

[illegible]


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Software Evolution : TOC

1. Introduction to Software Maintenance & Evolution
2. Taxonomy of Software Maintenance and Evolution
3. Evolution and Maintenance Models
4. Program Comprehension
5. Impact Analysis
6. Refactoring
7. Reengineering
8. Legacy Information Systems
9. Reuse and Domain Engineering

Maintenance as part of the SDLC – Example

 Bugzilla

Browse Advanced Search >>

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Sat Sep 28 2019 22:53:55 PDT

Component: Firefox Monitor Product: Firefox Resolution: ---

13 bugs found.

ID	Type	Summary	Product	Comp	Assignee▲	Status▲	Resolution	Updated
1554379	⚙️	Mozilla Websites that is hosted by google is forbidden to access	Firefox	Firefox Monitor	nobody	UNCO	---	2019-06-10
1570197	➕	Update Monitor panel for "generic" data breaches	Firefox	Firefox Monitor	lcrouch	NEW	---	2019-09-09
1547517	📋	Enable fxmonitor test on debug	Firefox	Firefox Monitor	nobody	NEW	---	2019-05-07
1548893	⚙️	Sites visited in Private Browsing mode will show alerts in every session	Firefox	Firefox Monitor	nobody	NEW	---	2019-05-03
1531274	⚙️	Monitor doorhanger closes after dragging tab out of the window	Firefox	Firefox Monitor	nobody	NEW	---	2019-07-22
1583134	📋	[meta] Firefox Monitor: Notify user of breaches that are not "searchable" - QA bug tracking	Firefox	Firefox Monitor	ciprian.georgiu	NEW	---	Mon 05:08
1583193	📋	[meta] Firefox Monitor: Non-FxA Subscriber Email Component - QA bug tracking	Firefox	Firefox Monitor	ciprian.georgiu	NEW	---	Mon 05:26
1485651	➕	Tracking bug for Firefox Monitor telemetry	Firefox	Firefox Monitor	nobody	NEW	---	2018-08-27
1494377	➕	Feature request - persistent marker for what accounts I have handled	Firefox	Firefox Monitor	nobody	NEW	---	2018-09-26
1497040	➕	My grandparents have no idea what to do about their Firefox Monitor email report	Firefox	Firefox Monitor	nobody	NEW	---	2018-10-07
1505978	➕	It would be nice if monitor.mozilla.org forwarded to monitor.firefox.com	Firefox	Firefox Monitor	nobody	NEW	---	2018-11-08
1511998	➕	Email variant support	Firefox	Firefox Monitor	nobody	NEW	---	2018-12-04
1576180	📋	Find out if the warnedHost pref migration still needs to be migrated and tested	Firefox	Firefox Monitor	nobody	NEW	---	2019-08-23

13 bugs found.

[REST](#) | [CSV](#) | [Feed](#) | [Calendar](#)

<https://bugzilla.mozilla.org/buglist.cgi?product=Firefox&component=Firefox%20Monitor&resolution=--->

Maintenance as part of the SDLC – Example

[Copy Summary](#) [View](#)

Open Bug 1548893 Opened 5 months ago Updated 5 months ago

Sites visited in Private Browsing mode will show alerts in every session

Categories

Product: Firefox

Component: Firefox Monitor

Type:  defect

Priority: P3

Tracking

Status: NEW

Tracking Flags:

firefox68

Tracking Status
--- affected

People (Reporter: nhnt11, Unassigned, NeedInfo)

Details

Bottom

Tags

Timeline



Nihanth Subramanya [nhnt11]

Reporter

Description • 5 months ago

STR:

1. Visit a breached site in Private Browsing mode, dismiss the alert.
2. Close all private windows, make a new private browsing window
3. Visit the same breached site again

The alert will be shown again. If there is a site that the user frequently visits in PBM, this might be annoying.

A wider view on Software Maintenance

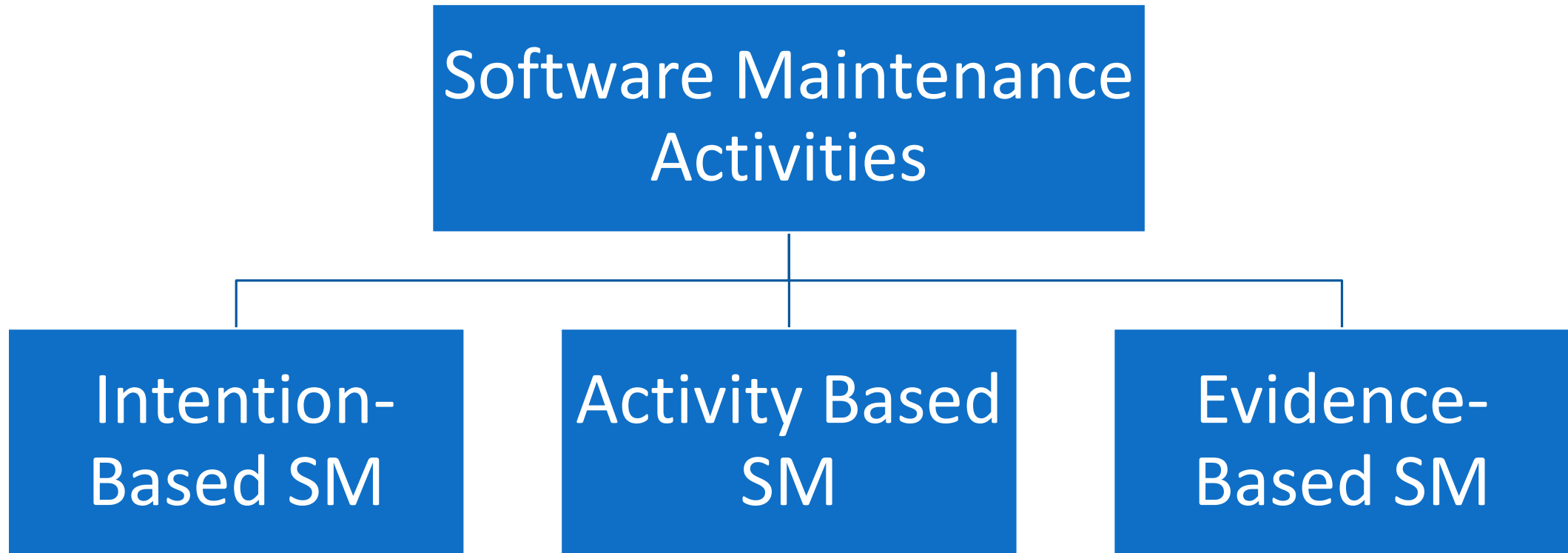
❑ Practitioners took a narrow view of maintenance as

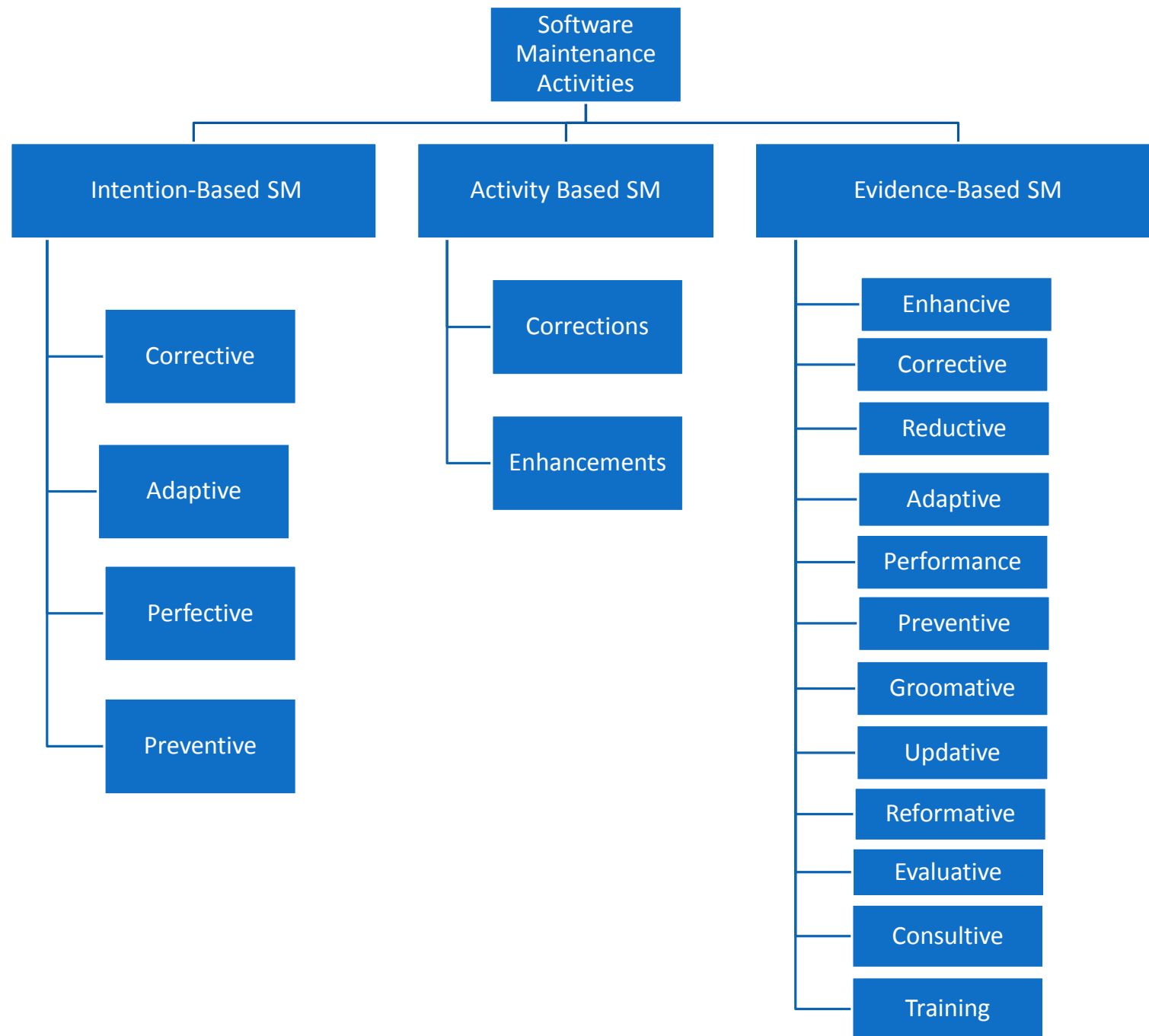
- ❑ **correcting** errors
- ❑ **enhancing** the functionalities of the software.

