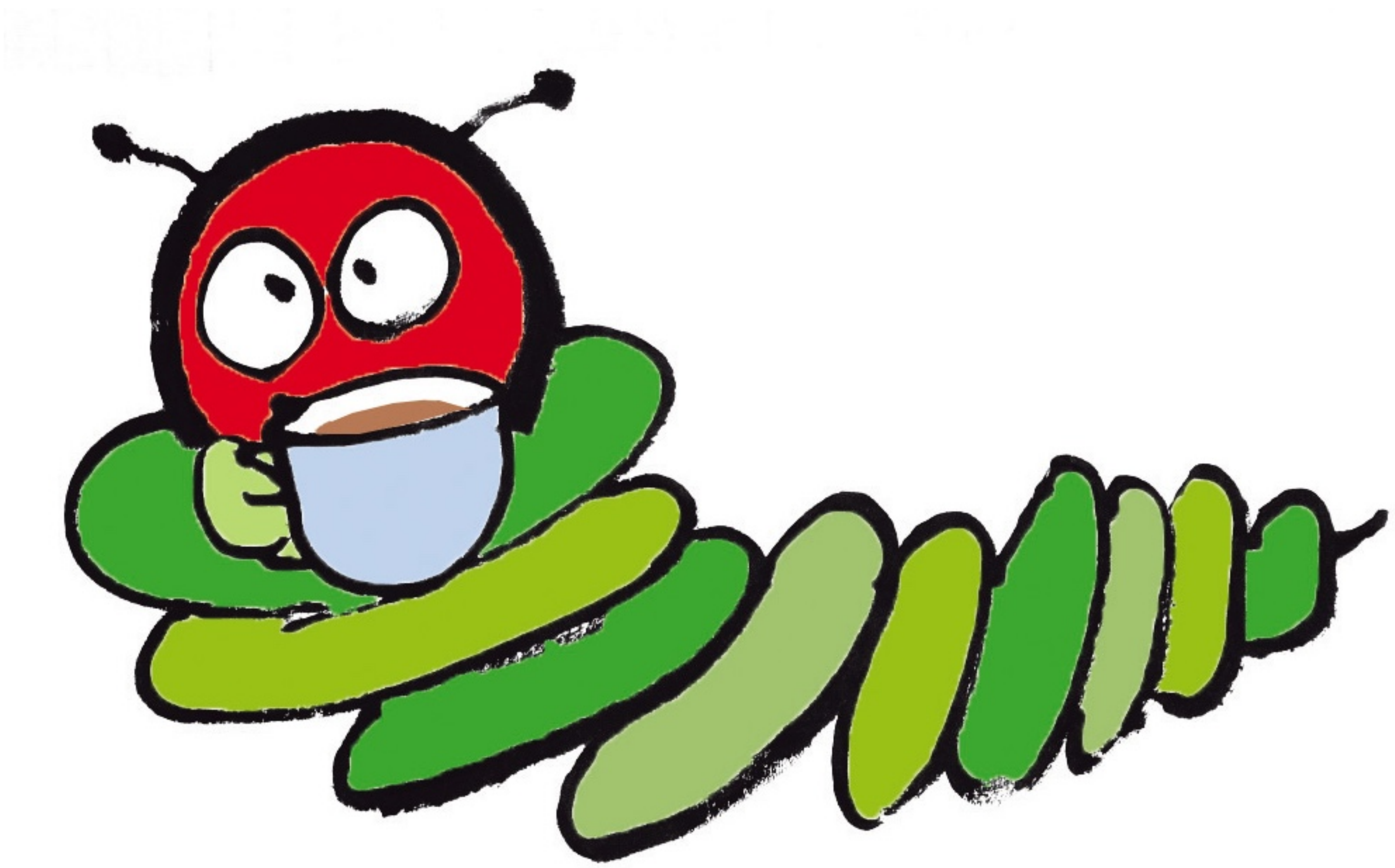
Thursday



```
def submit
  Order.transaction do
    @order.save!
    @order.update_product_inventory
  end

  FulfillmentClient.submit_order(@order)
  @order.update!(status: :submit)
end
```

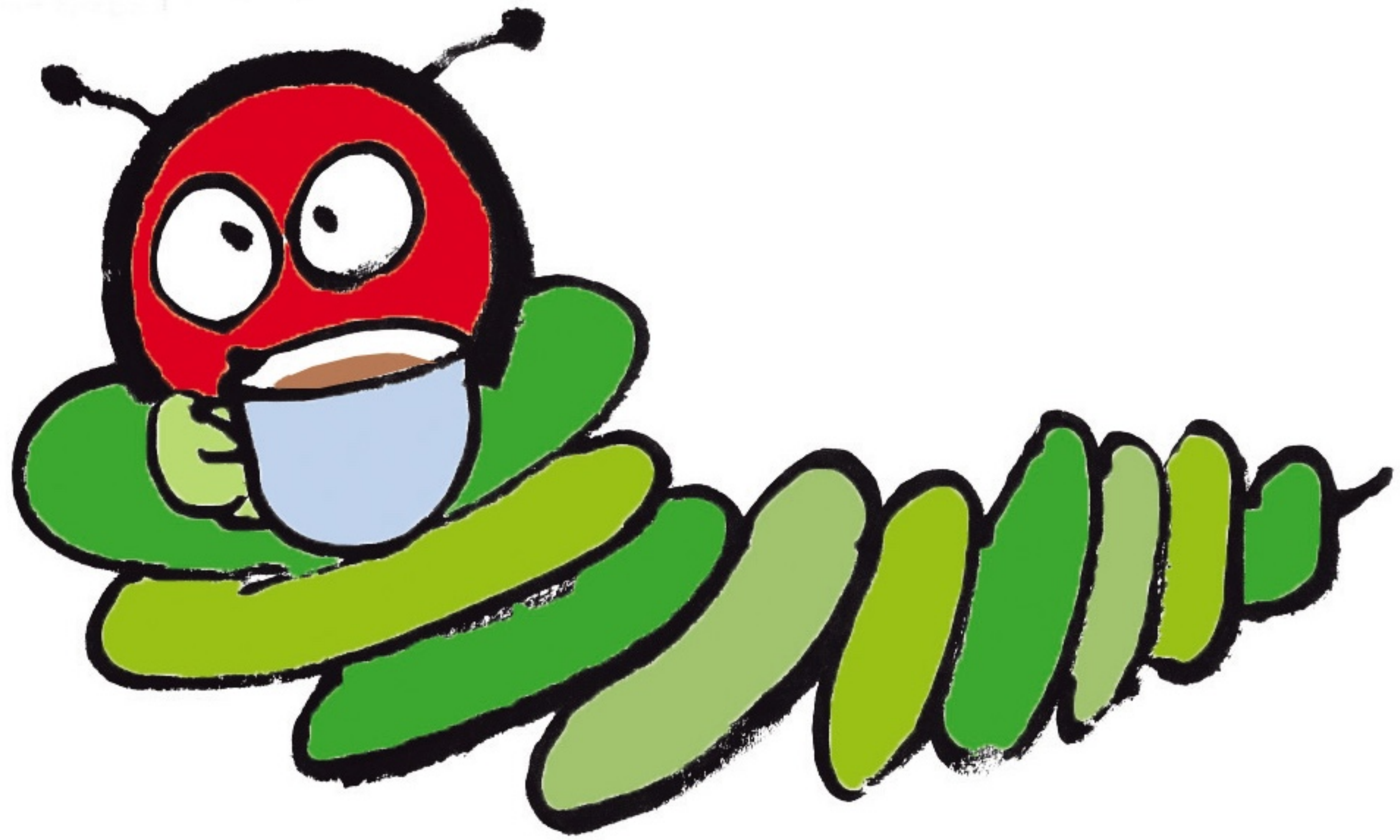
Friday

Multiple Databases

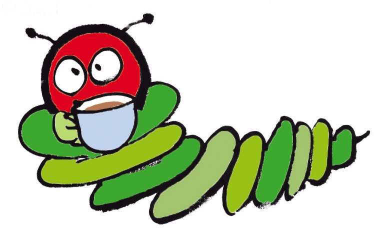


“

I expect a reliable website. BugHub has been having a lot of problems lately.

