Fraglight: Shedding Light on Broken Pointcuts Using Structural Commonality

Work in progress

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Crosscutting Concerns

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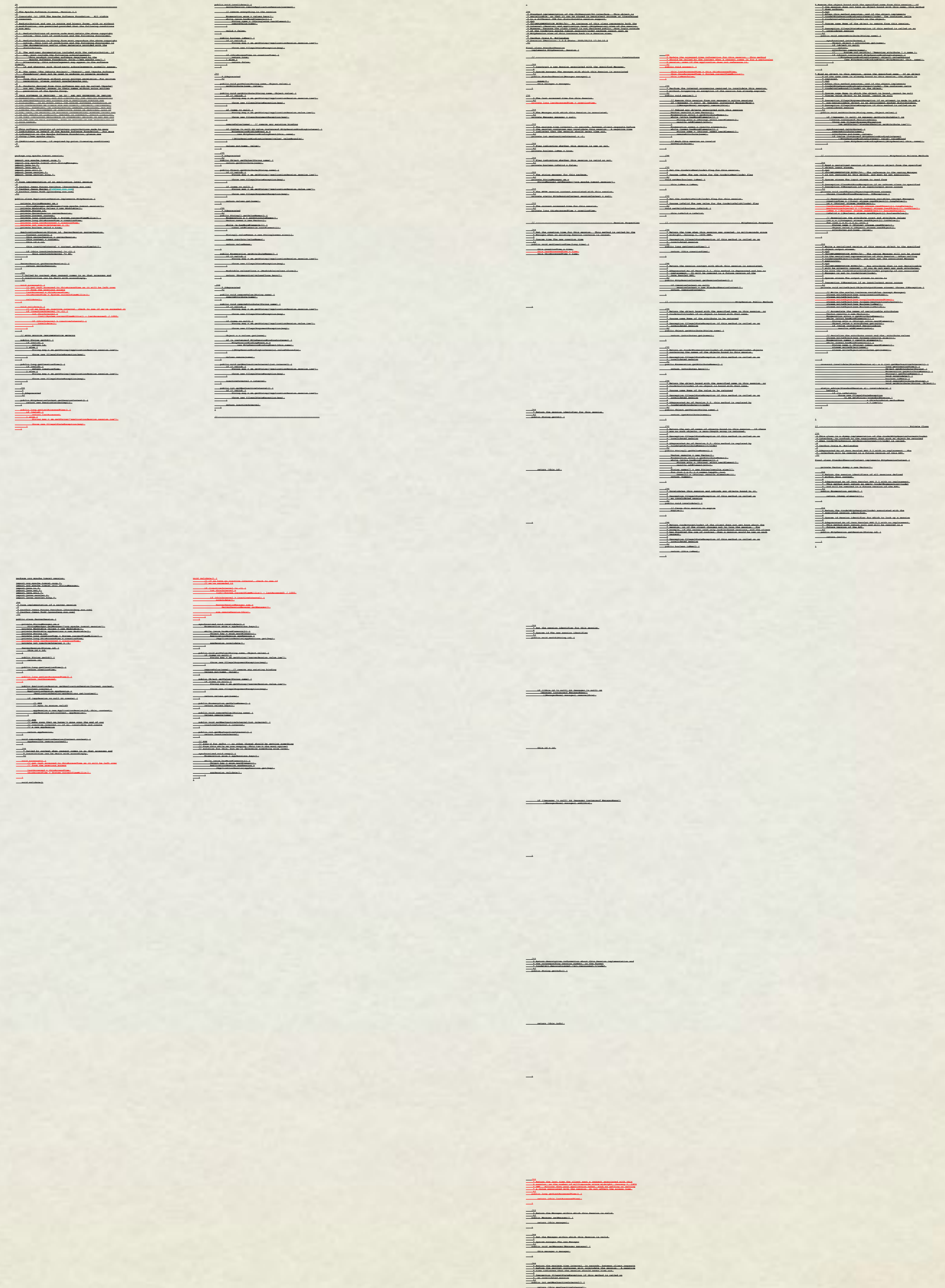
- Crosscutting concerns (CCCs) affect many heterogenous software modules.



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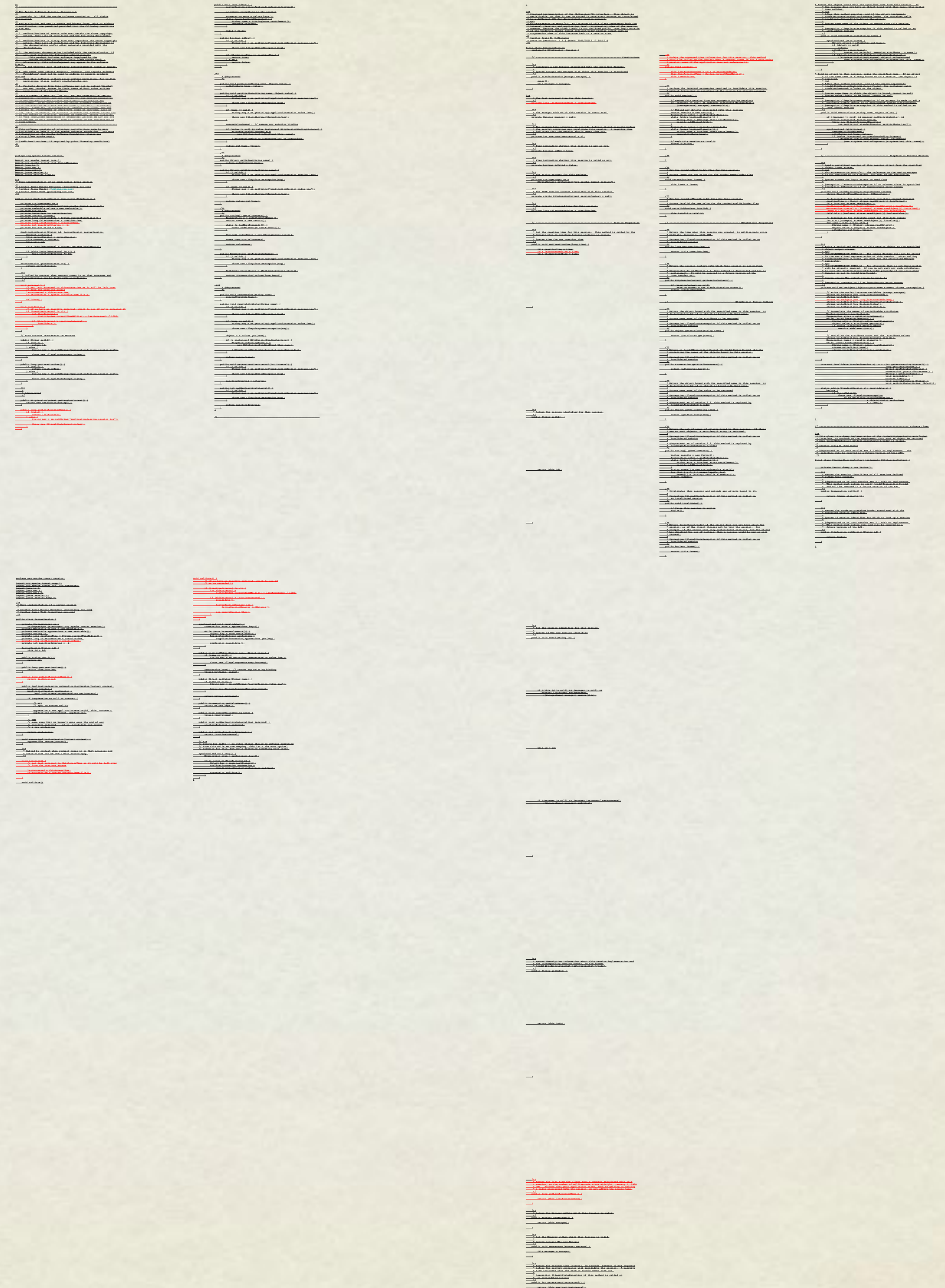

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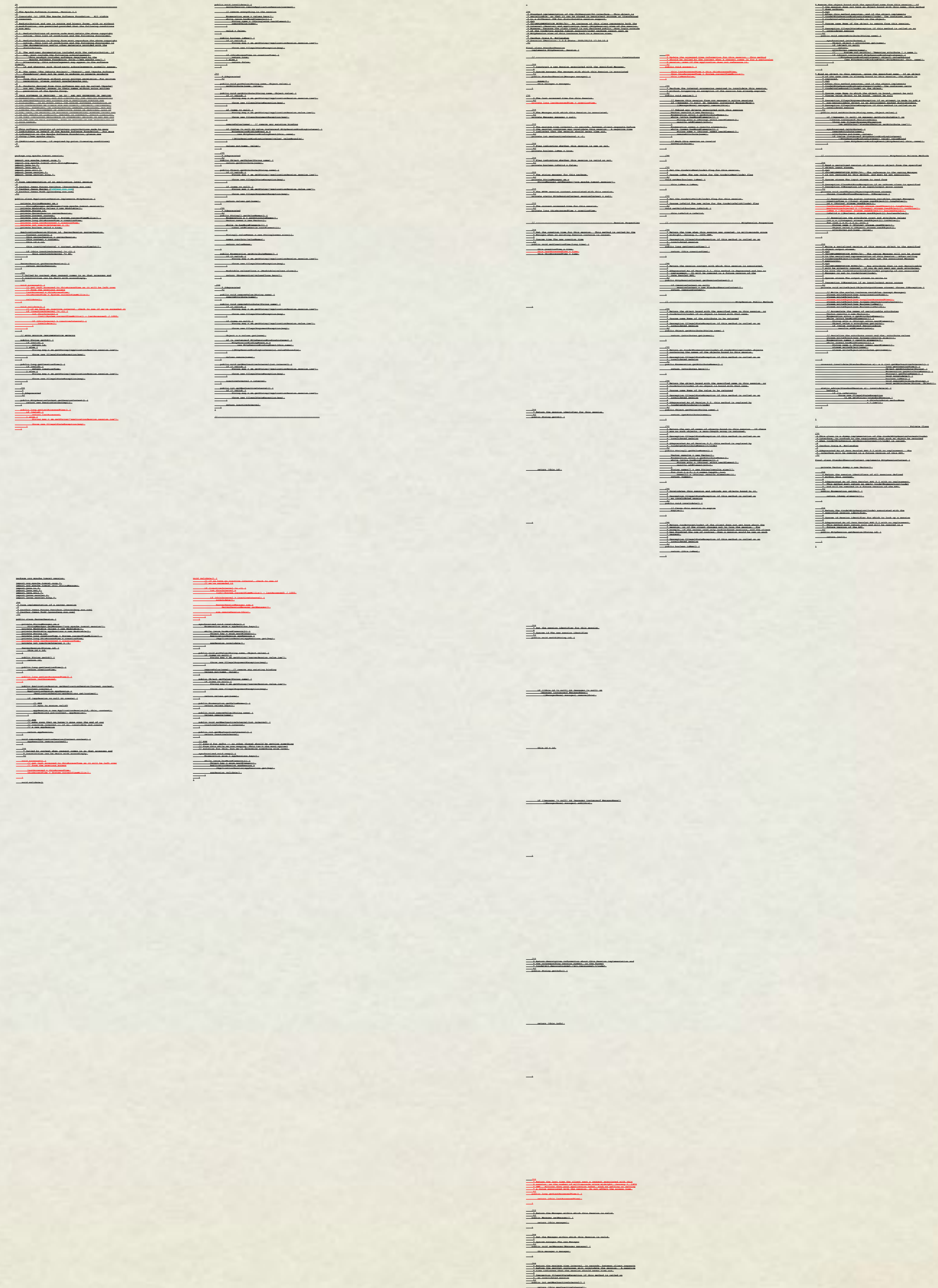

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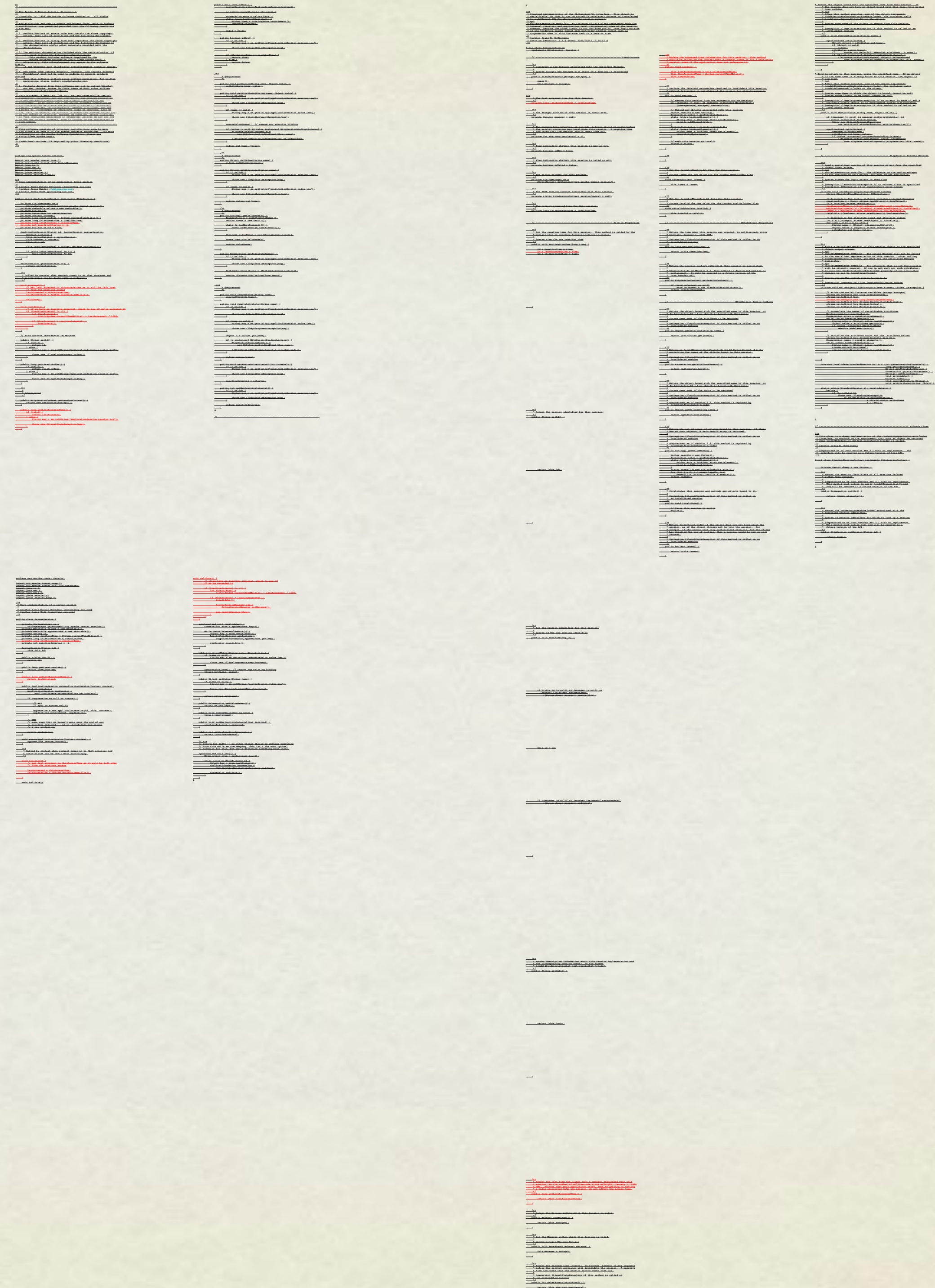