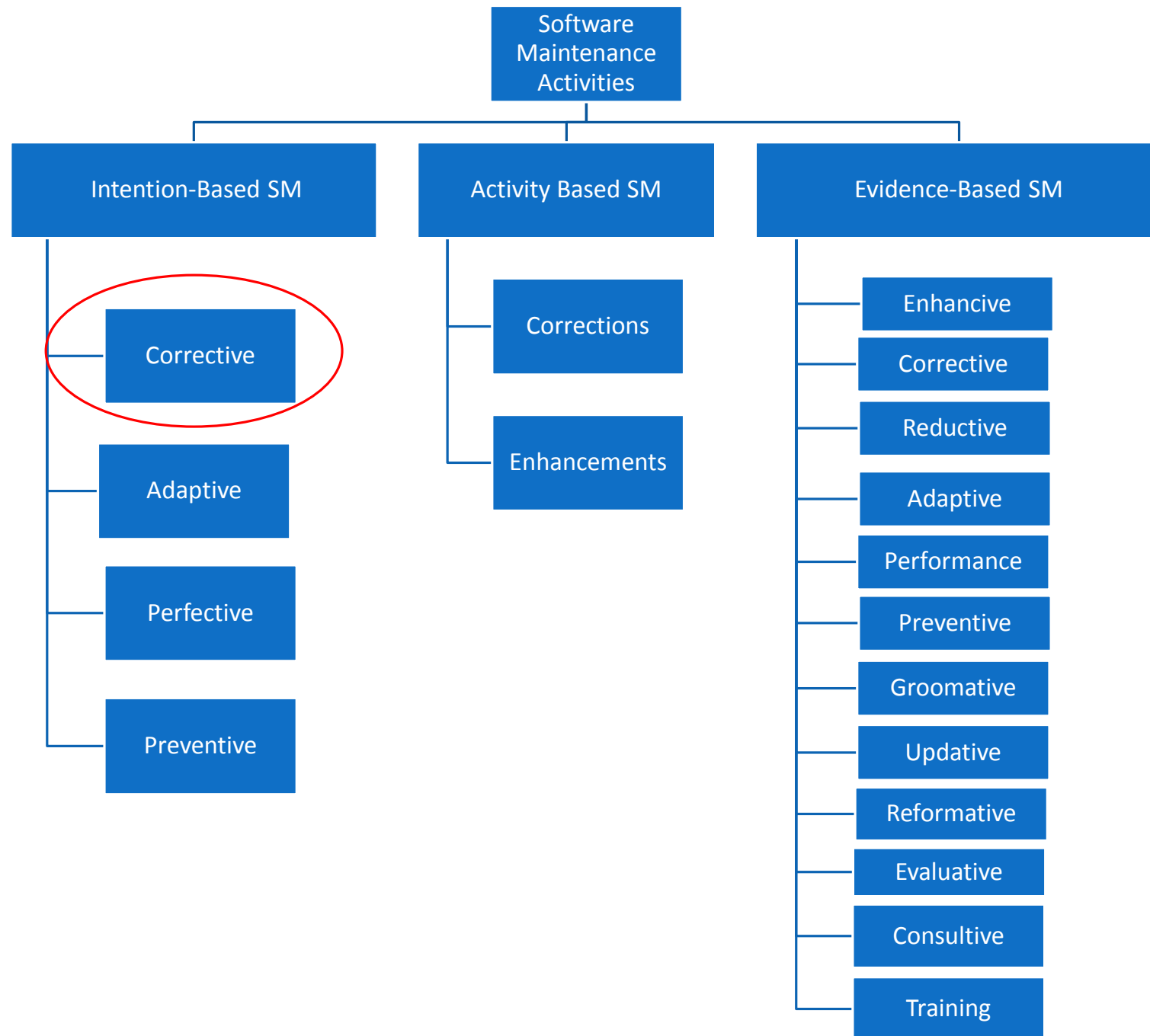
❑ The ISO/IEC 14764 standard defines software maintenance as

- “the totality of activities required to provide **cost-effective support** to a software system. Activities are performed during the **pre-delivery** stage as well as the **post-delivery** stage.”
 - ❑ Post-delivery activities includes **changing software**, **providing training**, and **operating a help desk**.
 - ❑ Pre-delivery activities include **planning for post-delivery operations**.