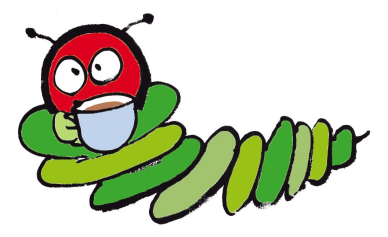


Friday

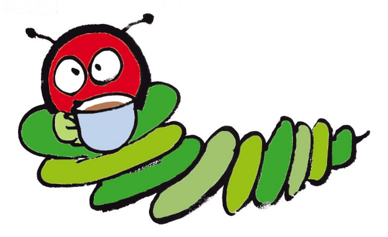


Orders
Products

Friday



```
def submit
  Order.transaction do
    @order.save!
    FulfillmentClient.submit_order(@order)
    @order.update_product_inventory
  end
end
```

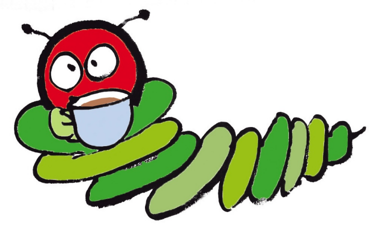
Friday 

```ruby
def submit
  Order.transaction do
    Product.transaction do
      @order.save!
      FulfillmentClient.submit_order(@order)
      @order.update_product_inventory
    end
  end
end
```

🚨Bug Report

All of the above, but worse

Friday



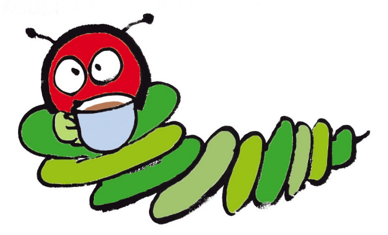
```
def submit
  Order.transaction do
    Product.transaction do
      ...
    end
  end
end
```

← Problems Affect Both Databases

🚨Bug Report

Products incorrectly marked out-of-stock

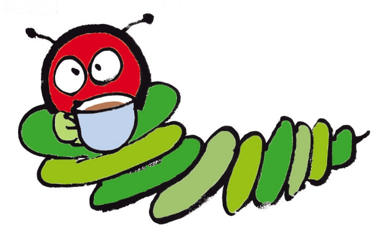
Friday



```
def submit
  Order.transaction do
    Product.transaction do
      ...
    end
  end
end
```

Not Atomic

Friday



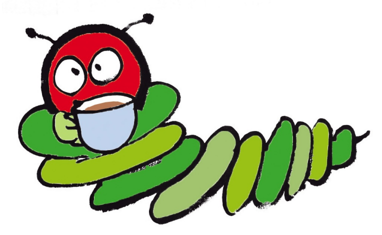
Orders Database

```
=> BEGIN
=> INSERT INTO orders ...



=> COMMIT
```

Products Database

```
=> BEGIN
=> UPDATE products ...
=> COMMIT
```

Both Commit 👍

Friday 

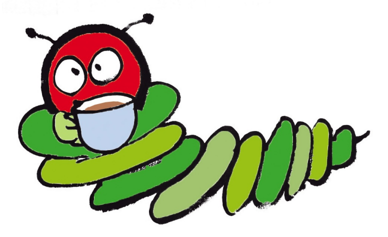
Orders Database

```
=> BEGIN
=> INSERT INTO orders ...



=> ROLLBACK
```

Products Database

```


=> BEGIN
=> UPDATE products ...
=> ROLLBACK
```

Both Rollback 👍

Friday 

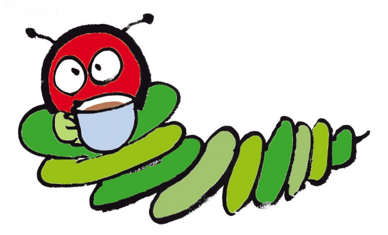
<u>Orders Database</u>

```
=> BEGIN
=> INSERT INTO orders ...



=> ROLLBACK
```

<u>Products Database</u>

```
=> BEGIN
=> UPDATE products ...
=> COMMIT
```

Not Atomic 👎

Friday 

Orders Database

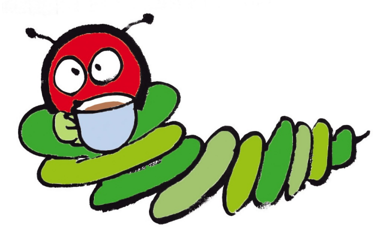
```
=> BEGIN
=> INSERT INTO orders ...
```

Idle

Products Database

```
=> BEGIN
=> UPDATE products ...
=> COMMIT
```

Friday



Orders Database

```
=> BEGIN
=> INSERT INTO orders ...
```

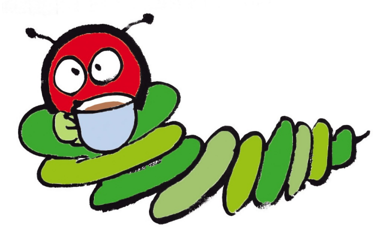
Idle

❌ Connection Failed

Products Database

```
=> BEGIN
=> UPDATE products ...
=> COMMIT
```

Friday

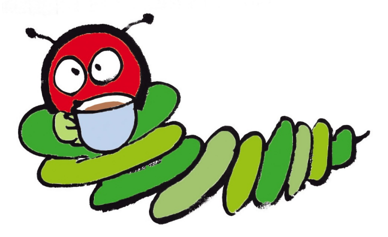


```
def submit
  Order.transaction do
    Product.transaction do
      ...
    end
  end
end
```

Friday

```
def submit
  Product.transaction do
    ...
  end

  Order.transaction do
    ...
  end
end
```

