

Utilizing Artificial Intelligence to Evaluate and Estimate Requirements

Prepared for:

2022 ICEAA Professional Development & Training Workshop



Abstract

- Business Analysts face the challenge of parsing through hundreds/thousands of requirements to define system needs or to accurately estimate the software development cost. This is a grueling process and mistakes are still an inevitability. However, Artificial Intelligence (AI) can serve analysts in automating requirements analysis, producing high-level concepts, and informing total lifecycle estimates in a short period of time. This presentation provides an overview of select AI capabilities and shows their applications to requirements analysis and cost estimation.

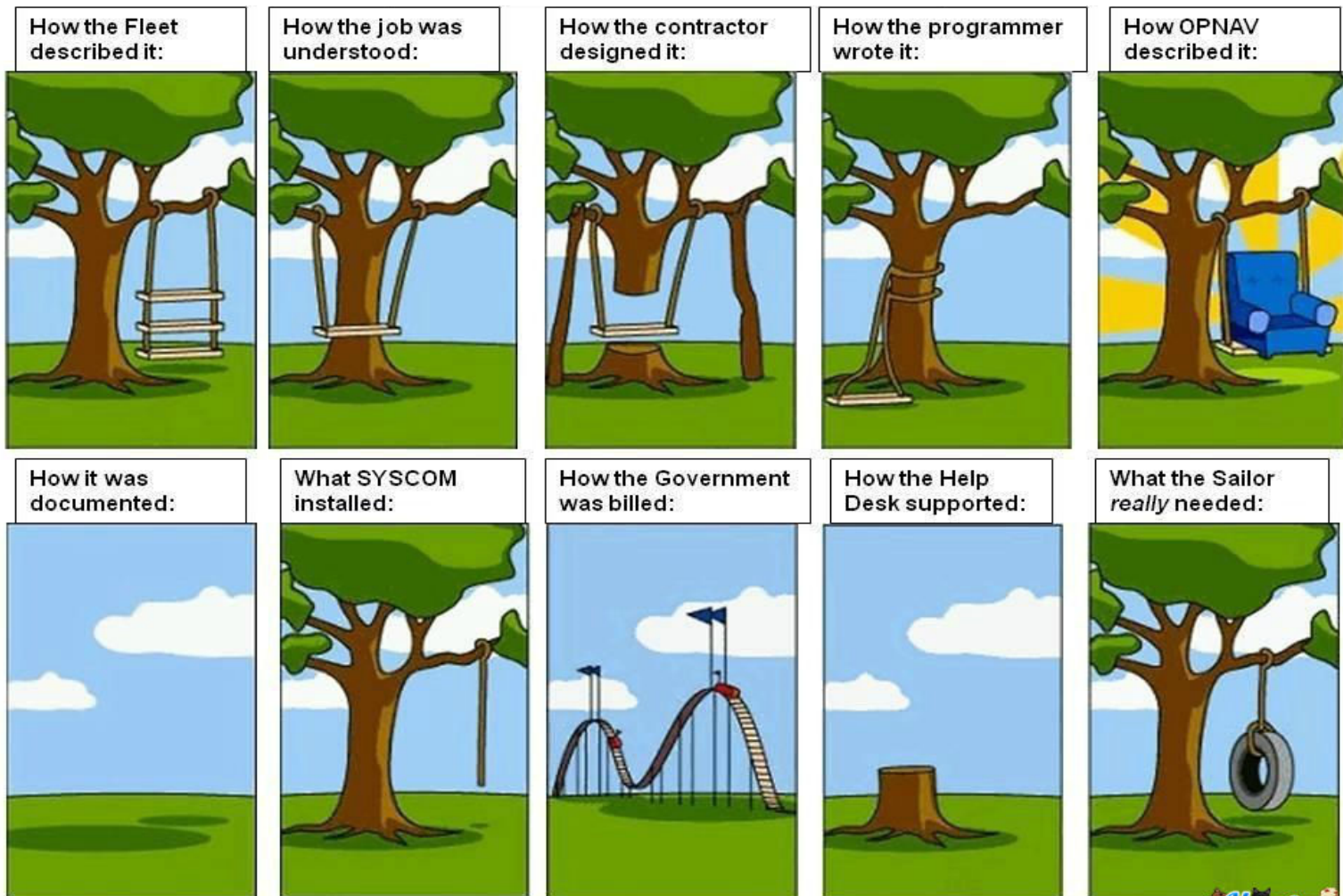
Agenda

- 🌀 Background
- 🌀 Working With Requirements and Function Points
- 🌀 Challenge and Possible Solution
- 🌀 Birth and Journey of Cadence
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Background

- ❖ In 1987, American Computer Architect, Software Engineer, and Computer Scientist Fred Brooks suggested that “the hardest single part of building a software system is deciding precisely what to build. No other part of the conceptual work is as difficult as establishing the detailed technical requirements . . . No other part of the work so cripples the resulting system if done wrong. No other part is as difficult to rectify later.”
(Brooks, April 1987)
- ❖ More than 30 years later, Brooks’s assessment remains true. A poor understanding of requirements can lead to long-term problems.

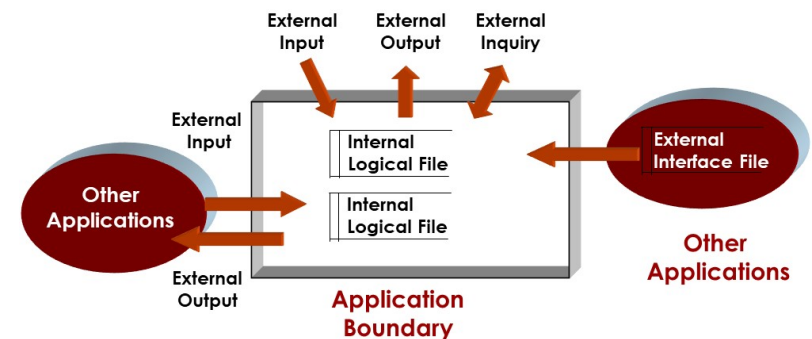
Working with Requirements



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Working with Function Points

- ❁ **Function points** are a measure of functional size, and not effort or complexity, and is often used in software estimation and project planning, and vendor comparison.
