DSL Design with Python

Using TTRPG Examples

S.Lott

https://fosstodon.org/@slott56
https://github.com/slott56

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Link to Slide Deck Repository

https://github.com/slott56/dsl-with-python

Table of Contents

You have a Problem...

> *Before a small brick building surrounded by forest.*
> *A stream flows out of the building and down a gully.*

Descend to find a door with a giant lock and two keys with labels.

Above the door is this quote:

> *Some people, when confronted with a problem, think "I know, I'll use regular expressions." Now they have two problems.*

The labels:

1. "RE's are bad; RE $\subseteq$ DSL $\therefore \forall$ DSL's are bad. $\blacksquare$"
2. "They always lie."

The "RE is two problems" fallacy

RE syntax is an ugly jumble of infix and postfix operators.

Overuse of regular expressions can be bad.
(The famous Jamie Zawinski quote was about PERL.)

You know: "When your only tool is a hammer. . ."

Benefit: a DSL decomposes a problem.

1. The Domain-Specific Language. . .
2. Used to solve the problem.

Are there better RE's?

A digression

Consider Al Sweigart's HUMRE.

It has all the regular expression features.
In **Python** syntax.

HUMRE is a DSL for regular expressions in Python syntax.

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HUMRE is a DSL for regular expressions in Python syntax.

And. Bonus. It supports my thesis.

Section 2

DSL Design

Behind the entrance door is a dark hallway.

The hallway leads to another door. A sign on the door says **Model**.

On your left, you find a door labeled **Syntax**.

The **Syntax** workroom

Door 1:
two work tables

- **Tokenizer**
  tools and libraries and modules.
- **Parser**
  more tools and libraries.

Books by **DABEAZ** everywhere.

A pile of parts labeled **Lark**.

Door 2:
a shelf with labels

- JSON
- YAML
- TOML
- HUML

Archway:
flanked by two friendly-looking snakes.

[Pythons? Roll an Intellect *check.]*

You entered turning left through the **Syntax** door...
The **Model** door is still ahead of you!

Why the Python door?

You don't need yet another parser.

But *whattabout*...?

- **Security? The DSL is Code!**

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  A chaotic evil 9th level Sorcerer won't waste time hacking
  `rot13("vzcbeg bf; bf.flfgrz('sbezng p:')")`
  into DSL-based content.
  The **whole app** is visible, hackable Python.
  Consider a side-quest to query the Sphinx.

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- **The really ugly data model?**

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- The really ugly data model?

  Wait for case study 2.

Section 3

Case Study 1 — TTRPG “dice expressions”

TTRPG “dice expressions”

Example

`3d6+2`	“roll 3 six-sided dice, add 2”

Example

`4d8`	“roll 4 eight-sided dice”

There’s more, but that’s for lower levels of the dungeon.

Which path?

- Turn left and write RE’s for the syntax?
- Define Python classes and objects?

TTRPG "dice expressions"

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Which path?

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The syntax isn't Pythonic.

How to proceed?

Strategy Tip: Adjust the syntax to be Pythonic

From this: $3d6 + 2$.

To this: `3 * D6 + 2`

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Python syntax lets you teleport straight to the data model.

But *whattabout* the users?

It's a *.
Create significant leverage and they'll embrace it.

The Dice class

```
class Die:
    def __init__(self, faces: int = 6, n: int = 1) -> None:
        ...
    def __rmul__(self, other: Any) -> Die:
        match other:
            case int():
                return Die(self.faces, n * other)
            case _:
                return NotImplemented
    def roll(self) -> int:
        ...

D6 = D(6)
```

This is the data model.

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```

This is the data model. And, 3*D6 is valid DSL.

Section 4

Case Study 2 — **OpenD6** spells

Context — legacy data

OpenD6 rules have an Open Gaming License (OGL), making them open source with attribution.
Perfect for extensions and customizations.

