Descriptors story

talented developers | flexible teams | agile experts

Adrian Dziubek - EuroPython - 2016-07-18

About me

Adrian Dziubek
Senior Python developer
at STX Next in Wrocław,

Creating web applications
using Python and Javascript.

Also
Cyclist, photographer,
Ultimate Frisbee player.

The talk

A story about tree structures
and accidental rediscovery of descriptors.

Knowledge vs usage

The plan

- Introduction to project,
- Fighting the lost war,
- Starting anew,
- Lessons learned.

Warning: legacy code ahead

The project

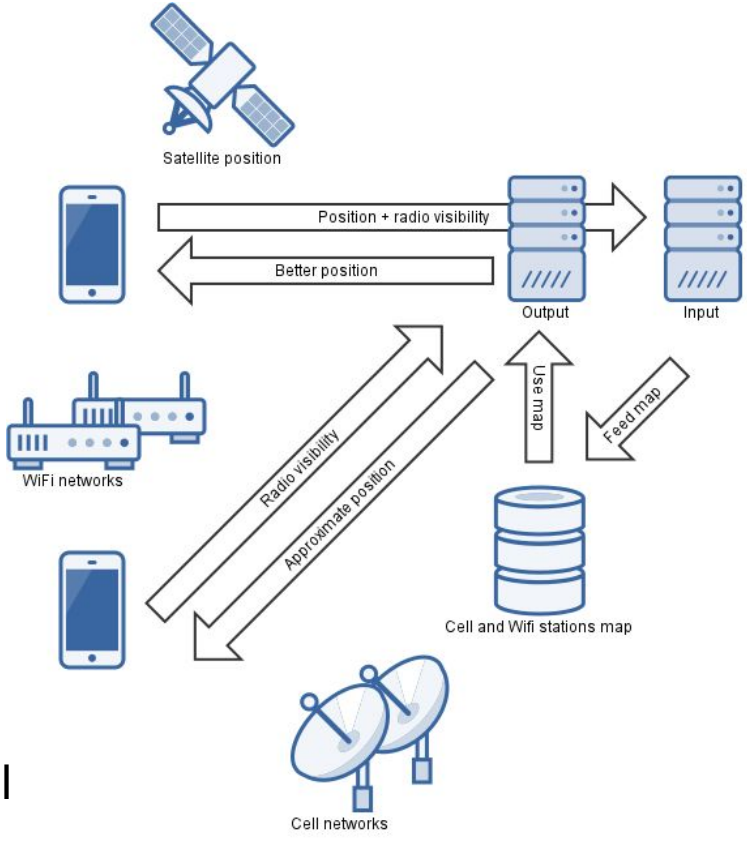
Positioning system

Input
Satellite provided position + radio visible

Storage
A map of radio stations with metadata

Output
Approximate position based on radio signal

Why?
Assisted GPS, positioning inside the buildings

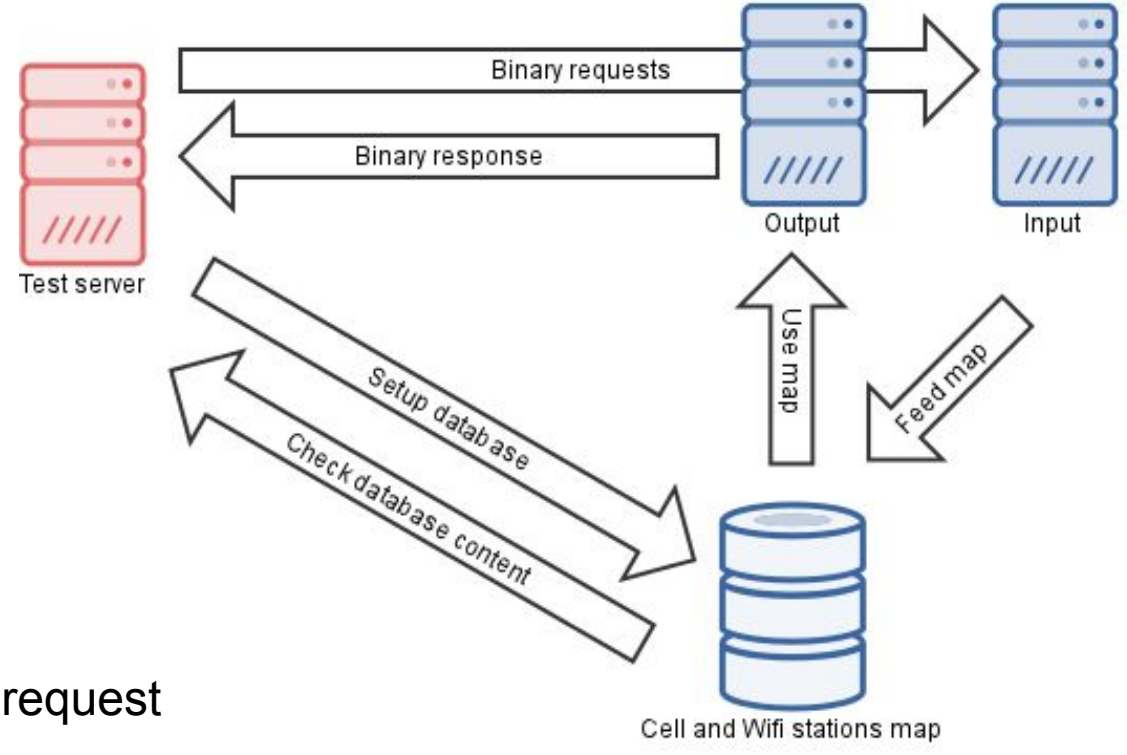


The test project

Blackbox test tool in Python

Input testing
Binary data
against
Database requests

Output testing
Database setup + binary request
against
Binary response



The code

Problems:

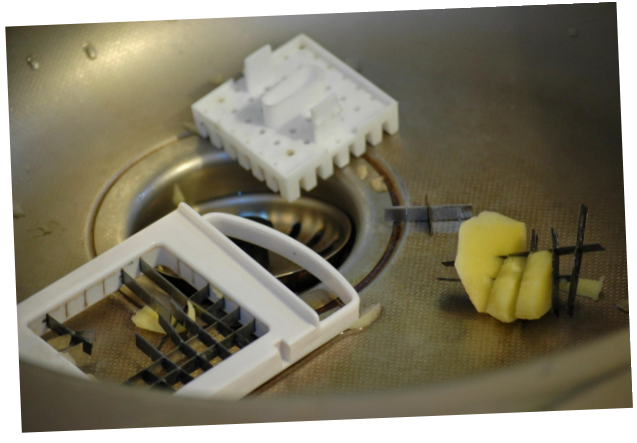
- star imports, race conditions,
- repetition, C++ styling,
- no use of introspection.

```
# top/protocol/__init__.py PACKAGE
from Serializer import *
from DeSerializer import *
from ABC import *
# top/protocol/ABC.py TYPE DEFINITION
from toplevel.protocol.SomeElementBase import BaseElement
class ABCType(NamedEnum):
  UNKNOWN = 0
  A = 1
  # ...
class ABCElement(BaseElement):
  # used for name validation and sorting
  __slots__ = ('type', 'version', 'children')
  def __init__(self):
    BaseElement.__init__(self, {
      'type': ABCType(0, 5, ABCType.UNKNOWN, 'type'),
      'version': VersionElement(1, 1, 'version'),
      'children': TypedList(0, 20, [CDElement, FGElement], 'children'),
    })
  # each function below manually walks the tree
  def pretty_print(self, article = ''):  # ...
  def __eq__(self, other): # ...