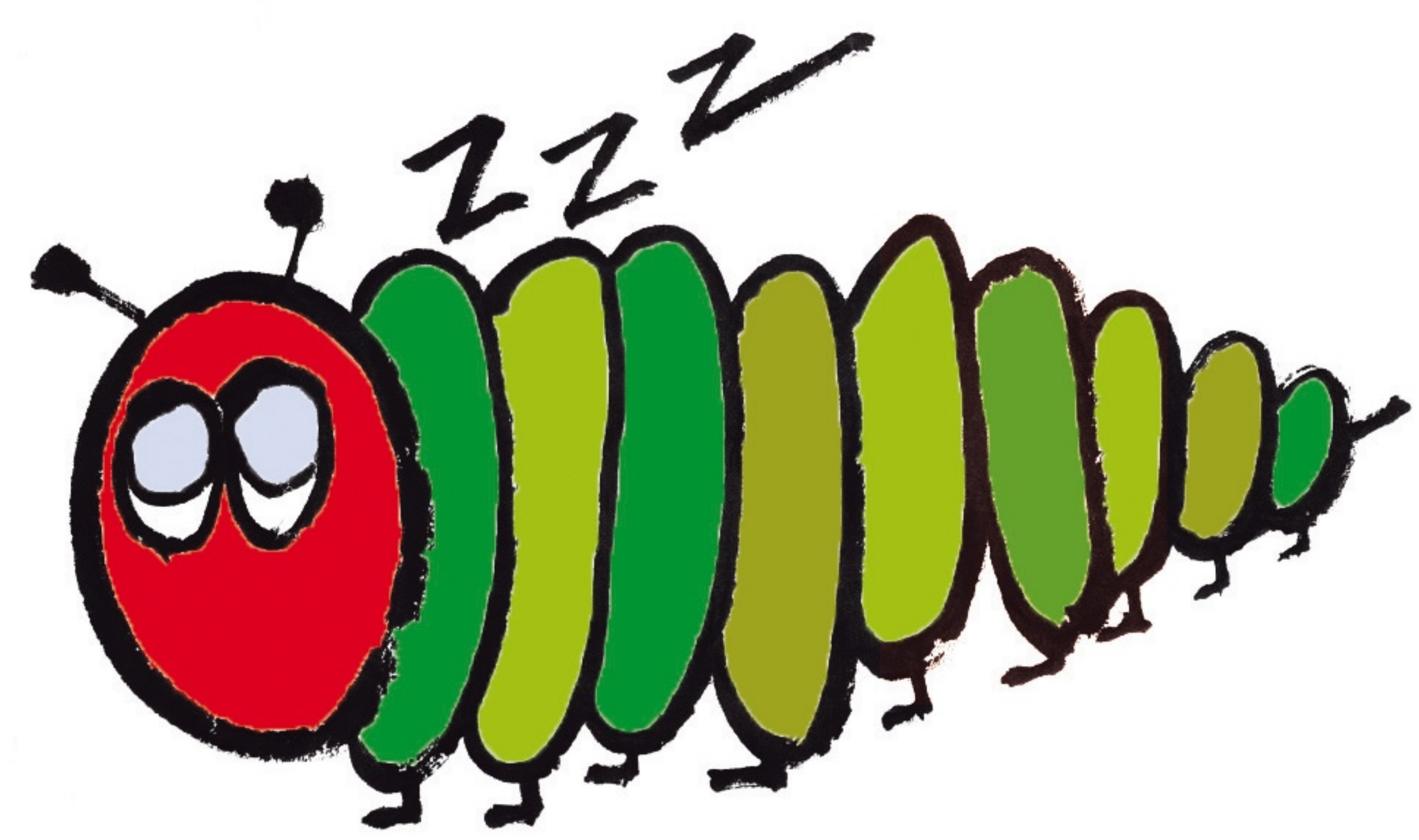
Friday



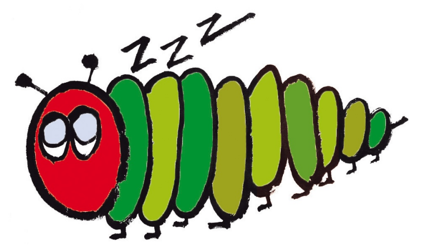
```
def submit
  Order.transaction do
    ...
  end

  Product.transaction do
    ...
  end
end
```

Weekend

Rest and Reflect

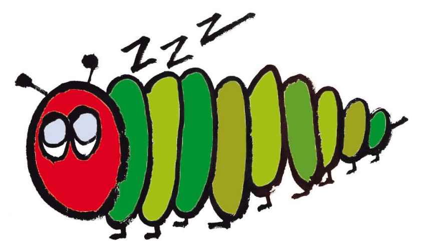


Weekend



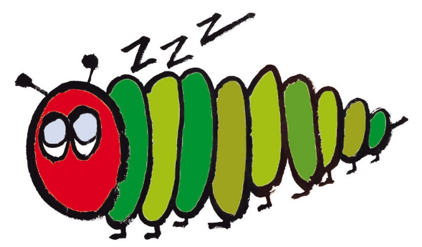
External Calls within Transactions are a Risk

Weekend



External Calls within Transactions are a Risk

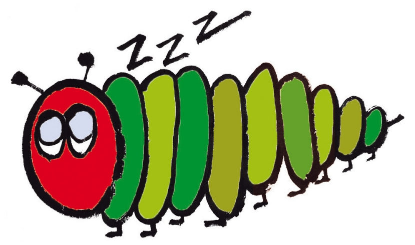
- Data Integrity Problems

Weekend 

External Calls within Transactions are a Risk

- Data Integrity Problems
- Cascading Failures

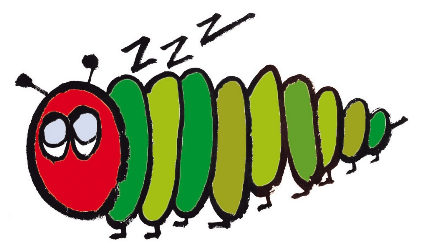
Weekend



External Calls within Transactions are a Risk

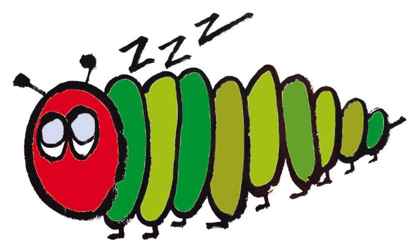
- Data Integrity Problems
- Cascading Failures
- Includes: HTTP requests, emails, jobs, queries to other databases, etc.

