Agile Construction of Data Science DSLs (Tool Demo)

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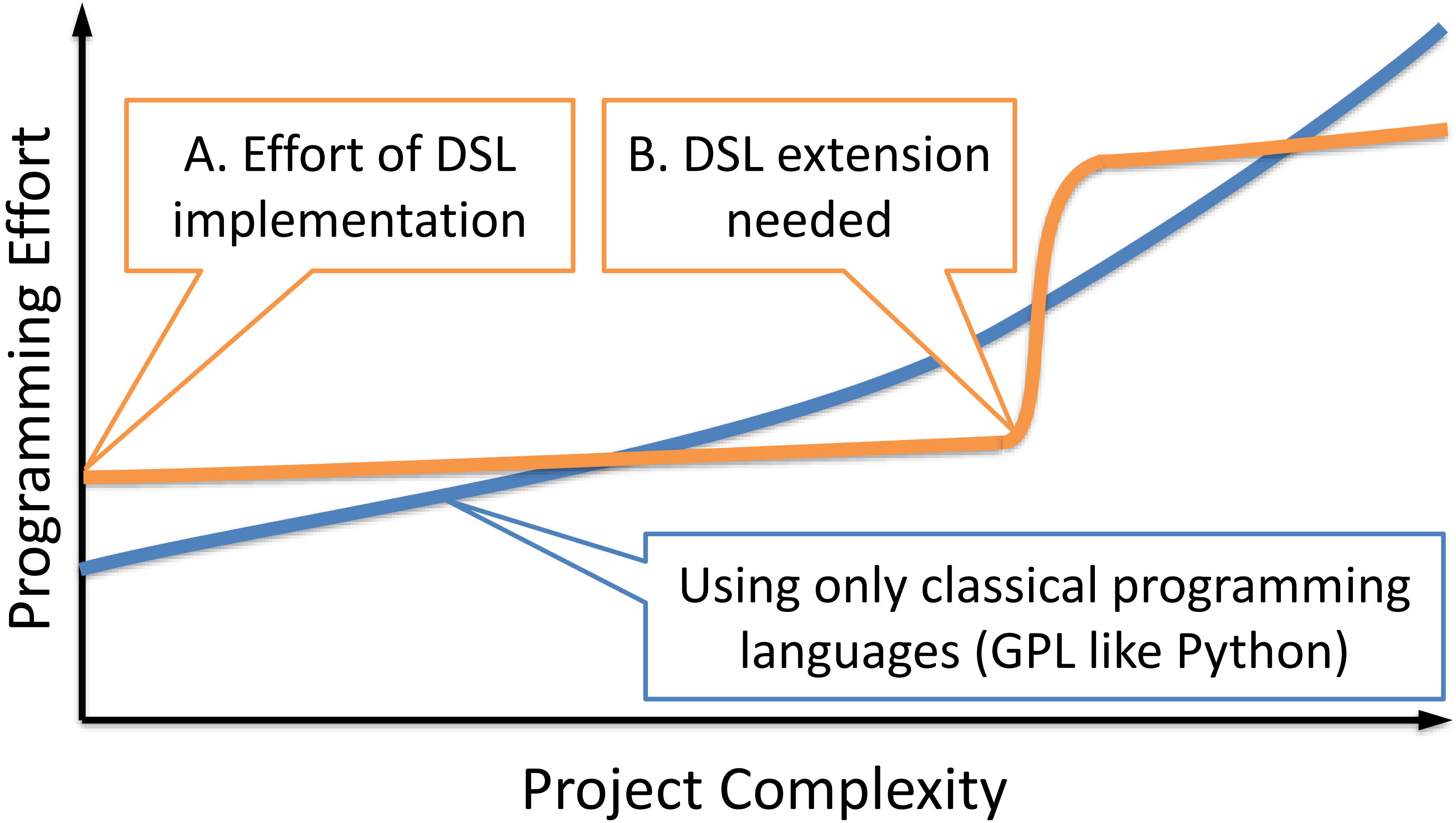
DOMAIN SPECIFIC LANGUAGES: BLESSINGS AND CURSES