  def serialize(self, serializer): # ...
  def compare_to(self, other): # ...
  def __call__(self, other = None):
    if type(other) == type(self): self.value = other.value
    else: self.value = other
```

The data

Problems:

- attribute access chains,
- singleton pattern,
- can't reuse locals.



```
# top/protocol/Data.py DATA DEFINITION
class ABCData(object):
  @staticmethod
  def get( index = 0 ):
    abc_element = ABCElement()
    abc_element.setVersion(5, 1)
    if index == 0:
      cd_element = CDData.get(1)
      cd_element.sub_elem = SubElement()
      cd_element.sub_elem.infra_elem1(0x123)
      cd_element.sub_elem.infra_elem2(0x234)
      fg_element = FGElemeent()
      abc_element.children.append(cd_element)
      abc_element.children.append(fg_element)
    # ...
    return abc_element

# top/scenario/ProtocolCase.py TEST CASE
class ProtocolCase(Runner):
  def abc( self ):
    abc_element = ABCData.get(0)
    cd_element = CDElement()
    fg_element = FGElement()
    cd_element.sub_elem.infra_elem1(1)
    cd_element.sub_elem.infra_elem1(0x123)
    cd_element.sub_elem.infra_elem2(0x234)
    abc_element.children([cd_element, fg_element])
    # test run below
```

What is the goal?

Easy to use trees for testers:

- data definition,
- difference reporting,
- server configuration.

Optimize data definition
looks a bit like assignment.

```
# top/protocol/Data.py DATA DEFINITION
children1 = [
   CDElement(
      sub_elem=SubElem(
         infra_elem1=0x123,
         infra_elem2=0x234
      ),
   FGElement()
],
abc_element1 = ABCElement1(
   type=ABCType(ABCType.A),
   version=Version(5, 1),
   children=children1,
)

# top/scenario/ProtocolCase.py TEST CASE
from top.protocol import Data, Data2
abc = copy.deepcopy(Data.abc_element1)
abc.children = copy.deepcopy(Data2.children2)
```

How to get there

Low hanging fruit:

- keyword arguments,
- use diff library on output.