Classification of Software Maintenance Activities

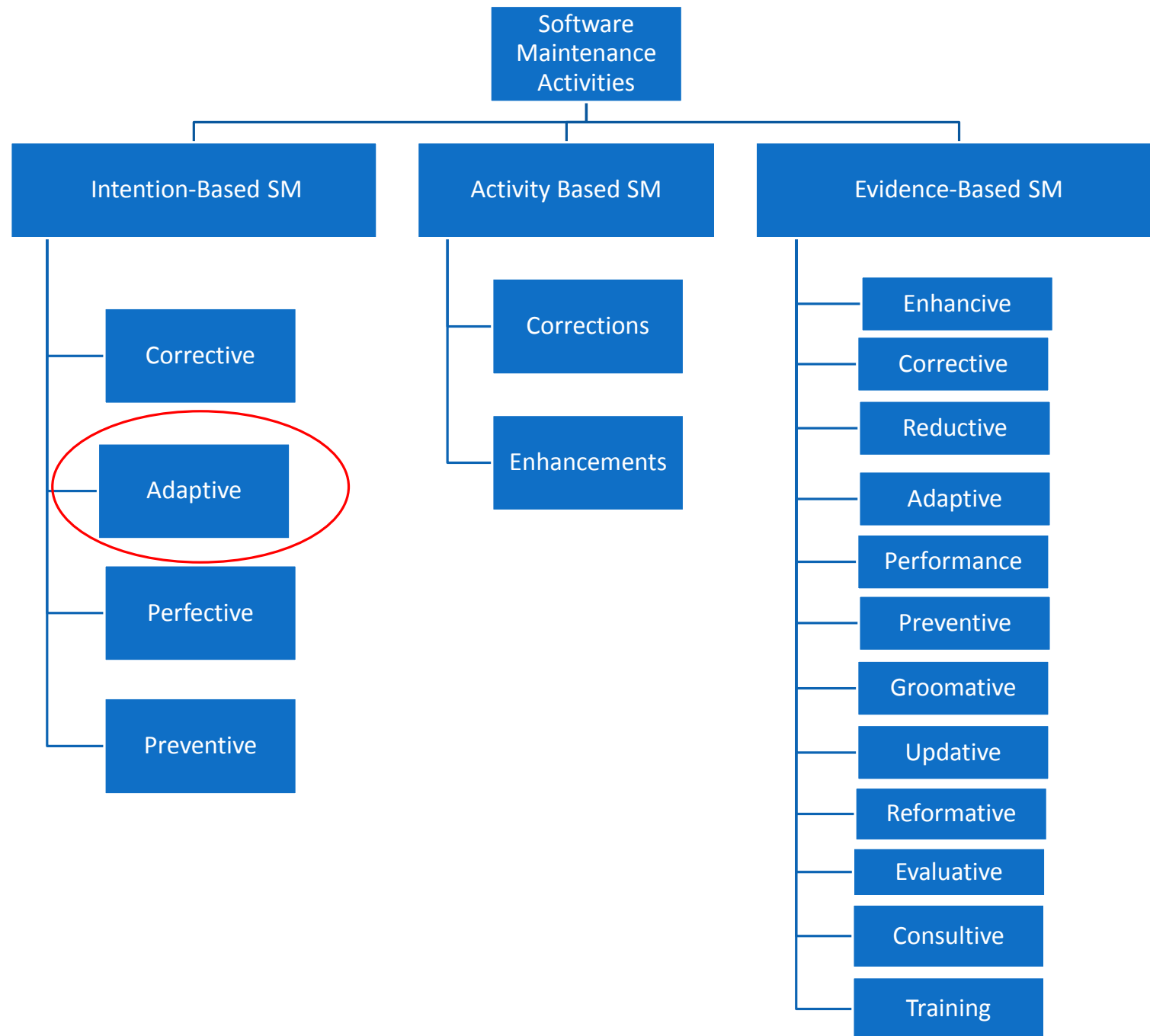






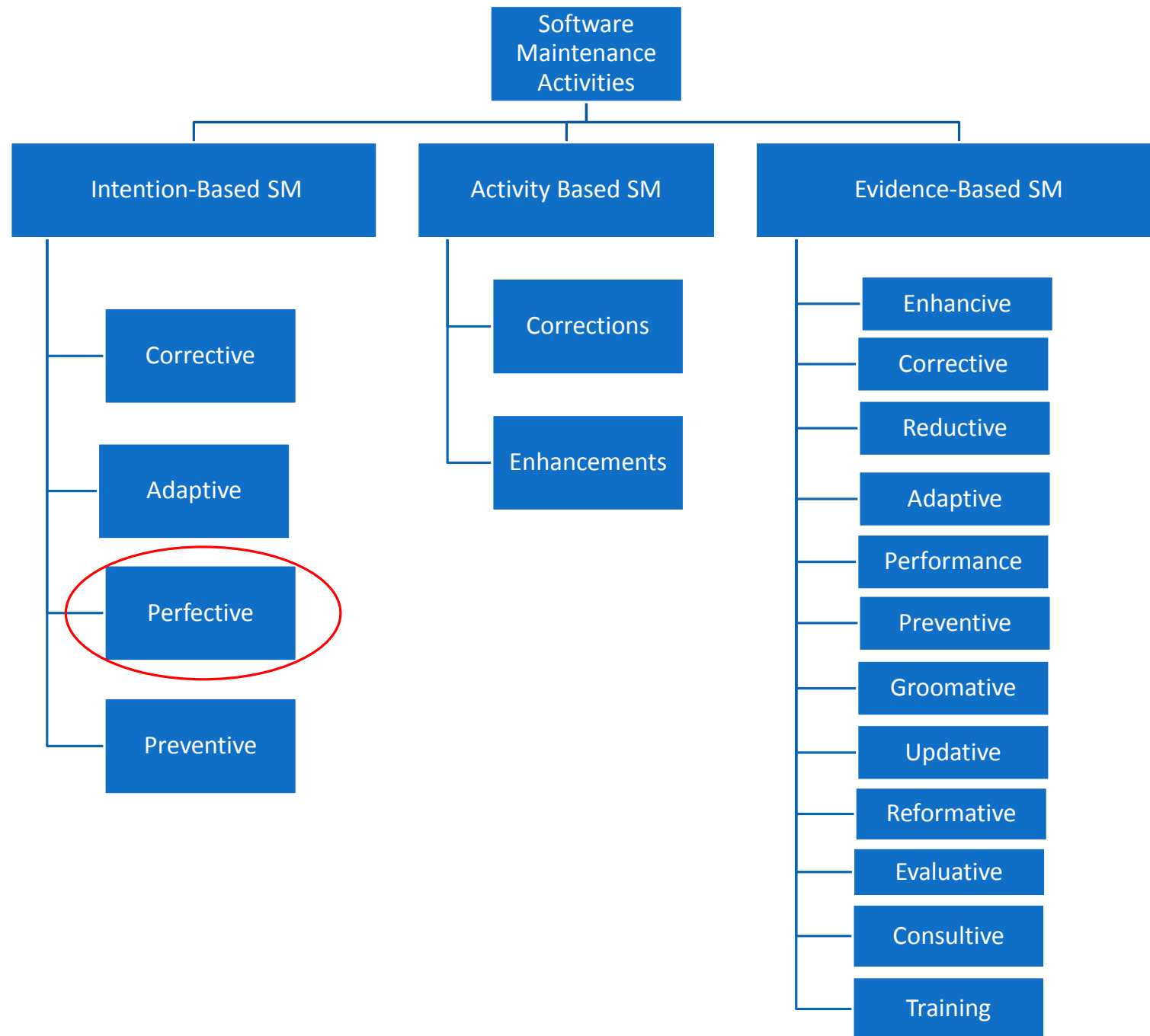
Intention-based Classification of Software Maintenance - Corrective Maintenance

- ❑ **Corrective maintenance:** The purpose of corrective maintenance is to correct failures: **processing** failures and **performance** failures.
- ❑ Examples of corrective maintenance:
 - A program producing a wrong output → processing failure.
 - a program that aborts or produces incorrect results → processing failure.
 - A program not being able to meet real-time requirements → performance failure.
- ❑ The process of corrective maintenance includes isolation and correction of defective elements in the software.
- ❑ Corrective maintenance is a **reactive process**, which means that corrective maintenance is **performed after detecting defects** with the system.



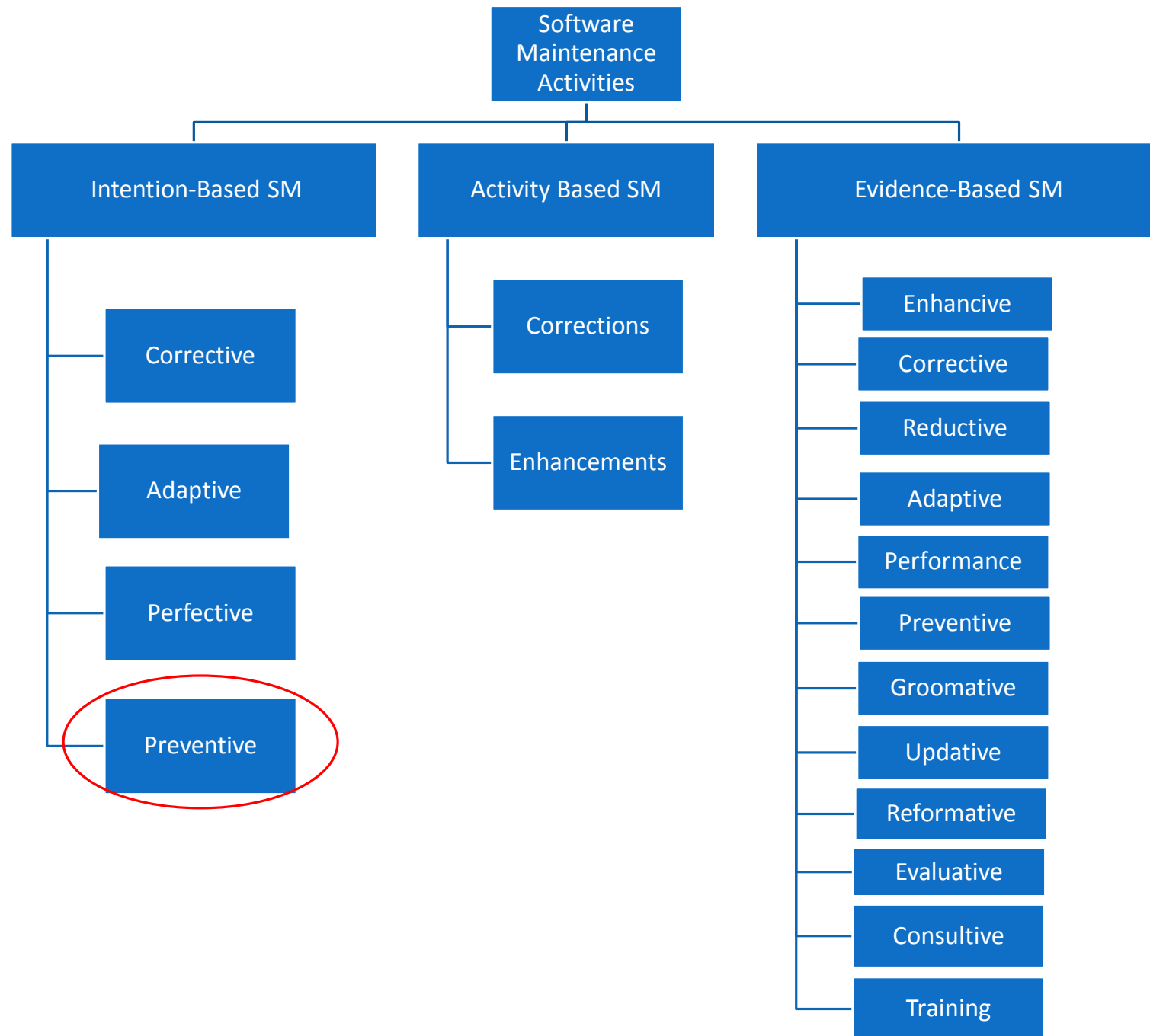
Intention-based Classification of Software Maintenance - Adaptive Maintenance

- ❑ **Adaptive maintenance:** The purpose of adaptive maintenance is to enable the system to adapt to changes in its data environment or processing environment.
- ❑ This process **modifies** the software to properly interface with a **changing or changed environment**.
- ❑ Adaptive maintenance includes **system changes, additions, deletions, modifications, extensions, and enhancements** to meet the evolving needs of the environment in which the system must operate.
- ❑ Examples of Adaptive maintenance are:
 - changing the system to support **new hardware** configuration
 - converting the system **from batch to on-line** operation
 - changing the system to be **compatible** with other applications (OS or Database)