Disadvantages of (External) DSLs



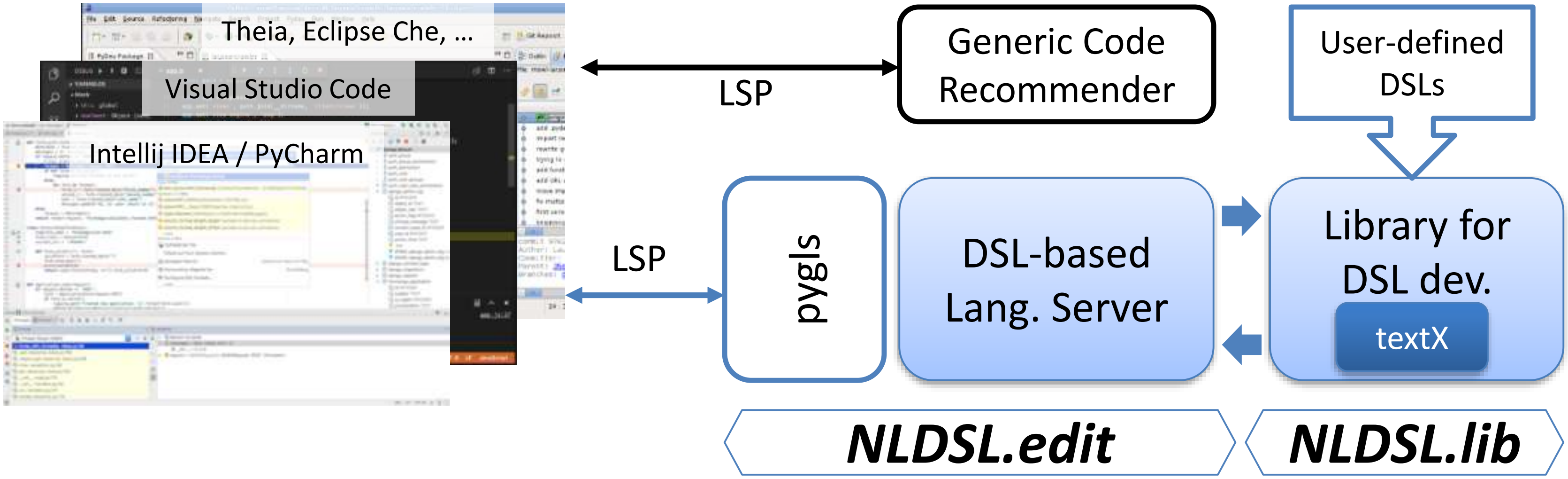
Ideal DSL Engineering

Solution Postulates:

- A. Low initial “price” for implementing a DSL
- B. No extra overhead for tasks outside DSLs
- C. Integration with existing code base
- D. Support for common IDEs / editors