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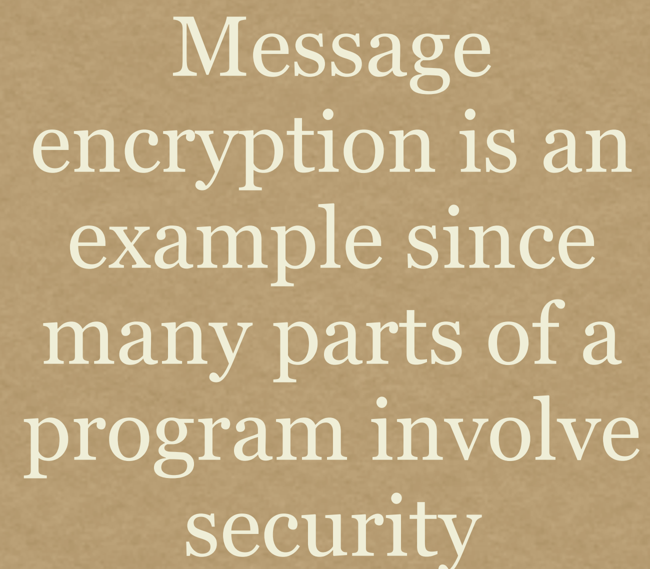

Message encryption is an example since many parts of a program involve security

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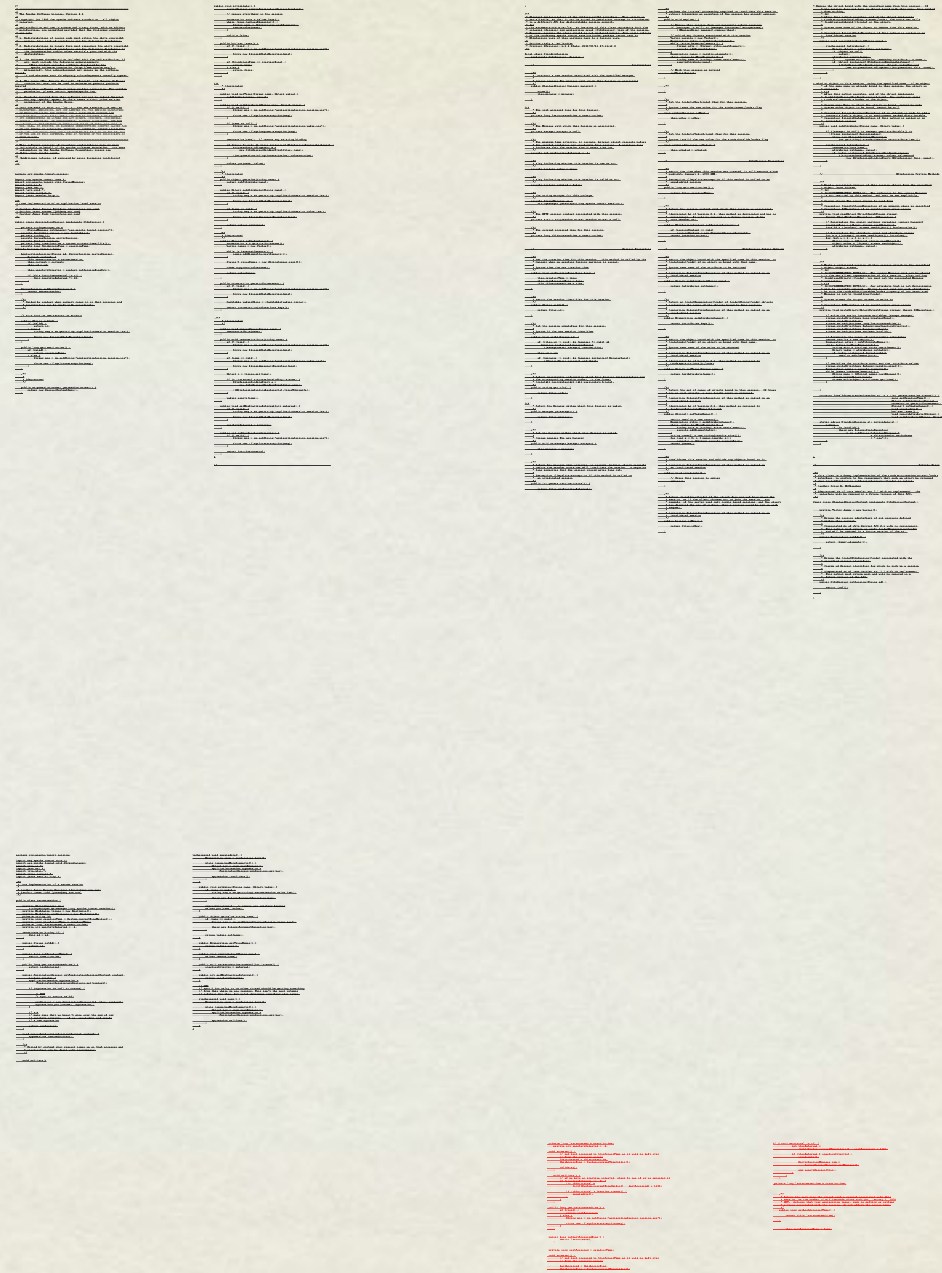

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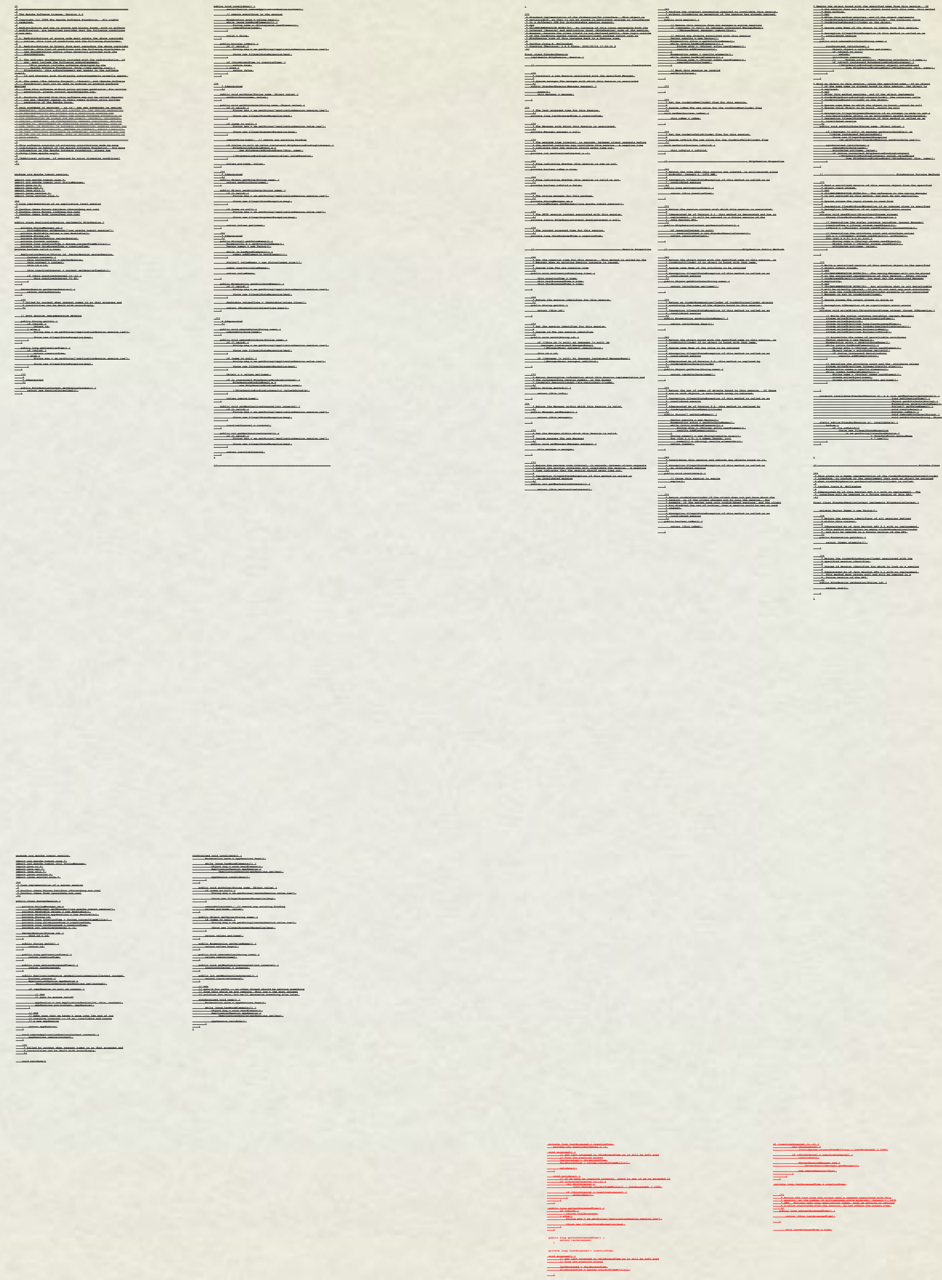

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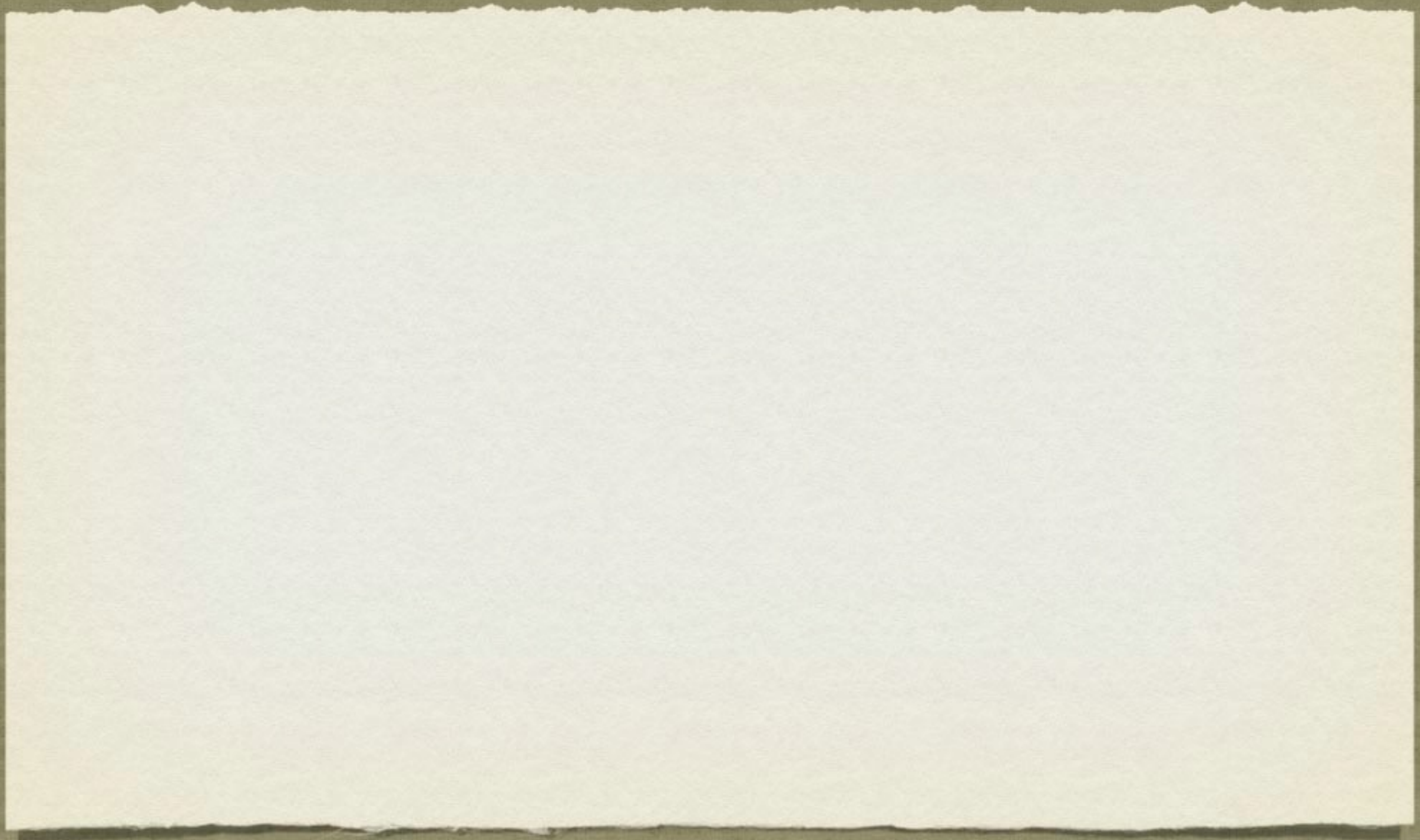
Aspects allow code to be localized into a single module

Message Encryption Example



Message Encryption Example

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messageSent():

execution(* send*(..))
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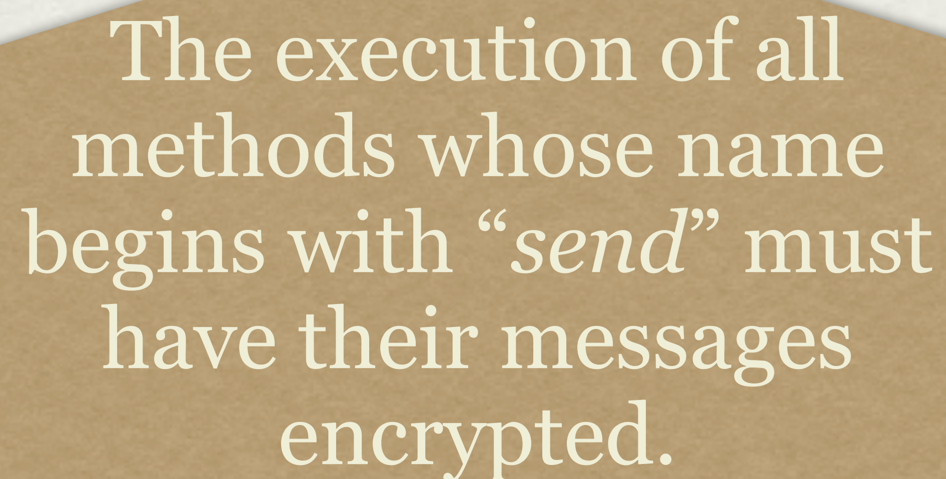