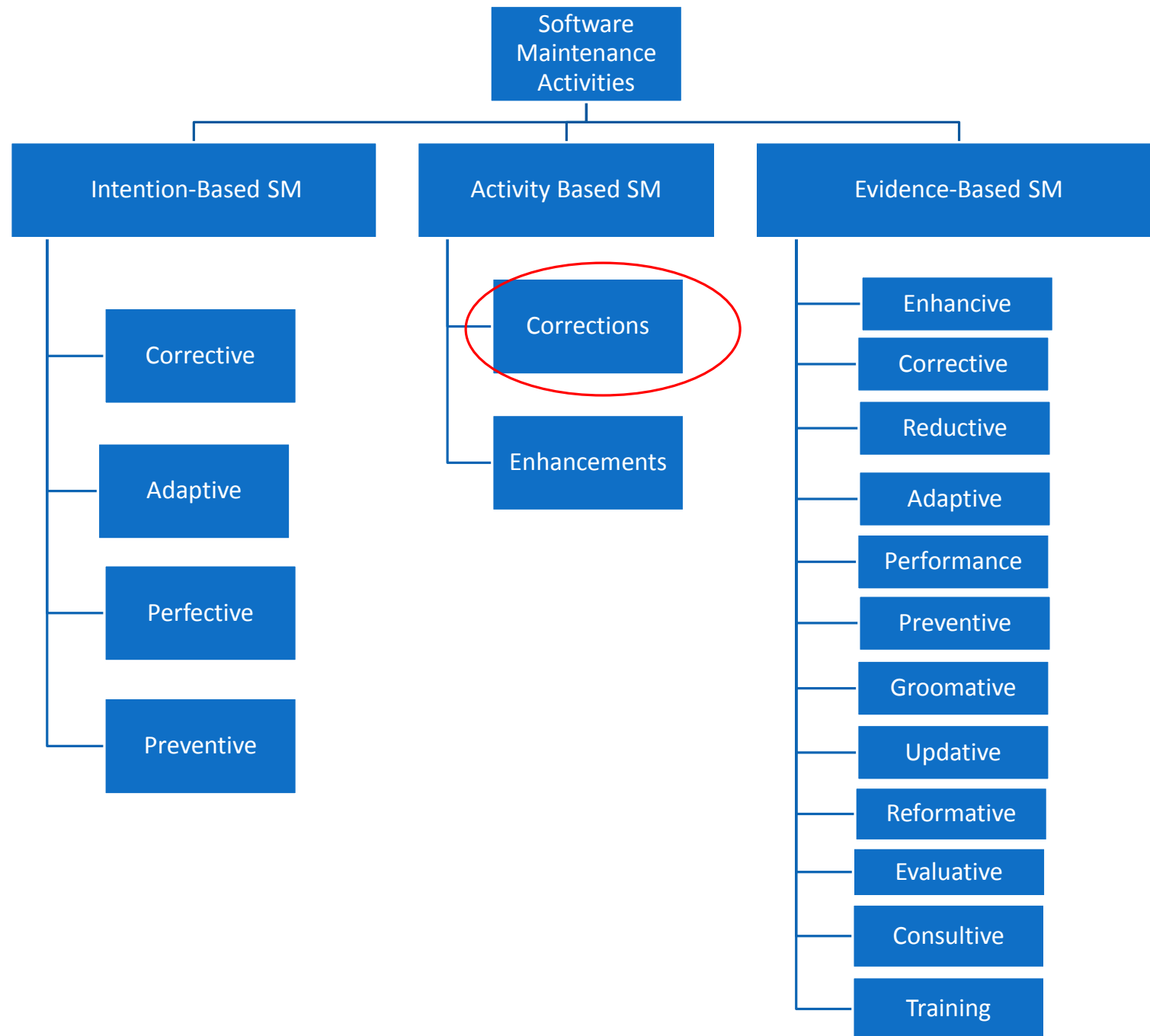
Intention-based Classification of Software Maintenance - Perfective Maintenance

- ❑ **Perfective maintenance:** The purpose of perfective maintenance is to make a variety of improvements, namely, user experience, processing efficiency, and maintainability.
- ❑ Examples of perfective maintenance are:
 - the program outputs can be made more readable for **better user experience**;
 - the program can be **modified** to make it faster, thereby **increasing the processing efficiency**;
 - and the program can be **restructured** to improve its readability, thereby **increasing its maintainability**.
- ❑ Activities for perfective maintenance include **refactoring- restructuring of the code** , **creating and updating documentations**, and tuning the system to **improve performance**.
- ❑ It is also called “**reengineering**”.



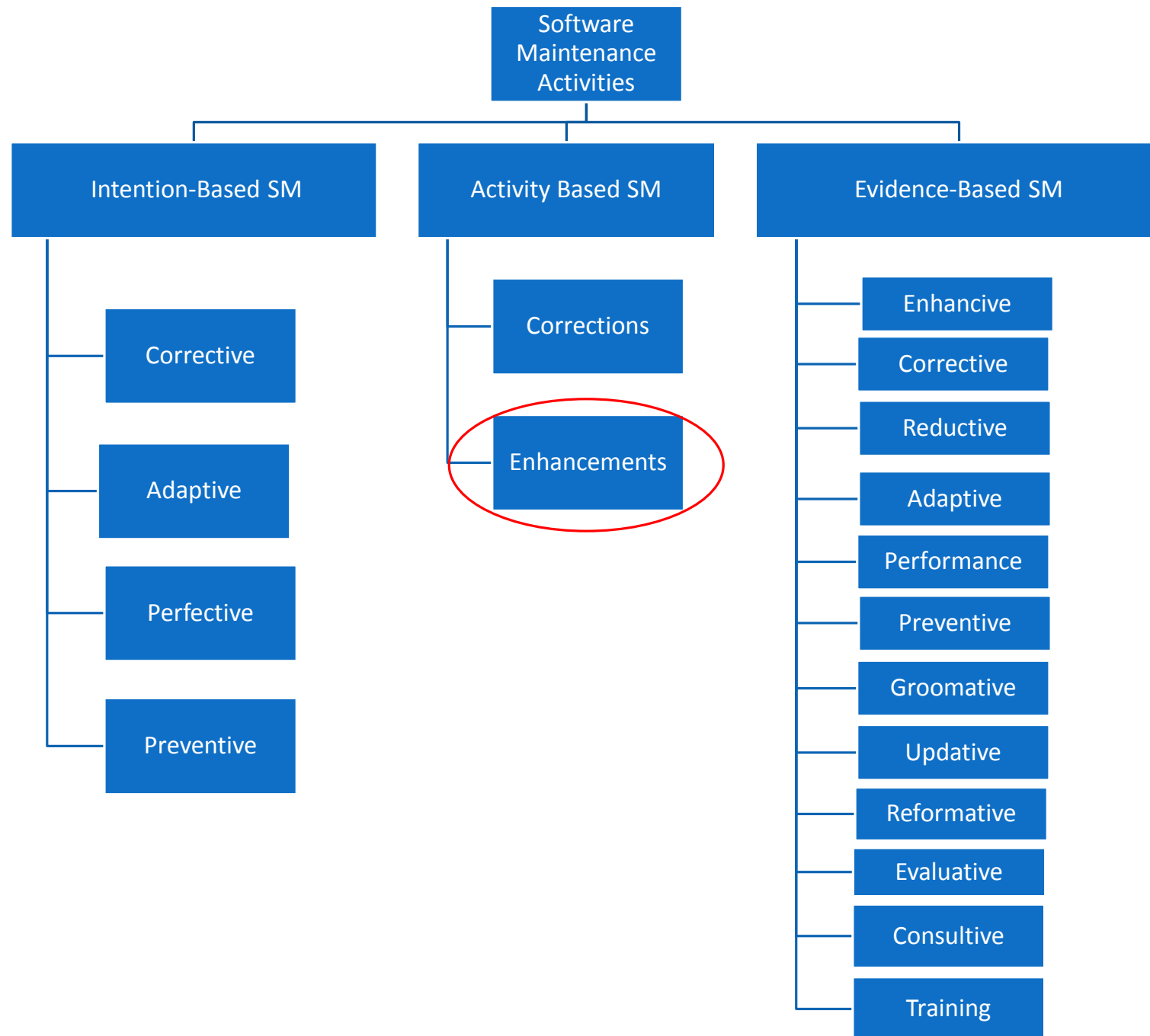
Intention-based Classification of Software Maintenance - Preventive Maintenance

- ❑ **Preventive maintenance:** The purpose of preventive maintenance is to **prevent problems from occurring** by modifying software products. to **eliminate hazard** or reduce its associated **risk** to an acceptable level.
 - a hazard is a state of a system or a physical situation which, when combined with certain environment conditions, could lead to an accident.
- ❑ **Preventive maintenance** is identifying future risks and unknown problems, and taking actions so that those problems do not occur. It involves **occasionally terminating an application** or a system, **cleaning its internal state**, and **restarting it**.
- ❑ Preventive maintenance is very often performed on **safety critical** and **high available software** systems (eg. Control software for Patriot Missile, control software for telecommunication services).
- ❑ The concept of “**software rejuvenation**” is a preventive maintenance measure to prevent, or at least postpone, the occurrences of failures (crash) resulting from continuously running the software system.



