COSMIC-FFP & Entropy: A Study of their Scales, Scale Types and Units

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- Entropy Scale, Scale Type & unit
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Introduction

- ***Well defined measures in sciences and engineering should have most of the many characteristics described in metrology, including 'scales', 'units' and 'etalons'.***

- ***That is to ensure meaningfulness of the numbers obtained from measurement.***

- ***Previous studies have analyzed the scale types of many software measures*** ***(i.e. Zuse, Fenton, Whitemire)***

- ***But.. the concept of 'scale' (and how it is used in the design of a measurement method) is not analyzed.***

Scale Types

- **Scale *is defined as a set of ordered values, continues or discrete, or a set of categories to which the attribute is mapped*** *ISO/IEC IS 15939*

- **Scale type *depends on the nature of the relationship between values on the scale*** *ISO/IEC IS 15939*

Five Scale Types

1. ***Nominal Scale Type*** *(each empirical class might be represented by a unique number or symbol)*

2. ***Ordinal Scale Type*** *(assigns numbers or symbols to the objects so they may be ordered with respect to an attribute)*

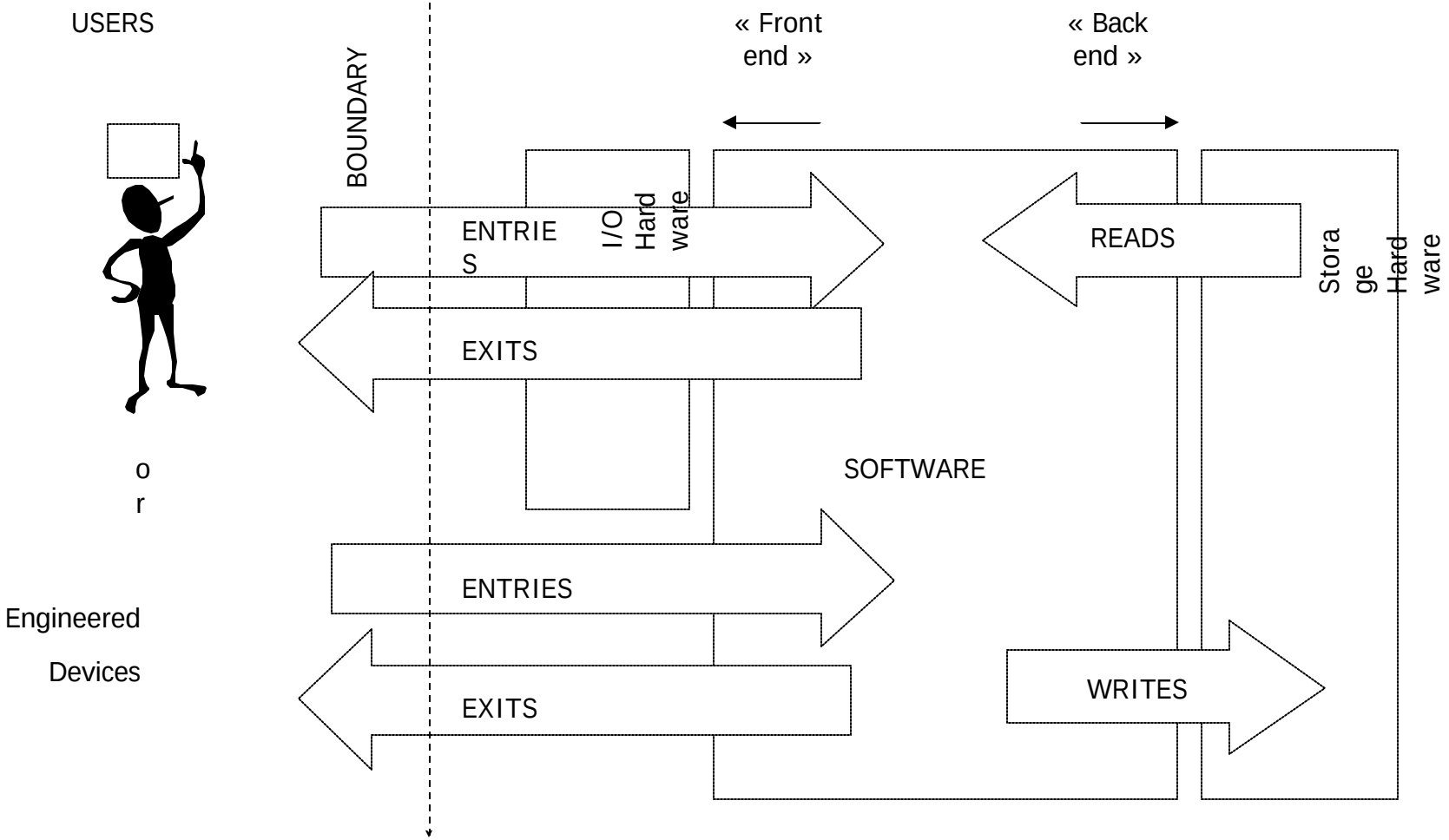
3. ***Interval Scale Type*** *(the difference in units between any two of the ordered classes in the range of the mapping is known)*