Weekend



Slow Transactions are a Risk

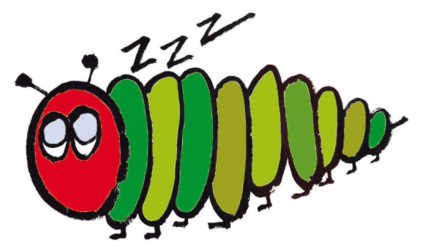
Weekend



Slow Transactions are a Risk

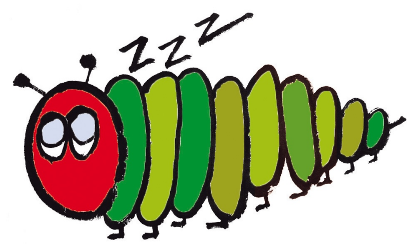
- Slow Requests

Weekend



Slow Transactions are a Risk

- Slow Requests
- Contention

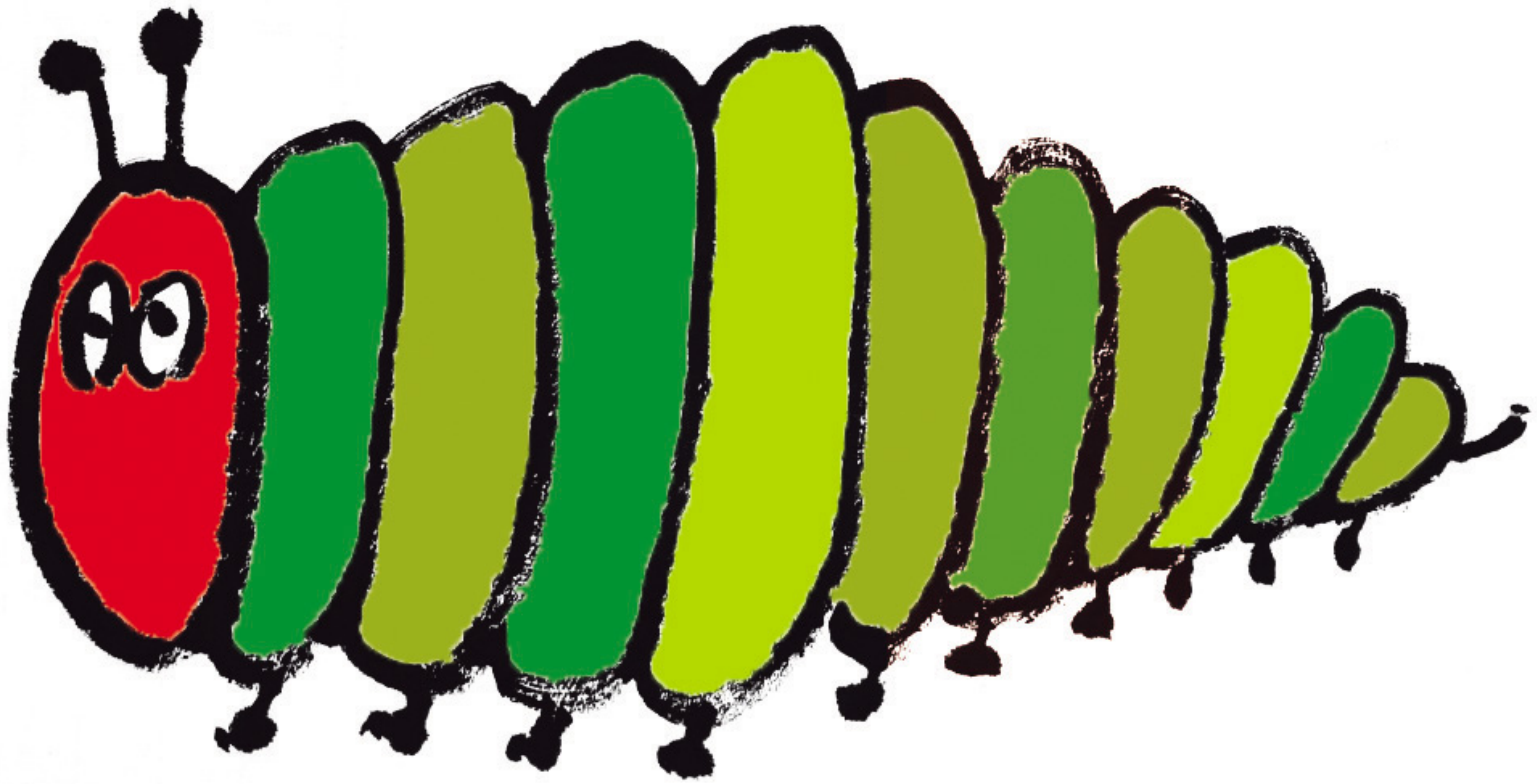
Weekend 

Slow Transactions are a Risk

- Slow Requests
- Contention
- Resource Exhaustion

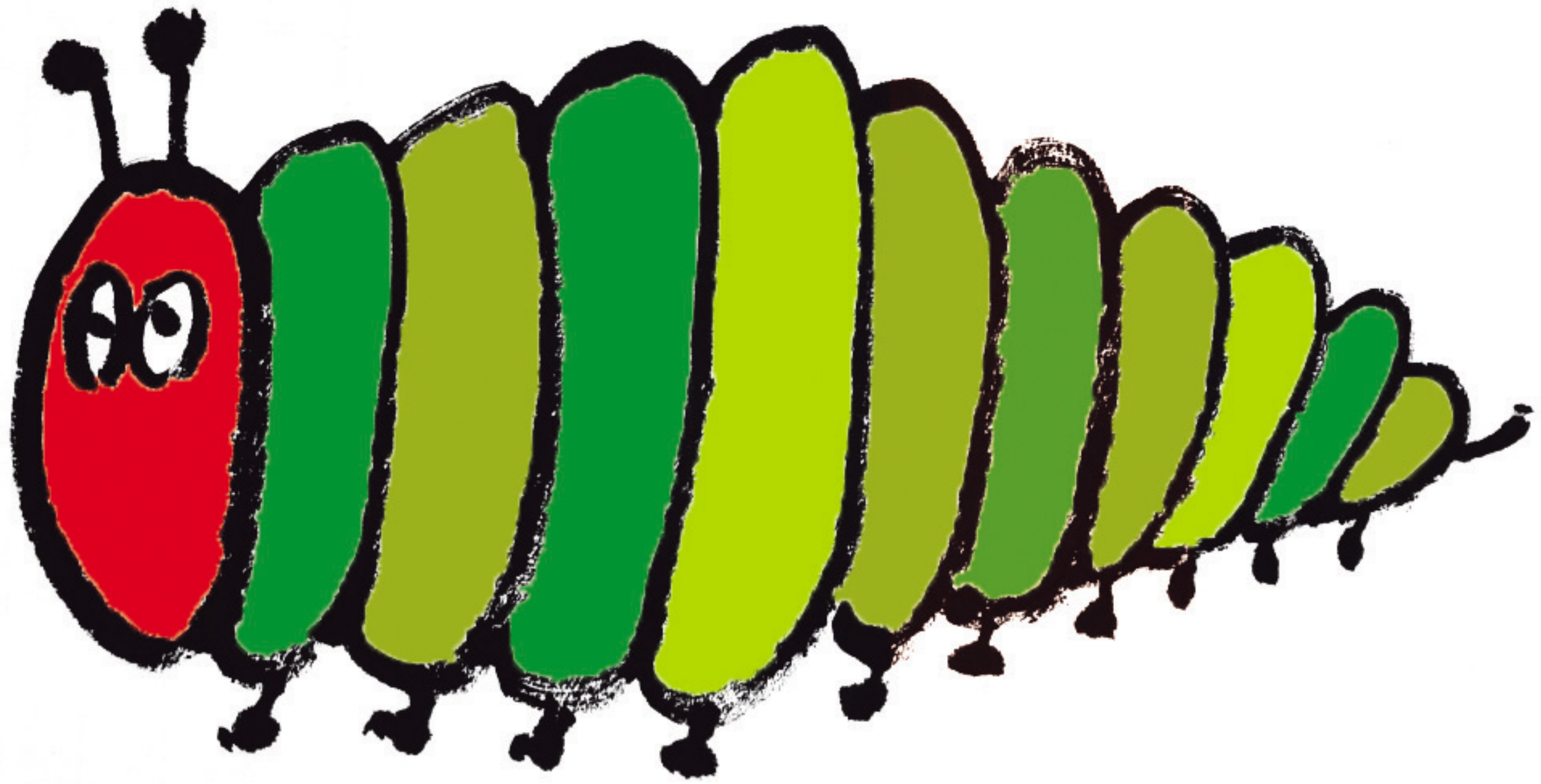
Monday

Metamorphosis

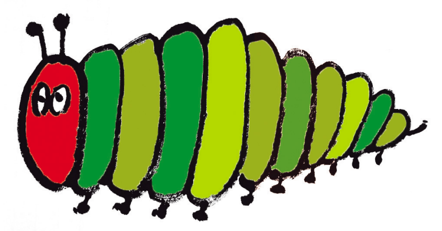


Monday

```
def submit
  Order.transaction do
    Product.transaction do
      Chrysalis.transaction do
        code.not_meant_for_reading!
        @order.save!
        FulfillmentClient.submit_order(@order)
        @order.update_product_inventory

        @product_suggestions = SuggestionService.build_for(@bug)

         seriously.stop_reading_this!
        if @order.bug.caterpillar?
          @bug.very_hungry!
          basket = Chrysalis::Basket.create!(@bug)
          PromotionMailer.new_basket(basket).deliver_later
          @product_suggestions << Chrysalis.default_items_for(@bug)
        else
          @bug.book_suggestions.create!(
            Book.find_by(author: "Eric Carle”, bug: @order.bug)
          )
        end

        @bug.suggest(@product_suggestions)
        @bug.friends.each do |friend|
          @order.share_with(friend) if @bug.sharing_orders?
        end
      rescue => e
        handle_transaction_error(e)
      ensure
        nobody.should_have_read_any_of_this
      end
    end
  end
end
```



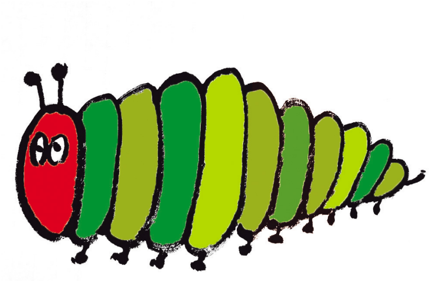
Monday



```
def submit
  Order.transaction do
    Product.transaction do
      Chrysalis.transaction do
        code.not_meant_for_reading!
        @order.save!
        FulfillmentClient.submit_order(@order)
        @order.update_product_inventory

        @product_suggestions = SuggestionService.build_for(@bug)

         seriously.stop_reading_this!
        if @order.bug.caterpillar?
          @bug.very_hungry!
          basket = Chrysalis::Basket.create!(@bug)
          PromotionMailer.new_basket(basket).deliver_later
          @product_suggestions << Chrysalis.default_items_for(@bug)
        else
          @bug.book_suggestions.create!(
            Book.find_by(author: "Eric Carle", bug: @order.bug)
          )
        end

        @bug.suggest(@product_suggestions)
        @bug.friends.each do |friend|
          @order.share_with(friend) if @bug.sharing_orders?
        end
      rescue => e
        handle_transaction_error(e)
      ensure
        nobody.should_have_read_any_of_this
      end
    end
  end
end
```