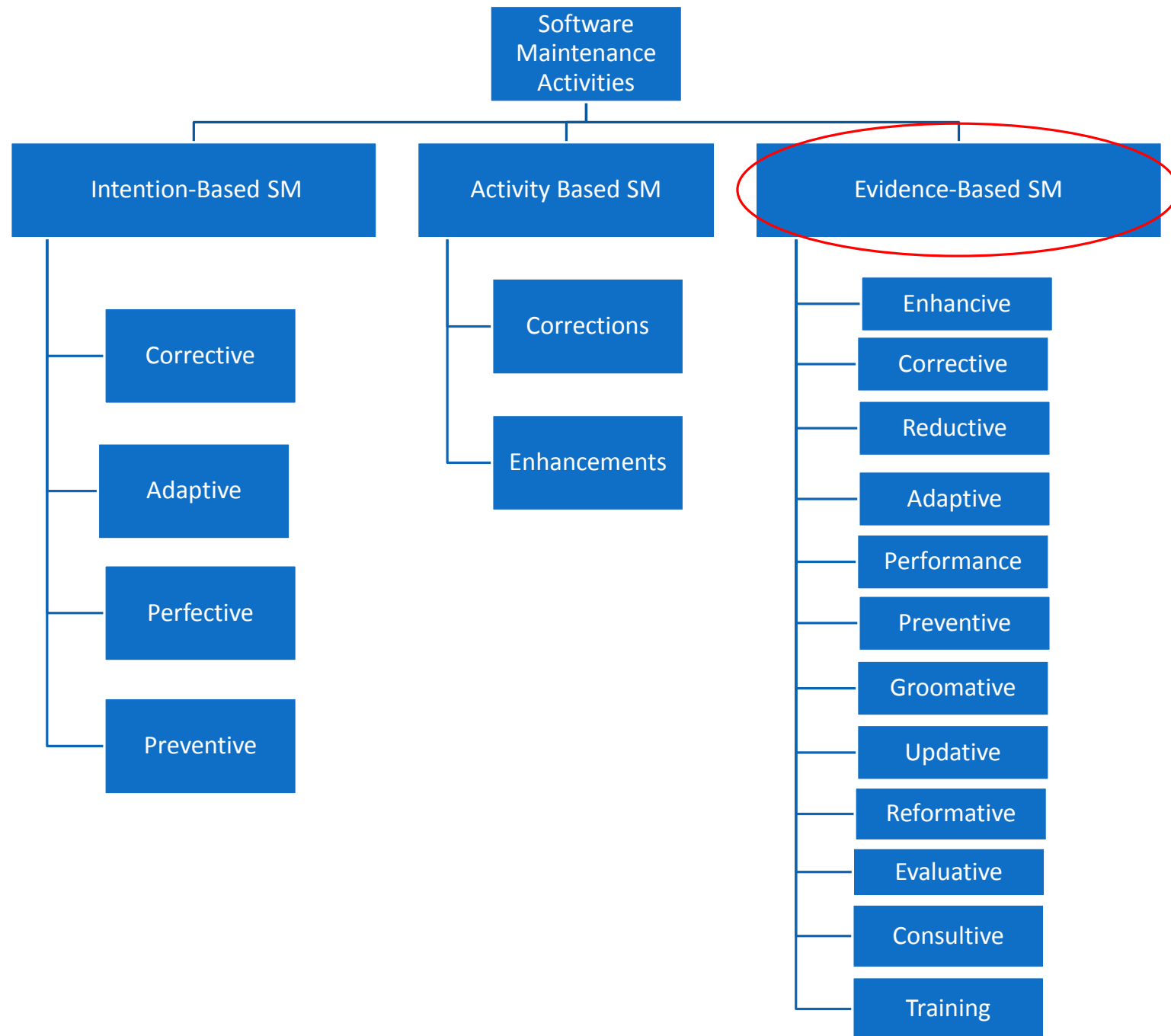
Activity-based Classification of Software Maintenance -Corrections

- ❑ **Corrections:** Activities in this category are designed to **fix defects** in the system, where a defect is a discrepancy between the expected behaviour and the actual behaviour of the system.
- ❑ e.g. wrong calculation of taxes in a payroll component of the system
- ❑ e.g. usage of wrong metrics for calculation



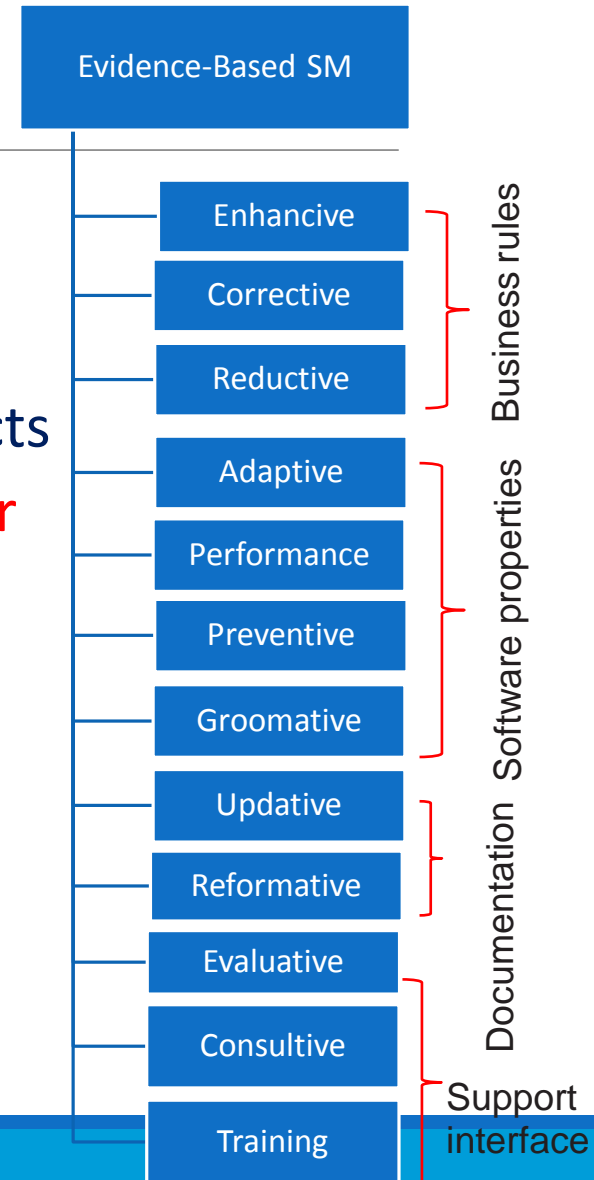
Activity-based Classification of Software Maintenance -Enhancements

- ❑ Enhancements Maintenance activities are designed to effect changes to the system.
- ❑ It is further divided into three subcategories as follows:
 - enhancement activities that **modify** some of the existing **requirements** implemented by the system;
 - enhancement activities that **add new** system requirements
 - enhancement activities that **modify** the implementation **without changing** the **requirements** implemented by the system.



Evidence-based Classification of Software Maintenance

- ❑ Twelve **mutually exclusive** types of maintenance activities were grouped into four clusters.
- ❑ Modifications **performed, detected, or observed** on four aspects of the system being maintained, are used as the **criteria to cluster** the types of maintenance activities, these are:
 - the whole software
 - the external documentation
 - the properties of the program code
 - the system functionality experienced by the customer



Evidence-based Classification of Software Maintenance

Evidence-Based SM

❑ **Enhanceive:** Ordinary activities in this type are **adding** and **modifying business rules** to enhance the system's functionality available to the customer, and **adding new data flows** into or out of the software.

❑ **Corrective:** Ordinary activities in this type are **correcting identified bugs**, adding **defensive programming strategies**, and **modifying the ways exceptions are handled**.

❑ **Reductive:** Ordinary activities in this type drop some data generated for the customer, **decreasing the amount of data input to the system**, and **decreasing the amount of data produced** by the system.