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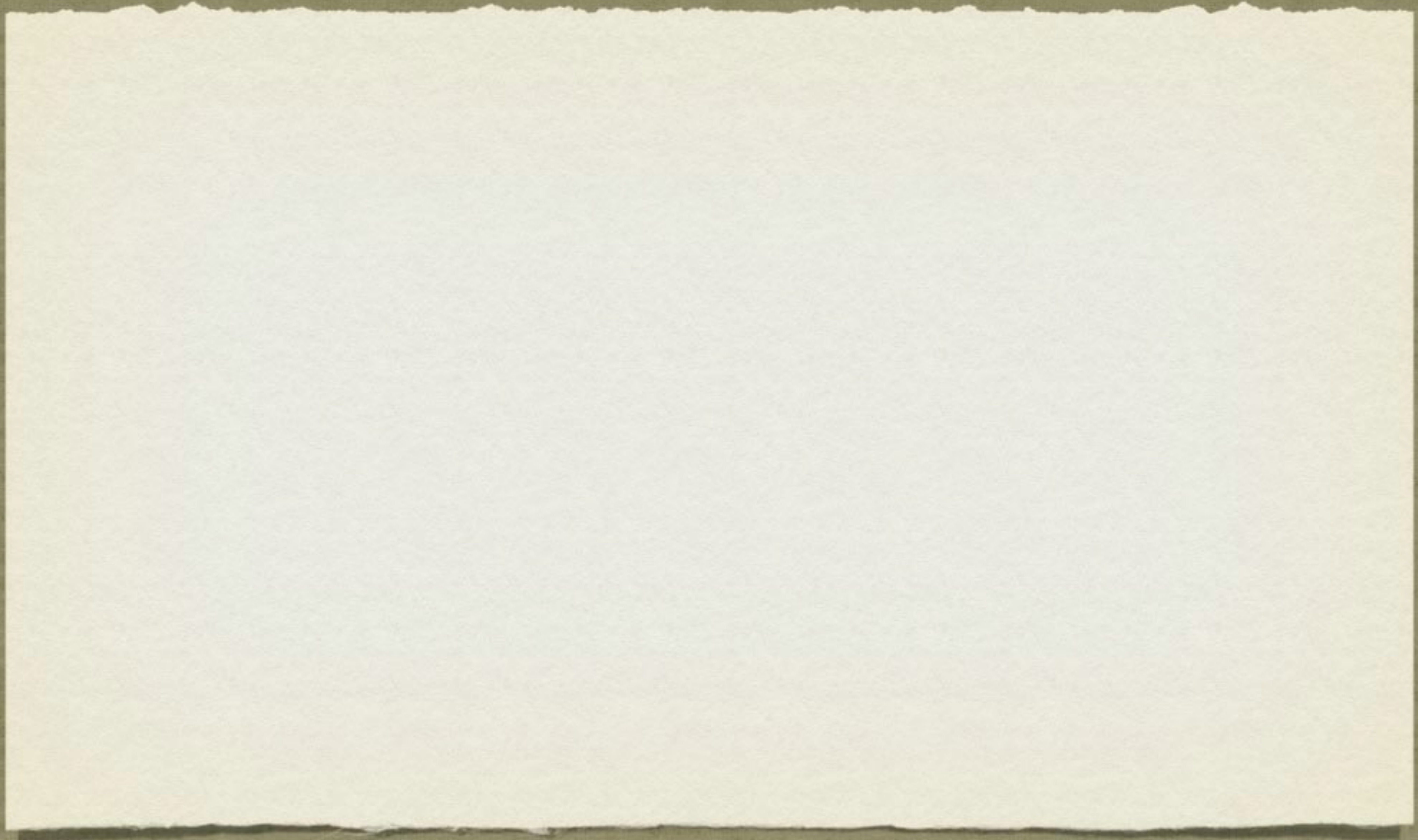
- Otherwise, a pointcut is ***fragile***.
- Fragile pointcuts can cause software to ***silently*** **malfunction**!

Pointcut Fragility Example



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- Our pointcut ***breaks*** as a result.
- Thus, `messageSent()` is a fragile pointcut.

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Appox. 12.95 pointcuts per project

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Broken Pointc

On average, ≈12.95 pointcuts must be checked after ***every*** Δ base-code change!

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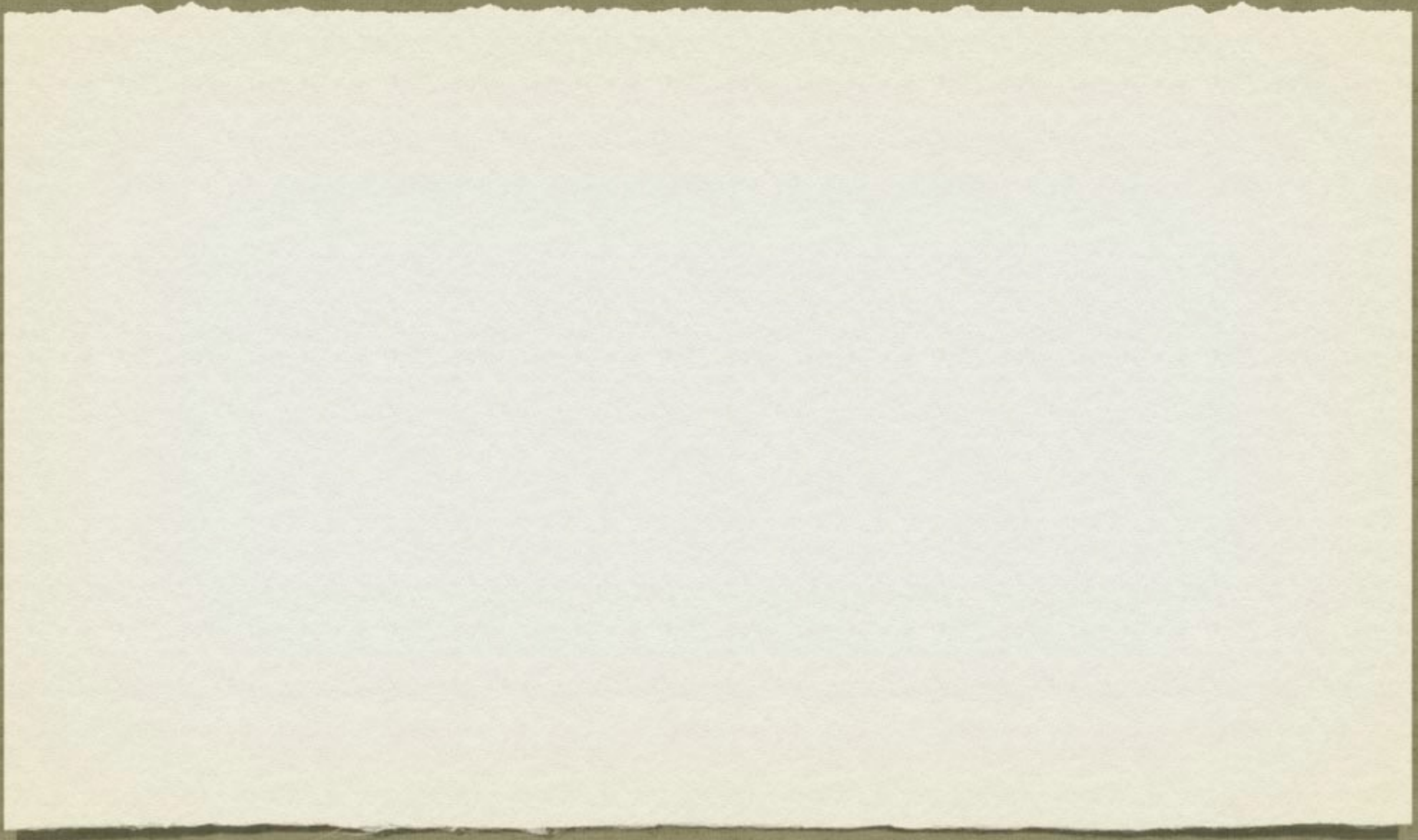

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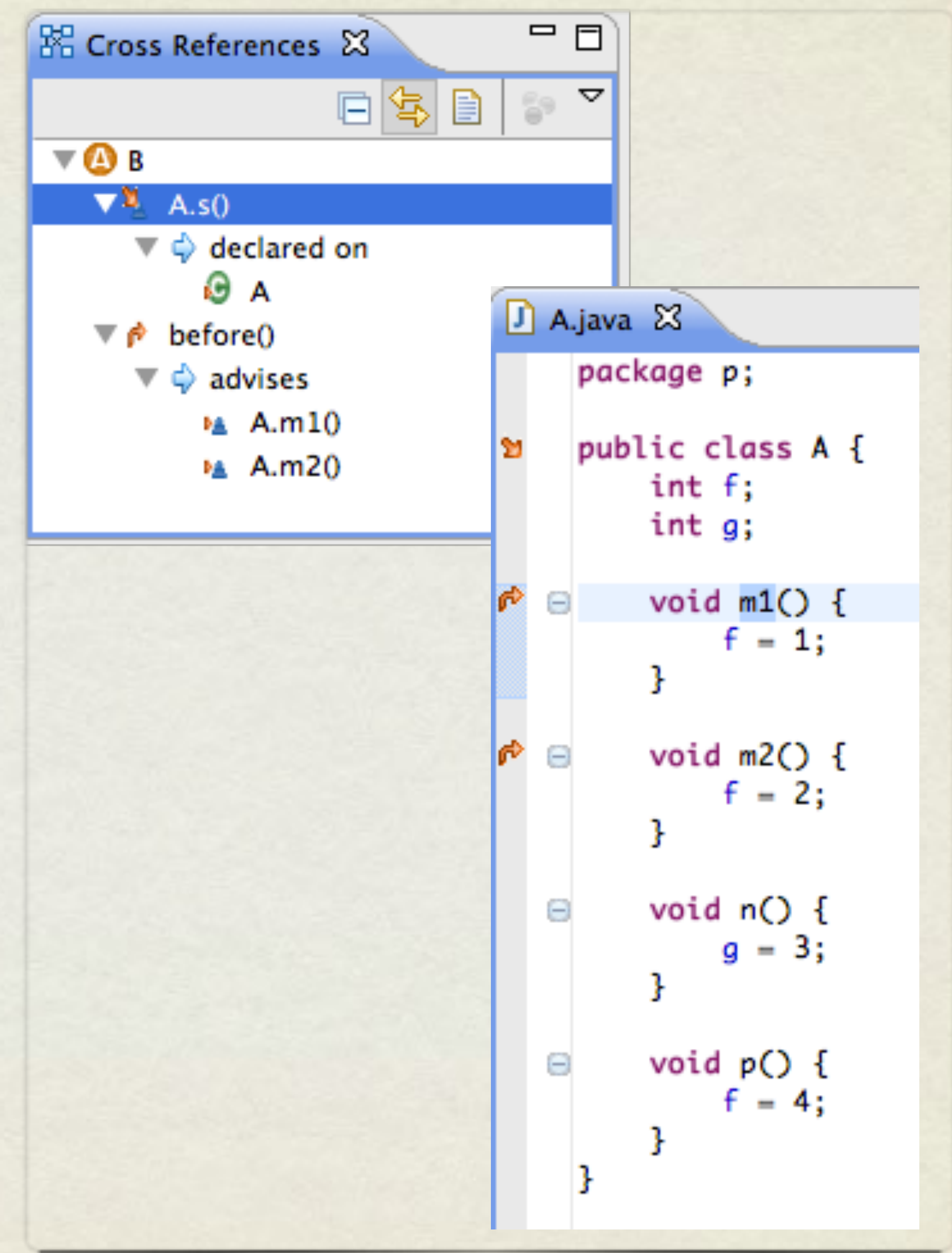
Use *Mylyn* context to promote *interesting* pointcuts in UI

AspectJ Developer Tools



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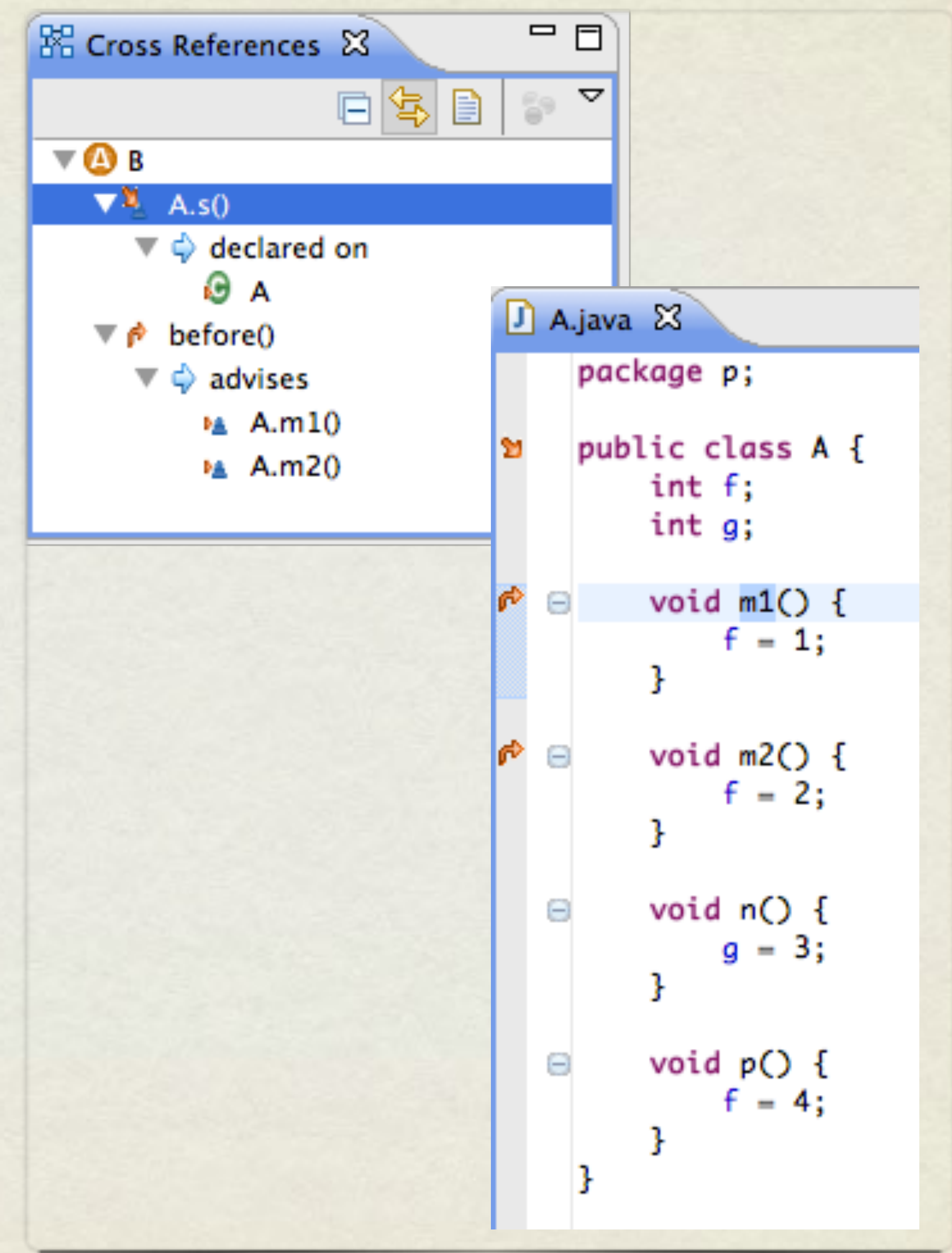