Battles lost:

- star imports,
- repetition,
- serialization,
- other projects using it.

```
# top/protocol/ABC.py TYPE DEFINITION
class ABCElement(BaseElement):
  __slots__ = ( 'type', 'version', 'children')
  def __init__( self, **kwargs):
    # initialization like before, but added kwargs
    BaseElement.__init__(self, { ... }, **kwargs)

# top/protocol/BaseElement.py BASE TYPE DEFINITION
class BaseElement(object):
  def __init__(self, fields, **kwargs):
    # field handling like before, but added kwargs
    for name, value in kwargs.items():
      getattr(self, name)(value)
  def __call__(self, other = None):
    if type(other) == type(self):
      self.value = copy.deepcopy(other.value)
    else:
      self.value = copy.deepcopy(other)
  def diff_to(self, other):
    diff = ''.join(difflib.ndiff(
      repr(self).splitlines(True),
      repr(other).splitlines(True)
    ))
    # ...
    return diff
```

A new beginning

Assignment

- intercept, handle in child,
- __setattr__() and _assign().

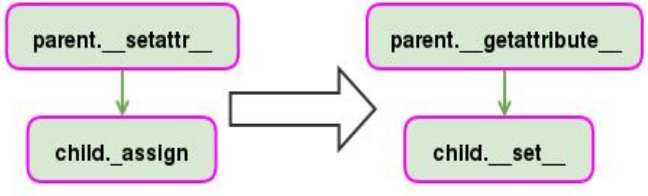
Repetition

- field ordering (Django),
- introspection
  - dir()
  - isinstance(),
- printing and serialization.

```
class NewBase(object):
    _creation_counter = 0
    def __lt__(self, other):
        if isinstance(other, NewBase):
            return self._creation_counter < other.creation_counter
        return NotImplemented
    def __init__(self, **init_values):
        self._creation_counter = NewBase._creation_counter
        NewBase._creation_counter += 1
        self.fields = self._sorted_fields()
        for name, value in init_values.items():
            setattr(self, name, value)
    def __setattr__(self, name, value):
        sub = getattr(self, name)
        if isinstance(sub, NewBase):
            sub._assign(name, value)
        else:
            super(NewBase, self).__setattr__(name, value)
    def _assign(self, name, other):
        if isinstance(other, type(self)):
            self._value = other._value
            for name in self.fields:
                setattr(self, name, getattr(value, name))
        else:
            self._value = other
```

Data descriptors

Achievement unlocked
reinvented data descriptors.