- ❁ Function points have been in practice for over 40 years, has a global footprint, and follows the ISO standard for function size measurement
- ❁ **Function Point Analysis (FPA)** represents a user's perspective on software requirements irrespective of technical implementation, language, or architecture
- ❁ FPA assesses the functionality delivered to its users based on the user's external view of the functional requirements
- ❁ **Functional Size Measurement (FSM)** is a technique for measuring software in terms of the functionality it delivers.
- ❁ The ISO/ IEC standard for FSM 14143-1:2006 defines FSM as a means of quantifying the Functional User Requirements
 - (i.e., functions that the business has requested to be delivered)
- ❁ Use of IFPUG or Simple Function points is a common example of FSM



Challenge and Possible Solution

- ❖ FSM is well-suited for automation due to use of repeatable business rules
- ❖ The key issue with automation of size measurement is that requirements be written in a consistent manner
- ❖ Poor requirements have long been a problem across both industry and the federal government.
- ❖ Requirements engineers, business analysts, and estimators often face the challenge of parsing through 100s and sometimes 1000s of requirements in an effort to define system design needs or to accurately estimate the software development cost.
 - This detail-oriented and often grueling process requires analysts to be highly experienced and have a tremendous amount of tolerance for repetitive requirements parsing. Despite even the most meticulous analysis, mistakes are still an inevitability.
- ❖ With artificial intelligence (AI), machines are now capable of “learning” processes and automating previously human-dependent functions.
- ❖ AI can serve to aid analysts in the understanding and parsing of requirements reducing the time and effort necessary to accurately analyze projects.