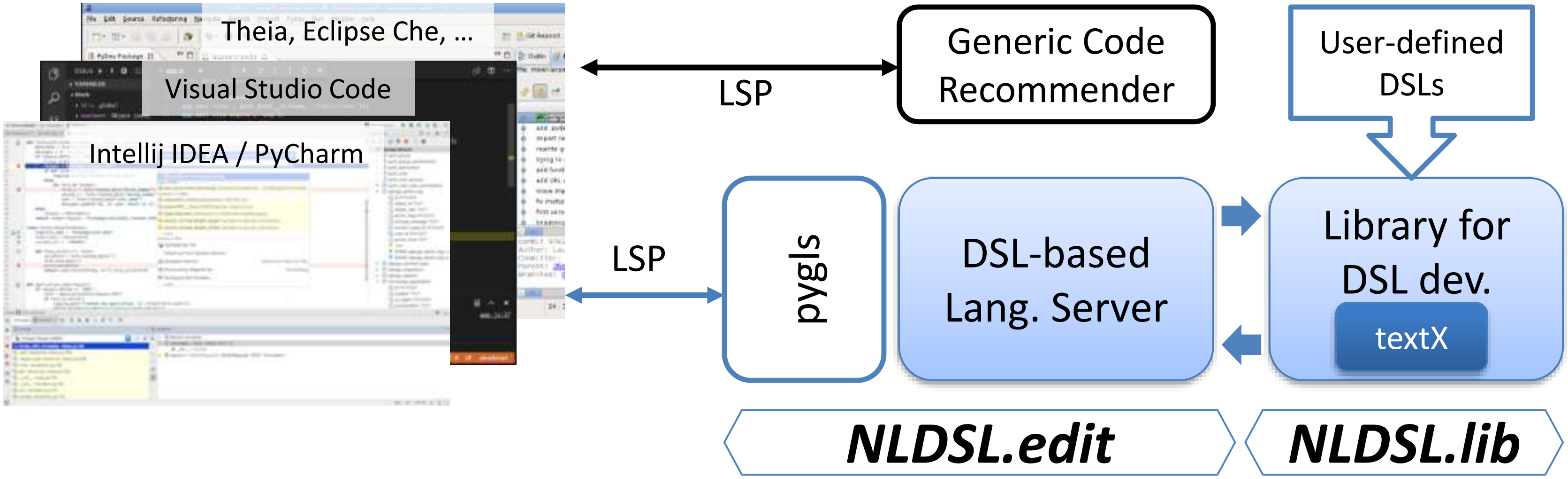
TOOL NLDSL: KEY CONCEPTS

Tool NLDSL: Overall Architecture



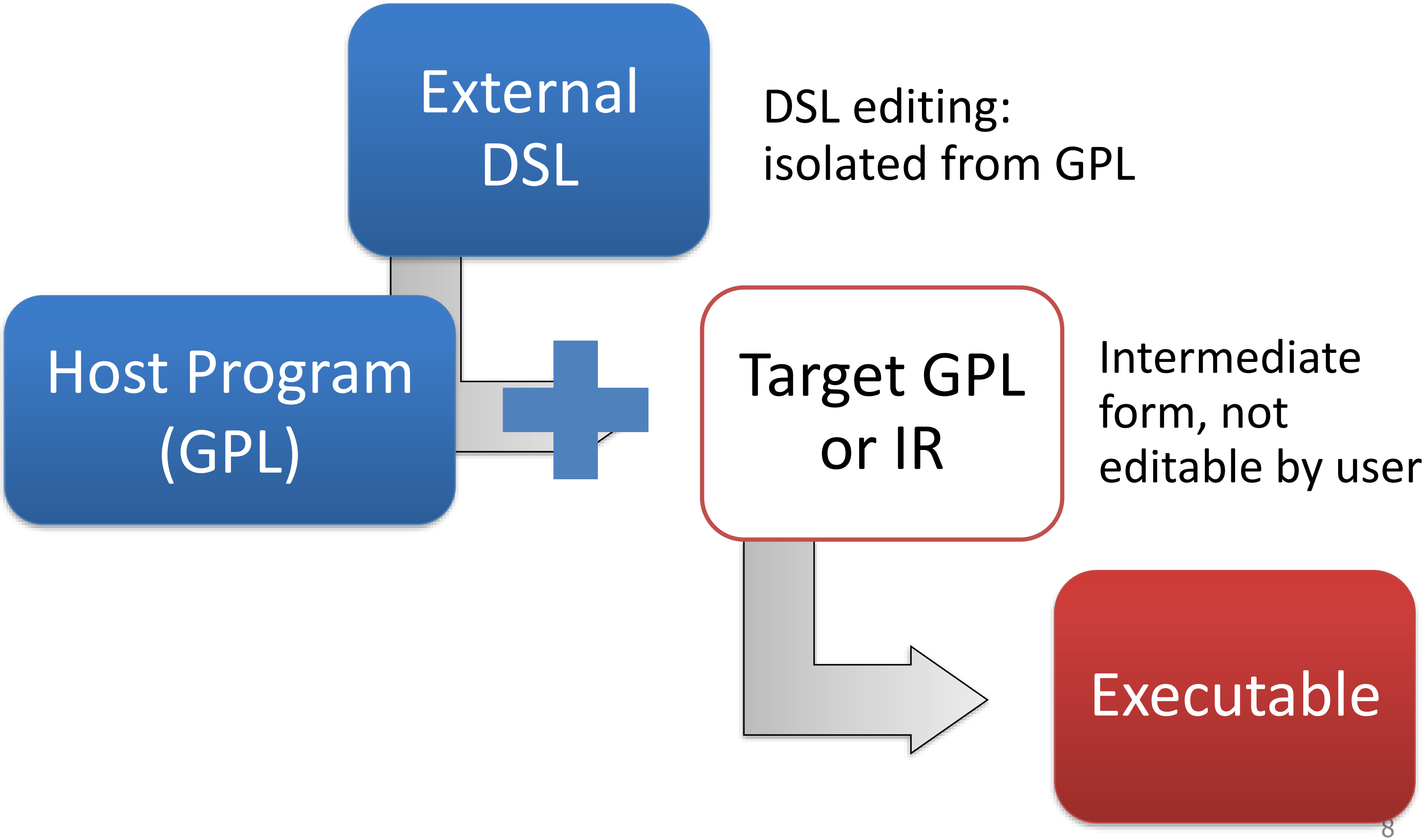
- Our tool NLDSL consists of:
- A library *.lib for implementing pipeline-oriented DSLs
- An environment *.edit for DSL editing and in-editor code generation for IDEs supporting LSP