4. ***Ratio Scale Type*** *(is an interval scale with ratio on which there exists an absolute zero)*

5. ***Absolute Scale Type*** *(represents counts of objects in a specific class)*

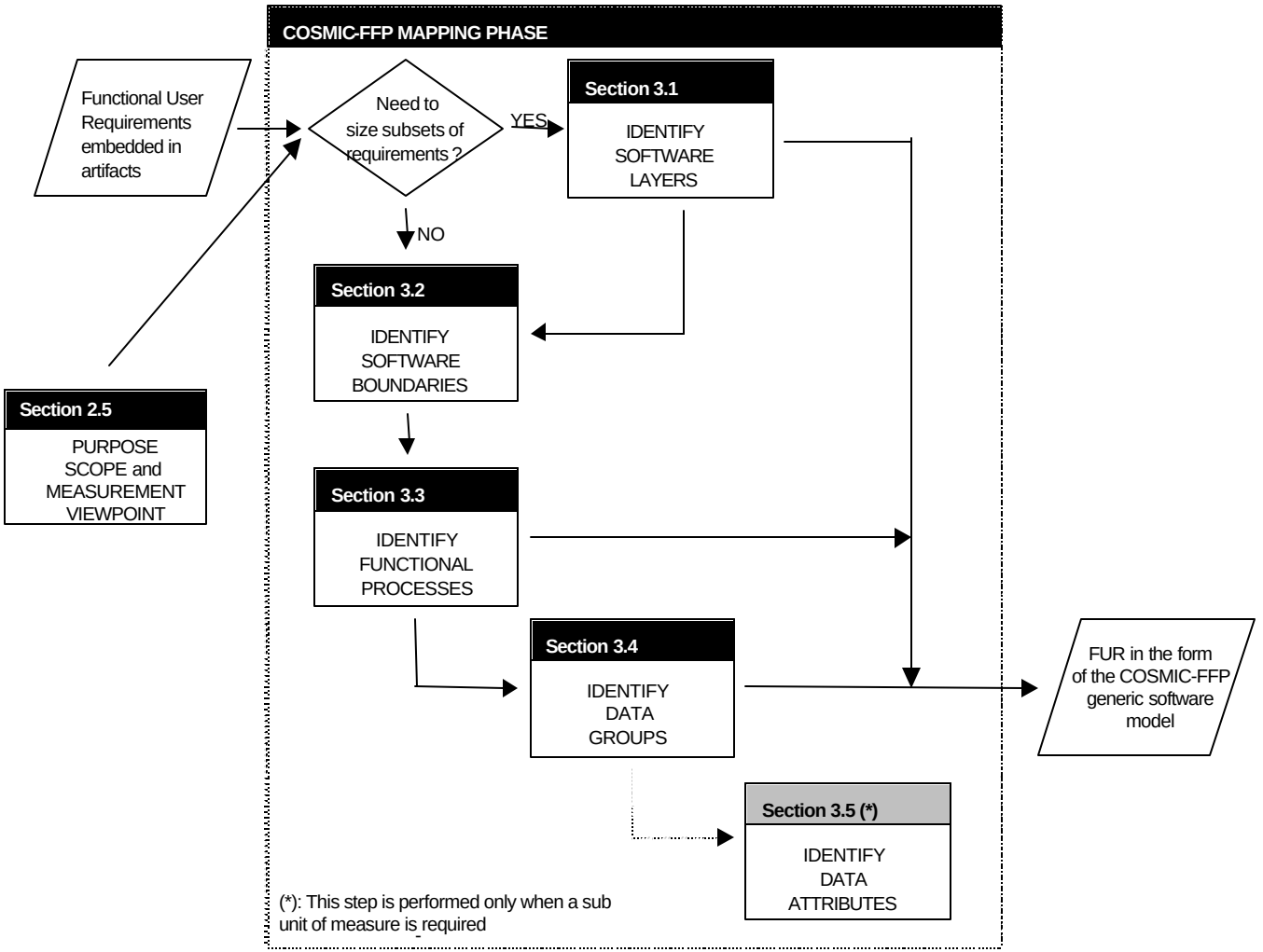
COSMIC-FFP – ISO 19761

- *Designed to measure the functional size of management information systems, real-time software and multi-layer systems.*
- *Its design conforms to all ISO requirements (ISO 14143-1) for functional size measurement methods.*
- *Was developed to address some of the major weaknesses of the earlier methods – like Function Points Analysis*
- *Focus: the "user view" of software functional requirements*
- *Applicable throughout the development life cycle, right from the requirements phase to the implementation and maintenance phases.*