AI: Natural Language Processing (NLP)

What is Natural Language Processing (NLP)



Automating Previously Human-Dependent Functions

- ⦿ Natural Language Processing (NLP) enables computers to derive meaning from human or natural language input



Cutting-Edge Technology, Getting Smarter by the Day

- ⦿ NLP has made dramatic strides in the last decade with new tools and extensive research



Wide Use Across Industry

- ⦿ Industries using NLP technology – defense intelligence, legal, healthcare



Requirements are excellent subjects for NLP analysis because they have a semi-structured construct

Birth and Journey of Cadence

	2017	2018	2019-2020	2021	2022
	Proof of Concept	Version 0 Alpha Release	Version 1	Version 1.5 MVP	Version 2.0
Description	<ul style="list-style-type: none"> Python engine (command line) Basic parsing 	<ul style="list-style-type: none"> NLP parsing Initial desktop application NLTK, SpaCY, and Kivy libraries Features include Requirements Assessment, System Discovery, FPA, N-grams, and reporting Internally used 	<ul style="list-style-type: none"> Refined desktop application Developed and supported by 3rd party Supports IFPUG and Simple Function Point sizing Clients include system engineers and federal government Training classes offered 	<ul style="list-style-type: none"> On-prem or SaaS application (AWS) Developed and supported by 3rd Party firm Enhanced GUI, visuals, tagging, and grouping Customizable business rules and elaboration Analyst given greater control over FP analysis Online Help and support Logapps Training course offered 	<ul style="list-style-type: none"> Jira Integration Desktop version released Value Stream Measurement Tagging Release Planning Budget Planning
Key Research	<ul style="list-style-type: none"> Word searching 	<ul style="list-style-type: none"> NLTK SpaCy Neural Networks & Word Embeddings 	<ul style="list-style-type: none"> Named Entity Recognition Levenshtein algorithm Negation 	<ul style="list-style-type: none"> Schwartz-Hearst algorithm Thesaurus libraries 	

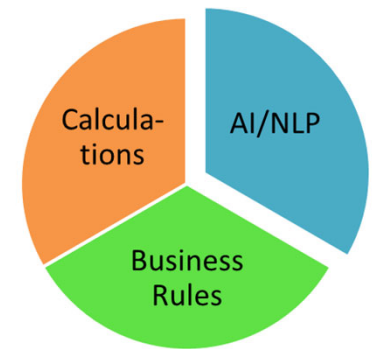
What is Cadence

Cadence is a web-based/desktop early planning tool that uses AI to automate requirements analysis, produce high-level concepts, and inform total lifecycle estimates.

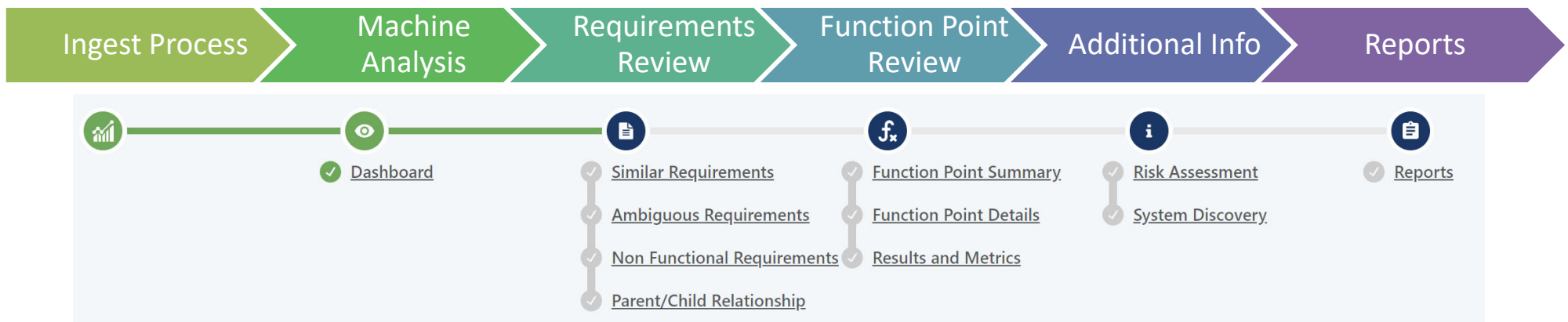


❖ Cadence developed around three critical components

1. AI/NLP: Parsing and tagging
2. Business Rules: INCOSE standards, User Stories rules, Keywords, whitelist, exceptions, etc.
3. Calculations: Function Point, Simple Function Point, Metrics, Hours, Costs, etc.