Small Incremental Changes

Monday



```
def submit
  Order.transaction do
    Product.transaction do
      Chrysalis.transaction do
        code.not_meant_for_reading!
        @order.save!
        FulfillmentClient.submit_order(@order)
        @order.update_product_inventory

        @product_suggestions = SuggestionService.build_for(@bug)

         seriously.stop_reading_this!
        if @order.bug.caterpillar?
          @bug.very_hungry!
          basket = Chrysalis::Basket.create!(@bug)
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        else
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        end

        @bug.suggest(@product_suggestions)
        @bug.friends.each do |friend|
          @order.share_with(friend) if @bug.sharing_orders?
        end
      rescue => e
        handle_transaction_error(e)
      ensure
        nobody.should_have_read_any_of_this
      end
    end
  end
end
```
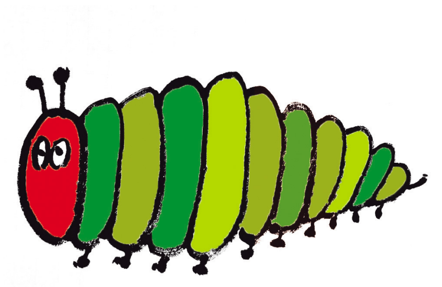

Defer Until After Commit

Monday



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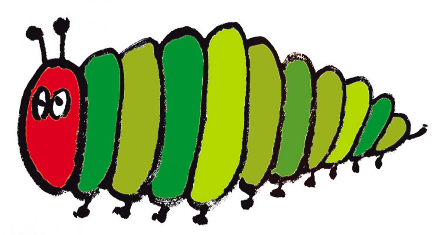
Defer Until After Commit

- Rails 7.2 - *Automatically delay Active Job enqueues to after commit* #51426

Monday



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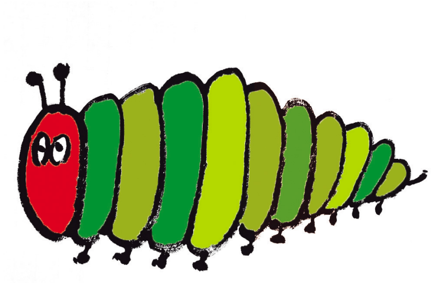
Defer Until After Commit

- Rails 7.2 - *Automatically delay Active Job enqueues to after commit* #51426
- Rails 7.2 - *Allow to register transaction callbacks outside of a record* #51474

Monday



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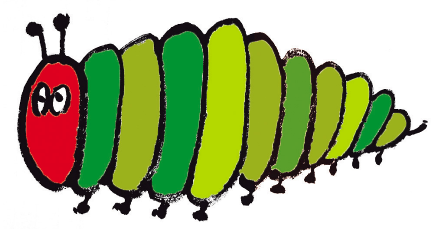
Identify Other Problematic Transactions

Monday



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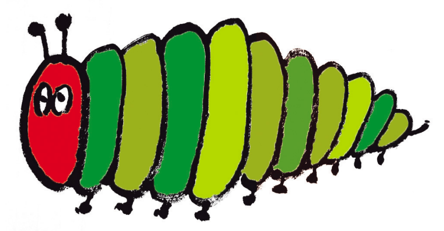
Identify Other Problematic Transactions

- Database Observability

Monday



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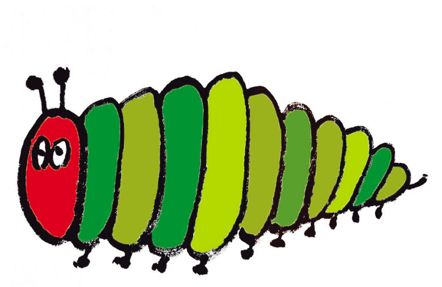
Identify Other Problematic Transactions

- Database Observability
- Rails 7.1 - *Instrument Active Record transactions* *#49192*

Monday



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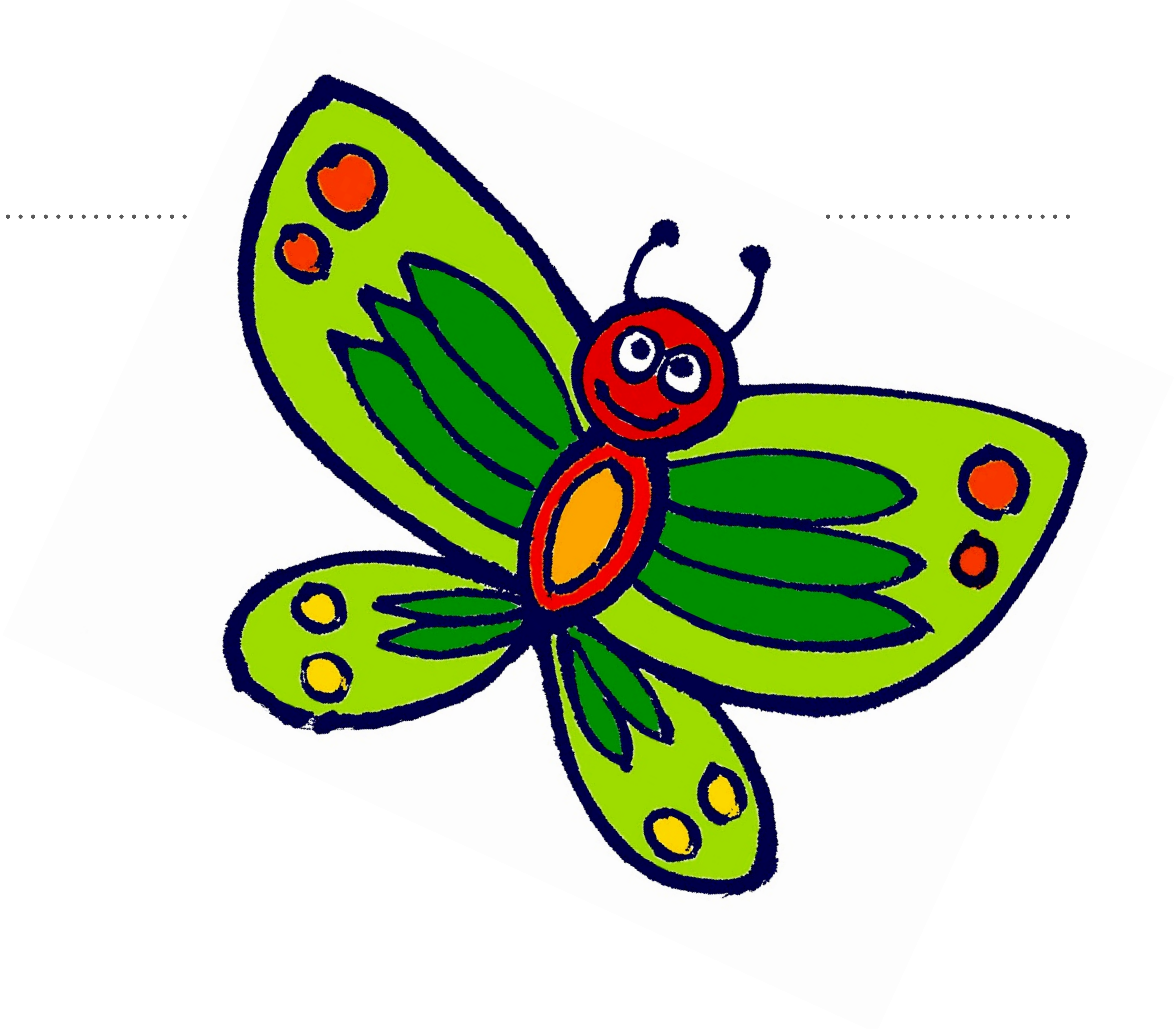
Prevent Further Problematic Transactions

