ADJUSTMENT COMPUTATIONS SPATIAL DATA ANALYSIS

CHARLES D. GHILANI, AND PAUL R. WOLF

FIRST PART CHAPTERS

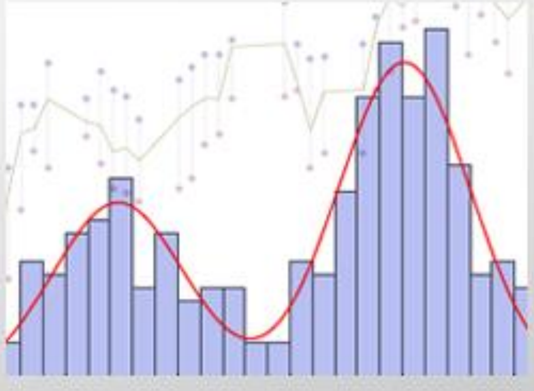
- 1- **INTRODUCTION (LECTURE 1)**
- **2- OBSERVATIONS AND THEIR ANALYSIS (LECTURE 2)**
- **3- RANDOM ERROR THEORY (LECTURE 3)**
- **4- CONFIDENCE INTERVALS (LECTURE 4)**
- **5- STATISTICAL TESTING (LECTURE 5)**

1- INTRODUCTION

- ONE OF THE MOST IMPORTANT ASPECTS IS TO ACCOUNT FOR THE FACT THAT NO *MEASUREMENTS* ARE *EXACT*. THAT IS, THEY ALWAYS CONTAIN *ERRORS*.
- THE FIELD SURVEYING, *TOTAL STATION* INSTRUMENTS, GLOBAL POSITIONING SYSTEM (*GPS*) EQUIPMENT, *DIGITAL METRIC CAMERAS*, AND *SATELLITE IMAGING* SYSTEMS ARE ONLY SOME OF THE NEW INSTRUMENTS THAT ARE NOW AVAILABLE FOR RAPID GENERATION OF VAST QUANTITIES OF MEASURED DATA.

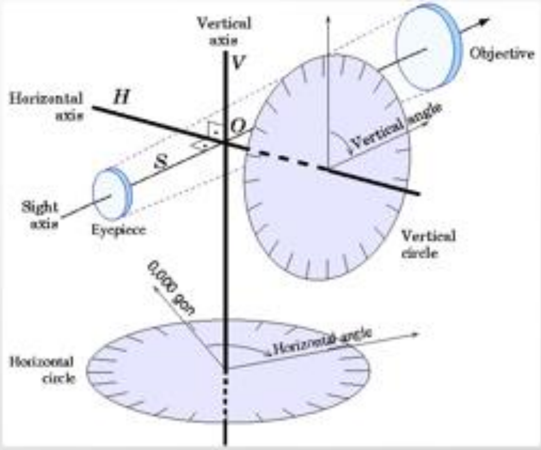
THE STEPS INVOLVED IN ACCOUNTING FOR THE EXISTENCE OF ERRORS IN MEASUREMENTS

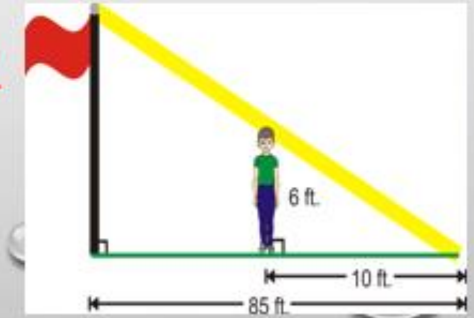
1. PERFORMING *STATISTICAL ANALYSES* OF THE OBSERVATIONS TO ASSESS THE *MAGNITUDES* OF THEIR ERRORS AND TO STUDY THEIR DISTRIBUTIONS TO DETERMINE WHETHER OR NOT THEY ARE WITHIN *ACCEPTABLE TOLERANCES*; AND IF THE OBSERVATIONS ARE *ACCEPTABLE*
2. *ADJUSTING* THEM SO THAT THEY CONFORM TO EXACT *GEOMETRIC CONDITIONS* OR OTHER REQUIRED *CONSTRAINTS*.