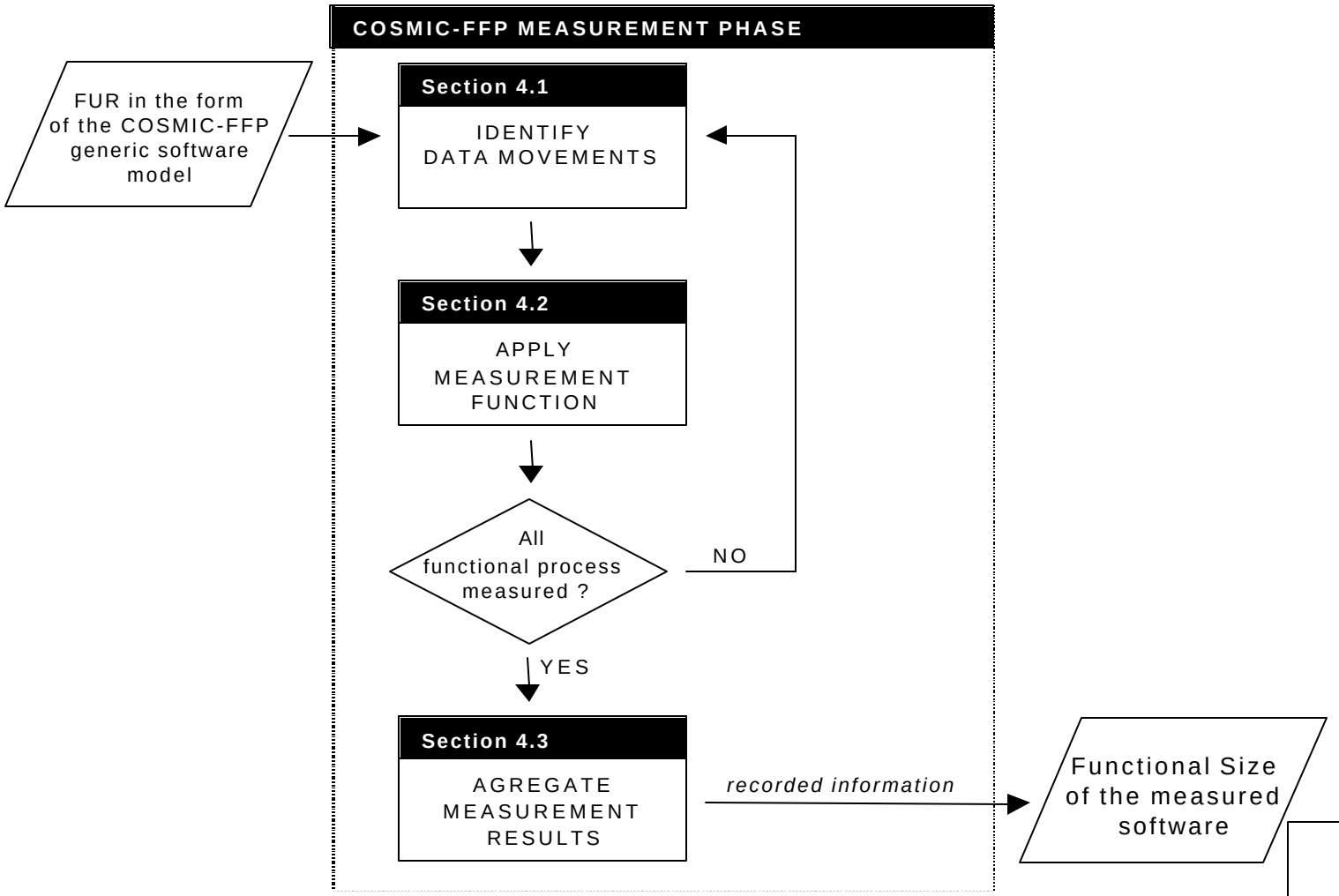


Generic flow of data groups through software from a functional perspective