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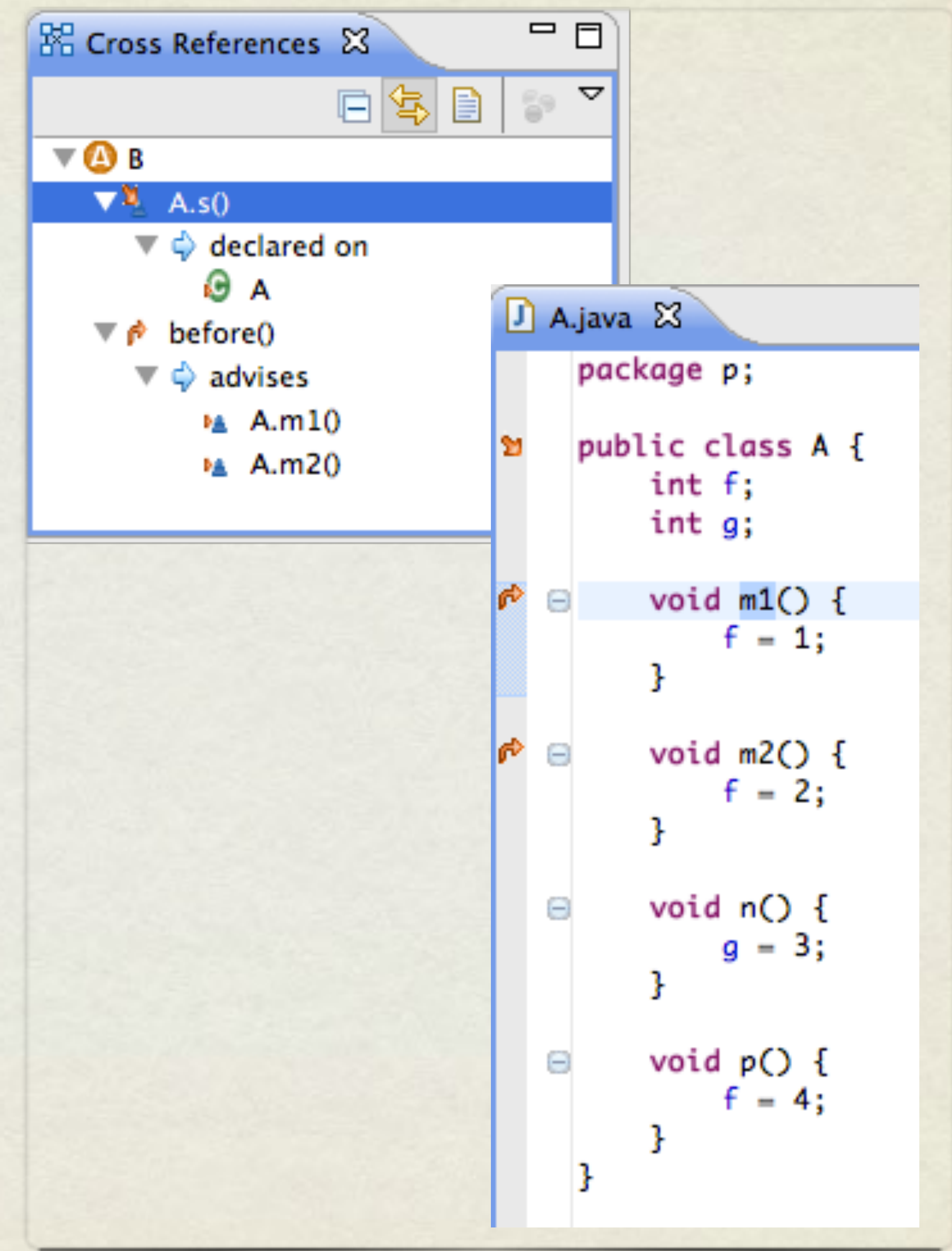

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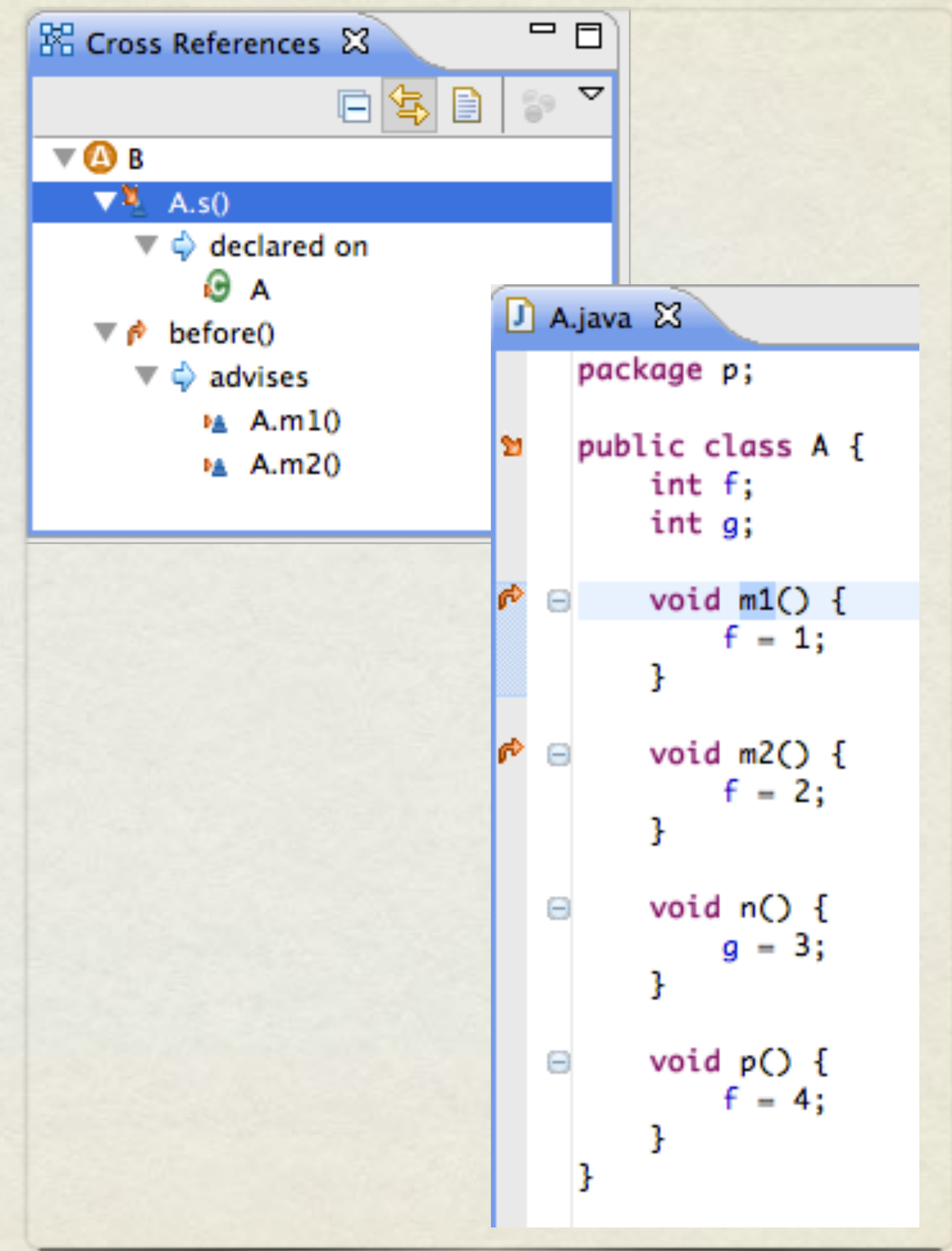

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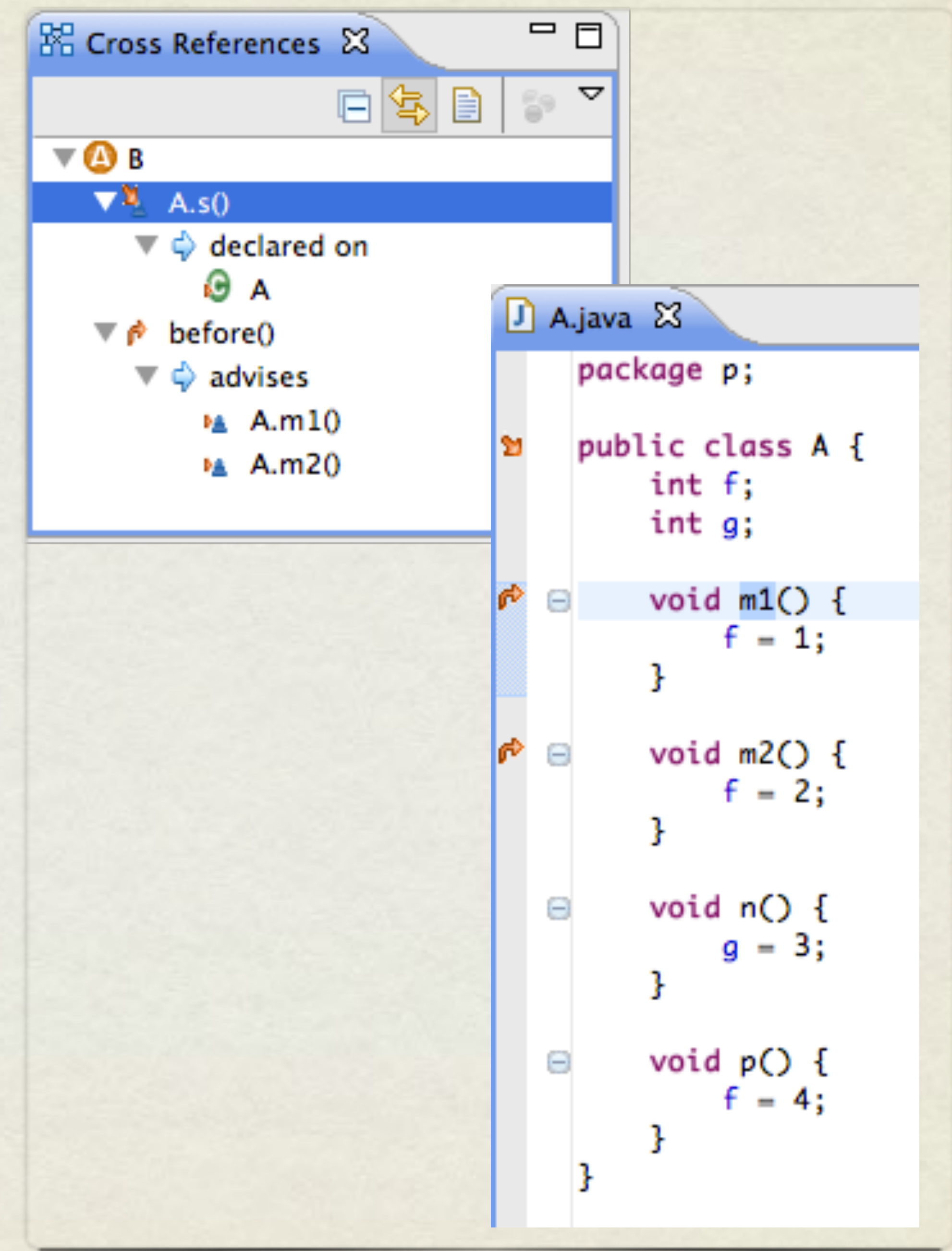

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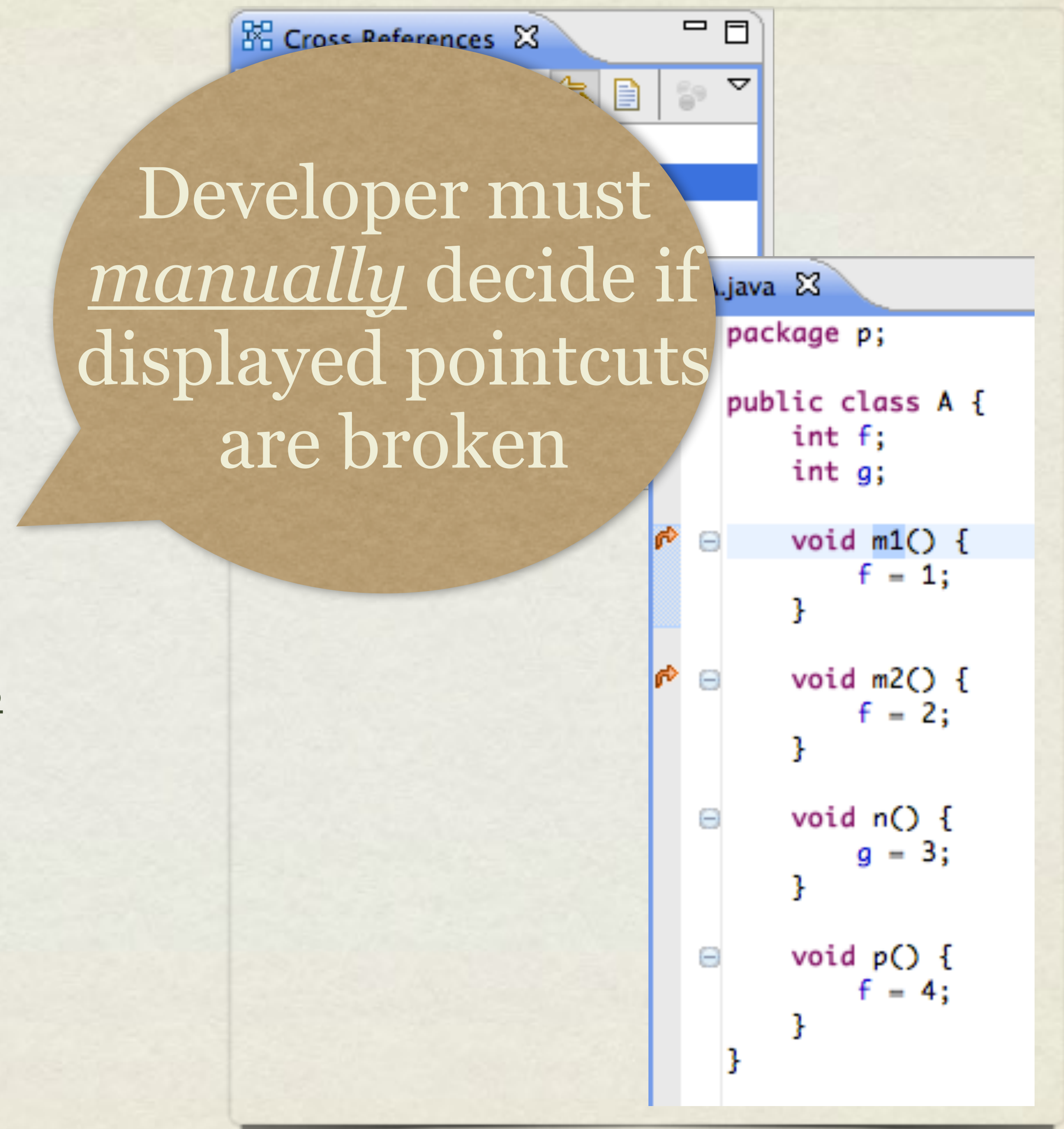