Enhanceive

Corrective

Reductive

Adaptive

Performance

Preventive

Groomative

Updative

Reformative

Evaluative

Consultive

Training

Business rules

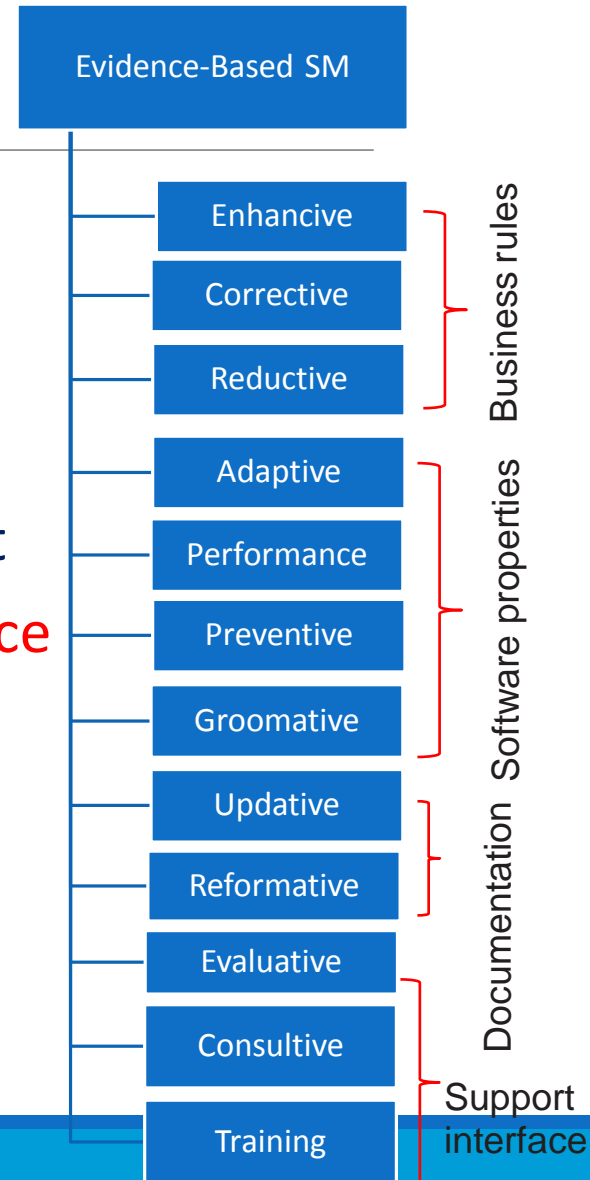
Software properties

Documentation

Support interface

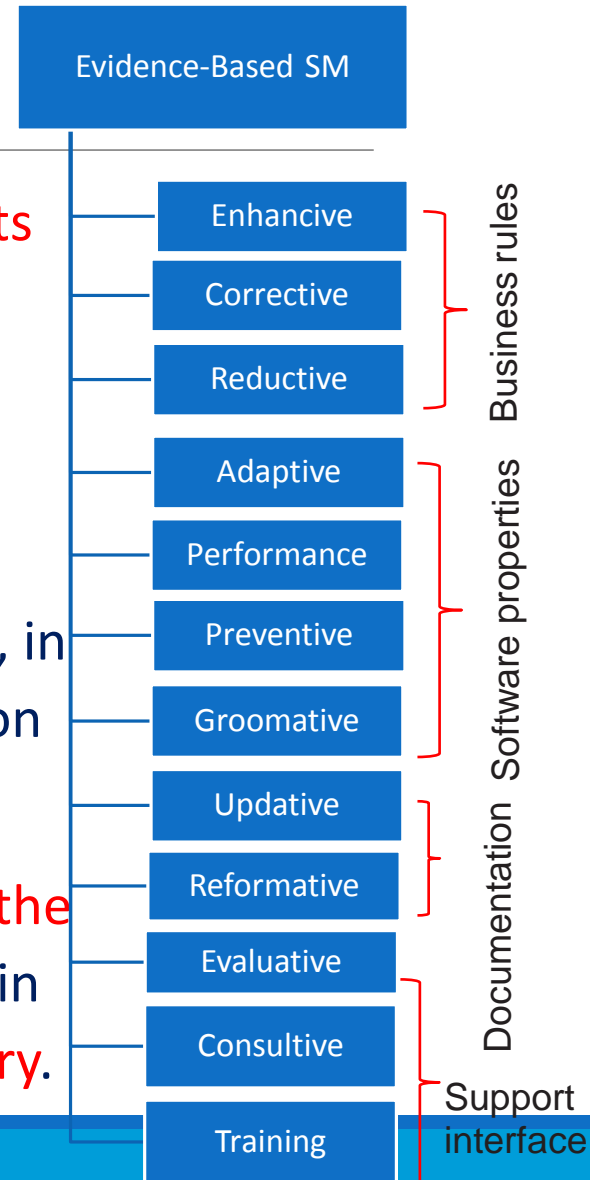
Evidence-based Classification of Software Maintenance

- ❑ **Adaptive:** Ordinary activities in this type **port the software to a different execution platform**, and **increase the utilization of COTS components**.
- ❑ **Performance:** Activities in performance type produce results that **impact the user**. Those activities **improve system up time** and **replace components and algorithms with faster ones**.
- ❑ **Preventive:** Ordinary activities in this type perform changes to enhance maintainability, and establish a base for making a future transition to an emerging technology.



Evidence-based Classification of Software Maintenance

- ❑ **Groomative:** Ordinary activities in this type are **substituting components and algorithms** with more efficient and simpler ones, **modifying the conventions** for naming data, changing **access authorizations**, **compiling source code**, and **doing backups**.
- ❑ **Updative:** Ordinary activities in this type are **substituting out-of-date documentation** with up-to-date documentation, making semi-formal, say, in UML to **document current program code**, and updating the documentation with **test plans**
- ❑ **Reformative:** Ordinary activities in this **type improve the readability of the documentation**, make the **documentation consistent** with other changes in the system, prepare **training materials**, and **add entries to a data dictionary**.



Evidence-based Classification of Software Maintenance

Evidence-Based SM

❑ **Evaluative:** In this type, common activities include reviewing the program code and documentations, **examining the ripple effect of a proposed change, designing and executing tests**, examining the programming support provided by the **operating system**, and finding the required data and **debugging**.

❑ **Consultive:** In this type, cost and length of time are estimated for maintenance work, personnel **run a help desk**, customers are assisted to **prepare maintenance work requests**, and personnel make **expert knowledge** about the available resources and the system to others in the organization to **improve efficiency**.

❑ **Training:** This means **training the stakeholders** about the **implementation** of the system.

Enhance

Corrective

Reductive

Adaptive

Performance

Preventive

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Updative

Reformative

Evaluative

Consultive

Training

Business rules

Software properties

Documentation

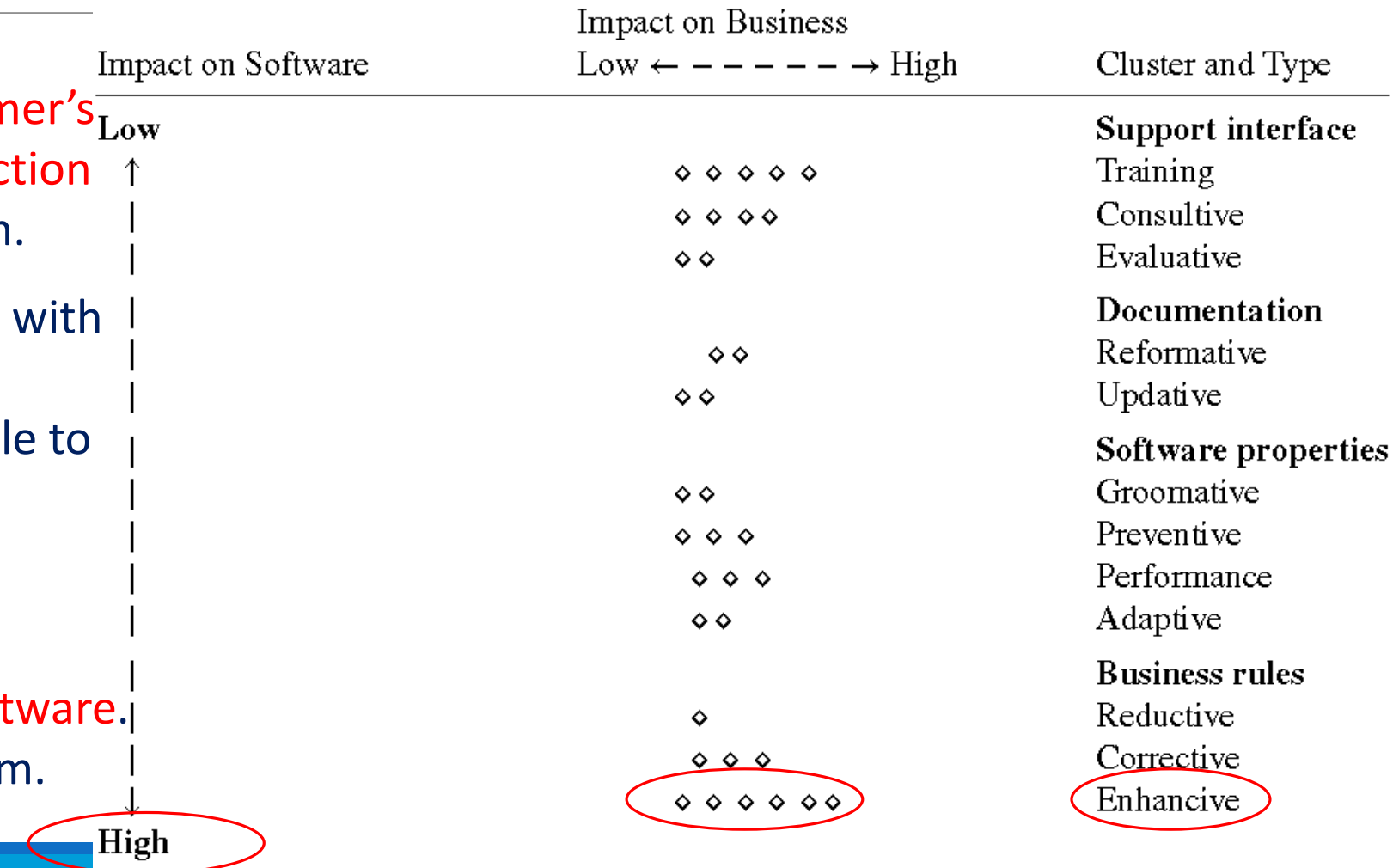
Support interface

Evidence-based Classification of Software Maintenance – Impact of Maintenance

□ The first dimension is the **customer's ability to perform its business function** while continuing to use the system.

- E.g. if the software is enhanced with new functionalities, then the customer is more likely to be able to achieve its business goals than modifications on non-code documentation.

□ The second dimension is the **software**. This is arranged from top to bottom.



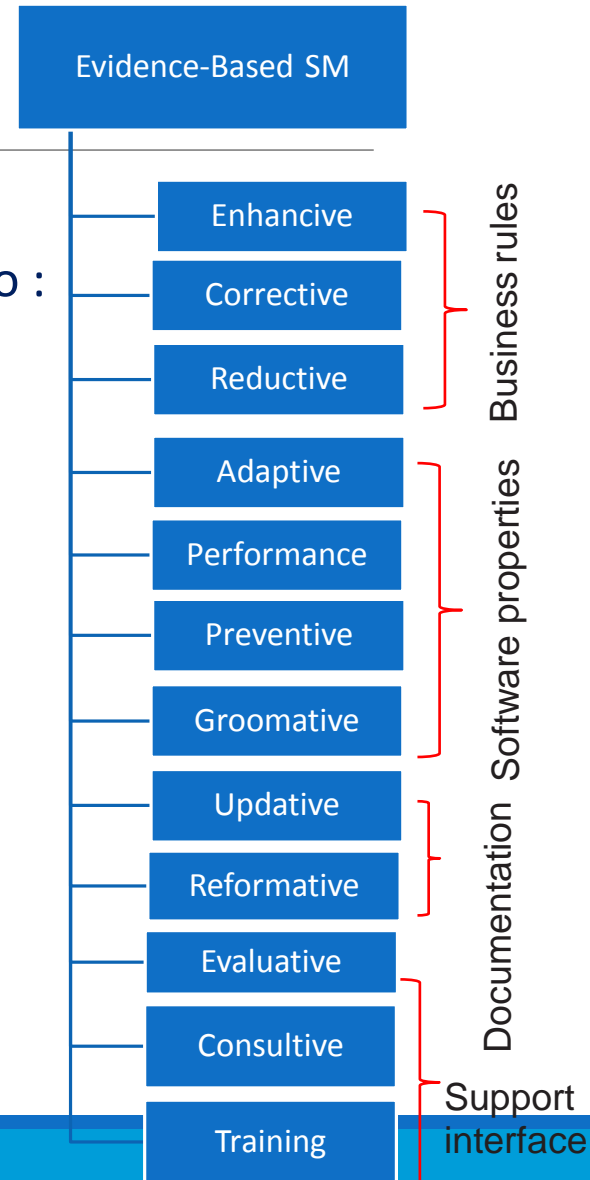
Evidence-based Classification of Software Maintenance - Decision Criteria

□ The classification is based on modifications deliberately done, modifications observed, modifications manifested, and modifications detected. With respect to :

- A—the whole software system.
- B—the program code.
- C—the functionalities experienced by customers.
- D—the external documentation

□ Activities are classified into different types by applying a two-step decision process:

- First, apply **criteria-based** decisions to make the clusters of types.
- Next, apply the **type decisions** to identify one type within the cluster.



