# Structural Quality & Software Evolution

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# Introduction

**Maintainability Index and Refactor Scores**

- Areas of concern: cost, timeline, quality
- Quality is hard to understand
- Pylint & Radon are a static analysis tools
- Refactor violations point out code smells

# Keeping Users Engaged Long Term

**Why does software evolution matter?**

- Users find bugs
- Users want new features
- New security threats
- New laws from governing bodies

Need a thriving community of engaged users in order to keep apps and games successful.

In an open source system, need a thriving community of engaged developers in order to continue evolving.

# Keeping Users Engaged Long Term

**How do we ensure software evolution?**

Keep the project maintainable.

- Bugs should be quick and easy to fix
- New features should be easy to add

**Software Maintenance**

- Consistent standards (naming, small methods, etc)
- Large portion of project cost in a typical software system is in the maintenance phase

# The Impact of Structural Quality

**Measuring Maintainability**

- easy to maintain = easy to evolve
- Pylint & Radon Maintainability Index (MI)

**Maintainability Scores**

- Refactor Messages (Pylint) — code smells
- Code smells point out problems in Architecture
- PEP 8 is a set of Python standards

# The Impact of Structural Quality

**Other Maintainability Characteristics**

- Low coupling, high cohesion
- Confidence that metrics around software structure provide value in keeping systems maintainable (and therefore can evolve)
- Readability
  - Big commits reduce maintainability
  - PEP 8 enforces readability

# The Impact of Structural Quality

**Documentation and Maintainability**

- Documentation holds the results of significant design decisions
- Can influence the ability to evolve because. . .
  - Enhances code understanding
  - Comprehensibility impacts maintainability in a positive way

# Related Work

**Design Patterns and Software Quality**

- Design patterns provide flexibility
- Classes with frequent changes
  - Easy to extend (okay)
  - Correlates to other classes (high coupling... red flag!)
- We look at refactor score (code smell) not error score (bugs)

Keeping this in mind, we focus on *changes for system extensions and adaptiation*, not bug fixes.

# Related Work

**Software Architecture and Maintainability**

- Maintainability
- Extensibility
- Simplicity, understanding
- Re-usability
- Performance

Keep these in mind for easier future development when adding or changing code.

# Methodology

**Initial Repository Set**

- Popular
- Long development history
- Multiple release cycles

**Filtered Respository Set**

*At least 80% Python code and top 20th percentile in these categories:*

- Long history of commits (2,968+ commits)
- Large number of contributors (90+ contributors)
- Many releases (44+ releases)
- Substantial Age (66.4+ months)

Results in 46 repositories for further research.