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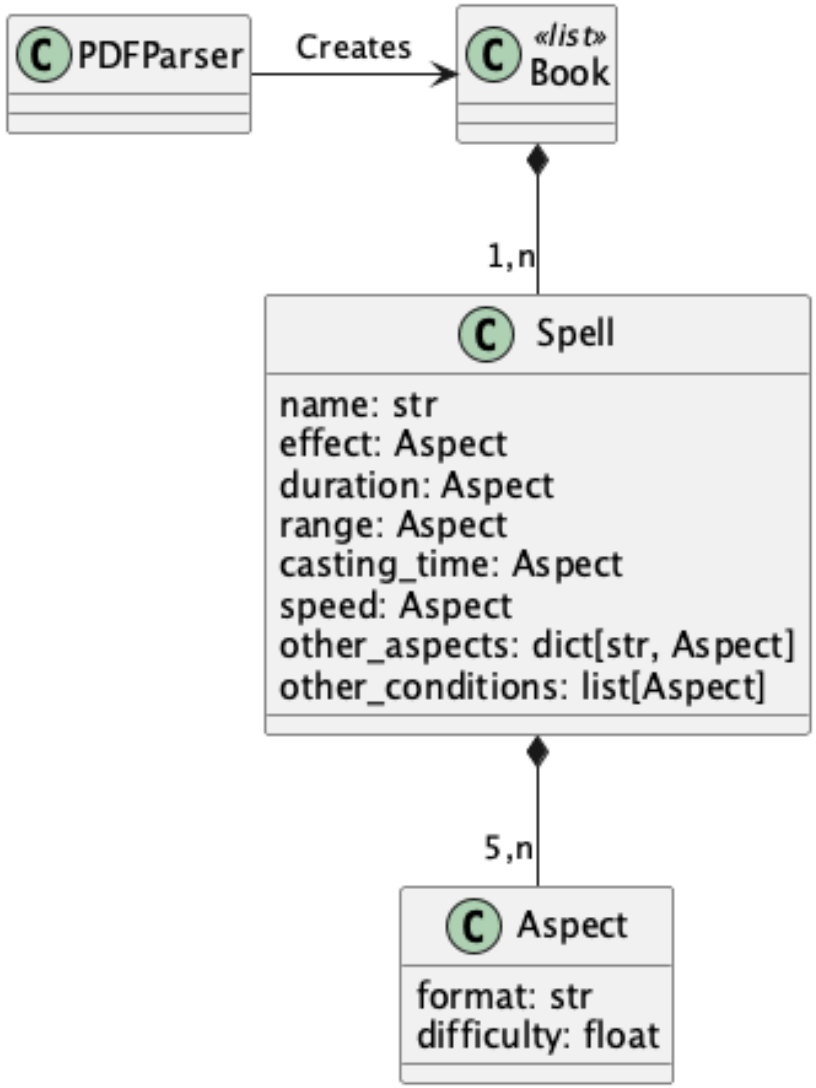
How to capture legacy data?