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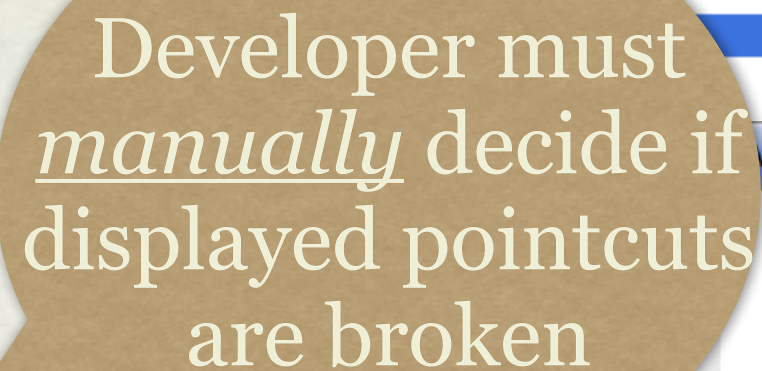

Developer must *manually* find all pointcuts and decide if each should apply to the given join point

Our Hypothesis

Program elements corresponding to join points selected by a pointcut in a particular version typically share ***structural commonality*** that persists throughout subsequent versions.

[Khatchadourian, Greenwood, Rashid, Xu ’09]

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Program elements corresponding to join points selected by a pointcut in a particular version typically share ***structural commonality*** that persists throughout subsequent versions.

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Can be used to *mechanically identify* broken pointcuts!

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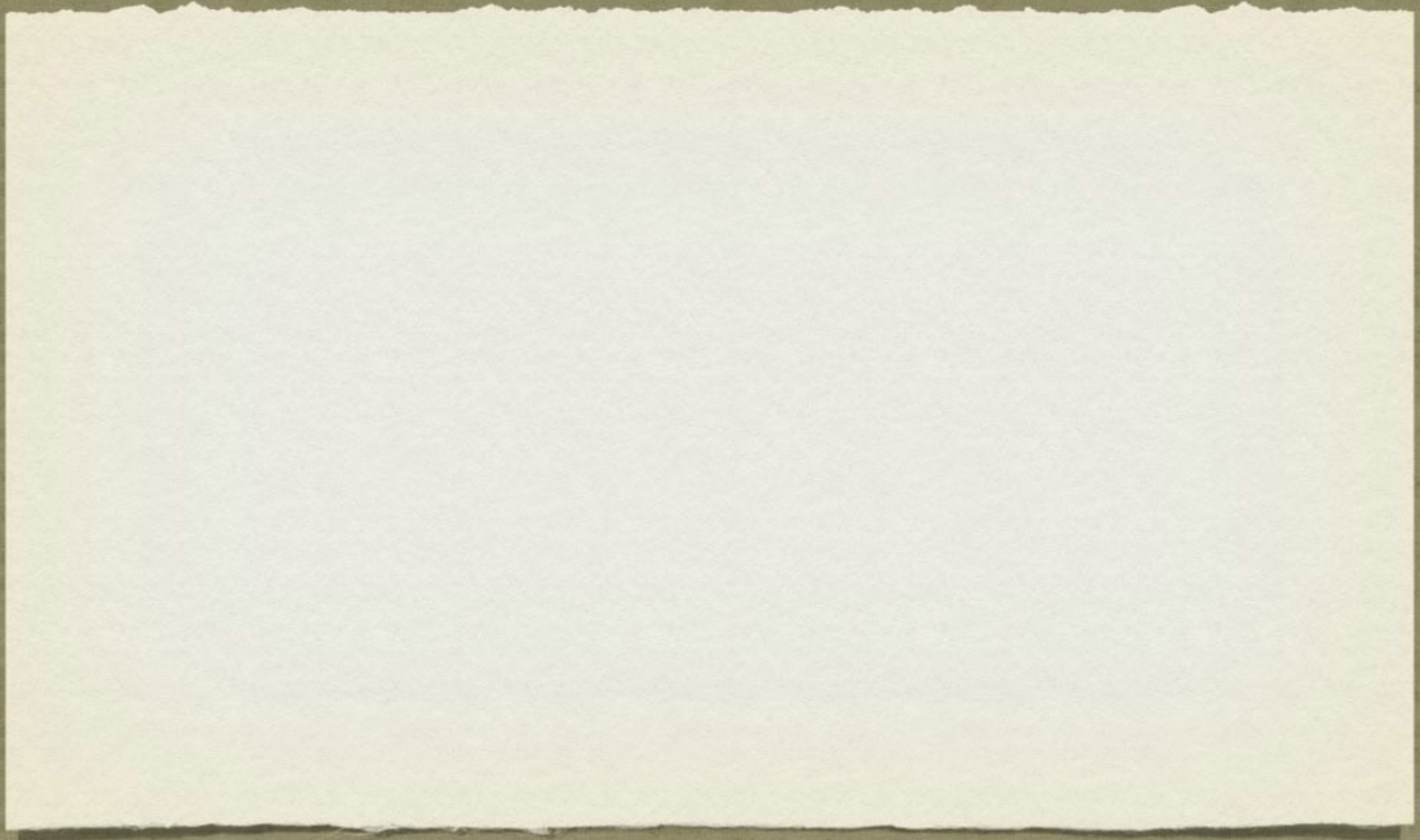

Aspect Example

```
aspect Encryption {









}
```

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```
aspect Encryption {

    pointcut messageSent() : execution(* send*(String));









}
```

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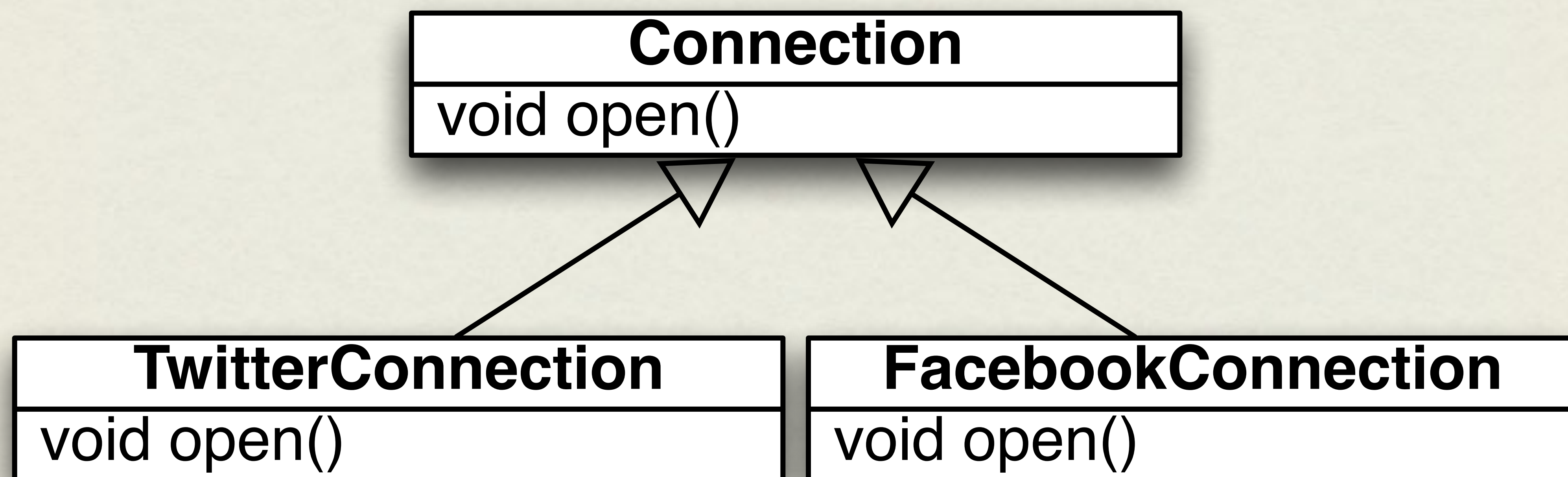
aspect Encryption {

    pointcut messageSent() : execution(* send*(String));



    void around(String message) :
    messageSent() && args(message) {
         proceed(encrypt(message));}


}
```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void open()
TwitterConnection
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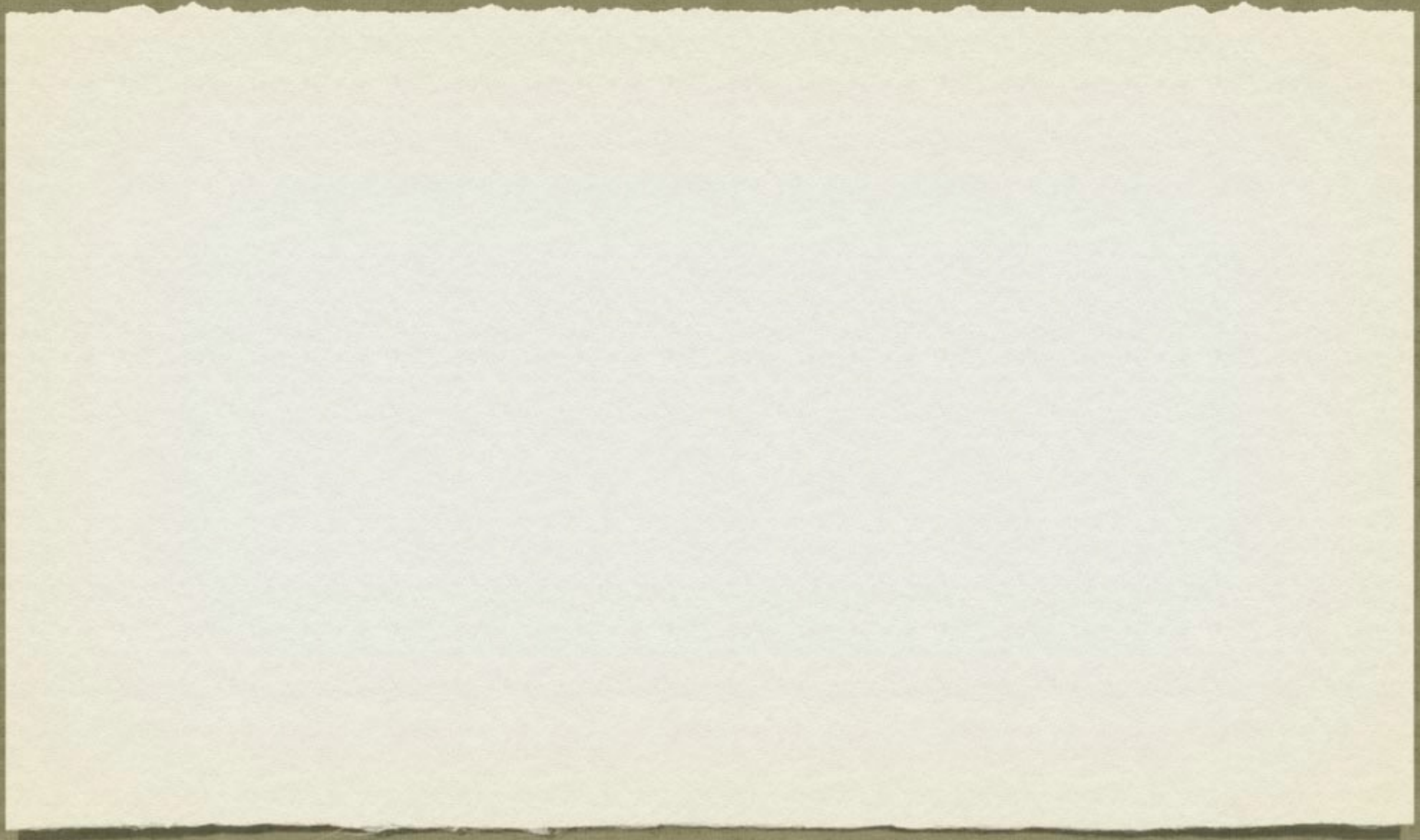
void open()

Base Code Example



Base Code Example

```
class SocialMessanger {

}
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class SocialMessanger {


    Connection tconn = new TwitterConnection();
    Connection fconn = new FacebookConnection();





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class SocialMessanger {

    Connection tconn = new TwitterConnection();
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    void sendTweet(String tweet) {tconn.open();…}

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class SocialMessanger {


    Connection tconn = new TwitterConnection();
    Connection fconn = new FacebookConnection();

    void sendTweet(String tweet) {tconn.open();…}
    void sendFacebookUpdate(String update) {fconn.open();…}



}
```

Base Code Example

```
class SocialMessanger {

    Connection tconn = new TwitterConnection();
    Connection fconn = new FacebookConnection();

    void sendTweet(String tweet) {tconn.open();…}
    void sendFacebookUpdate(String update) {fconn.open();…}
    void updateLocation() {tconn.open();fconn.open();…}

}
```

Structural Analysis

Phase I: Extract structural commonality between currently selected join points.