D. Support for common IDEs / editors



- Our tool uses a Language Server Protocol (LSP)
  - Separates editor “frontend” from services (completion, lint, …)

Development Phases with External DSLs

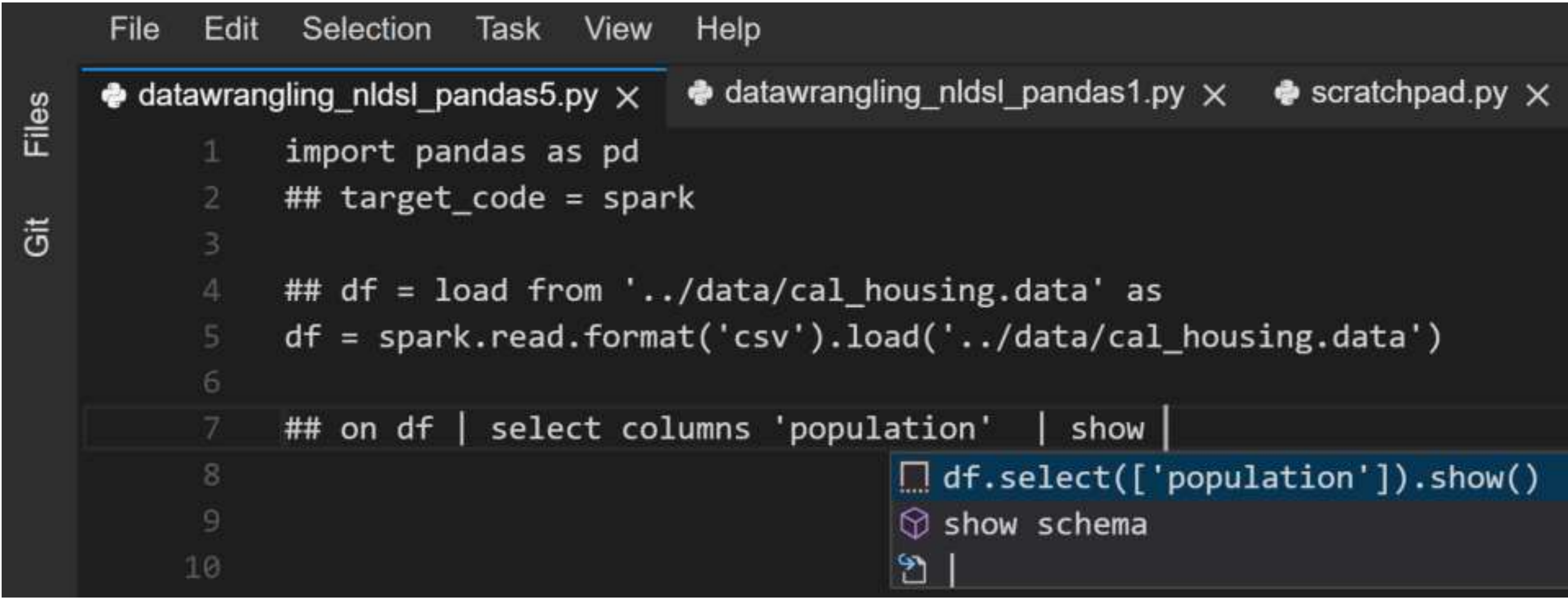


DSL editing:
isolated from GPL

Intermediate
form, not
editable by user

B: No Overhead for Tasks Outside DSLs

- GPL code is generated on-demand during editing
- User enters DSL code in comments, assisted by editor