COSMIC-FFP (Mapping Phase)

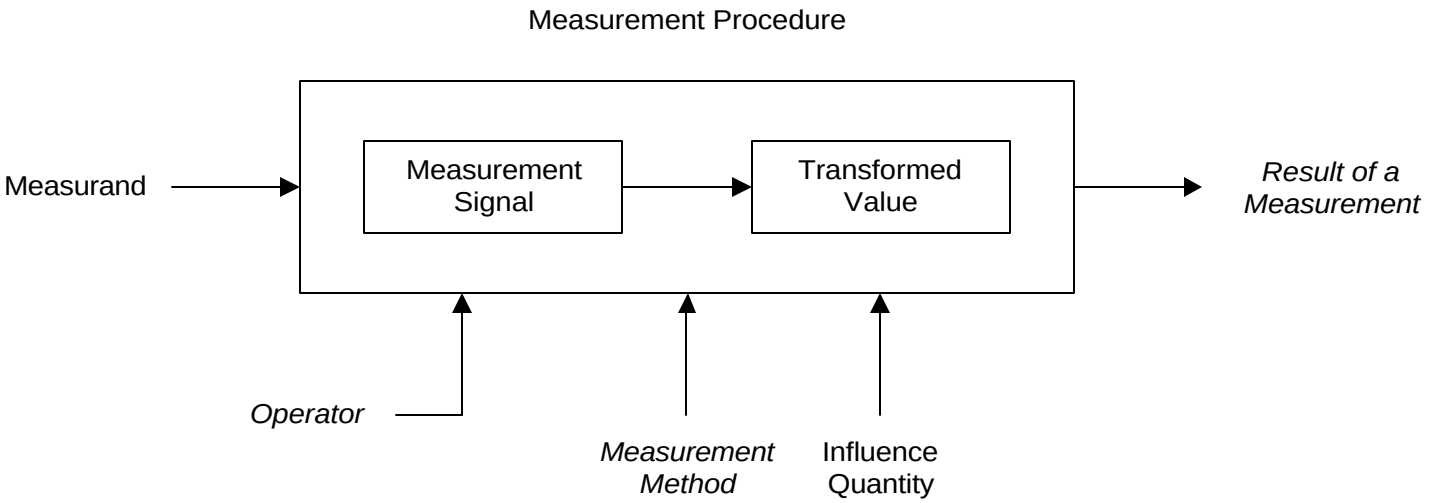


COSMIC-FFP (Measurement Phase)