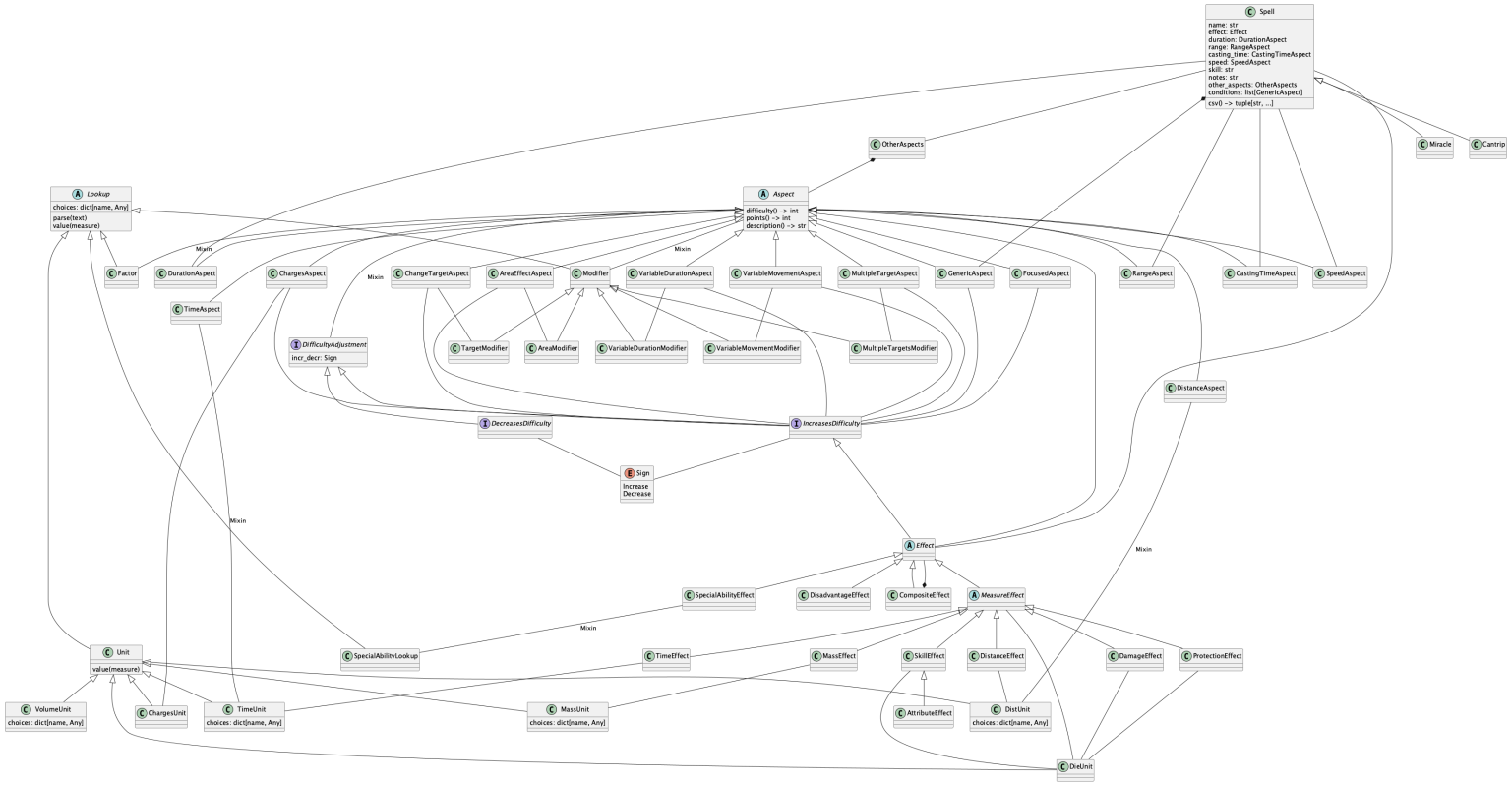
Strategy Tip: Q&D (Quick & Dirty) Model

1. Define a throw-away data structure to capture legacy content.
2. Then, work out a more useful, semantically complete DSL.

Legacy Data Model



Expanded DSL Data Model



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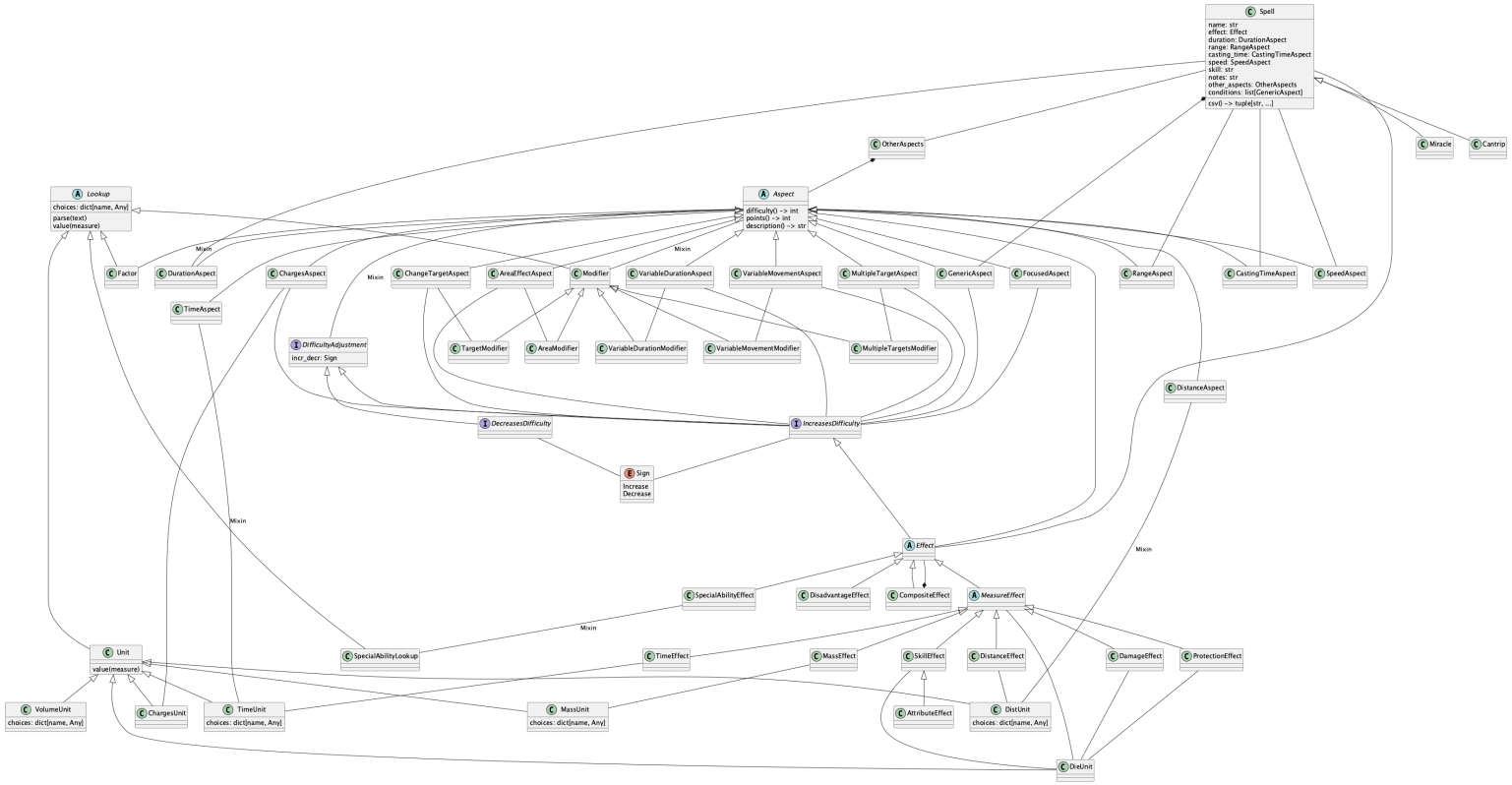