❖ Cadence Process



AI: Natural Language Processing

Processing (NLP)

Natural Language Processing – Requirement Example

#3.2 System shall update the Masterfile based on XXX calculations.

Req. #	Subject (noun)	Verb	Object (noun)	Prepositional phrase
3.2	System	shall update	Masterfile	based on XXX calculations

Req. #	Key Verb	Other Verb	Proper Noun	Noun	Subject	Object	Verb Phrase
3.2	update	based	System, Masterfile, XXX	calculations	System	Masterfile, XXX, calculations	update the Masterfile based on XXX calculations

In Cadence →

■ Actions
1

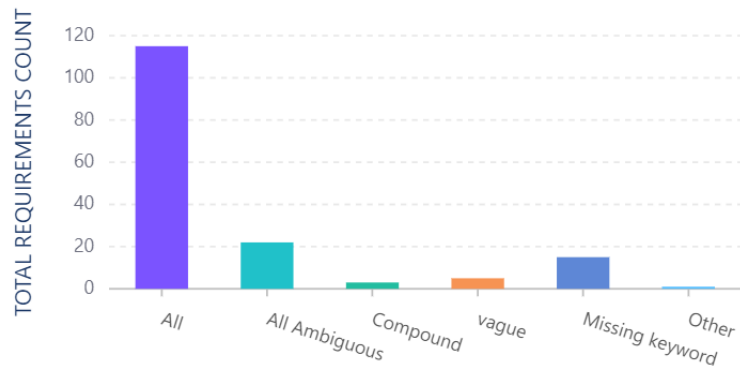
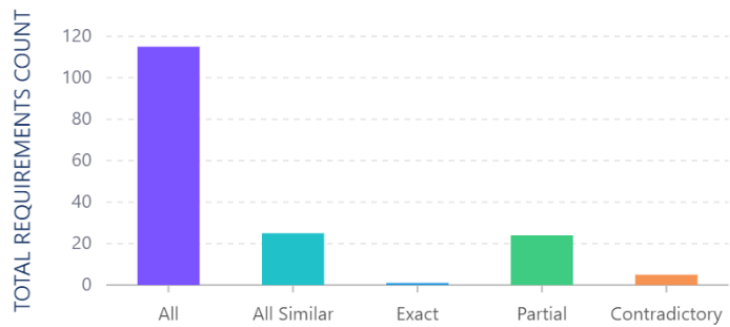
■ Objects
2

■ Other Actions
1

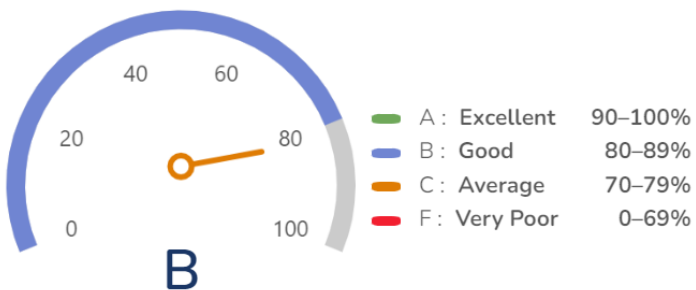
Requirement ⓘ

System shall update ✗ the Masterfile ✗ based ✗ on
certain calculations ✗ .

