Django Web Framework Software Metrics Measurement Using Radon and Pylint

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***Abstract*— Nowadays, sites are complex applications that carry out transactions, render real-time information and offer interaction. Creation of web applications that allow many designers, advanced tools, and many more options. Web frameworks deliver a brilliant way between creating an application from the ground and using a content management system. This article centers around an open source web development framework, to be specific to Django. The methodology that used in the study is measuring Django Web Frameworks code quality metrics using Radon and Pylint. Django option in the main directory has 2,200 lines of code, Cyclomatic Complexity score is 16.375 considered as average complexity, and 6.69/10 by the pylint score.**

Keywords—Cyclomatic Complexity, Maintainability Index, Software Metrics, Python Web Framework

I. INTRODUCTION

Nowadays, in a fast-paced, very demanding and competitive era people tend to use a web application framework to build their web-enabled applications. Software frameworks used to establish web application, and website development, web services, and web resources are called Web application frameworks. A favorite type of web app framework is the Model-View-Controller (MVC) design separates the code for each application component into modules [1], [2].

Python gains its popularity since 2016 and become number 1. Together with Python, C, Java, and C++ remain in the top four in popularity; this paper focuses on Python web frameworks [3]. The Python web frameworks are full of options, such as Django framework is a compact Python framework intended for quick development in quickly paced environments that function well with relational databases [4]. Flask framework is a Python micro-framework with a moderate approach and powerful by itself. Flask perfect for stand-alone applications and rapid prototyping. Pyramid known as Pylons is a framework that gives reproducibility with NoSQL integration. Pyramid best for APIs, prototyping, and extensive web apps, like content management systems development [5], [6]. Tornado is an event-based, non-blocking Python web server and web application framework serve high-traffic volume [7]. The Bottle is a light and simple microframework [8]. Django is chosen because of its popularity and widely used.

In this article, we will find out software metrics for Django using Radon that provides cyclomatic complexity raw metrics that consists SLOC, comment lines, number blank lines, Maintainability Index and Halstead metrics, also use pylint [9], [10]. Pylint is a source code analyzer that finds for errors in programming, assists to use a coding standard strictly.

II. RELATED WORK

A. Django Web Framework

In the fall of 2003, Django was created at the Lawrence Journal-World newspaper. Adrian Holovaty and Simon Willison started using Python to create web applications. In July 2005, Django was released under a BSD license for the public. Django is used by The National Aeronautics and Space Administration (NASA), Google, Public Broadcasting Service (PBS), Bit-Bucket, and other newspapers. Guitarist

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Django Reinhardt is used as the framework name. Django is a framework for web development using python and created for the quick development of database driven sites [11]. Inside Django is MVC-style, a high-level, opensource bunch of libraries programmed in Python. Django is the most popular server-side web frameworks. Don't repeat yourself is Django's motto. As much as Python, it focuses inefficiency, giving developer to do almost all tasks with as little coding effort as possible.

Furthermore, Django is also scalable, mature, and fast with a numerous community of developer and a robust set of built-in components. Django can access or create JSON or XML data instances and deal with out-of-the-box with relational database management systems such as Oracle, MySQL, SQLite, and PostgreSQL. At deployment, Django is fully backed up by the cloud platform AWS Elastic Beanstalk and Heroku.

Three items make Django excel are its maturity, structure, and community. In contrast to Flask and Pyramid, Django stresses on getting started right out of the box using particular modules. In other words, Djangos bundled applications and modular components can reduce developer time when he/ she was trying to make a web application ready and functioning. Data science is a buzzword nowadays, and multitalented developers are needed more than ever before. A simple preparation in building apps with a framework as powerful, minimalistic, and easy-to-learn as Django will be an essential skill when launching their career as the web developer or an entrepreneur.

B. Software Complexity

Software complexity is defined as the tool to measure the difficulty level of any software. Software complexity is a branch of software metrics which is concentrated on direct measurement of software qualities, as disparate to additional software trials such as testified system failure and project innovative status. There are many software complexity trials, fluctuating from the simplest, e.g., lines of code, to the complex, e.g., the number of usage associations or variable definition [12]. It is the calculation of efforts required for the development, maintenance, and execution of software code. As the complexity of the code increases the time and effort also required increases [13], [14], [15].