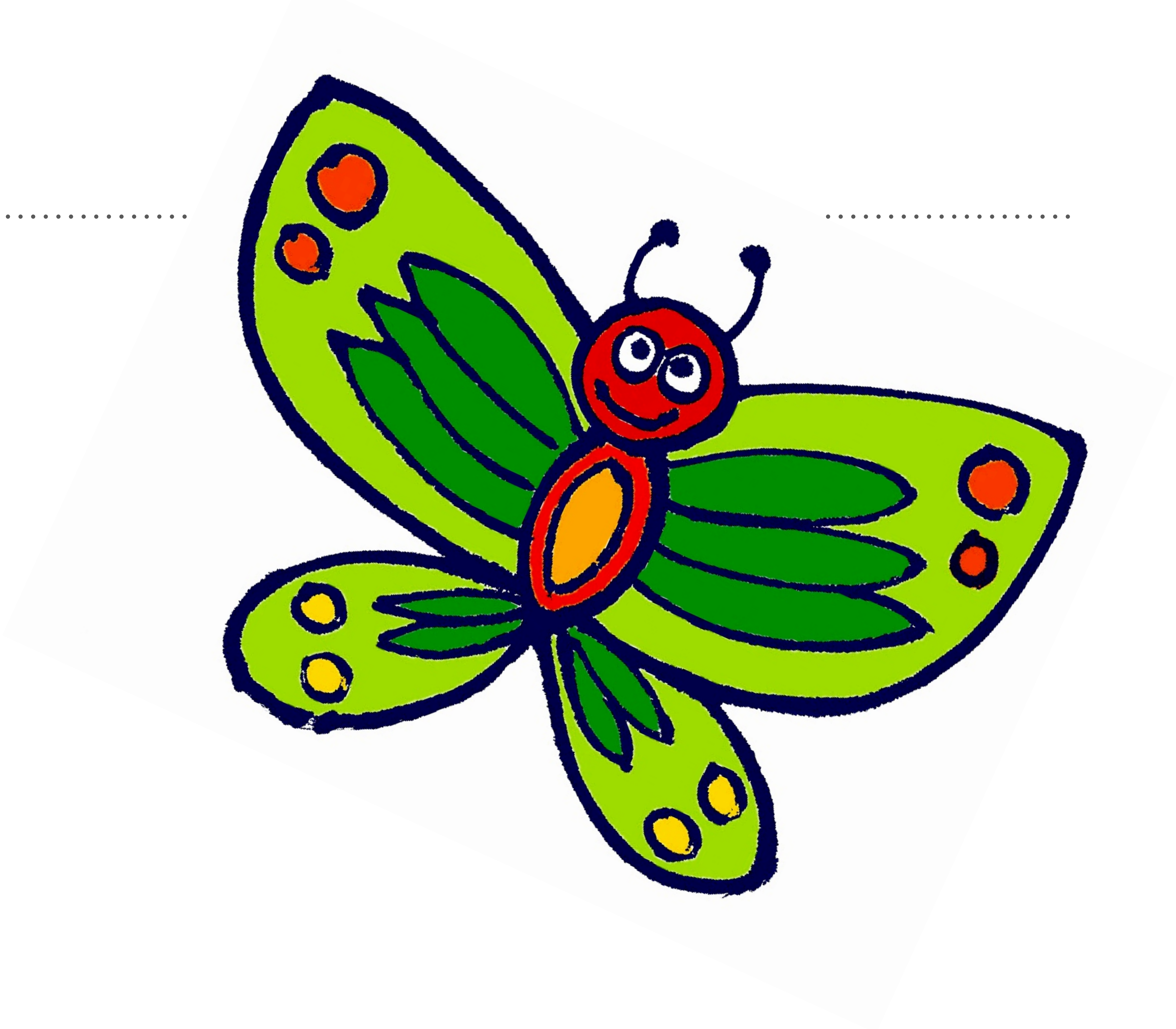
Safe Transactions



Safe Transactions

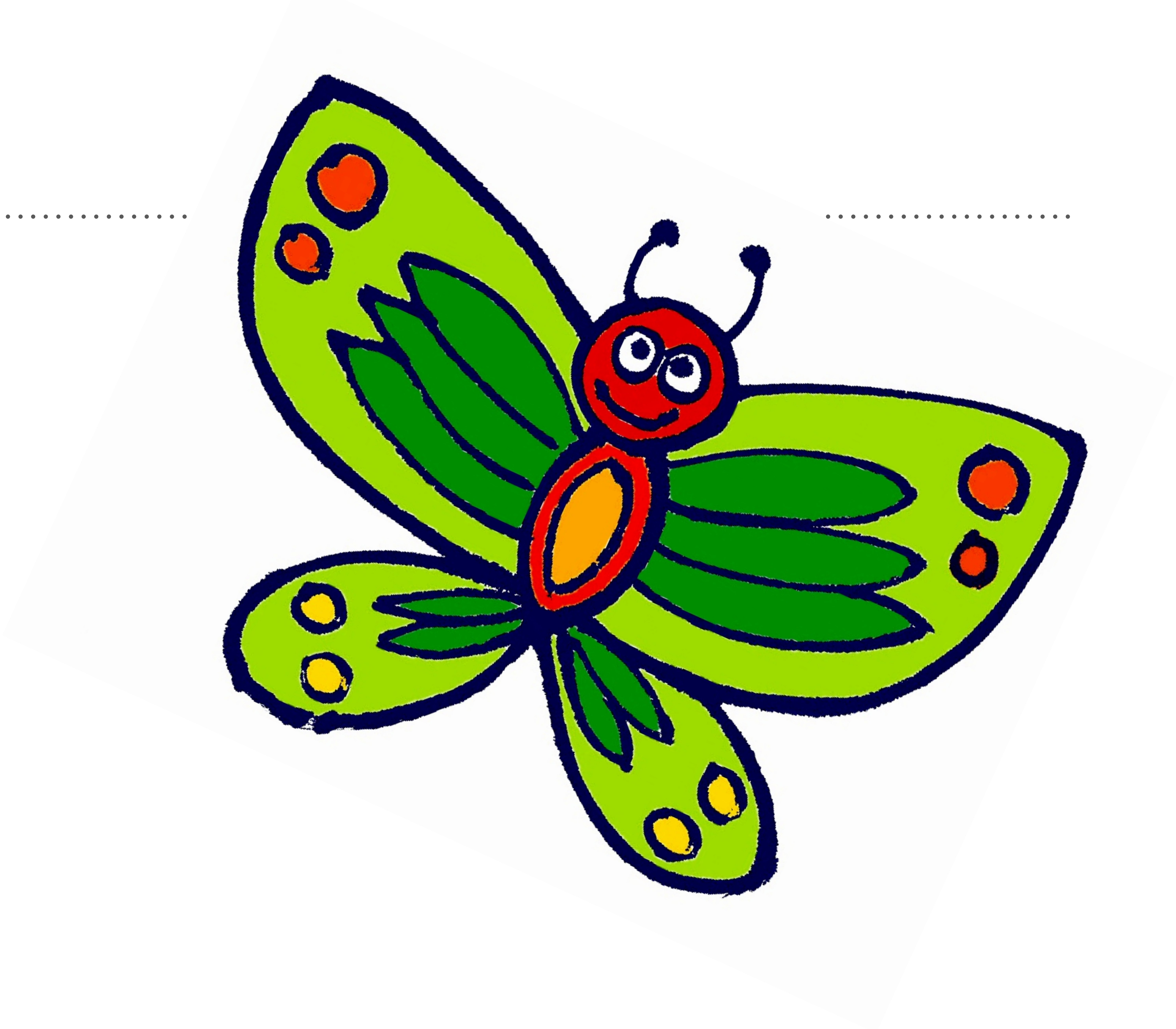
Keep Transactions Short

- Ideally < 1 Second



Safe Transactions

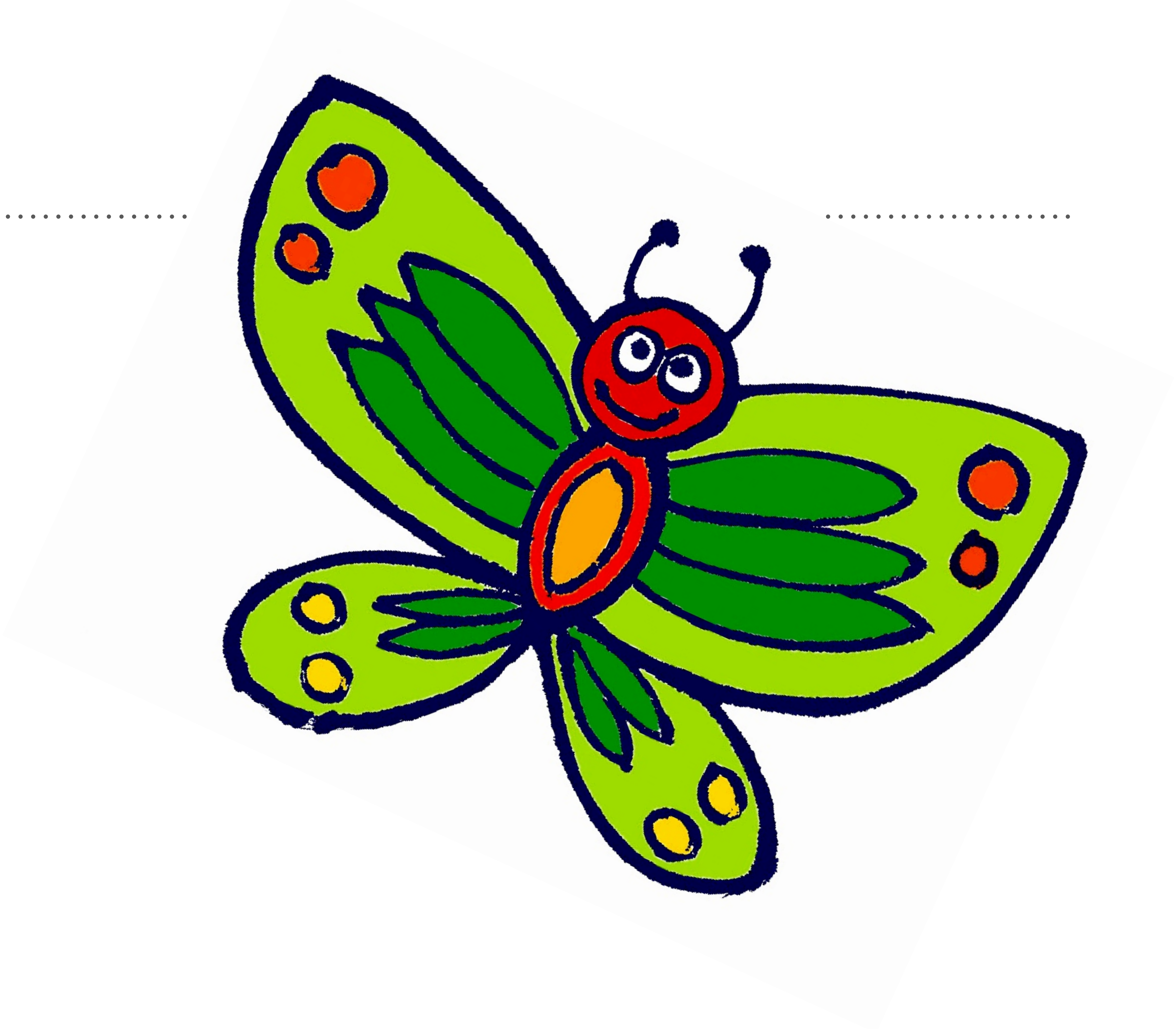
Fast Queries



Safe Transactions

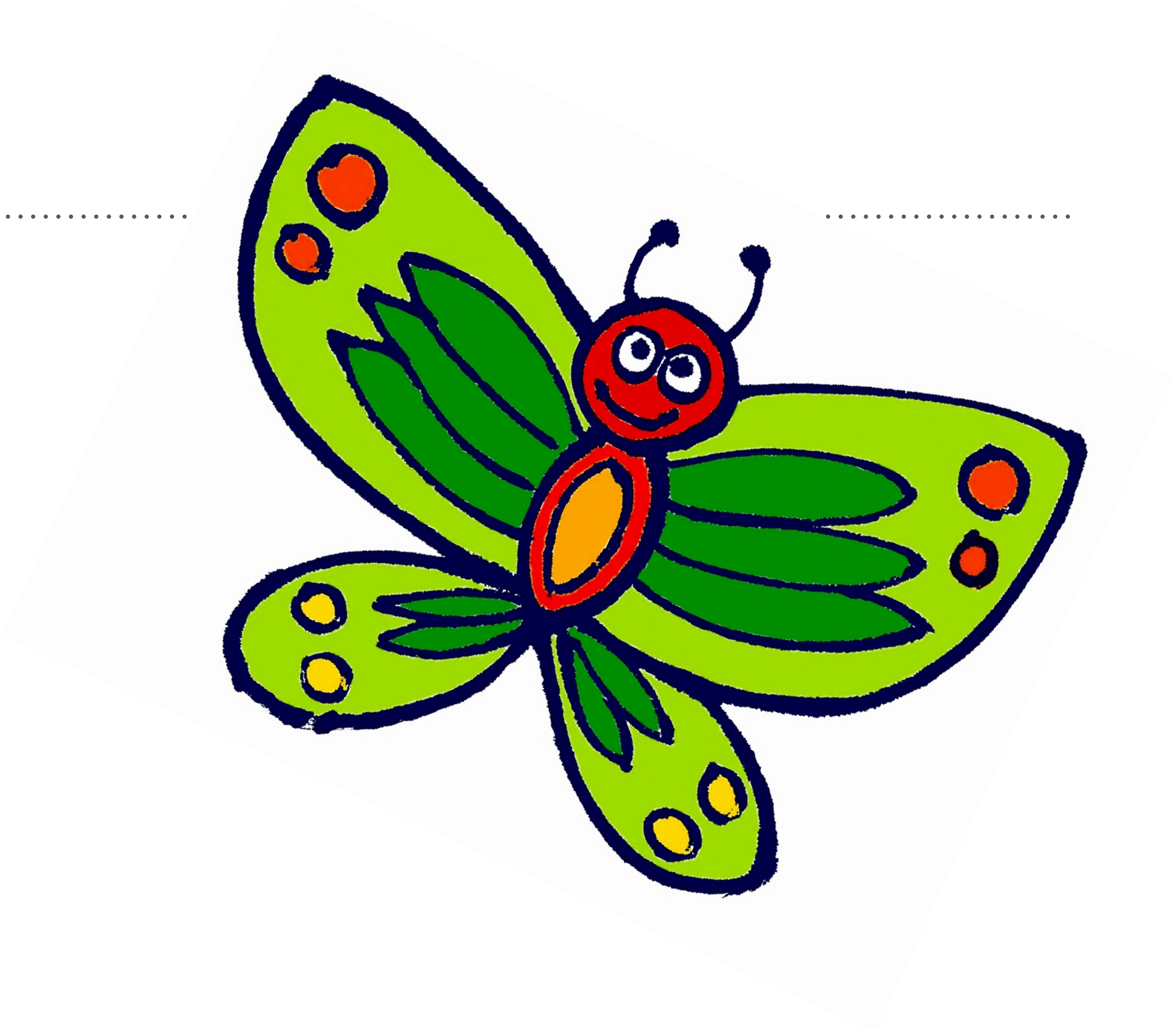