What is Cadence: Business Rules



Requirement Grade i



Keyword	Add	Change	Delete	View	Report	Save	Interface	Actions
Accept	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	
Activate	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Add	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	

Input Object Check

Objects Occurrences

These object(s) do not have an "Add" requirement, Please review requirements and adjust if necessary

multiple documents	2
documents	1

Data Group Check

Save Interface Both

Objects Occurrences

This object is repeated in multiple requirements and is listed as a "Save" in all cases. To avoid overcount, click Yes

invoices	2	<input checked="" type="radio"/> Yes
user accounts	3	<input checked="" type="radio"/> Yes

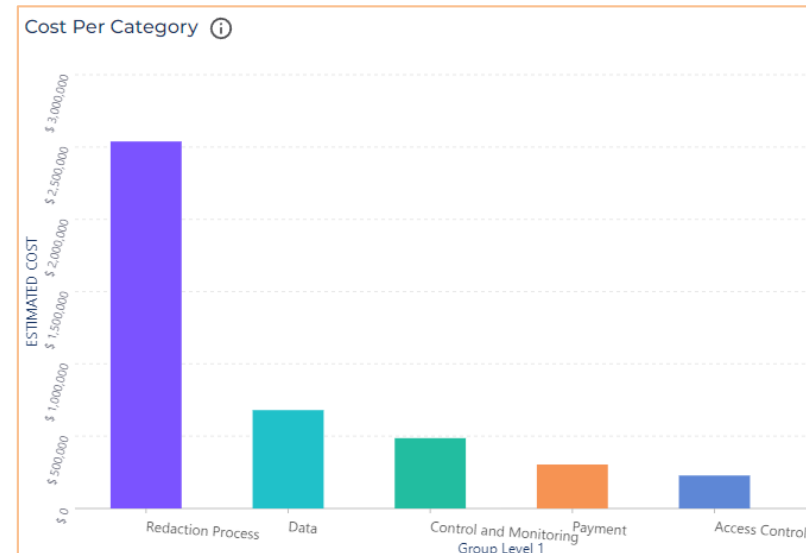
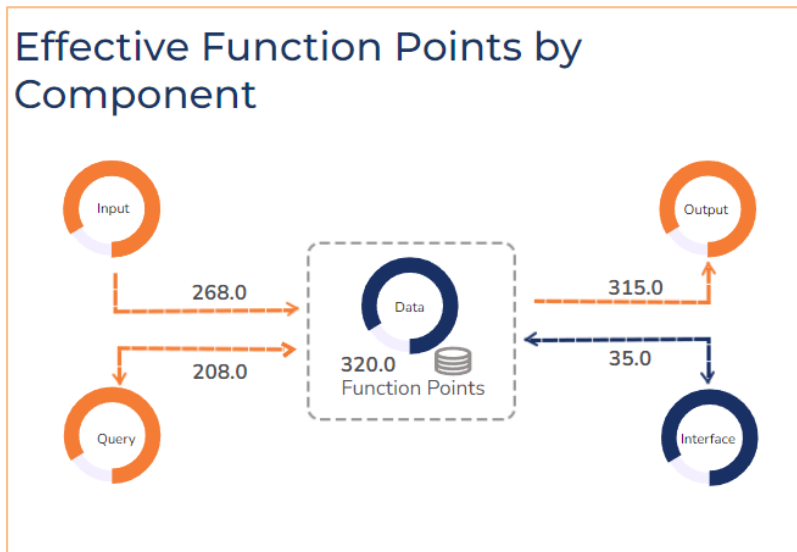
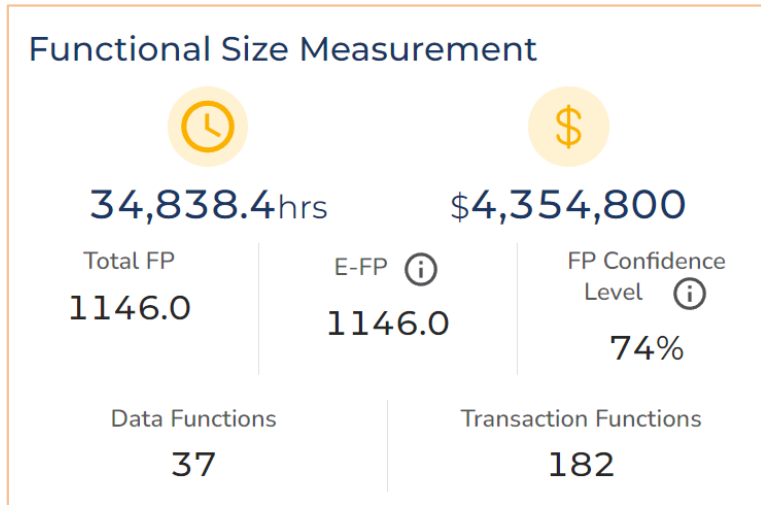
Related Requirements