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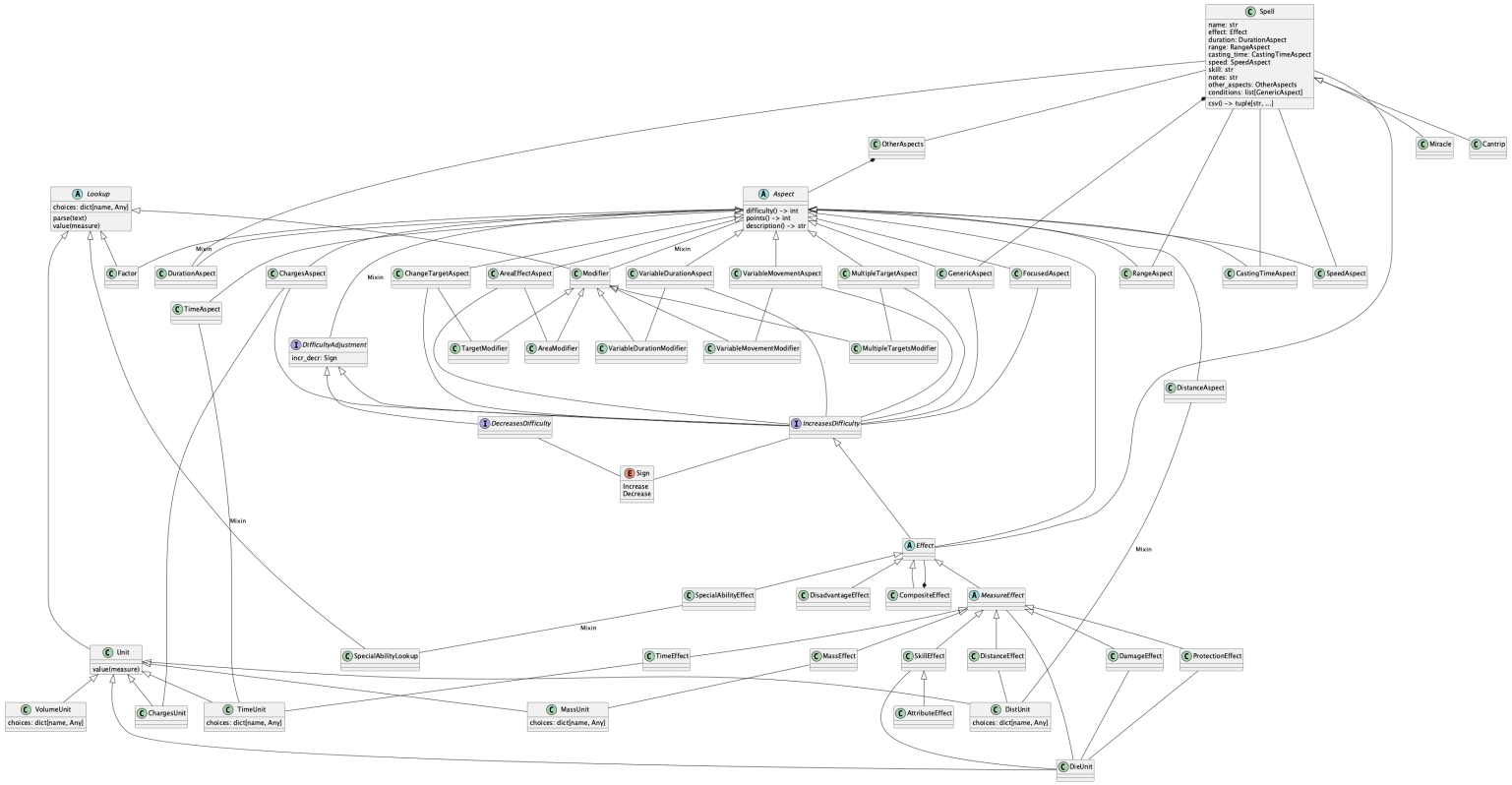