Limit # of Queries

- Ideally < 100



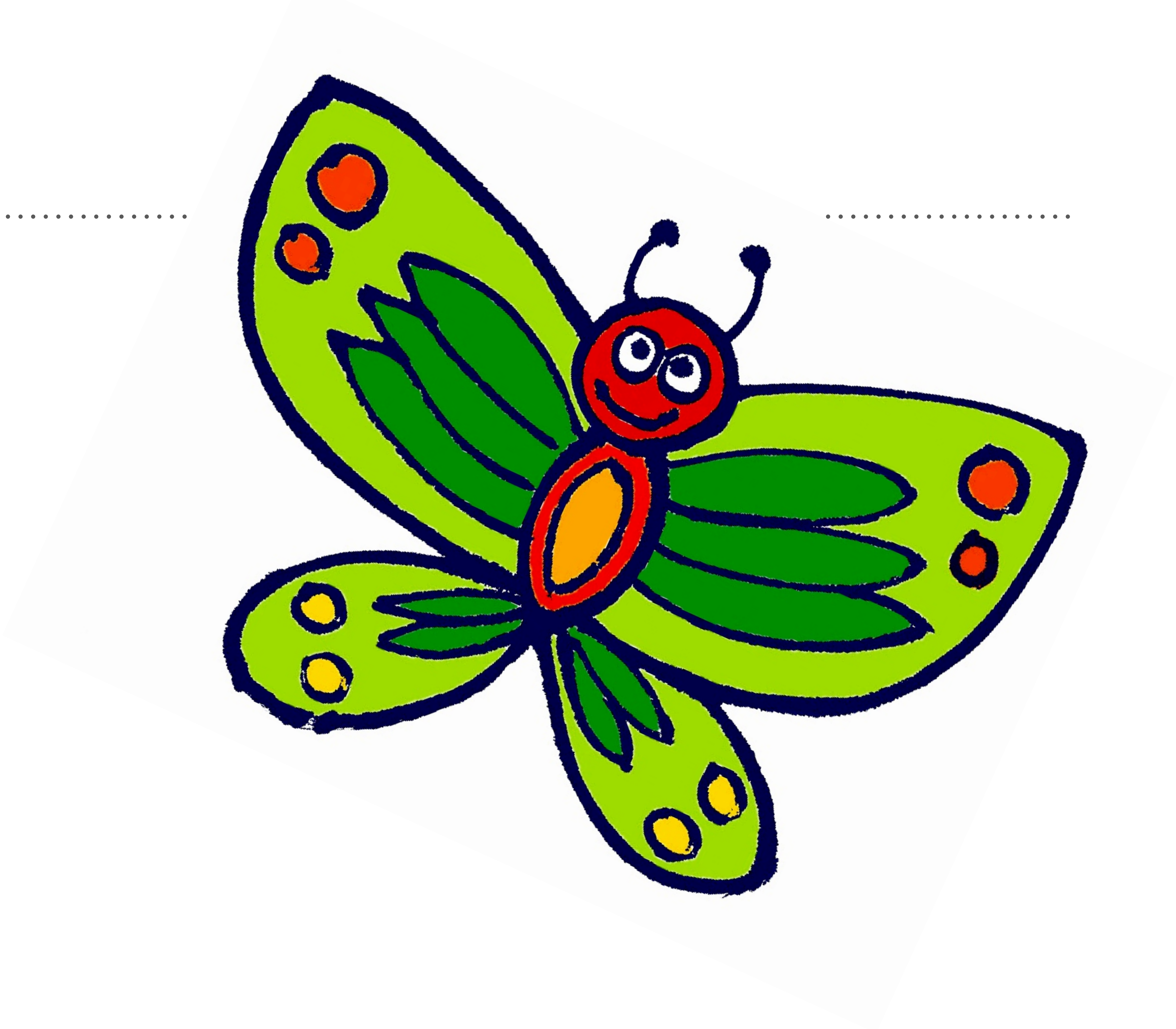
Safe Transactions

No External Calls



Safe Transactions

As Little Code as Possible



Safe Transactions

As Little Code as Possible

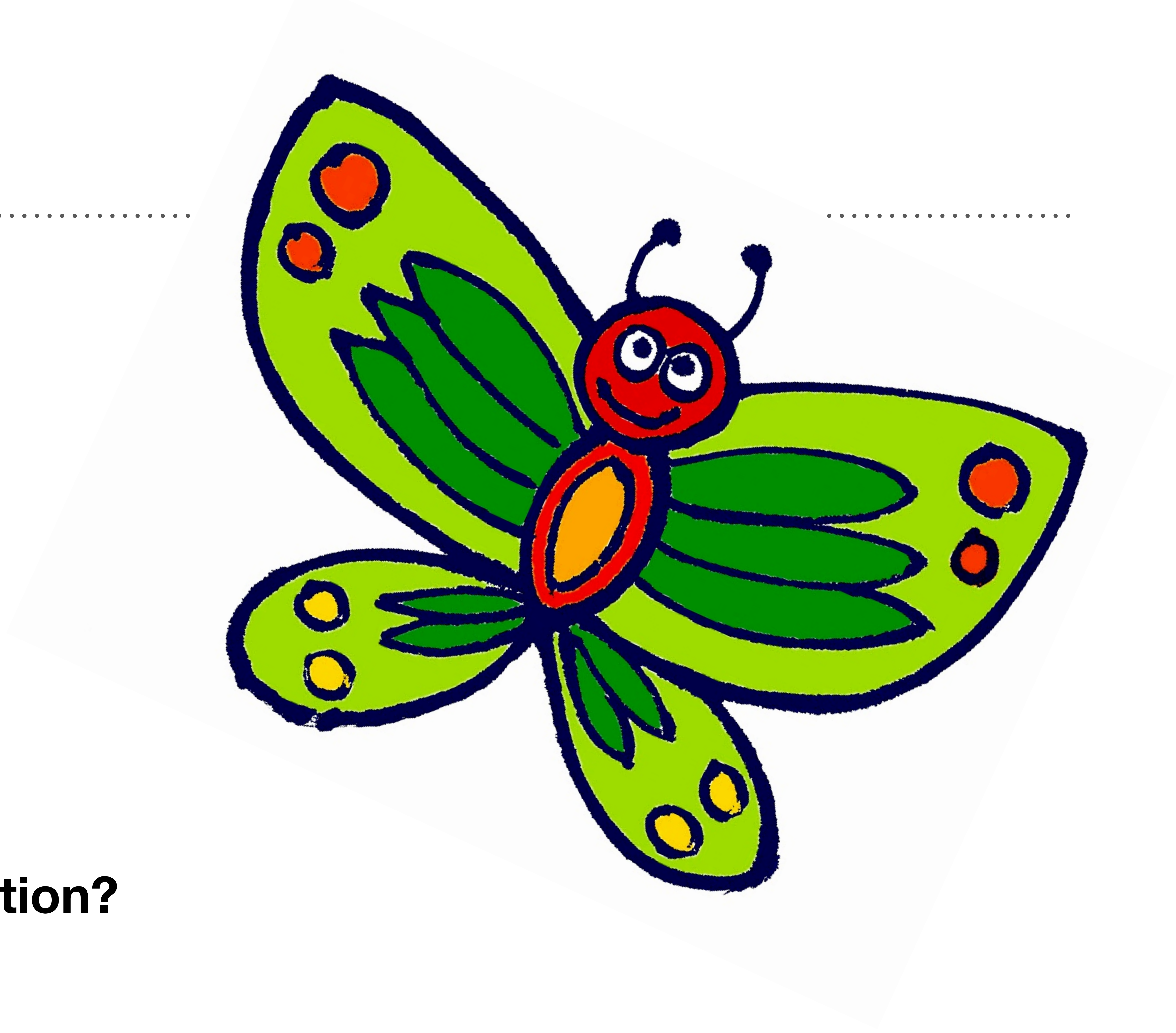
- Default to after_commit callbacks

Safe Transactions

Do You Really Need a Transaction?

Safe Transactions

- **Keep transactions short**
- **Fast queries**
- **Limit # of queries**
- **No external calls**
- **As little code as possible**
- **Do you really need a transaction?**



Daniel Colson

@composerinteralia

Illustrated by ChangHo Kim and DongBeom Kim