Notes:

Types is read from left to right, bottom to top.

Questions have been listed in Table 2.2.

Italics show the type name when the type decision at the left of it is 'Yes'

For "cc," read "change to code"

* indicates the default type in the cluster.

A—the whole software system.

B—the program code.

C—the functionalities

experienced by customers.

D—the external documentation

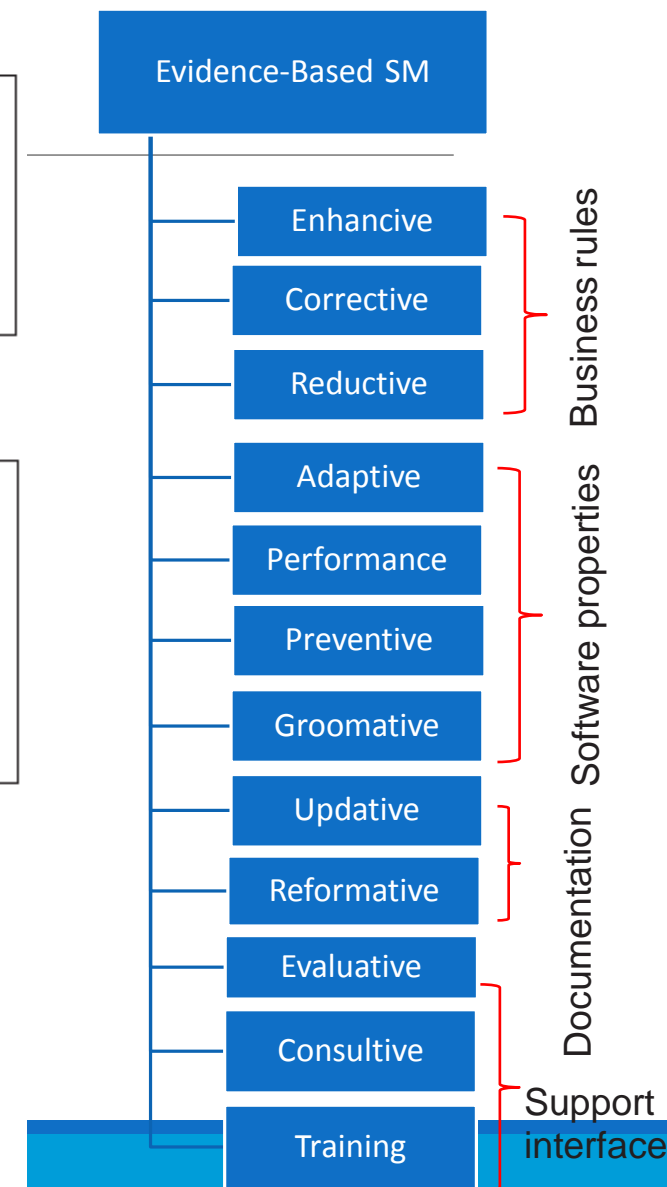
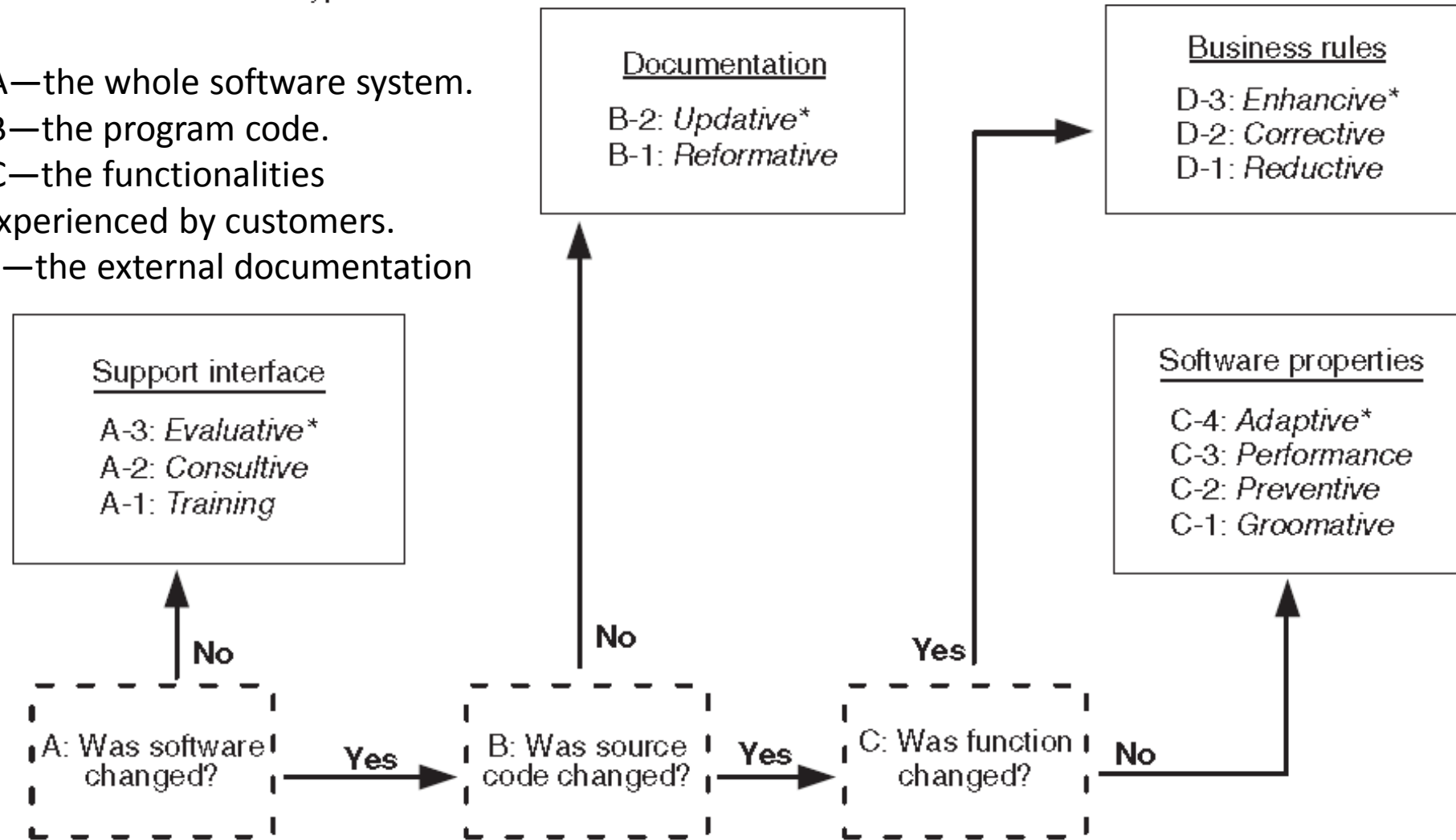
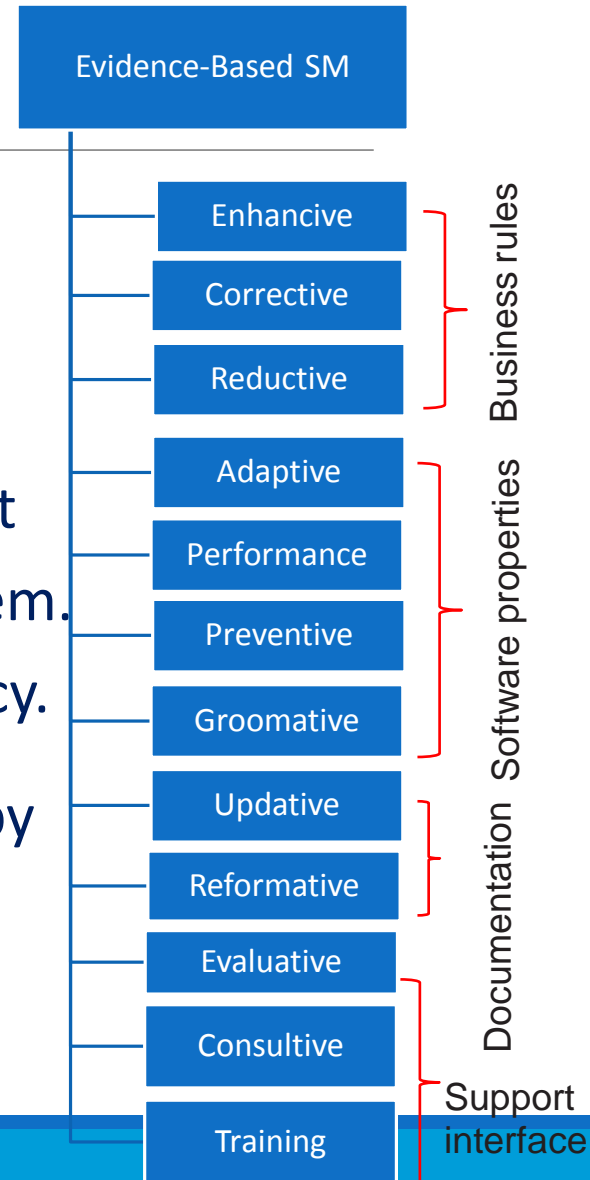


