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# Repo Velocity: Diagnosing Git Repository Health

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## 1 Introduction

Understanding the health of open source projects is important to industry because it helps them assess risk associated with their technology stack. Forecasting health is important to investors because this information can help them make profitable investments in open source. Academia is interested to know if there are links between theory, such as programming language design [1], and the health of open source software. A previous metric used to assess open source software health is the Truck Factor [2]. Truck Factor is the smallest subset size of developers who contributed 50% of the code in an open source project. The underlying intuition is that open source projects with a lower Truck Factor are more susceptible to project disruption in the event of adverse circumstances.

By borrowing from Physics, this paper <sup>1</sup> contributes to the advancement of understanding the health of open source projects, studying a subset of GitHub repositories, with the following:

- Introducing a health measure that can be assessed at time  $t_{i\pm k}$  where  $k$  is a multiple of  $i$ .
- New health measure can be used in forecasting as well as description
- Health measure is rooted in Physics so we can derive related measures using preexisting theory.

## 2 Related Work

Truck Factor reflects robustness of project [2] by computing the minimum number of developers required to comprise 50% of file ownership. The underlying intuition is that a project with a low number of dominant developers will be more susceptible to failing due to external shocks. Projects where file ownership is shared by a large number of developers are interpreted as more healthy with this approach.

Not all projects reflect software which requires support. Researchers have classified many project types such as 'software development projects', 'solutions for homework', 'projects with educational purposes', 'data sets', and 'personal web sites' [3]. The observation that many projects are not software development is also a noted peril when analyzing GitHub [4]. We may also find repositories containing code duplicates [5]. These factors may comprise threats to validity which are important to address in this analysis.

## 3 Methods

The Truck Factor assesses Git repository health at time  $t_i$ . We would like to better understand health at different points in time  $t_{i\pm k}$  where  $k \geq 1$ . We can borrow from Physics to find such a measure. Velocity,  $v(t)$ , is a measure of distance over time. What is a proxy for distance in the context of Git

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<sup>1</sup>Code available on GitHub: <https://github.com/tbonza/EDS19>

repository health? Total lines of code changed in a project during time  $t_i$  can tell us how quickly the code base is changing. We apply this definition of velocity,  $v(t)$ , for our new measure Repo Velocity.

$$\text{Repo Velocity} \approx v(t) = \frac{d}{t} = \frac{\text{lines added} - \text{lines deleted}}{t} \quad \forall i \pm k \in t | i \in \mathbb{R}, k \in \mathbb{R}_{>0} \quad (1)$$

Equation 1 defines our target measure, Repo Velocity, and posits that the Physics concept of 'distance' can provide insight into how a GitHub repository is changing over time. We can compute velocity,  $v(t_i)$  at time  $t_i$  where  $i$  is a real number. We can also compute average velocity,  $v_{avg}(t_{i \pm k})$ , at time  $t_i$  to time  $t_{i \pm k}$ . The Repo Velocity measure also has the advantage of allowing aggregation and disaggregation. Truck Factor is a measure which can only be analyzed at an aggregate level. There can be a lot of interesting variation below a Repository level aggregation. Repo Velocity can also be used to capture individual contributor velocity. The ability of Repo Velocity to be applied over time as well as at aggregated and disaggregated levels make the measure a unique contribution to the understanding of Git repository health. The remaining methodology seeks to establish Repo Velocity as an informative descriptive and predictive target or dependent variable.

### 3.1 Establishing Baseline Repo Velocity

In our effort to establish the Repo Velocity measure, we first examine behavior on Git repositories known to be either (a) active and currently well-maintained, (b) previously active and not currently maintained. The repositories I chose for the baseline subset are as follows:

1. torvalds/linux (a) - Linux kernel, a fundamental component in many cloud computing server operating systems such as Amazon Linux.
2. docker/docker-ce (a) - Community edition of Docker including the open repositories Docker Engine and Docker client, a popular enterprise application container platform currently heavily utilized in projects such as Kubernetes.
3. apache/spark (a) - Unified analytics engine for Big Data. Allows for an alternative to Map/Reduce and is currently widely favored by industry. One of the most active projects in the Apache Software Foundation [6].
4. apache/lucene-solr (a) - Mirror of Apache Lucene + Solr. Apache Lucene is a high-performance, full featured text search engine library written in Java. Apache Solr is an enterprise search platform written using Apache Lucene. Notably, Lucene is a major dependency for Elasticsearch [7]
5. apache/attic-lucy (b) - Mirror of Apache Lucy, search engine library provides full-text search for dynamic programming languages. Previously active project in the Apache "attic".
6. apache/attic-wink (b) - Apache Wink, simple yet solid framework for building RESTful Web services. Previously active project in the Apache "attic".