Base Code Example

```
class SocialMessanger {

    Connection tconn = new TwitterConnection();
    Connection fconn = new FacebookConnection();

    void sendTweet(String tweet) {tconn.open();…}
    void sendFacebookUpdate(String update) {fconn.open();…}
    void updateLocation() {tconn.open();fconn.open();…}

}
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Base Code Example

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class SocialMessanger {

    Connection tconn = new TwitterConnection();
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    void sendTweet(String tweet) {tconn.open();…}
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}
```

Base Code Example

Both methods call
Connection.open()

```
class SocialMessanger {

    Connection tconn = new TwitterConnection();
    Connection fconn = new FacebookConnection();

    void sendTweet(String tweet) {tconn.open();…}
    void sendFacebookUpdate(String update) {fconn.open();…}
    void updateLocation() {tconn.open();fconn.open();…}

}
```

- A ***structural pattern*** for `messageSent()` is "all executions of method whose bodies (textually) include a call to `Connection.open()`"

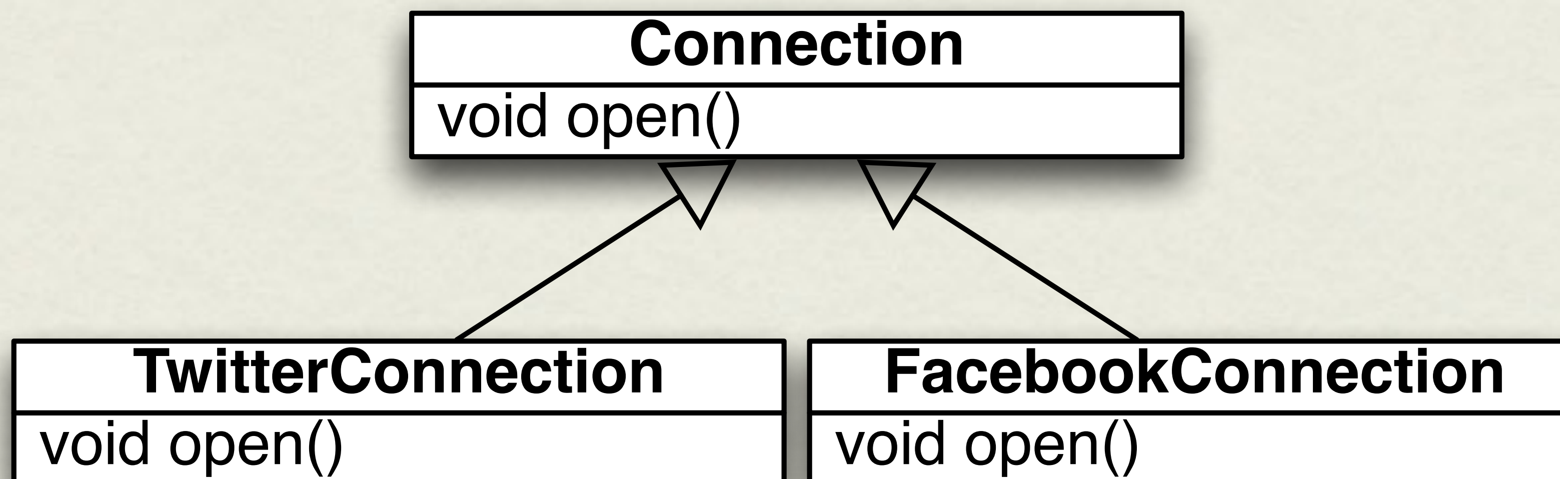
- `messageSent()` selects *two* of these methods.

- The pattern describes *three* methods (includes `updateLocation()`).

- Thus, the ***confidence*** [Dagenais, Breu, Warr, Robillard '07] of this pattern is 2/3.

Pointcut Break Detection

Phase II: Apply extracted structural patterns to revised base code.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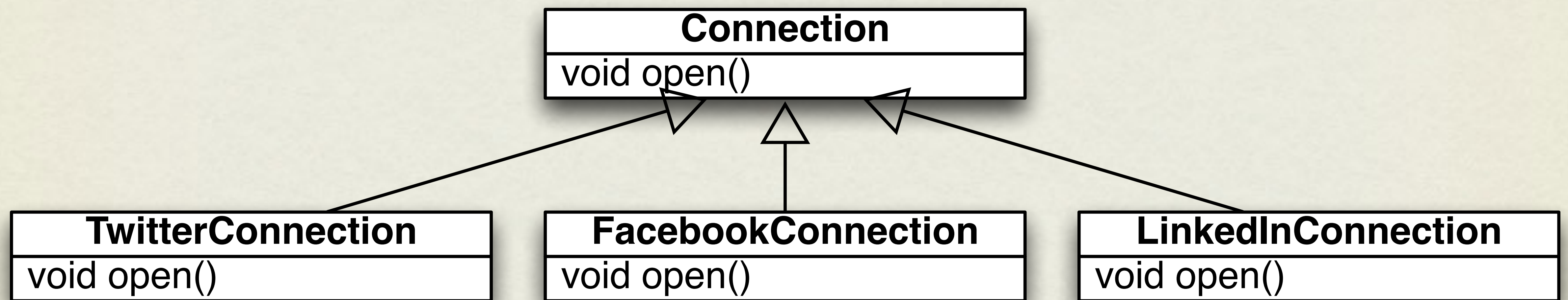
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    //...



    //...




}
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```
class SocialMessanger {

    //...
    Connection lconn = new LinkedInConnection();



    //...




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```
class SocialMessanger {

    //...
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    //...

    void transmitLinkedInStatus(String update) {lconn.open();…}



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Base Code Evolution

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class SocialMessanger {

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Should be encrypted but not selected by `messageSent()`!

Base Code Evolution

```
class SocialMessanger {

    //...
    Connection lconn = new LinkedInConnection(

    //...

    void transmitLinkedInStatus(String update) {lconn.open();…}

}
```

Also calls `Connection.open()`

Should be encrypted but not selected by `messageSent()`!

Base Code Evo

```
class SocialMessanger {

    //...
    Connection lconn = new LinkedInC

    //...
    void transmitLinkedInStatus(String update) {lconn.open();…}

}
```

2/3 *confident* that `messageSent()` has broken as a result since `transmitLinkedInStatus()` is not selected by `messageSent()` but shares ***structural commonality*** with elements selected by `messageSent()`

Also calls `Connection.open()`

Should be encrypted but not selected by `messageSent()`!

If a *new join point* is added to the base code that *shares* a *high degree* of structural commonality with elements selected by a pointcut and is *not selected* by the pointcut, the pointcut becomes *more interesting* as it may need to be altered to *include* the new join point.

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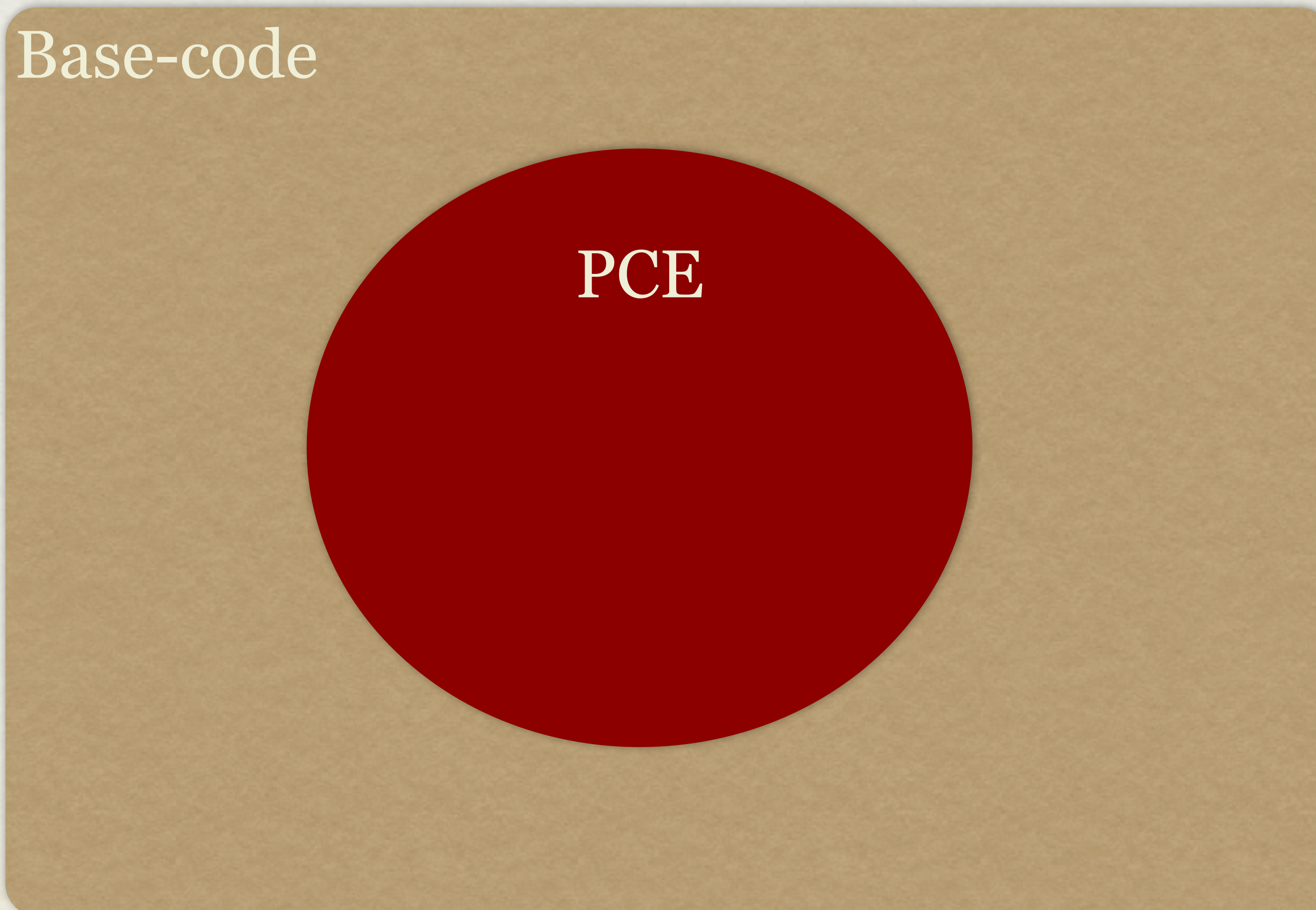

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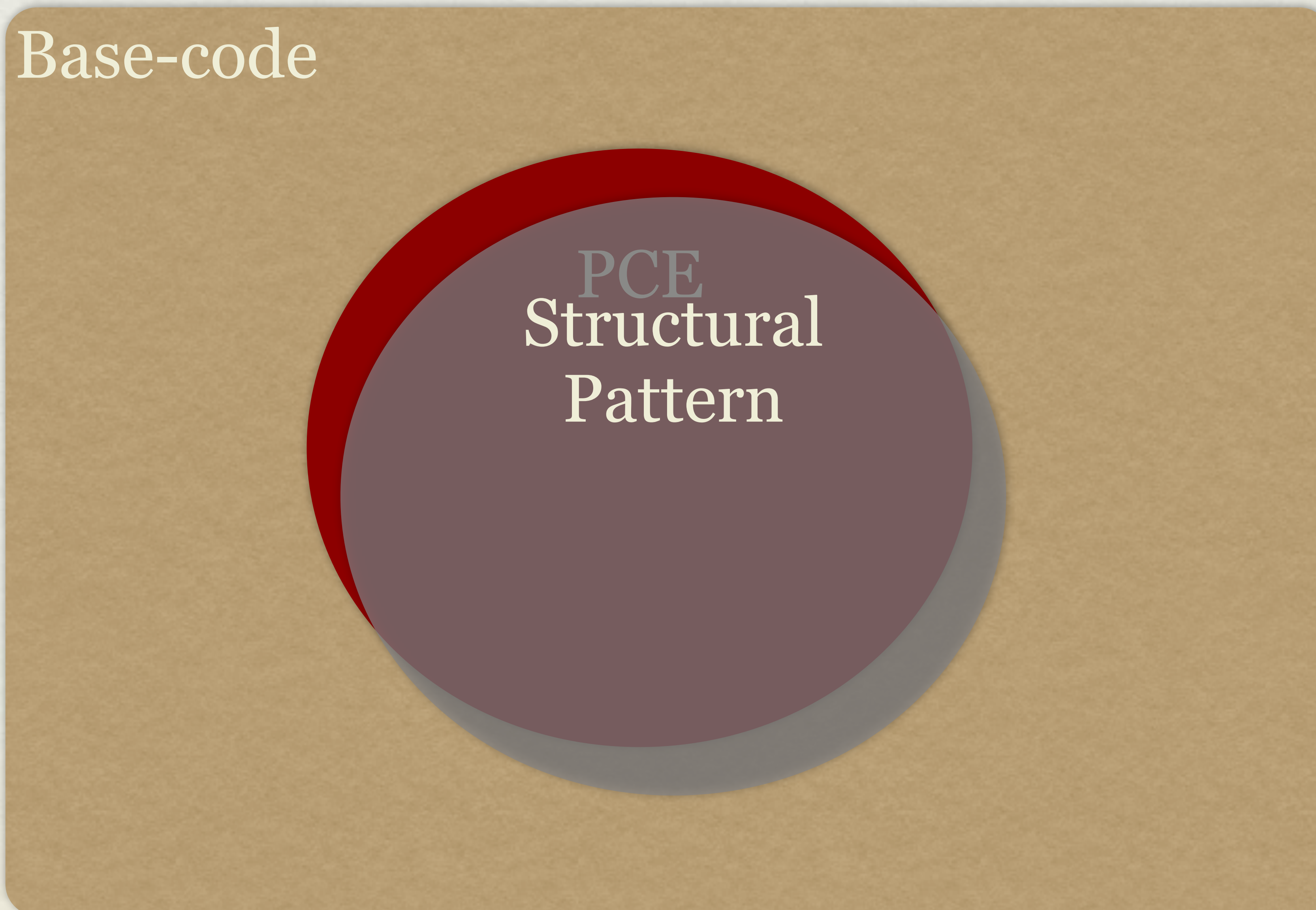

