Test-Driven Development

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Test-driven development

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Yes that sounds weird, but let's give the computer scientists some credit. We actually do it all the time intuitively.

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   Improve design, implementation, maintainability, all the while constantly testing to make sure that all tests still pass.

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Integration tests

Tests how multiple pieces of code work together.

TDD in practice: An example

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- Write the function, making sure it passes all the test cases.
- Refactor the code as needed, making sure all tests still pass.
- Repeat the process for any additional features or bug fixes.

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- TDD improves code maintainability by providing a clear and complete set of tests for the code.
- It also helps to improve the development process by making it more incremental and iterative, allowing for a faster development cycle.

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- Once TDD is implemented, we can go through rapid cycles of model development:
  - Make it easier to make changes or add new features (to the cognitive model, not just software).
  - Ensure the reliability and robustness of a model.
  - Continuous testing cycles facilitate rapid model development.

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  - ...
- Often the test can be evaluated informally (e.g., looking at a figure of model vs. data), but ideally it is automated.

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4. **Watch it pass:** Run the test and see that it passes, as the desired behavior or feature has now been implemented.
5. **Refactor:** Refactor the code as needed, making sure all tests continue to pass.

TDD workflow continue

6. **Repeat the process:** Repeat the process of adding a test, running all tests, writing the code, running all tests, and refactoring as needed for each desired behavior or feature.

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7. **Continuously verify:** Continuously verify the correctness of the code through the tests.
8. **Maintaining a test suite:** Maintaining a comprehensive test suite that covers all desired behaviors and features of the code.

Unit tests

Unit tests in Python

```
import unittest

class TestStringMethods(unittest.TestCase):
    def test_upper(self):
        self.assertEqual('foo'.upper(), 'FOO')
    def test_isupper(self):
        self.assertTrue('FOO'.isupper())
        self.assertFalse('Foo'.isupper())
    def test_split(self):
        s = 'hello world'
        self.assertEqual(s.split(), ['hello', 'world'])
        with self.assertRaises(TypeError):
            s.split(2)
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```
# Run the tests
if __name__ == '__main__':
    unittest.main()
```

```
# If using jupyter...
if __name__ == '__main__':
    unittest.main(argv=['first-arg-is-ignored'], exit=False)
```

Unit tests in Python

More on unit tests in Python via DigitalOcean:

https://www.digitalocean.com/community/tutorials/how-to-use-unittest-to-write-a-test-case-for-a-function-in-python

An applied example

Bayes factor for binomial data

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- We have two competing models that differ in their prior distributions for θ:
  - The "slab" prior: $\theta \sim U(0, 1)$
  - The "spike" prior: $\theta \sim U(0.45, 0.55)$

Bayes factor for binomial data

- The posterior distributions given the data can be found as:

$$p(\theta|k) \propto p(k|\theta)p(\theta)$$

$$p(\theta|k, \text{slab}) \propto \binom{n}{k}\theta^k(1-\theta)^{n-k} \times U(\theta|0,1)$$

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$$p(\theta|k, \text{spike}) \propto \binom{n}{k}\theta^k(1-\theta)^{n-k} \times U(\theta|0.45,0.55)$$

- The Bayes factor for comparing the two models can be calculated as:

$$B = \frac{p(k|\text{spike})}{p(k|\text{slab})}$$

$$= \frac{\int_{0.45}^{0.55}\binom{n}{k}\theta^k(1-\theta)^{n-k}d\theta}{\int_0^1\binom{n}{k}\theta^k(1-\theta)^{n-k}d\theta}$$