There will be times as a software developer when a programmer works on projects that do not have unit tests, a daily build, a mess of legacy spaghetti code. His/ her goal is to control that legacy project, and the only way for any project to get back under control is to have metrics and to measure how the code base fares and then to keep weekly (even daily), a track of those metrics and monitor how they are varying. Lines of code (LOC) are the most simple indicators and warnings. A massive, complicated project will have hundreds of thousands of LOC and that normal if the project is well-managed. Any metrics are better than none.

At the point when first beginning work on the legacy project developer require a baseline to recognize what sort of code he/ she has acquired. The baseline will enable the developer to know whether he/ she moves towards viable excellent code which encourages rapid advancement or whether he/ she fails towards slower improvement with messier code. If the project is in excellent condition, the baseline will be high enough, and at one point any changes or bug fixes will have reducing returns. In the other hand, if the project is in a dangerous condition, the baseline will be lower, and he/ she can make sure that every change he/ she make is giving essential benefits on finishing the project.

C. Radon

Radon is a Python tool which can measure various metrics from the source code. Radon can find out: raw metrics (Source lines of code or SLOC, blank lines, comment lines), all Halstead metrics, Cyclomatic Complexity such as McCabes Complexity, and the Maintainability Index for a Visual Studio metric [16], [17].

1. Raw Metrics.

The accompanying is the definitions utilized by Radon:

- LLOC: The variety of logical strains of code. Each logical line of code contains precisely one statement.
- SLOC: The quantity of source lines of code. It does not relate to the LLOC.
- LOC: The aggregate number of lines of code. It doesn't relate to the number of lines in the file.
- Multi: The number of lines that represent multiline strings.
- Comments: The number of comment lines. Multiline strings are not considered comment, to the Python, they are just strings.
- Blanks: The number of clear lines or whitespace.

The formula SLOC + Single comments + Multi + Blank = LOC ought to always hold. Moreover, comment stats are computed:

- C % L: the proportion of the number of comment lines and LOC, stated as a percentage;
- C % S: the proportion of the number of comment lines and SLOC, stated as a percentage;
- C + M % L: the proportion between the number of comment and multiline strings lines and LOC, stated as a percentage.

2. Maintainability Index.

Maintainability Index is a software metric that evaluates how maintainable (simple to maintain and modify) the source code is. The maintainability index is measured as a factored formula comprising of Cyclomatic Complexity, Source Lines Of Code (SLOC), and Halstead volume. It is applied as a part of some automated software program metrics tools.

General formulas are:

- The original formula:

  $MI = 171\text{-}5.2ln\text{V}\text{-}0.23\text{G}\text{-}16.2ln\text{L}$

- the derivative utilized by Software Engineering Institute:

  $MI = 171\text{-}5.2log2\text{V}\text{-}0.23\text{G}\text{-}16.2log2\text{L}+50\ \sin(\sqrt{2.4}\text{C})$

- the derivative utilized by Visual Studio:

$$MI = max\left[0, 100\frac{171\text{-}5.2lnV\text{-}0.23G\text{-}16.2lnL}{171}\right]$$

- Radon uses another derivative, calculated from Visual Studio derivative and SEI:

$$MI = \max\left[0, 100 \times \frac{171 - 5.2\ln V - 0.23\,G - 16.2\ln L + 50\ \sin\sqrt{(2.4\,C)}}{171}\right]$$

Where:

- L is the quantity of Source Lines of Code (SLOC)
- G is the total Cyclomatic Complexity
- V is the Halstead Volume
- C is the percent of comment lines.

Table 1 shows the Maintainability Index, so software developer can measure and aware how their code complexity and its maintainability then he/ she can charge accordingly to the user.

TABLE 1. MAINTAINABILITY INDEX

CC Value	Interpretation	Bad Fix Probability	Maintenance
1-10	Simple procedure	5%	Minimal
11-20	More complex	10%	Moderate
21-50	Complex	20%-40%	High
50-100	"Untestable"	40%	Very High
>100	Holy Crap!	60%	Extremely High

3. Mccabe's Cyclomatic Complexity.

McCabe's Cyclomatic Complexity metric is applied to discover an upper bound on the model for rating the number of defects. Complexity is equated with the range of selections a software makes so that overly elaborate sections can be recoded. McCabe's metric provides the upper bound on module complexity. The graph and formula below define Cyclomatic Complexity [18], [19]. The Abstract Syntax Tree (AST) tree of a Python program to compute Cyclomatic Complexity is analyzed by Radon. As shown in Table 2 commands that have the effects on Cyclomatic Complexity.