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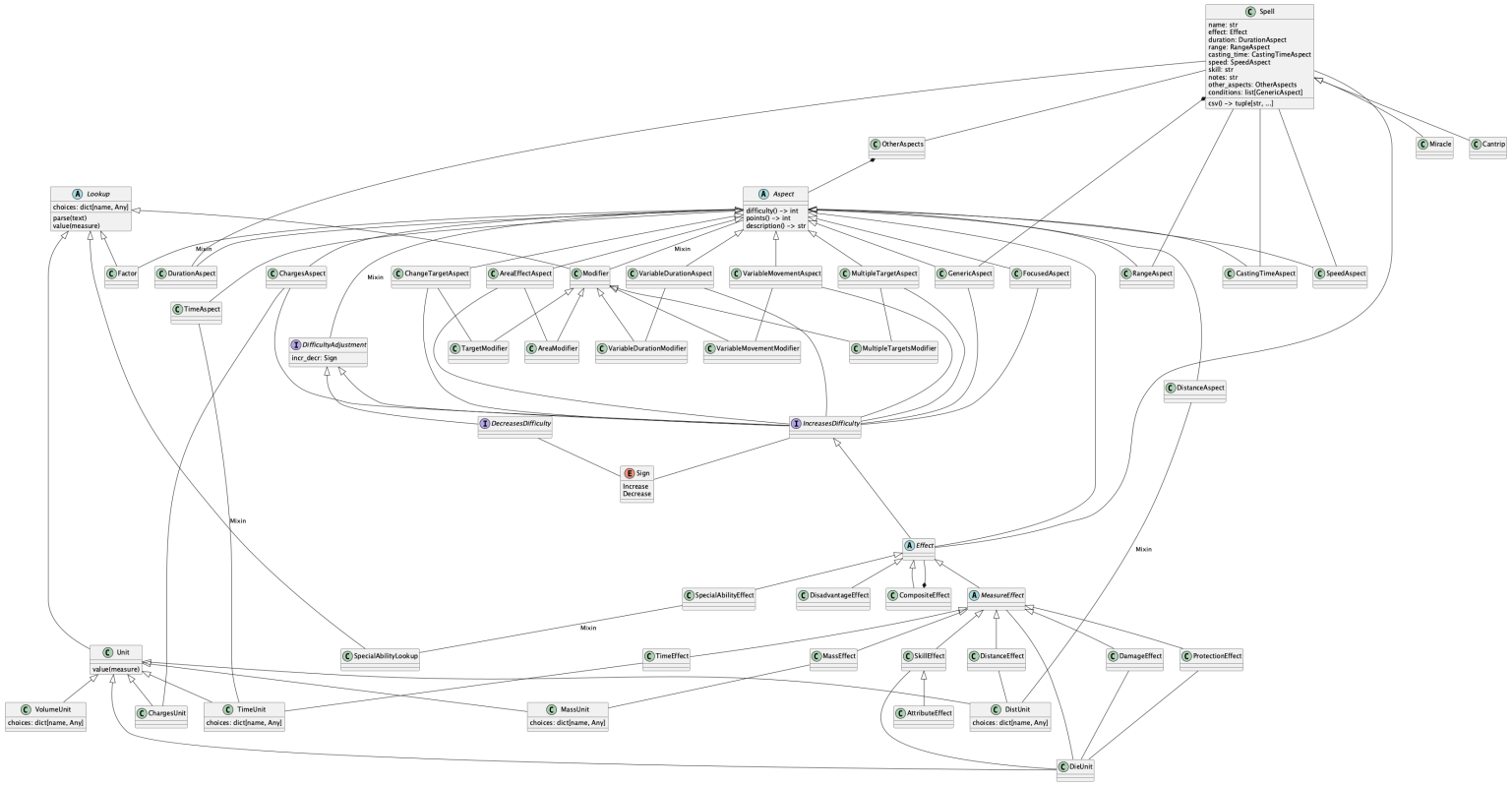

