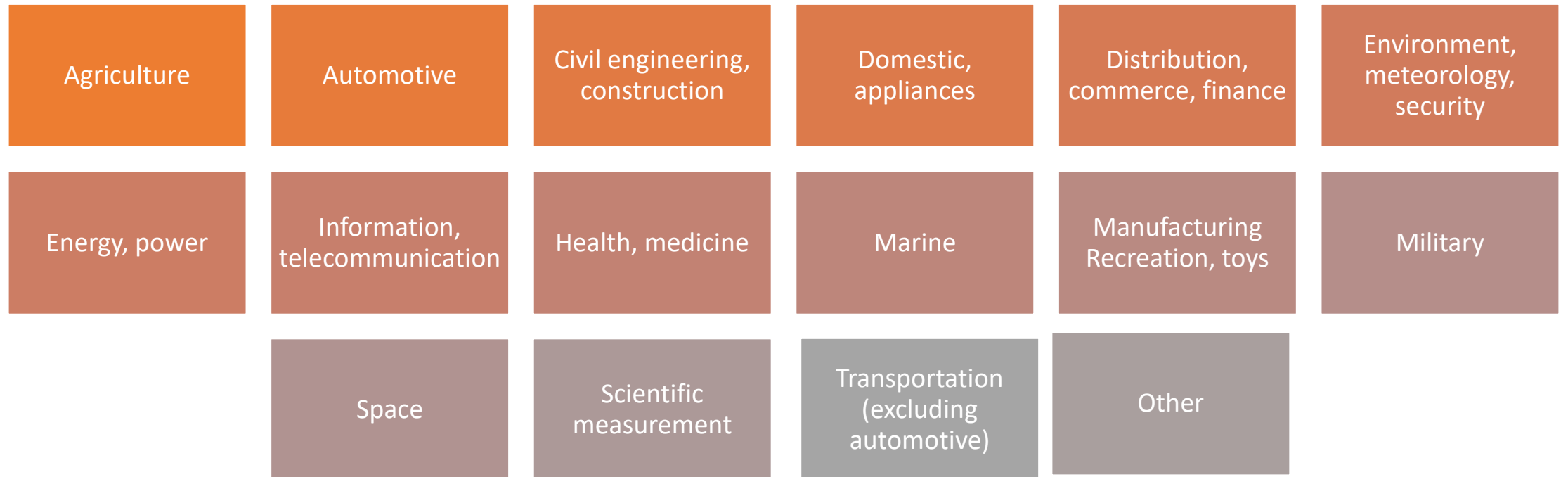


Outline

- Definitions
- **Sensor Classification**
- **Sensor Characteristics**
- **Sensor Working Principles**

Classification: Field of applications



Classification : Stimuli

Stimulus		Stimulus	
<i>Acoustic</i>		<i>Mechanical</i>	Position (linear, angular)
Wave amplitude, phase			Acceleration
Spectrum polarization			Force
Wave velocity			Stress, pressure
Other			Strain
<i>Biological</i>			Mass, density
Biomass (types, concentration states)			Moment, torque
Other			Speed of flow, rate of mass transport
<i>Chemical</i>			Shape, roughness, orientation
Components (identities, concentration, states)			Stiffness, compliance
Other			Viscosity
<i>Electric</i>			Crystallinity, structural integrity
Charge, current			Other
Potential, voltage			
Electric field (amplitude, phase, polarization, spectrum)		<i>Radiation</i>	Type
Conductivity			Energy
Permittivity			Intensity
Other			Other
<i>Magnetic</i>			
Magnetic field (amplitude, phase, polarization, spectrum)		<i>Thermal</i>	Temperature
Magnetic flux			Flux
Permeability			Specific heat
Other			Thermal conductivity
<i>Optical</i>			Other
Wave amplitude, phase, polarization, spectrum			
Wave velocity			
Refractive index			
Emissivity, reflectivity, absorption			
<i>Other</i>			

Handbook of Modern Sensors; Physics, Designs,
and Applications
Fifth Edition – Jacob Fraden

Classification : Sensing element material



Inorganic/Organic



Conductor /Insulator



Semiconductor



Liquid gas or plasma



Biological substance



Other....