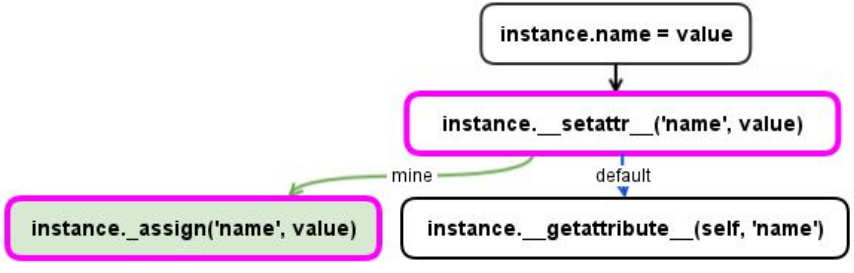


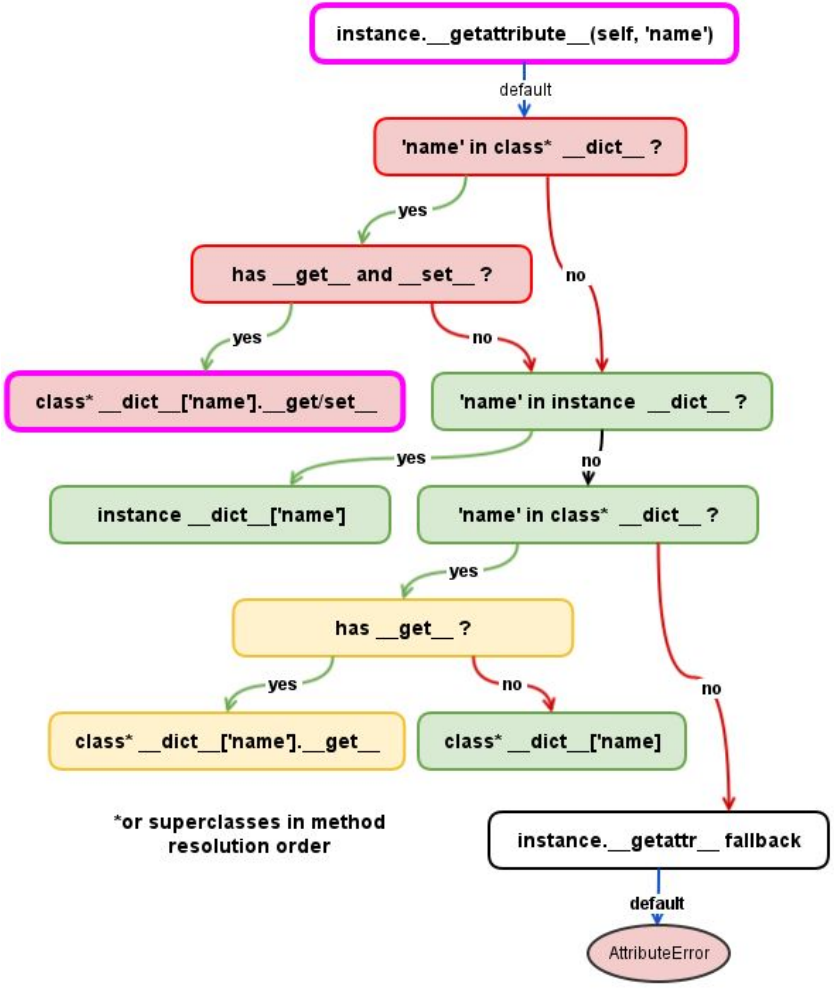

```
class NewerBase(object):
  _creation_counter = 0
  def __lt__(self, other):
    if isinstance(other, NewerBase):
      return self._creation_counter < other.
creation_counter
    return NotImplemented
  def __init__(self, **init_values):
    self._creation_counter = NewerBase._creation_counter
    NewerBase._creation_counter += 1
    self.fields = self._sorted_fields()
    for field in init_values.items():
      setattr(self, name, value)
  def __set__(self, instance, other):
    if self in instance.fields:
      if isinstance(other, NewerBase):
        self.value = other.value
        for name in self.fields:
          setattr(self, name, getattr(value, name))
      else:
        self.value = other
  def __get__(self, instance):
    return self
```

Scary call tree

Rules:

- Data descriptor (__set__ and __get__),
- Fallback to inheritance
  - instance,
  - class,
- Non-data descriptors,
- __getattr__ fallback,





A typical case

Overriding assignment:

- attribute read,
- attribute write,
- still use methods.

Used in:

- properties,
- class methods,
- static methods.

```
# top/protocol/library.py TYPE DEFINITION
class ABCType(atom.Enum):
  Unknown = 0
  A = 1
class Version(struct.Tree):
  major = atom.Uint8(max_value=99)
  minor = atom.Uint8(max_value=99)
class ConstrainedList(struct.List):
  allowed_types = (object,)
  #...
# top/protocol/data.py DATA DEFINITION
class ABCElement(struct.Tree):
  type = ABCType().A
  version = Version(major=1, minor=0)
  children = ConstrainedList(
     allowed_types=(CDElement, FGElement),
     default=[CDElement()]
  )
# top/scenarios/protocol_case.py DATA USAGE
abc = ABCElement(version=Version(major=2, minor=1))
abc.version.minor = 3  # intercept assignment
abc.version.minor.is_valid()  # it's still a field
abc.version.minor.serialize_to(stream)
abc.version.minor.pretty_print()
```

Bonus

Copy-pastable tests
simple definition,
easier to print,
easier to read,
copy-pasteable.

```
# pretty print output AND definition after
ABCElement1(
  type=ABCType().A,
  version=Version(major=5,minor=1),
  children=[
    CDElement(
      sub_elem=SubElem(
        infra_elem1=0x123,
        infra_elem2=0x234,
      ),
    ),
    FGElement()
  ]
)
```

```
# pretty print output before
# ABCElement:
#  Type: A
#  Version: 5.1
#   Children:
#     CDElement: ...

# definition before
abcElement = ABCElement()
abcElement.setVersion(5, 1)
cdElement = CDElement()
cdElement.SubElem = SubElement()
cdElement.SubElem.InfraElem1(0x123)
cdElement.SubElem.InfraElem2(0x234)
fgElement = FGElemeent()
abcElement.Children.append(cdElement)
abcElement.Children.append(fgElement)
```

Conclusion

“The moral of the story is that you can prove anything with a contrived example…”
— Joel Spolsky

- choose most bang for the buck,
- Pareto principle 80-20,
- new solutions on new features,
- if it’s not broken, don’t fix it.

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