Cyclomatic complexity calculates the number of decision logic in a software module, based on the structure of the software control flow graph. It is measured using the control flow graph of the program: nodes of the graph match to separabwhole groups of statements of a program, and an engaged edge joins two nodes if the second statement is probably executed immediately after the first statement. Cyclomatic complexity may likewise be pragmatic to discrete components, functions, classes or methods within a package or a program.

TABLE 2. CYCLOMATIC COMPLEXITY

Construct	Effect on CC	Reasoning
if	+1	An if statement is a single decision.
elif	+1	The elif statement adds another decision.
else	+0	The else statement does not cause a new decision. The decision is at the if.
for	+1	There is a decision at the start of the loop.
while	+1	There is a decision at the while statement.
except	+1	Each except branch adds a new conditional path of execution.
finally	+0	The finally block is unconditionally executed.
with	+1	The with statement roughly corresponds to a try/except block.
assert	+1	The assert statement internally roughly equals a conditional statement.
Comprehension	+1	A list/set/dict comprehension of generator expression is equivalent to a for loop.
Boolean Operator	+1	Every boolean operator (and, or) adds a decision point.

McCabe number is equivalent to the quantity of linearly independent paths throughout the code. This number can be utilized as a guide when testing conditional logic in blocks. Every block will be positioned from A as best complexity score to F as worst complexity score. Ranks correspond to complexity scores as shown in Table 3.

TABLE 3. CYCLOMATIC COMPLEXITY RANK

CC Score	Rank	Risk
1-5	A	Low - simple block
6-10	B	Low = well structured and stable block
11-20	C	Moderate - slightly complex block
21-30	D	More than moderat - more complex block
31-40	E	High - complex block, alarming
41+	F	Very high - error prone, unstable block

D. Pylint

Pylint is a Python instrument which verifies a module for coding standards. As indicated by the TurboGears project coding guidelines, PEP8 is the standard and pylint is a decent mechanical test to help the developer in accomplishing the goal. The scope of verifies run from Python errors, unused imports, missing docstrings, an unintended redefinition of built-ins, to awful naming and others. Following the analysis message, Pylint can show a group of reports, everyone concentrating on a specific part of the project, for example, number of messages by categories and modules dependencies. These highlights can be enabled via the –reports=y parameter, or -rn [20].

For example, the measurements report shows summaries assembled from the current run.

- the number of handled modules
- for every module, the errors percentage, and warnings the total number of errors and warnings
- classes percentage, functions and modules with docstrings, and comparison from the past run

- classes percentage, functions and modules with the correct name (as indicated by the coding standard), and comparison from the past run

a rundown of external dependencies found in the code, and where they show up.

III. Method and Results

The first step is to call radon to measure Django's raw information.

E:\Github\django>radon raw django/contrib/admin/options.py

Radon raw result screen shown in Fig. 1.

```
(radon) E:\Github\django>radon raw django/contrib/admin/options.py
django/contrib/admin/options.py
    LOC: 2022
    LLOC: 1035
    SLOC: 1379
    Comments: 142
    Single comments: 144
    Multi: 245
    Blank: 254
    - Comment Stats
        (C % L): 7%
        (C % S): 10%
        (C + M % L): 19%
```

Fig 1. Radon Raw Output

The next measurement is to know Cyclomatic Complexity, by issuing a command

E:\Github\django>radon cc Django/contrib/admin/options.py -a -nc

Where:

cc	Calculate Cyclomatic Complexity.
-a	Measure the average complexity at the end.
F	Function
M	Method
C	Class
-nc	Print only results with a complexity rank of C or worse.
-na	Print only results with a complexity rank of A or worse.