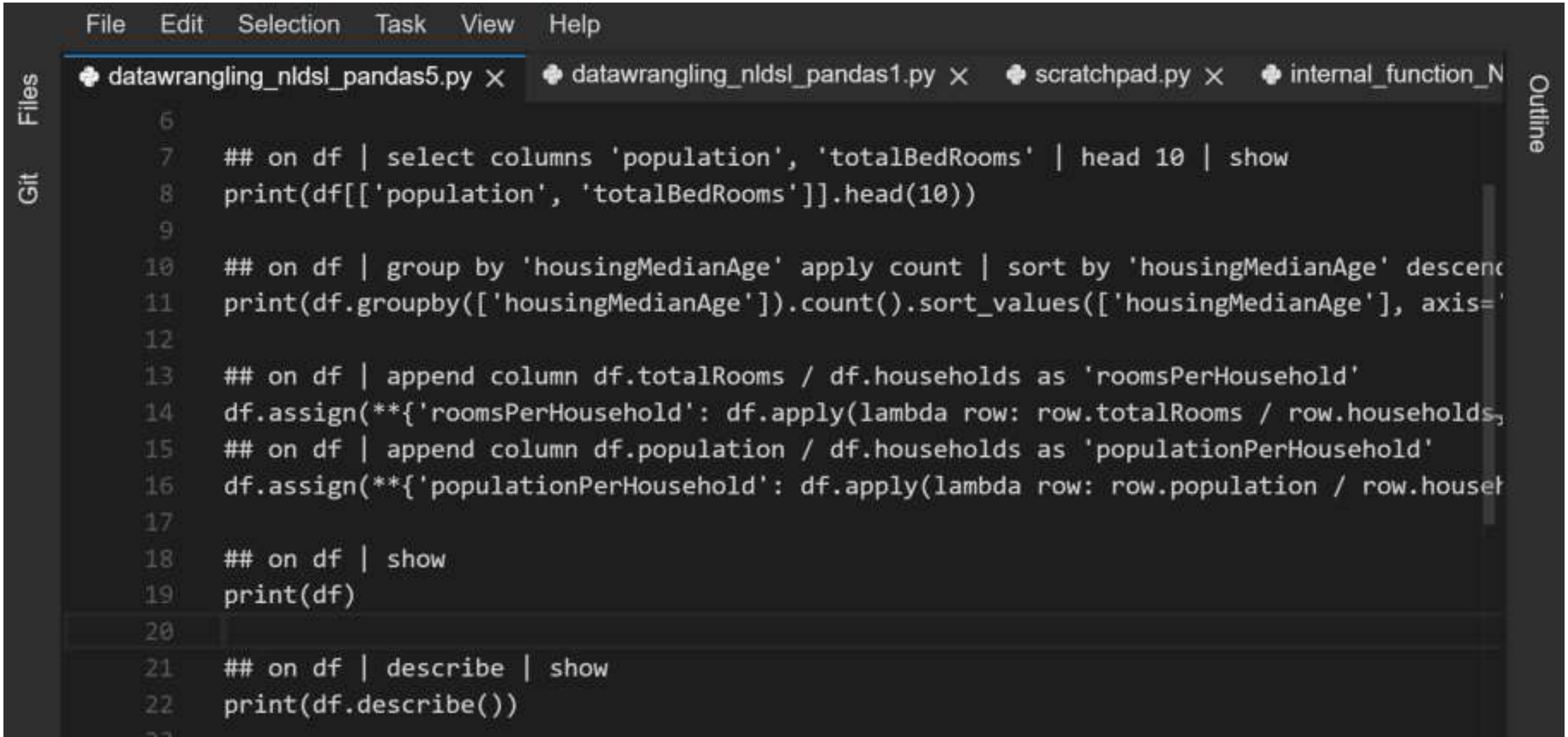

File
Edit
Selection
Task
View
Help
Files
Git
datawrangling_nldsl_pandas5.py
datawrangling_nldsl_pandas1.py
scratchpad.py

```
import pandas as pd
## target_code = spark

## df = load from '../data/cal_housing.data' as
df = spark.read.format('csv').load('../data/cal_housing.data')

## on df | select columns 'population'  | show |
```

```
df.select(['population']).show()
show schema
```

C. Integration with existing code base

- Final code is pure GPL (Python) code
- DSL in comments only, no dependencies on tool/DSL



```
## on df | select columns 'population', 'totalBedRooms' | head 10 | show
print(df[['population', 'totalBedRooms']].head(10))

## on df | group by 'housingMedianAge' apply count | sort by 'housingMedianAge' descend
print(df.groupby(['housingMedianAge']).count().sort_values(['housingMedianAge'], axis='

## on df | append column df.totalRooms / df.households as 'roomsPerHousehold'
df.assign(**{'roomsPerHousehold': df.apply(lambda row: row.totalRooms / row.households,
## on df | append column df.population / df.households as 'populationPerHousehold'
df.assign(**{'populationPerHousehold': df.apply(lambda row: row.population / row.househ

## on df | show
print(df)


## on df | describe | show
print(df.describe())
```

A. Low Effort for Implementing a DSL

- We created a framework for fast creation of families of DSLs (not only for data science)
- DSL families: syntax based on fluent API

Two ways of implementing/extending DSL

- 1. Fast creation/updates of core DSL operations
- 2. Instant extensions during editing by DSL users

A. Low Effort for Implementing a DSL

- We focus on family of constrained DSLs which model chains or pipelines of operations (similar to “fluent API” syntax)
- A compact implementation as a set of Python functions which bundle together DSL syntax description and code generation.
- We allow defining DSL-level functions as ad-hoc DSL extensions