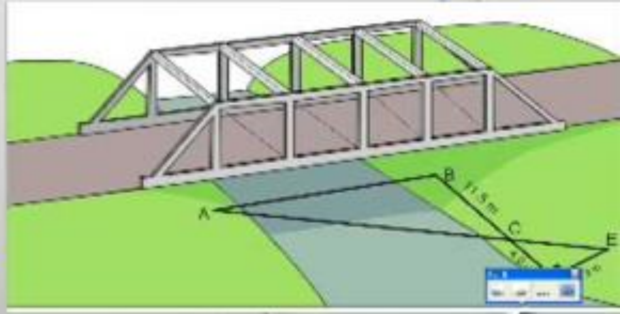


2- DIRECT AND INDIRECT MEASUREMENTS

1. *MEASUREMENTS* ARE DEFINED AS OBSERVATIONS MADE TO *DETERMINE* UNKNOWN *QUANTITIES*.
2. *DIRECT MEASUREMENTS ARE MADE BY APPLYING AN INSTRUMENT DIRECTLY TO THE UNKNOWN QUANTITY AND OBSERVING ITS VALUE, USUALLY BY READING IT DIRECTLY FROM GRADUATED SCALES ON THE DEVICE.*
3. *INDIRECT MEASUREMENTS* ARE OBTAINED WHEN IT IS NOT *POSSIBLE* OR *PRACTICAL* TO MAKE DIRECT MEASUREMENTS. IN SUCH CASES THE QUANTITY DESIRED IS DETERMINED FROM ITS *MATHEMATICAL RELATIONSHIP* TO *DIRECT MEASUREMENTS*.