All GitHub repositories chosen for the baseline sample would be classified as 'software development projects', or *DEV*<sup>2</sup> using the ClassifyHub designations [3]. This paper establishes baseline Repo Velocity expectations using descriptive and predictive (forecasting) methodologies.

#### 3.1.1 Descriptive Baseline

#### 3.1.2 Predictive Baseline

using a simple prediction

### 3.2 Validating Repo Velocity at Scale

Collecting from Facebook, etc.

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<sup>2</sup>The baseline distribution containing only DEV repositories is a fundamental part of the results presented in this paper.

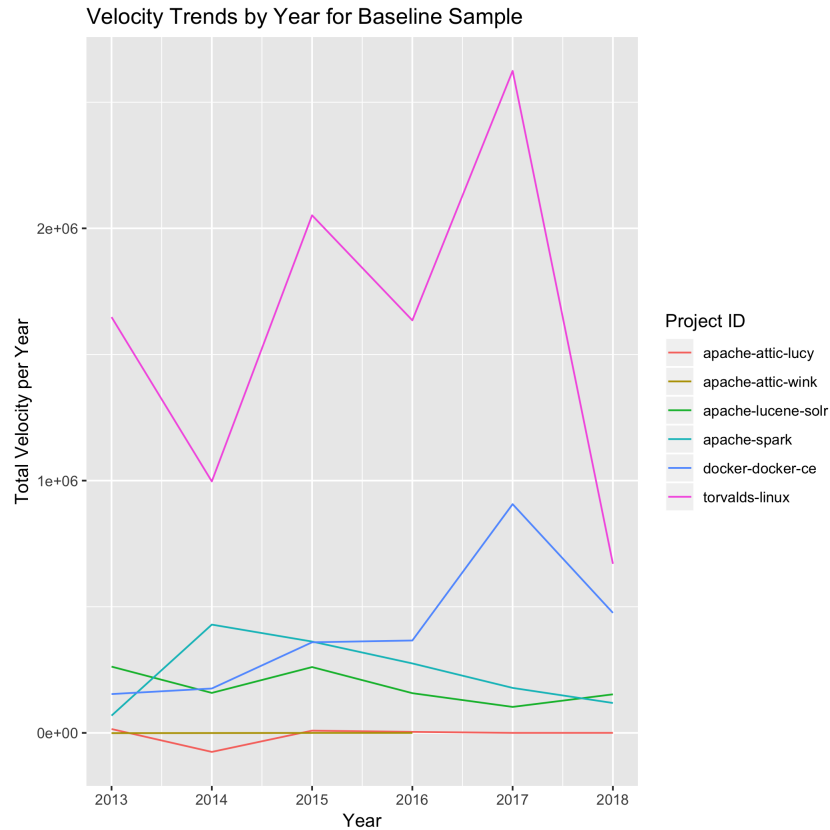


Figure 1: Repo Velocity Trends for Baseline Sample

### 3.3 Data Engineering

Wrote a Python package, Okra.

#### 3.3.1 Collecting Data

used kubernetes and “being nice”

#### 3.3.2 Processing Data

using Apache spark, using “hack/reduce”

## 4 Experiment

### 4.1 Results from Baseline Repo Velocity

#### 4.1.1 Results from Predictive Baseline

#### 4.1.2 Results from Scaled up Prediction

### 4.2 Results from Repo Velocity at Scale

#### 4.2.1 Modeling Outliers

bad

## 5 Discussion

had mixed results, should have better classified input GIGO

### 5.1 Threats to Validity

yup

## References

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