ID	Requirement
DAT.02.01	System shall
DAT.02.02	System shall

Related Requirements

ID	Requirement Text	Action	Count Reference
PAY.01.02	System may create invoices		
PAY.01.03	System may process invoices		

What is Cadence: Calculations



Other Tools and Techniques

Other tools and techniques within government and industry

ScopeMaster

- ScopeMaster is a cloud-hosted tool for improving the quality, estimation and delivery of software projects. ScopeMaster® analyses written requirements or user stories to deliver insight, exposing potential defects, improvement suggestions and functional size estimates. It has been developed in the UK and is owned by ScopeMaster Ltd.

SiSE

- Simplified Software Estimation (SiSE) , developed by DHS Cost Analysis Division (CAD) based on the open-source Simple Function Point (SiFP) method as published by Dr. Roberto Meli (v1.01), is an Excel-based tool that maps software requirements against a customizable verb keyword list to estimate risk-adjusted Simple Function Points (SiFP). The SiFP total can then be used for estimation of Agile software development effort, cost and schedule analysis. SiSE also produces project tracking (burn up) charts to identify performance against plan on sprint basis.

Case Study 1 – Cash Register

Logapps collected and analyzed requirements for a Cash Register System at the request of the client

- ✓ Received over 1000 requirements for the solution, then it was shortened to 840
- ✓ Identified and removed duplicate requirements
- ✓ Manually identified: 67 unique fonctions, 28 unique interfaces, 75 unique reports
- ✓ Calculated Function Point Count: 1,802



The effort took about 100 hours to be completed

How can we automate the process?

Case Study 1 – Cash Register

	Human	MARINE	Comments
Number of Requirements	840	840	
Identified Duplicates	21	30	Higher than 95% (27 100%)
Similarities	0	50	Greater than 80%, and less than 95%
Identified unique features/ reports/entities	170	88	With some analyst input
Estimated Function Point Count / Source lines of Code	1802 / 95,506	1309 / 69,377	Effected by the analyst review (10 minutes)
Time	~100 hours	1,147 seconds (~19 minutes)	

Case Study 2 – Training Wheels

Challenge

- Organization did not have function point specialists on staff
- Customer (Civil Agency) primarily uses function points as software sizing mechanism

Approach

- Train staff on functional size measurement following IFPUG rules
- Train staff on automated function point tool (Cadence)
- Support productivity measurement (hours per function point), adjust tool parameters

Results

- Organization has developed organic functional size measurement capability
- Cost estimates successfully delivered with parametric tool as basis of software development costs

Lessons Learned

- Train analysts on basics of functional size measurement
- Leverage AI to reduce FSM cycle time
- Adjust business rules to domain/agency
- Incorporate local productivity measures when using parametric tools

Cadence Video

Where We are Going

- ❖ Integration with 3rd party applications, such as: JIRA
- ❖ Develop Value Stream Measurement (VSM) technique to help determine how to improve delivery chain
- ❖ Expand the NLP engine to analysis other languages
 - Currently, we are working closely with a firm in Italy to analysis requirements and develop function points of requirements in Italian.
- ❖ Software factory
- ❖ Further research on how to use machine learning

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THANK YOU