FIGURE 2.2 Decision tree types. From Reference 15. © 2001 John Wiley & Sons

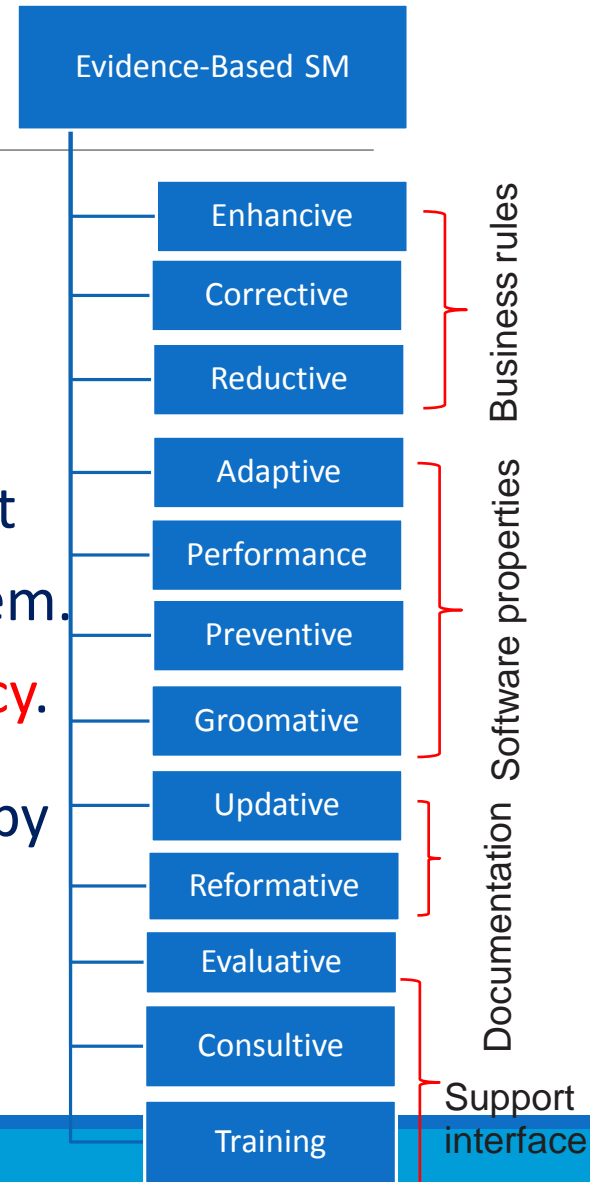
Evidence-based Classification of Software Maintenance - Example

- ❑ A maintenance engineer, after analyzing all the documentation along with the program code, modified the program code for one component without modifying other documentation, built the rewritten component, executed the regression test suite, checked it into the version control, and embedded it into the production system. The only consequence the customer observed was improved latency.
- ❑ Question: Identify the type of software maintenance performed by the engineer



Evidence-based Classification of Software Maintenance - Example

- ❑ A maintenance engineer, after analyzing all the documentation along with the program code, **modified the program code** for one component without modifying other documentation, **built the rewritten component, executed the regression test suite**, checked it into the version control, and embedded it into the production system. The only consequence the **customer observed was improved latency**.
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Evidence-based Classification of Software Maintenance - Decision Criteria

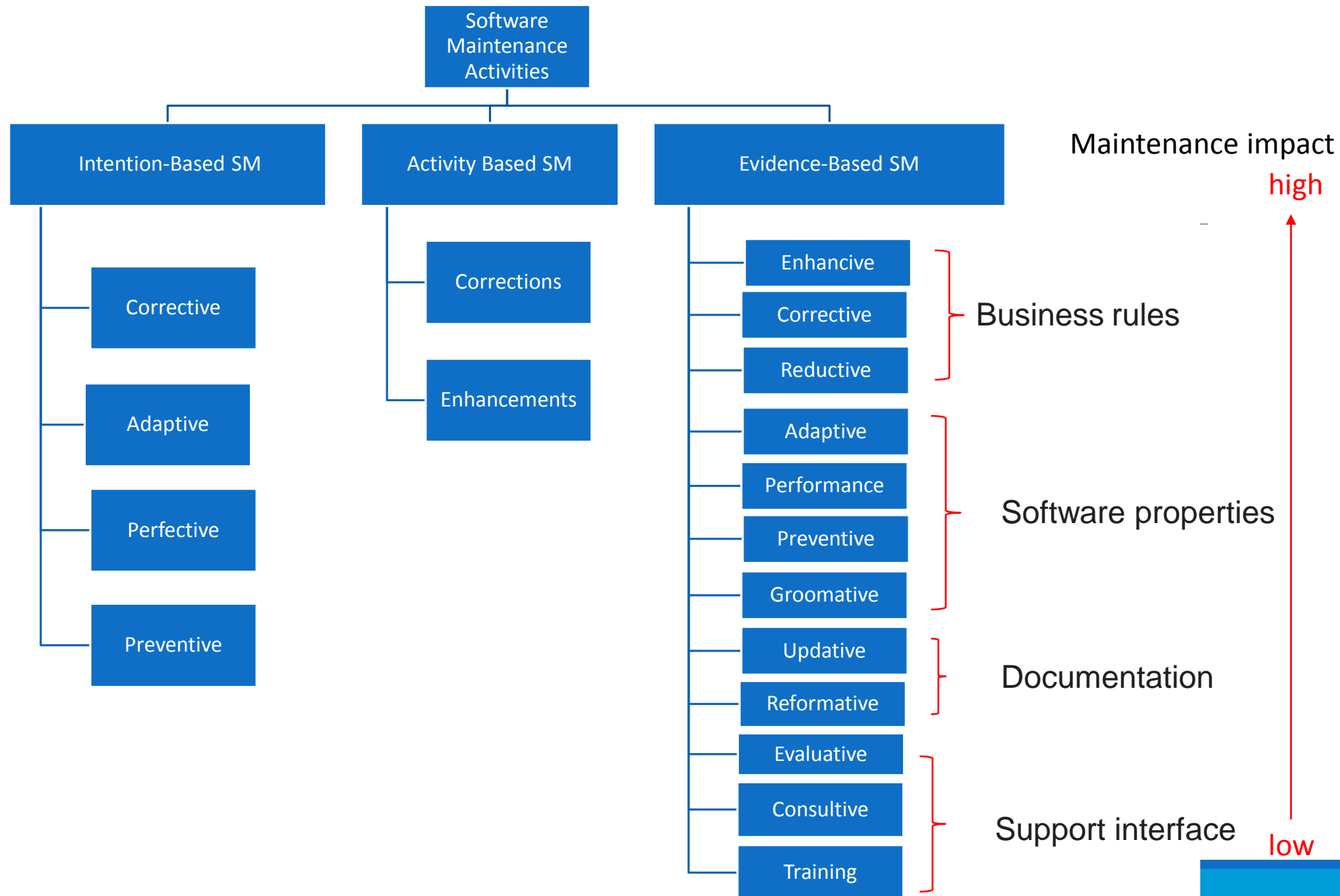
Criteria	Type decision question	Type
A-1	To train the stakeholders, did the activities utilize the software as subject?	Training
A-2	As a basis for consultation, did the activities employ the software?	Consultive
A-3	Did the activities evaluate the software?	Evaluative
B-1	To meet stakeholder needs, did the activities modify the non-code documentation?	Reformative
B-2	To conform to implementation, did the activities modify the non-code documentation?	Update
C-1	Was maintainability or security changed by the activities?	Groomative
C-2	Did the activities constrain the scope of future maintenance activities?	Preventive
C-3	Were performance properties or characteristics modified by the activities?	Performance
C-4	Were different technology or resources used by the activities?	Adaptive
D-1	Did the activities constrain, reduce, or remove some functionalities experienced by the customer?	Reductive
D-2	Did the activities fix bugs in customer-experienced functionality?	Corrective
D-3	Did the activities substitute, add to, or expand some functionalities experienced by the customers?	Enhance

Table 2.3: Summary of evidence-based types of software maintenance

A—the whole software system.
B—the program code.
C—the functionalities experienced by customers.
D—the external documentation

Evidence-based Classification of Software Maintenance - Decision Criteria

- ❑ Sometimes, an objective evidence may be found to be ambiguous. In that case, clusters have their designated default types for use.
- ❑ The overall default type is **evaluative**, if there are ambiguities in an activity.



Readings

□ Book Chapter 2

- Section 2.1

Questions

?

Assignment 1

- ❑ Define at least 5 of the quality attributes (aka. non-functional requirements) and mention how each is measured.
- ❑ Use the ISO 25010:2011 as your reference