Sensor Characteristics

Sensor specifications

- Sensitivity
- Stimulus range (span)
- Stability (short and long term)
- Resolution
- Accuracy
- Selectivity
- Speed of response
- Environmental conditions
- Overload characteristics
- Linearity
- Hysteresis
- Dead band
- Operating life
- Output format
- Cost, size, weight Other

<https://www.signaguard.com/case-studies-in-bridge-health-monitoring/>

Range and Span

- **Range**

Minimum and Maximum value of a physical quantity that a sensor can measure
Example: A Resistance Temperature Detector (RTD) for the measurement of temperature has a range of -200 to 800°C

- **Span**

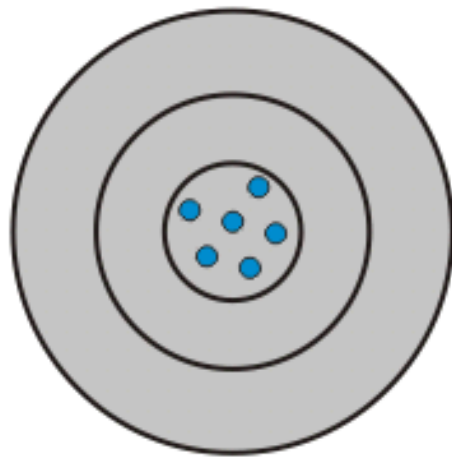
Difference between maximum and minimum values of input measured
In the above example, span of RTD = $800 - (-200) = 1000^{\circ}\text{C}$

Accuracy and Resolution

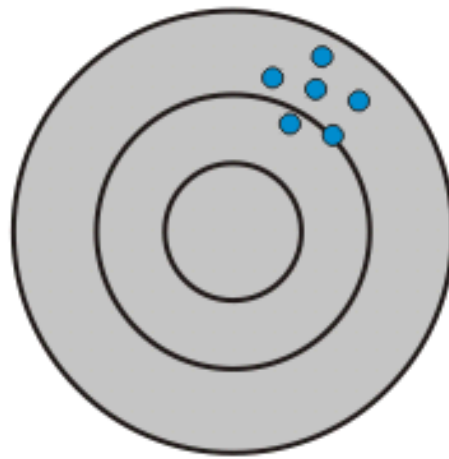
- **Accuracy** is the capacity of a sensor to give results close to the **TRUE VALUE** of the measured quantity
 - Measured by absolute and relative errors
 - $\text{ABSOLUTE ERROR} = \text{RESULT} - \text{TRUE VALUE}$ (measured value to a known absolute true value)
 - $\text{RELATIVE ERROR} = \text{ABSOLUTE ERROR} / \text{TRUE VALUE}$ (how close is the value to a standard value in relative terms)
- **Resolution** is the minimal change of the input necessary to produce a detectable change at the output

Precision

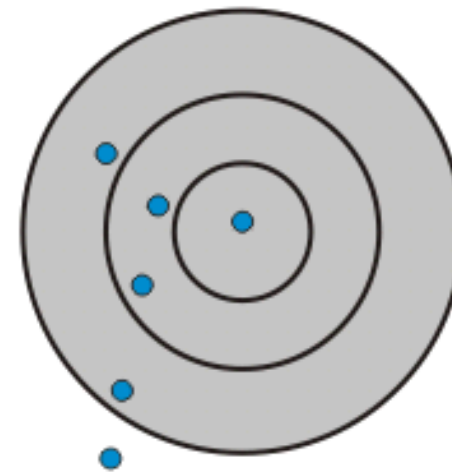
- Capacity of a sensor to give same reading when repetitively measuring the same quantity under the same prescribed conditions



High Accuracy
High Precision



Low Accuracy
High Precision



Low Accuracy
Low Precision

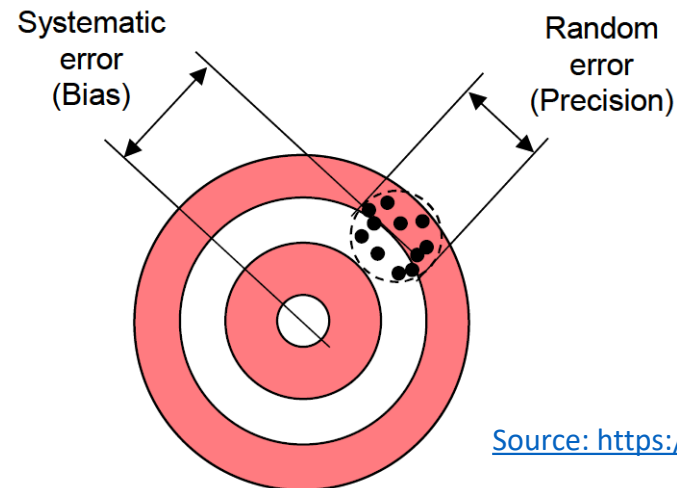
Errors

- **Systematic Errors**

Due to interfering or modifying variables (e.g., temperature), loading, attenuation, etc.

- **Random Errors**

A signal that carries no information such as environmental noise



Source: <https://www.philadelphia.edu.jo/academics/kaubaidy/uploads/Sensor-Lect2.pdf>