3- MEASUREMENT ERROR SOURCES

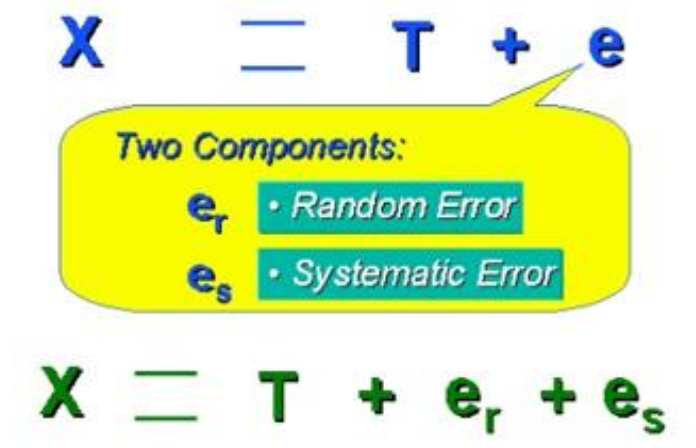
(1) *NO MEASUREMENT IS EXACT*

(2) *EVERY MEASUREMENT CONTAINS ERRORS*

(3) *THE TRUE VALUE OF A MEASUREMENT IS NEVER KNOWN*

(4) *THE EXACT SIZES OF THE ERRORS PRESENT ARE ALWAYS UNKNOWN*

- *DEFINITION*, AN *ERROR* IS THE DIFFERENCE BETWEEN A MEASURED VALUE FOR ANY *QUANTITY* AND ITS TRUE VALUE



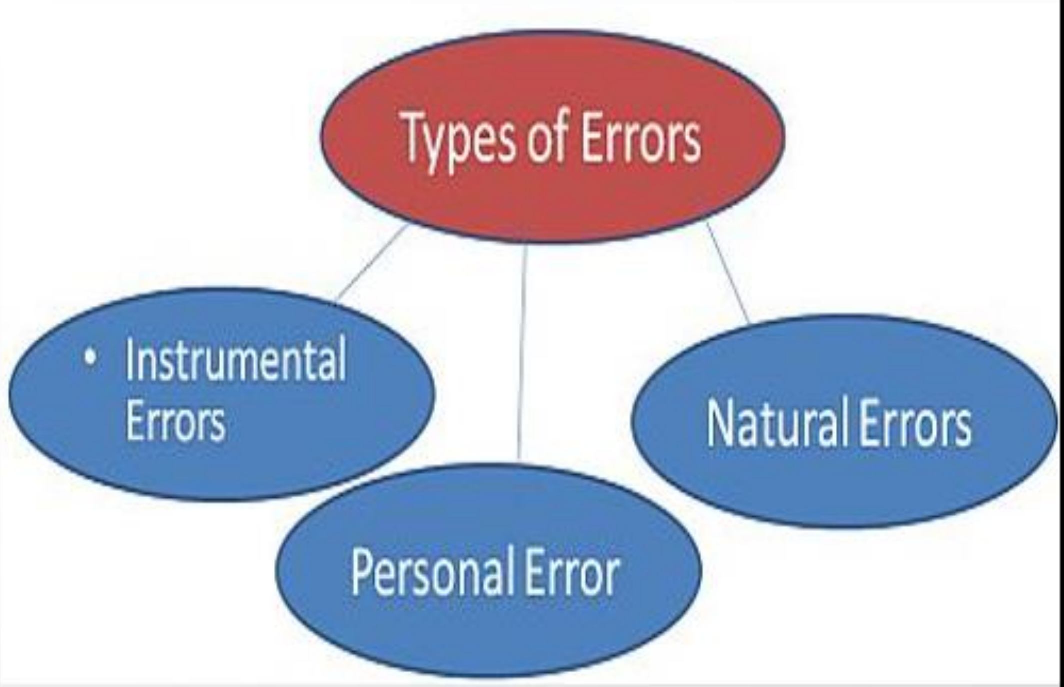
X=Observed Score

T=True Score

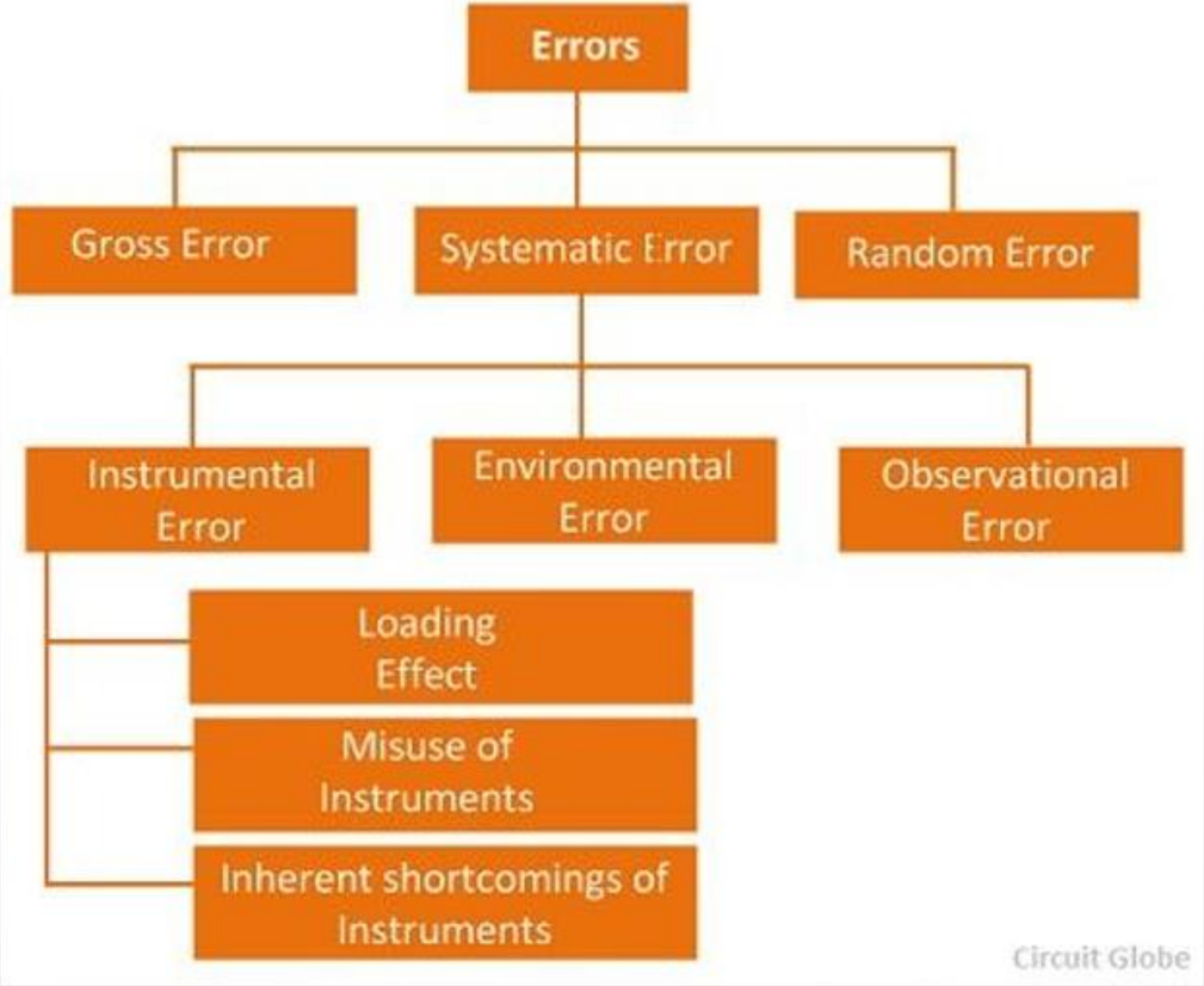
E=measurement error

ERRORS STEM FROM THREE SOURCES

1. *INSTRUMENTAL ERRORS.* *THESE ERRORS ARE CAUSED BY IMPERFECTIONS IN INSTRUMENT CONSTRUCTION OR ADJUSTMENT.*
2. *NATURAL ERRORS.* *THESE ERRORS ARE CAUSED BY CHANGING CONDITIONS IN THE SURROUNDING ENVIRONMENT, EX. ATMOSPHERIC PRESSURE, TEMPERATURE, WIND, GRAVITATIONAL FIELDS, AND MAGNETIC FIELDS*
3. *PERSONAL ERRORS.* *THESE ERRORS ARISE DUE TO LIMITATIONS IN HUMAN SENSES, SUCH AS THE ABILITY TO READ A MICROMETER OR TO CENTER A LEVEL BUBBLE.*



4- DEFINITIONS



4- **DEFINITIONS**

1. *MISTAKES.* THESE ARE CAUSED BY *CONFUSION* OR BY AN *OBSERVER'S CARELESSNESS*. THEY ARE NOT CLASSIFIED AS *ERRORS* AND MUST BE *REMOVED* FROM ANY SET OF OBSERVATIONS.

EX. MISTAKES IN READING GRADUATED SCALES, AND BLUNDERS IN RECORDING (I.E., WRITING DOWN 27.55 FOR 25.75). MISTAKES ARE ALSO KNOWN AS *BLUNDERS* OR *GROSS ERRORS*.

- Random Errors

  148.1 148.2 148.0 148.1 148.1

  148.1 148.2 147.9 149.3 148.2

  - Mean is 148.22 - should this value be used?
  - Exclude 149.3 and mean is 148.10
  - standard deviation is 0.10
  - value of 149.3 is 12 standard deviations from mean and should be excluded.