COSMIC-FFP (discussion)

Mapping Phase



Measurement process - detailed topology of sub-concepts

COSMIC-FFP (discussion)

Mapping Phase

- *The measurand is the textual description of the text (Functional User Requirements).*
- *The 'measurement signal' would be the elements within the text that are related to the Functional User Requirements.*
- *The mapping from 'whichever format' into the 'generic COSMIC model of software' could be the 'transformed value'.*
- *Finally, the 'measurement function' would be applied with the corresponding measurement unit.*

COSMIC-FFP (discussion)

Measurement Phase

- The Measurement phase *is broken into three steps:*
  - ***MSP1:*** *Identifying data movements.*
  - ***MSP2:*** *Applying measurement function.*
  - ***MSP3:*** *Aggregating measurement results.*

COSMIC-FFP (discussion)

Measurement Phase

- *A measurement scale of '1 data movement' is used and this 'read' on the measurement scale is the equivalent of the marks* (each mark being 1 data movement = 1 Cfsu).
- *The size is then figured out in terms of the number of marks – or units read on the scale.*
- Zero is meaningful, which means that software does not have a size, or size = 0.
- *Ratio Scale !*

Entropy Measurement

- Entropy is one concept in information theory.
- It was introduced by Shannon as a quantitative measurement of the uncertainty associated with random phenomena

Entropy based Functional Complexity

- *Functional complexity in a time slice is defined as an average amount of information in the corresponding sequence of events and is computed as follows:*

$$FC = -\sum_{i=1}^{n} (f_i / NE) \log_2 (f_i / NE)$$

where n *is the number of different event types in the sequence.*

Entropy based Functional Complexity (discussion)

- ***FC1***: *Calculating* f_i *for each event in the given scenario.*
- ***FC2:*** *Calculating* NE *for the given scenario.*
- ***FC3:*** *Calculating* f_i/NE *for each event in the scenario.*
- ***FC4***: *Calculating* $\log_2$ *of* ***FC3*** *for each event.*
- ***FC5***: *Multiplying* ***FC3*** *with* ***FC4.***
- ***FC6***: *Adding up* ***FC5*** *for all events.*
- ***FC7***: *Multiplying* ***FC6*** *with -1.*

Entropy based Functional Complexity (discussion)

- **FC1** is simply counting the frequency of the events' occurrences. *(Ratio)*
- **FC2** is adding the total number of events' occurrences in a scenario. *(Ratio)*
- **FC3** is a derived measure dividing **FC1** (Ratio scale) by **FC2** (Ratio scale). *(Ratio)*
- ***FC4*** *is applying the logarithmic function to* ***FC3****. The absolute value of the logarithmic function is exactly the number of binary digits (bits) required to represent the probability* n *of the event's occurrences.* *(Ratio)*

Entropy based Functional Complexity (discussion)

- ***FC5** is the total number of bits required for representing the probability of all occurrences of one event in the sequence. (Ratio)*

- In **FC6,** the representational size for the probability of all occurrences of all events is calculated. *(Ratio)*

- In **FC7**, the multiplication by –1 is required to obtain the non-negative value for the amount of information. It is a simple transformation that doesn't change the scale type since -1 does not have a unit itself. *(Ratio)*

- *Ratio Scale !*

Conclusions

- The “scale” concept is used in the COSMIC-FFP method to ensure meaningfulness of the numbers obtained from its measurement process.
- Entropy based functional complexity measure has no change of scale types through its steps.
- Even though some insights have been gained in the identification and analysis of the scale for the COSMIC-FFP measurement method, further analysis might be required to ensure that all metrology related issues in this measurement method have been adequately identified and analyzed.

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Thank You !

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