Figure 2 shows radon Cyclomatic Complexity (cc) result screen.

```
(radon) E:\Github\django>radon cc django/contrib/admin/options.py -a -nc
django/contrib/admin/options.py
    M 1558:4 ModelAdmin.changelist_view - D
    M 1452:4 ModelAdmin._changeform_view - D
    M 356:4 BaseModelAdmin.lookup_allowed - C
    M 411:4 BaseModelAdmin.to_field_allowed - C
    M 1715:4 ModelAdmin._delete_view - C
    M 628:4 ModelAdmin.get_form - C
    M 129:4 BaseModelAdmin.formfield_for_dbfield - C
    M 1089:4 ModelAdmin.response_add - C

8 blocks (classes, functions, methods) analyzed.
Average complexity: C (16.375)
```

Fig. 2. Radon Cyclomatic Complexity result

The third measurement is to know Django Maintainability Index (MI), by issuing a command

E:\Github\django>radon mi -m django/contrib/admin.

This statement examines Python source code files and calculates the Maintainability Index score. Every positional argument is handled as a starting point from which to start looking for Python files (as in the cc command). Its result is shown in Fig. 3.

```
(radon) E:\Github\django>radon mi -m django/contrib/admin
django\contrib\admin\actions.py - A
django\contrib\admin\apps.py - A
django\contrib\admin\checks.py - C
django\contrib\admin\decorators.py - A
django\contrib\admin\exceptions.py - A
django\contrib\admin\filters.py - A
django\contrib\admin\forms.py - A
django\contrib\admin\helpers.py - A
django\contrib\admin\models.py - A
django\contrib\admin\options.py - C
django\contrib\admin\sites.py - A
django\contrib\admin\tests.py - A
django\contrib\admin\utils.py - A
django\contrib\admin\widgets.py - A
django\contrib\admin\__init__.py - A
django\contrib\admin\bin\compress.py - A
django\contrib\admin\migrations\0001_initial.py - A
django\contrib\admin\migrations\0002_logentry_remove_auto_add.py - A
django\contrib\admin\migrations\__init__.py - A
django\contrib\admin\templatetags\admin_list.py - A
django\contrib\admin\templatetags\admin_modify.py - A
django\contrib\admin\templatetags\admin_static.py - A
django\contrib\admin\templatetags\admin_urls.py - A
django\contrib\admin\templatetags\log.py - A
django\contrib\admin\templatetags\__init__.py - A
django\contrib\admin\views\autocomplete.py - A
django\contrib\admin\views\decorators.py - A
django\contrib\admin\views\main.py - A
django\contrib\admin\views\__init__.py - A
```

Fig. 3. Radon Maintainability Index result

The fourth measurement using pylint.

E:\>pylint django/contrib/admin/options.py –reports=y

There are seven classes:

class IncorrectLookupParameters
class BaseModelAdmin(metaclass=forms.MediaDefiningClass)
class ModelAdmin(BaseModelAdmin)
class InlineModelAdmin(BaseModelAdmin)
class DeleteProtectedModelForm(base model form)
class StackedInline(InlineModelAdmin)
class TabularInline(InlineModelAdmin)

```
Report
======
953 statements analysed.

Statistics by type
------------------

+---------+------+------------+------------+-------------+---------+
|type     |number|old number  |difference  |%documented  |%badname |
+=========+======+============+============+=============+=========+
|module   |1     |1           |=           |0.00         |0.00     |
+---------+------+------------+------------+-------------+---------+
|class    |7     |7           |=           |42.86        |0.00     |
+---------+------+------------+------------+-------------+---------+
|method   |94    |94          |=           |81.91        |1.06     |
+---------+------+------------+------------+-------------+---------+
|function |5     |5           |=           |0.00         |0.00     |
+---------+------+------------+------------+-------------+---------+
```

```
django
  \-conf (django.contrib.admin.options)
  \-contrib
    | \-admin
    | | \-checks (django.contrib.admin.options)
    | | \-exceptions (django.contrib.admin.options)
    | | \-filters (django.contrib.admin.options)
    | | \-helpers (django.contrib.admin.options)
    | | \-models (django.contrib.admin.options)
    | | \-templatetags
    | | | \-admin_urls (django.contrib.admin.options)
    | | \-utils (django.contrib.admin.options)
    | | \-views
    | | | \-autocomplete (django.contrib.admin.options)
    | | | \-main (django.contrib.admin.options)
    | | \-widgets (django.contrib.admin.options)
    | \-auth (django.contrib.admin.options)
    | \-contenttypes
    | | \-models (django.contrib.admin.options)
    | \-messages (django.contrib.admin.options)
  \-core
    | \-exceptions (django.contrib.admin.options)
    | \-paginator (django.contrib.admin.options)
  \-db (django.contrib.admin.options)
    | \-models (django.contrib.admin.options)
    | | \-constants (django.contrib.admin.options)
    | | \-fields (django.contrib.admin.options)
    | \-transaction (django.contrib.admin.options)
  \-forms (django.contrib.admin.options)
    | \-formsets (django.contrib.admin.options)
    | \-models (django.contrib.admin.options)
    | \-widgets (django.contrib.admin.options)
  \-http (django.contrib.admin.options)
    | \-response (django.contrib.admin.options)
  \-template
    | \-response (django.contrib.admin.options)
  \-urls (django.contrib.admin.options)
  \-utils
    | \-decorators (django.contrib.admin.options)
    | \-html (django.contrib.admin.options)
    | \-http (django.contrib.admin.options)
    | \-safestring (django.contrib.admin.options)
    | \-text (django.contrib.admin.options)
    | \-translation (django.contrib.admin.options)
  \-views
    | \-decorators
    | | \-csrf (django.contrib.admin.options)
    | \-generic (django.contrib.admin.options)
```

```
Raw metrics
-----------

+----------+------+------+----------+------------+
|type      |number|%     |previous  |difference  |
+==========+======+======+==========+============+
|code      |1259  |62.20 |NC        |NC          |
+----------+------+------+----------+------------+
|docstring |381   |18.82 |NC        |NC          |
+----------+------+------+----------+------------+
|comment   |139   |6.87  |NC        |NC          |
+----------+------+------+----------+------------+
|empty     |245   |12.10 |NC        |NC          |
+----------+------+------+----------+------------+


Duplication
-----------

+-------------------------+-----+--------+----------+
|                         |now  |previous|difference|
+=========================+=====+========+==========+
|nb duplicated lines      |0    |0       |=         |
+-------------------------+-----+--------+----------+
|percent duplicated lines |0.000|0.000   |=         |
+-------------------------+-----+--------+----------+


Messages by category
--------------------

+-----------+-------+---------+----------+
|type       |number |previous |difference|
+===========+=======+=========+==========+
|convention |65     |65       |=         |
+-----------+-------+---------+----------+
|refactor   |30     |30       |=         |
+-----------+-------+---------+----------+
|warning    |90     |90       |=         |
+-----------+-------+---------+----------+
|error      |26     |26       |=         |
+-----------+-------+---------+----------+
Messages
--------

+---------------------------+-----------+
|message id                 |occurrences|
+===========================+===========+
|unused-argument            |41         |
+---------------------------+-----------+
|protected-access           |41         |
+---------------------------+-----------+
|missing-docstring          |27         |
+---------------------------+-----------+
|no-member                  |24         |
+---------------------------+-----------+
|invalid-name               |22         |
+---------------------------+-----------+
|line-too-long              |15         |
+---------------------------+-----------+
|no-self-use                |11         |
+---------------------------+-----------+
|no-else-return             |5          |
+---------------------------+-----------+
|too-many-locals            |3          |
+---------------------------+-----------+
|too-many-branches          |3          |
+---------------------------+-----------+
|too-many-arguments         |3          |
+---------------------------+-----------+
|redefined-builtin          |3          |
+---------------------------+-----------+
|too-many-statements        |2          |
+---------------------------+-----------+
|too-many-public-methods    |2          |
+---------------------------+-----------+
|fixme                      |2          |
+---------------------------+-----------+
|unused-variable            |1          |
+---------------------------+-----------+
|unsupported-membership-test|1          |
+---------------------------+-----------+
|undefined-loop-variable    |1          |
+---------------------------+-----------+
|too-many-return-statements |1          |
+---------------------------+-----------+
|too-many-lines             |1          |
+---------------------------+-----------+
|not-callable               |1          |
+---------------------------+-----------+
|dangerous-default-value    |1          |
+---------------------------+-----------+


--------------------------------------------------------------------
Your code has been rated at 6.69/10 (previous run: 6.69/10, +0.00)
```

Fig. 4. Pylint output

CONCLUSION

In conclusion, this paper has measure Django Web Framework code quality metrics. Django option in the main directory has 2,200 lines of code, Cyclomatic Complexity score is 16.375 considered as moderate complexity, and 6.69/10 by the pylint score. With the same method, other web frameworks can be measured too.

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