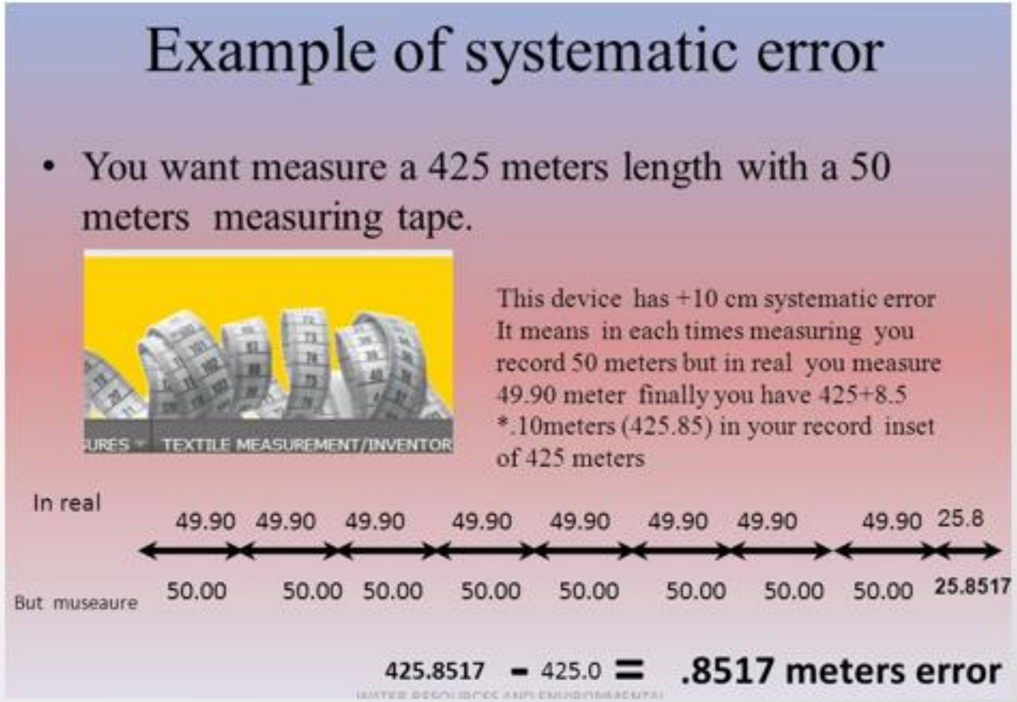
- Gross Errors should always be discarded

ERRORS STEM FROM THREE SOURCES

2-SYSTEMATIC ERRORS. THESE ERRORS FOLLOW SOME PHYSICAL LAW, AND THUS THESE ERRORS CAN BE PREDICTED.

CORRECTIONS FOR SYSTEMATIC ERRORS CAN BE COMPUTED AND APPLIED TO OBSERVATIONS TO *ELIMINATE* THEIR EFFECTS.

3-RANDOM ERRORS. *THESE ARE THE ERRORS THAT REMAIN AFTER ALL MISTAKES AND SYSTEMATIC ERRORS HAVE BEEN REMOVED FROM THE MEASURED VALUES. IN GENERAL, THEY ARE THE RESULT OF HUMAN AND INSTRUMENT IMPERFECTIONS. THEY ARE GENERALLY SMALL AND ARE AS LIKELY TO BE NEGATIVE AS POSITIVE.*



5- PRECISION VERSUS ACCURACY

1. DUE TO *ERRORS*, *REPEATED* OBSERVATION OF THE SAME QUANTITY WILL OFTEN YIELD DIFFERENT VALUES. A *DISCREPANCY* IS DEFINED AS THE *ALGEBRAIC DIFFERENCE* BETWEEN TWO OBSERVATIONS OF THE *SAME QUANTITY*.
2. *PRECISION* IS THE DEGREE OF *CONSISTENCY BETWEEN OBSERVATIONS* BASED ON THE SIZES OF THE *DISCREPANCIES* IN A DATA SET.
3. *ACCURACY* IS THE MEASURE OF THE ABSOLUTE *NEARNESS* OF A MEASURED QUANTITY TO ITS *TRUE VALUE*. SINCE THE TRUE VALUE OF A QUANTITY CAN *NEVER* BE *DETERMINED*, *ACCURACY* IS ALWAYS AN *UNKNOWN*.

SEE WEBSITE:
HTTPS://WWW.YOUTUBE.COM/WATCH?V=8CL5CEIT7HU