Yes, it's complicated.

A (second) bulk coversion was required.

I omitted some stuff, and it was still vast.

Example DSL statement

```
Spell(
    name="Push",
    skill="Apportation",
    notes="Even the most subtle of things,,,",
    effect=TimeEffect("sends a small object into the future", "10 min"),
    duration=DurationAspect(measure="10 minutes"),
    range=RangeAspect(measure="touch"),
    casting_time=CastingTimeAspect(measure="1 round"),
    speed=SpeedAspect.based_on(("range",), ""),
    other_aspects={
        "gestures": GesturesAspect("Wave one hand ...", "simple"),
        "incantations": IncantationsAspect(
           "Where did it go?", "sentence"
        ),
    },
)
```

It has a lot of boilerplate. API design needs work.

Typical DSL use cases

- Represent legacy content and rules in the DSL.
- Compute derived values from DSL.
  (Compare with legacy sources as acceptance test case.)
- Present content in RST format for publication.
- Identify special cases and possible errors.

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DSL and Learning

- Unless you're already the leading expert in the problem domain, expect the DSL evolution.
- DSL evolution $\equiv$ Learning
  The SOLID **Open/Closed Principle** is your friend.

But *whattabout* the ugly data model?

Strategy Tip: Replace tears with tiers

Foundation **Your ugly domain model that really captures everything the end users are prattling on about.**

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API **A layer on top of the ugly foundation that creates the classes and objects for a pleasant, easier-to-use DSL.**

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Strategy Tip: Replace tears with tiers

Foundation
: Your ugly domain model that really captures **everything** the end users are prattling on about.

API
: A layer on top of the ugly foundation that creates the classes and objects for a pleasant, easier-to-use DSL.

This is Pythonic OO design.

Patterns to use:

- Façade – Koan 5: flat is better than nested
- Adapter – Koan 8: make special cases fit the rules

More ideas? Run `import this`

Section 5

Conclusion

Tips for DSL design

- Use Python as the syntax for a DSL.

Pursue Pythonic Practices

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Tips for DSL design

- Use Python as the syntax for a DSL.
- Capture legacy rules with a Q&D model.
- As you learn, build a complete DSL model.
- Tears $\rightarrow$ tiers — layer the model for usability.

Pursue Pythonic Practices

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Appendix

Malicious Actors

How to handle malicious actors

Are **all** elements present?

- Untrusted sources of DSL, and
- Large DSL docs, and
- Difficulty in doing code validation.

Two strategies:

1. Use JSON or TOML.
   Use a `@classmethod` to build DSL model objects from `dict[str, Any]` content.
2. Don't allow DSL modules to use `import`.
   Use the **Compile-Check-Exec** pattern.

Avoid `import` with Compile-Check-Exec

Compile

```
source = Path(module).with_suffix(".py").read_text()
spell_book_code = ast.parse(source, module, "exec")
```

Check

```
visitor = AllImports(source)
visitor.visit(spell_book_code)
if visitor.imports:
    raise ValueError(f"import detected: {visitor.imports}")
```

Exec

```
global_defs: dict[str, Any] = {}
local_vars: dict[str, Any] = {}
exec("from magic2 import *", global_defs, local_vars)
exec(source, global_defs, local_vars)
return local_vars["spells"]
```

The AllImports visitor


```
class AllImports(ast.NodeVisitor):
    def __init__(self, source: str) -> None:
        self.source = source
        self.imports: list[str | None] = []

    def visit_Import(self, node: ast.Import) -> None:
        self.imports.append(ast.get_source_segment(self.source, node))

    def visit_ImportFrom(self, node: ast.ImportFrom) -> None:
        self.imports.append(ast.get_source_segment(self.source, node))
```