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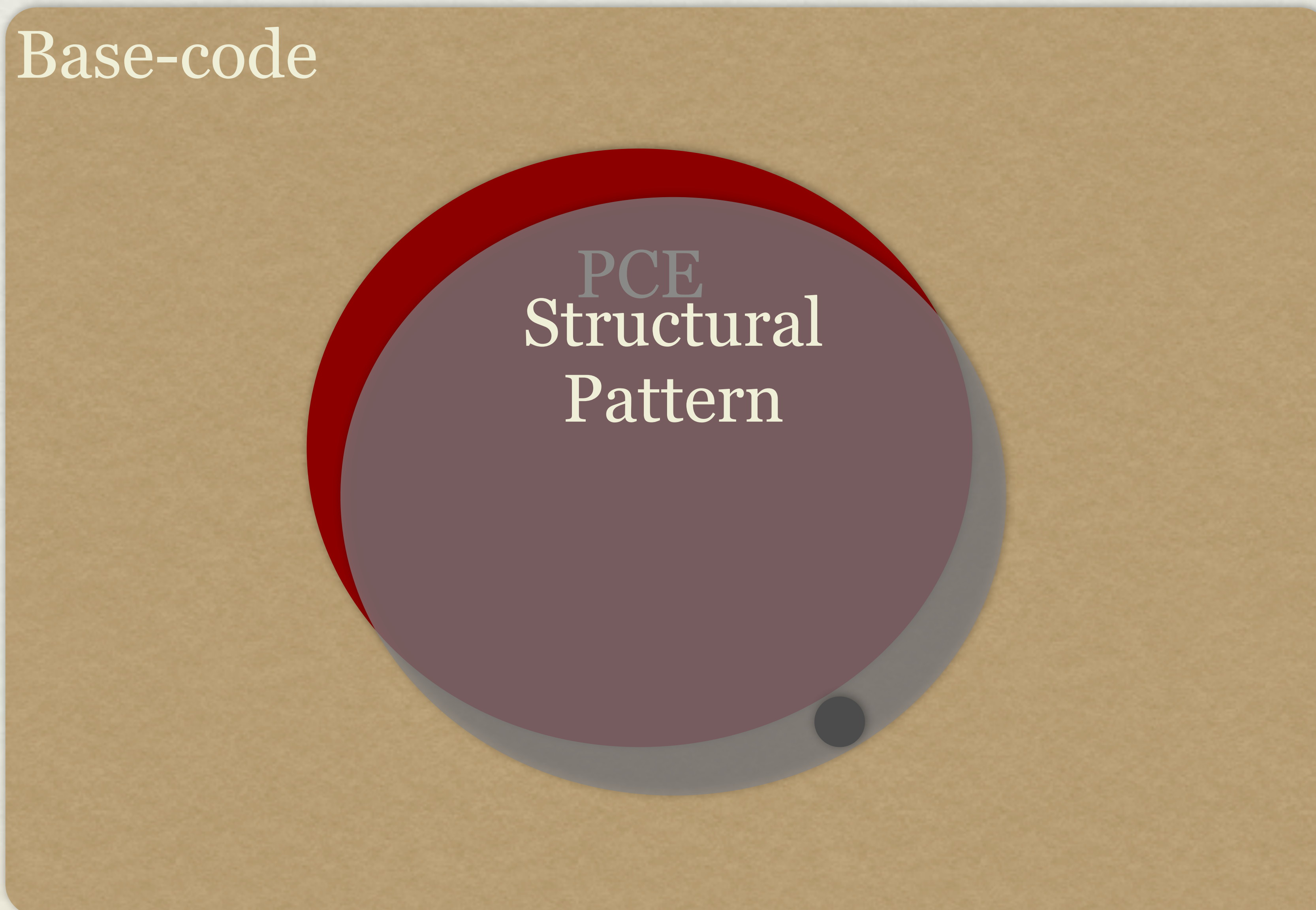

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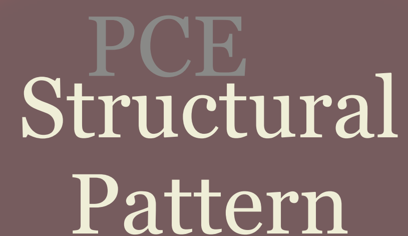
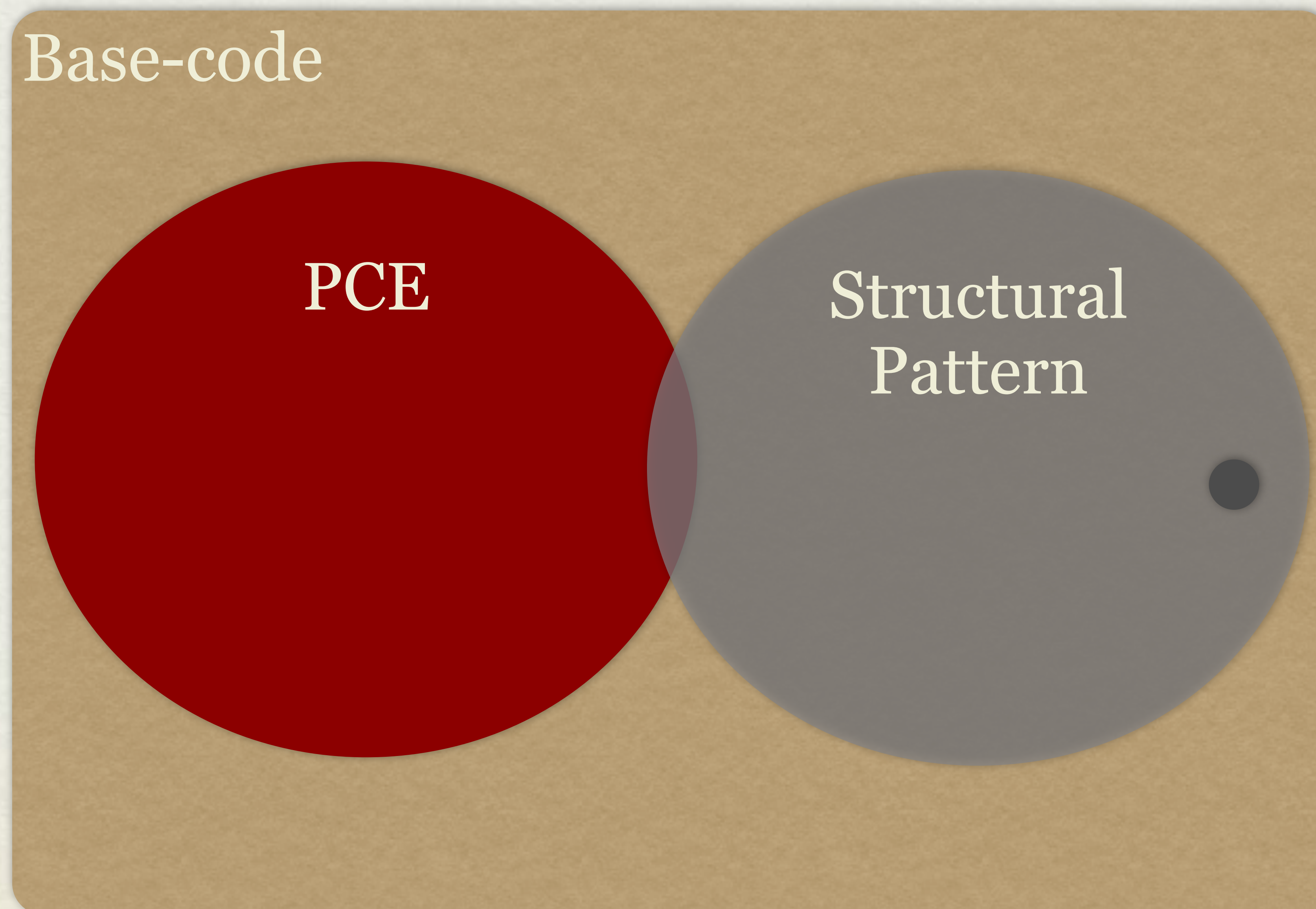


If a *new join point* is added to the base code that does not *share a high degree* of structural commonality with elements selected by a pointcut and *is not selected* by the pointcut, the pointcut becomes *less interesting* to preserve obliviousness.



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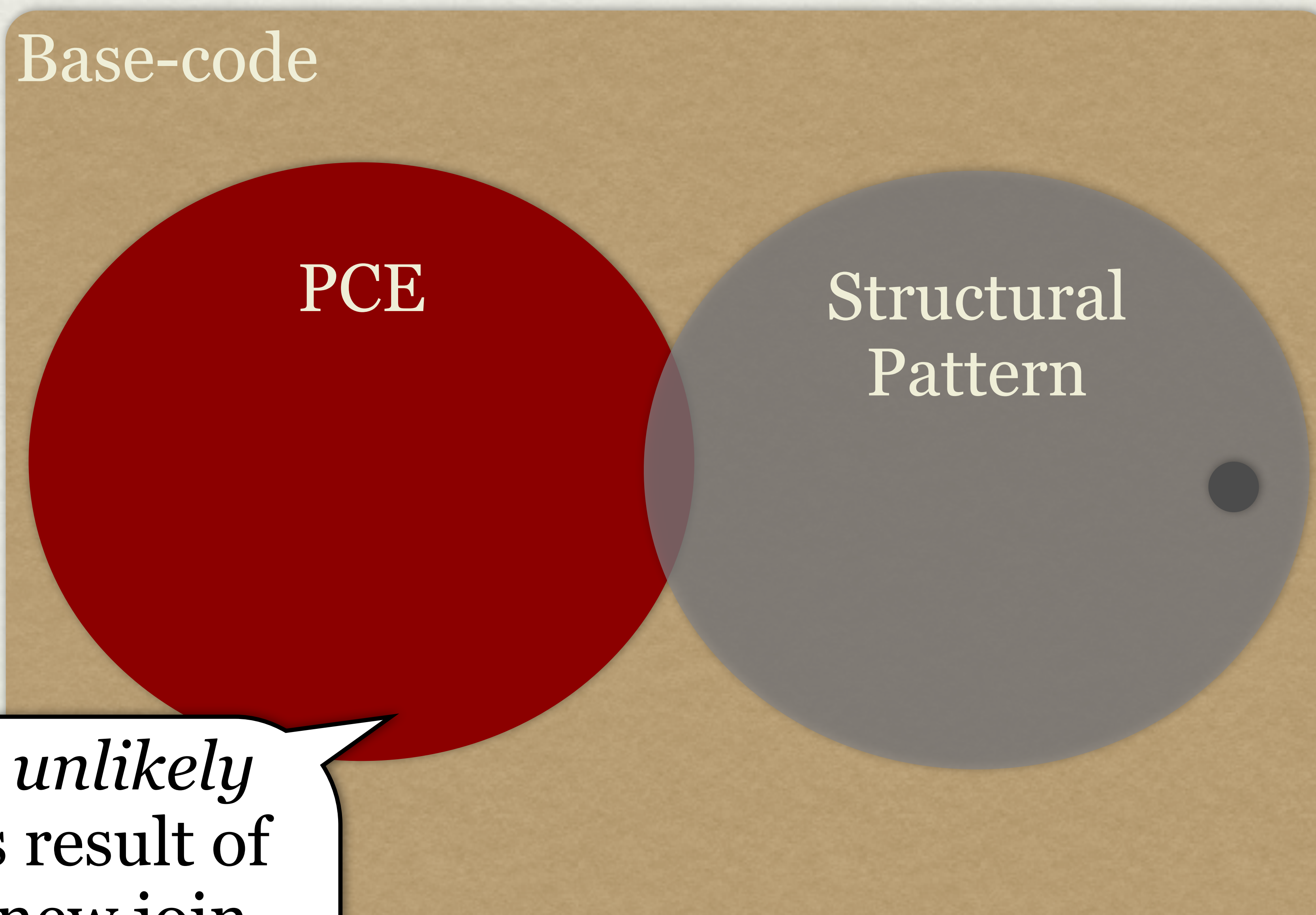

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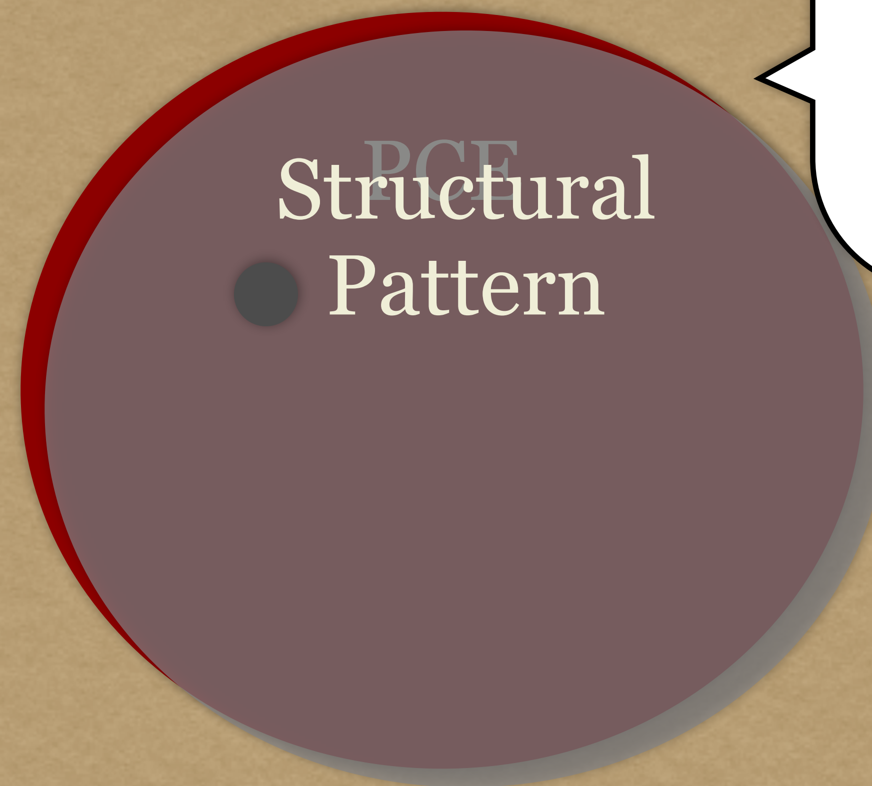
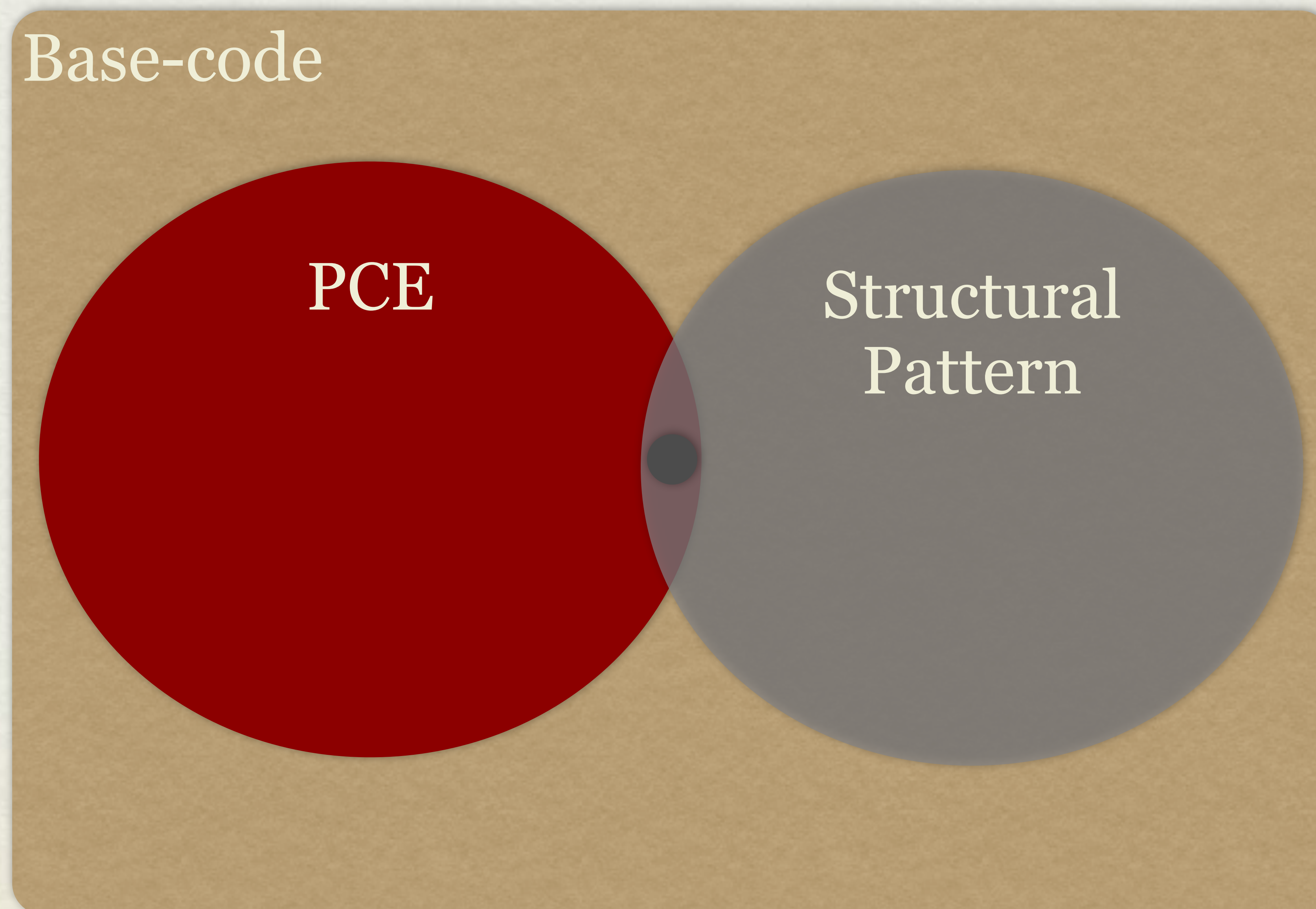