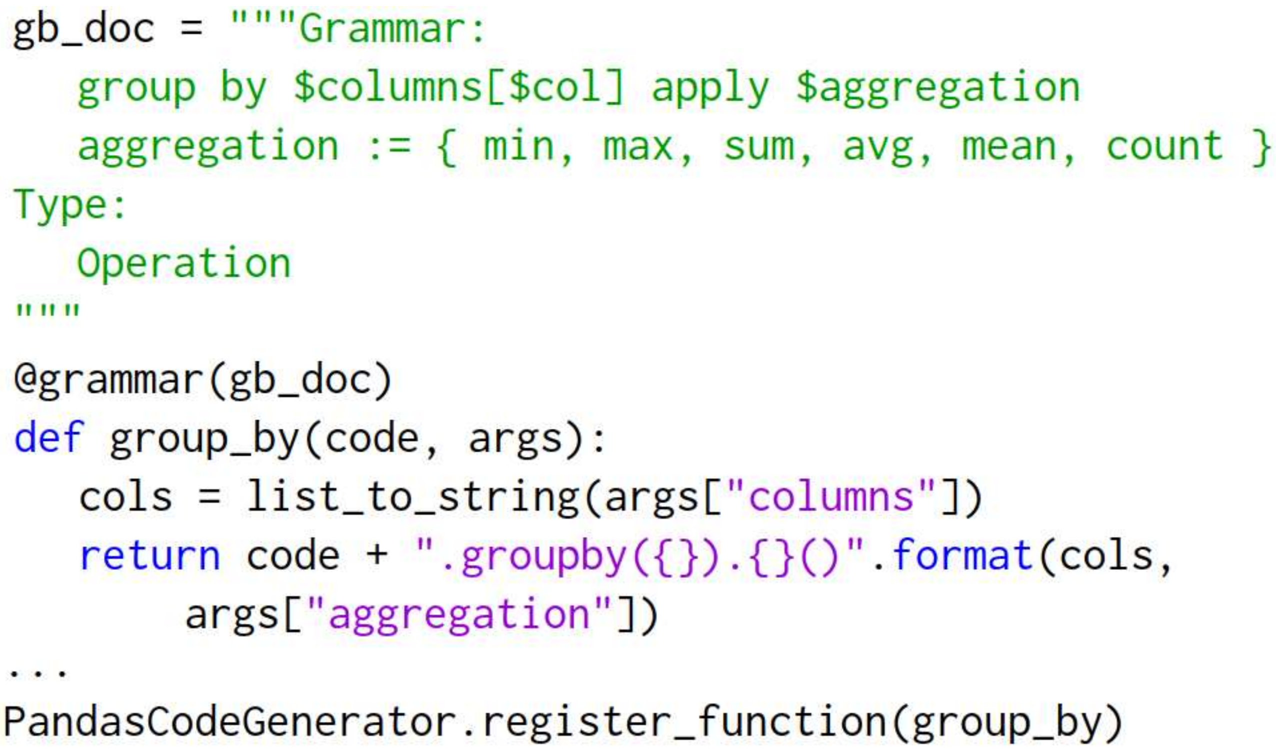
Fluent API

- Fluent API:
  - Object oriented APIs based on method chaining
  - Popular due to higher readability of the source code
- Supported DSL syntax:
  - **Object** | **Op1** | **Op2** | **Op3** | …
- Maps to GPLs/libs in data science, e.g. Pandas

```
wine.rename(columns={"color_intensity": "ci"})
.assign(color_filter=lambda x: np.where((x.h > 1), 1, 0))
.query("alcohol > 14 and color_filter == 1")
```

Implementing DSL Operations

- Each DSL element implemented as a Python method
  - Python docs: specify DSL syntax + parameters
  - Python code: generating target code



```
gb_doc = """Grammar:
   group by $columns[$col] apply $aggregation
   aggregation := { min, max, sum, avg, mean, count }
Type:
   Operation
"""

@grammar(gb_doc)
def group_by(code, args):
   cols = list_to_string(args["columns"])
   return code + ".groupby({}).{}()".format(cols,
        args["aggregation"])
...
PandasCodeGenerator.register_function(group_by)
```

Instant DSL Extensions

- Example of a new DSL command:
  - Divide a column by another column in the dataframe
- Rule definition:

  #$ **div columns** $col1 $col2 **as** $res = append column $col1 / $col2 as $res
- Rule usage (same file)

  ## on df | **div columns** df.totalRooms df.households **as** 'roomsPerHousehold’

  df.assign(**{'roomsPerHousehold': df.apply(lambda row: row.totalRooms / row.households, axis=1).values})