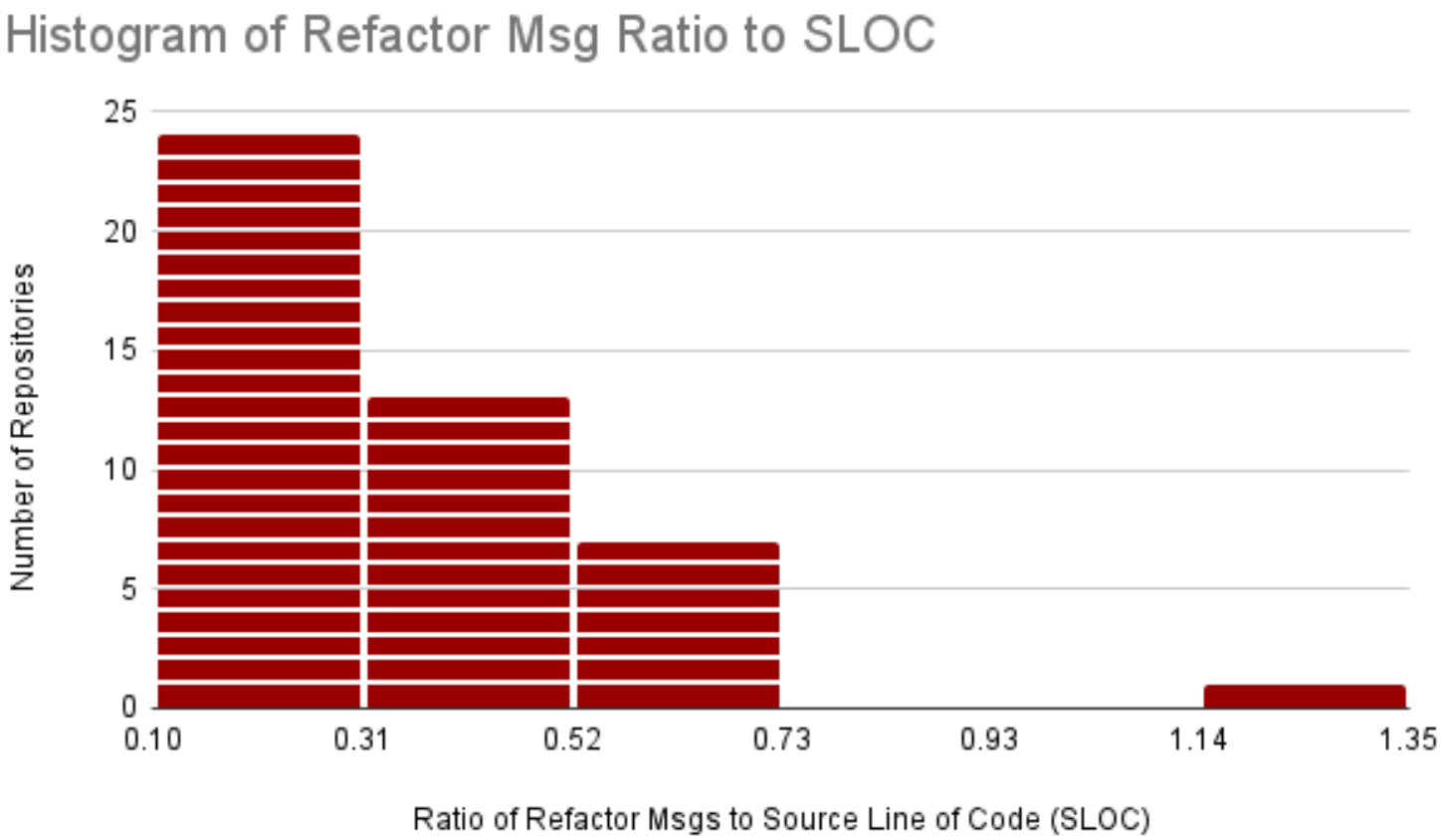
# Results

- Radon MI for all repositories rank as grade “A” which is considered “very high maintainability”
- Open source systems with engaged community of developers tend to have higher scores

To normalize, calculated ratio of refactor message count to SLOC.

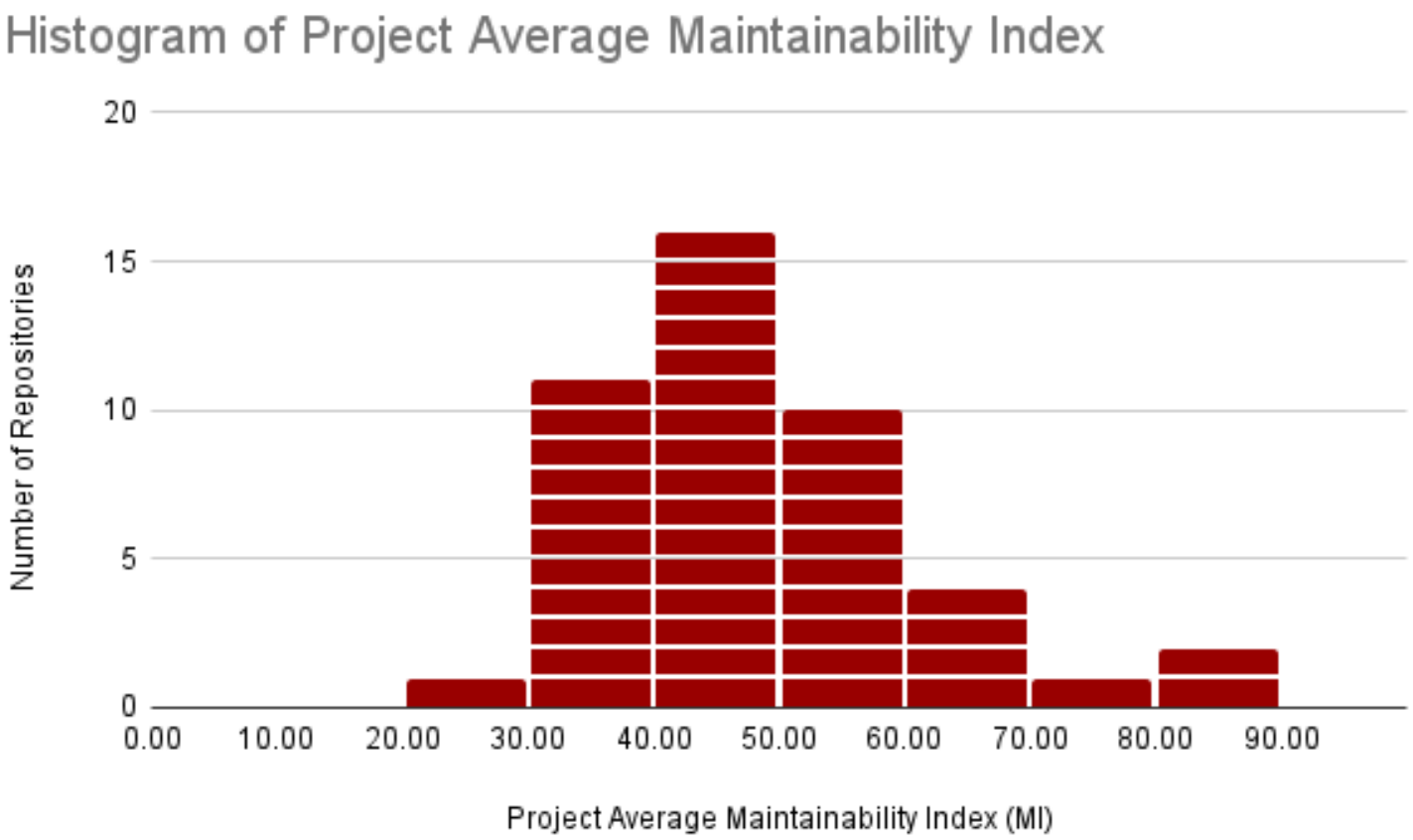
- Worst Score: **Raven-Python** - now deprecated
- Best Score: **Cython** - still active development

# Results




*Diligent development communities can keep refactor warnings low, regardless of system size (lines of code).*

# Results




*Many repositories average in the mid-score to high-score.*
*Radon considers 20 points and up to be very maintainable.*

# Conclusions

- Good projects will grow and evolve.
- Structural quality impacts software evolution.
- Poor structure leads to deprecation.
  *(if the development community is engaged, deprecation of the project may lead to a fresh, improved code base)*
- Open source and many contributor projects are vulnerable to degrading maintainability.

# Recommendations

- Reliable metric can be useful.
- Good architecture is important for evolution.
- Pick a set of standards and auto-enforce to maintain good architecture even with a large, open source community.