This PCE is *unlikely* to change as result of adding the new join point

If a new *join point* is added to the base code that does *not* share a *high degree* of commonality with other elements selected by the pointcut and *is selected* by a pointcut, the pointcut becomes *more interesting* as it may need to be altered to *exclude* the new join point.



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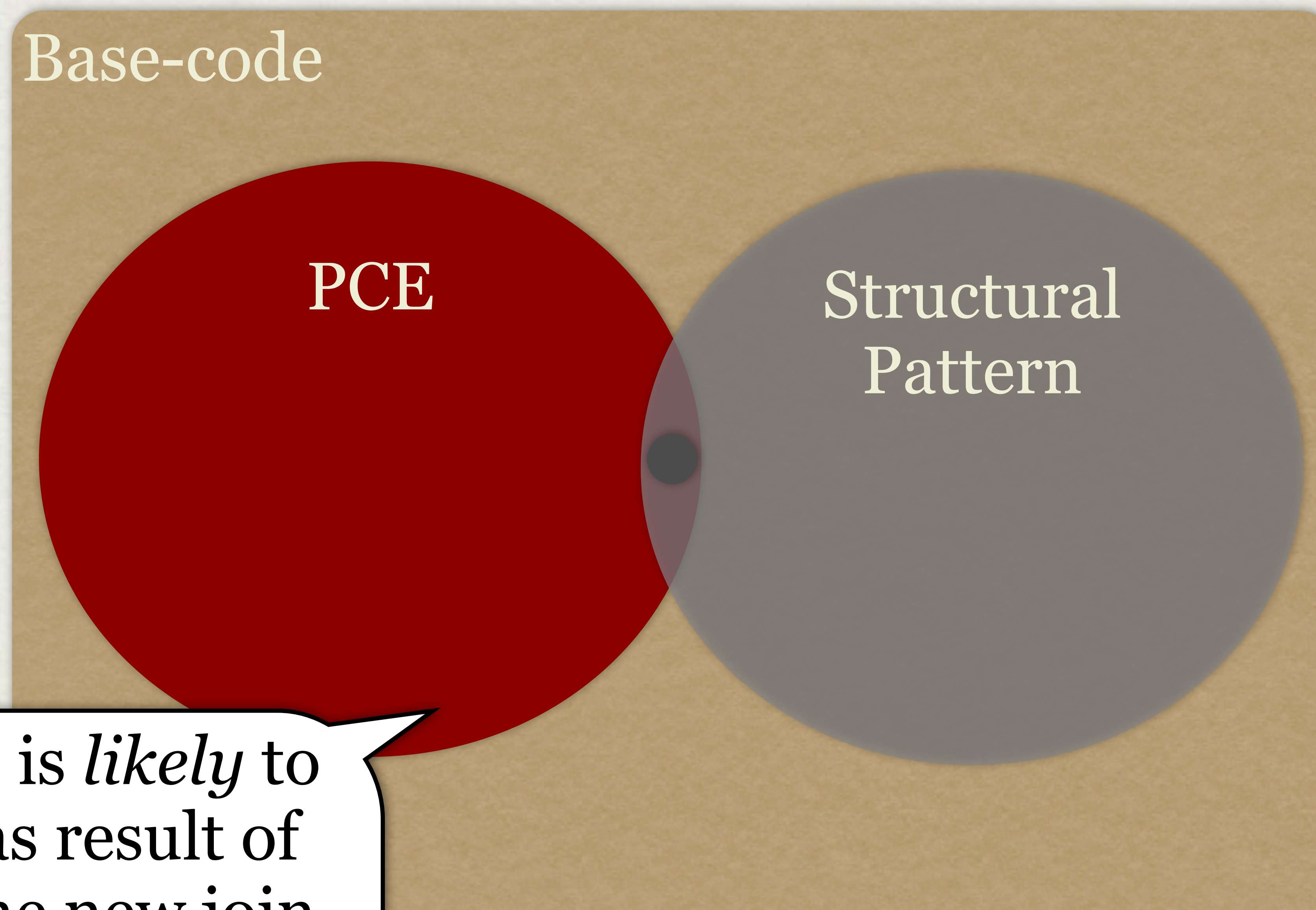
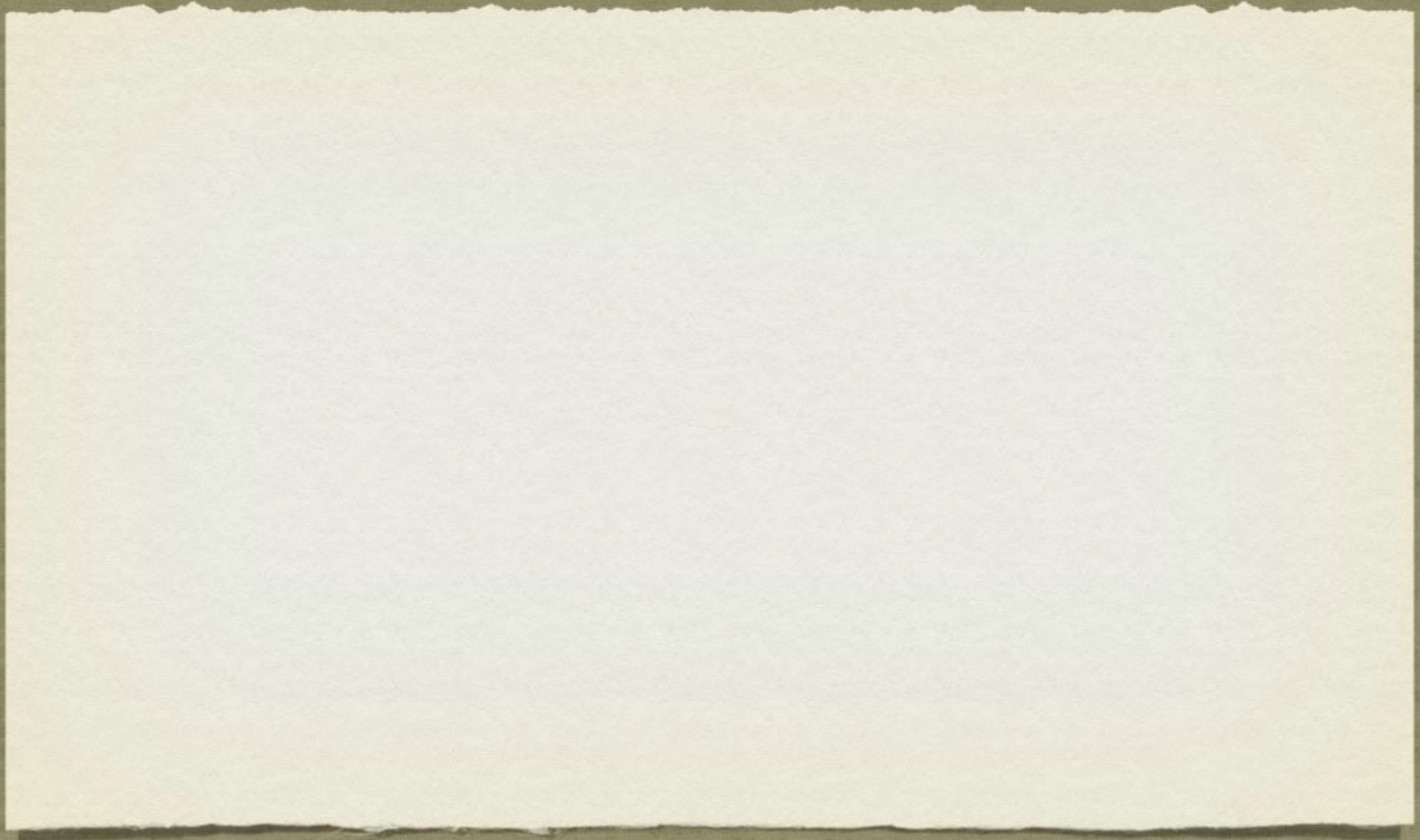


A Little About Pattern Construction



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- Arbitrary length (parameter into analysis)

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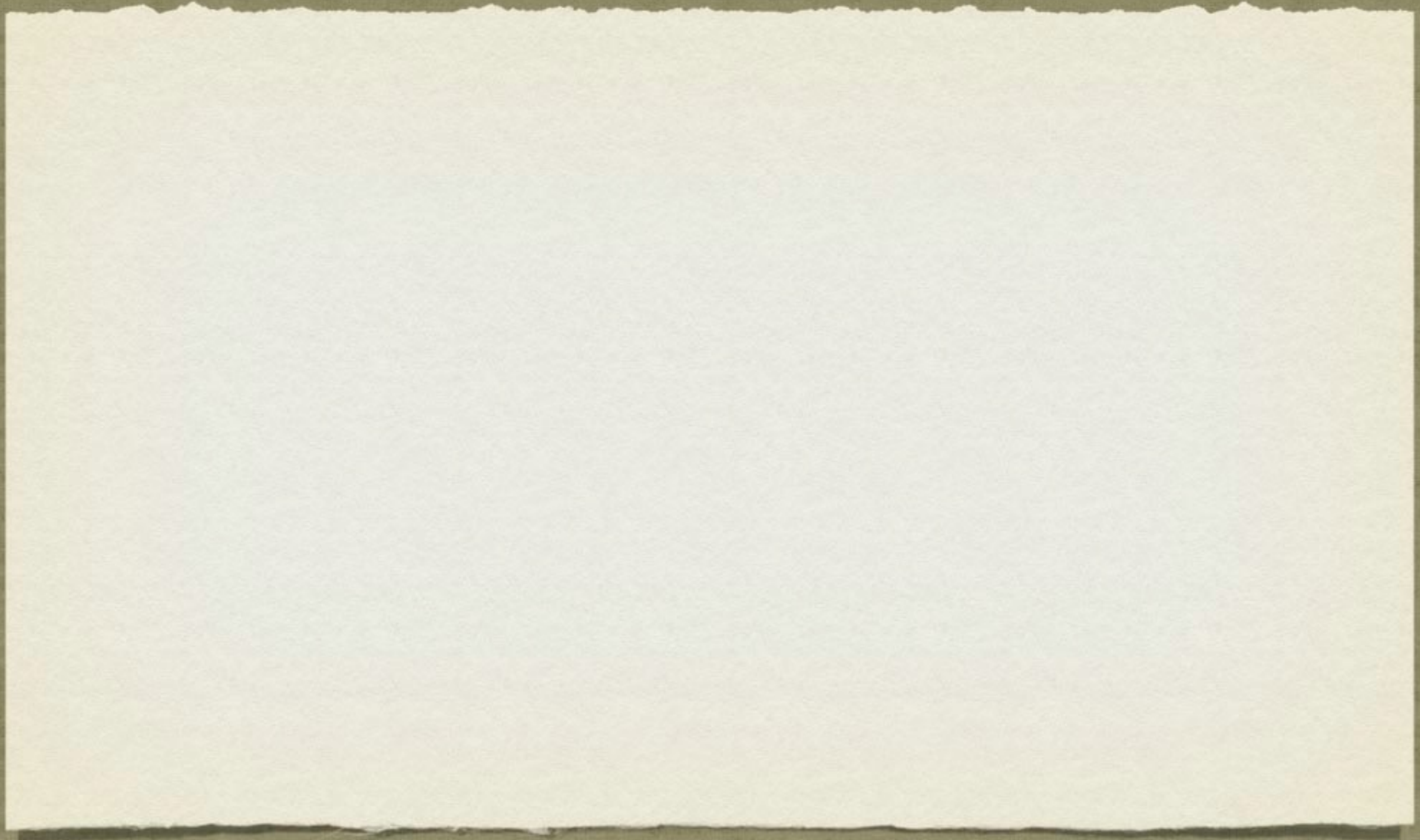
- Confidence is evaluated on three levels (see [Khatchadourian, Greenwood, Rashid, Xu ASE ’09] for details.

Ensuing Research Questions



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