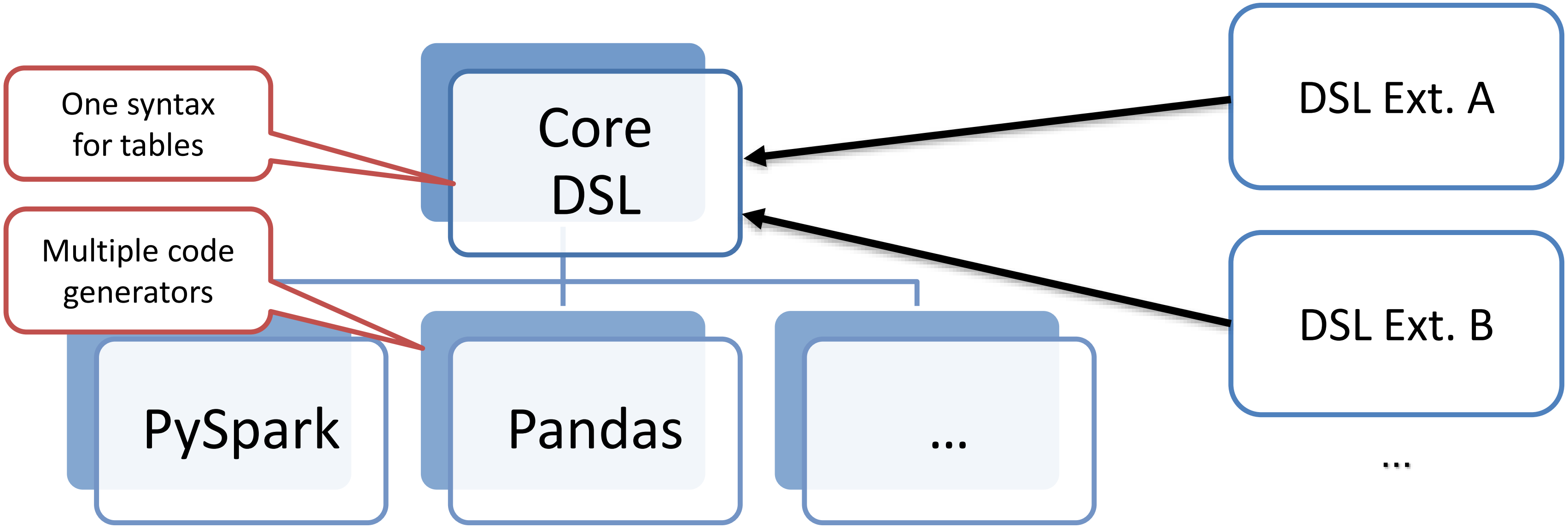
Proof of Concept: Data Science DSLs

One DSL, multiple targets

- DSL for dataframe operations (~ SQL)
- Targets: Pandas, Spark

Other DSLs:

- Visualization: seaborn
- Deep learning: Keras, TF



TOOL NLDSL: DEMO

Examples (PySpark) and Demo

```
## start_session named "Example"
spark = SparkSession.builder("Example").getOrCreate()

## df = load from '../data/cal_housing.data' as csv
df = spark.read.csv('../data/cal_housing.data')

## largeDelay = df | select_cols carrier, flight, arr_delay | select_rows "arr_delay" > 20
largeDelay = df.select(carrier, flight, arr_delay).filter(  col("arr_delay") > 20)

## on largeDelay | show
largeDelay.show()
```

Tool Availability

- Online editor (Theia) at http://129.206.61.41:3000/
- Demo outline: http://bit.ly/GPCEdemoNLDSL
- NLDSL.lib for DSL implementations:
  - GitLab: https://gitlab.com/Einhornstyle/nldsl
  - Docs: https://einhornstyle.gitlab.io/nldsl/
  - PyPI package: https://pypi.org/project/nldsl/
    - pip install nldsl
- Coming soon: Visual Studio Code extension

Thank you.

QUESTIONS ARE WELCOME!

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