1. INTRODUCTION

1.1. Noise and fluctuations in nature

What is noise?

- Well known: acoustic, electronic systems
- Noise known as limiting factor of measurements
- type: random, deterministic
- fluctuations can be found everywhere:
  - physical systems
  - biological systems
  - telecommunications, etc.

1.2. Random noise in physical systems

What is random?

Future state is unknown, but why?

- the rules and initial state are unknown
- too much and/or complex equations, quantities, but causality is valid

  (Laplace:"Give me all the equations...")
- chaotic systems: very sensitive points
- nature can be really random (?)

Examples:

- Simple problem: game of hazard/chance (dice throwing)
- Thermodynamics (T, p, S, etc.)

- Quantuum mechanics:
  - uncertainity relation: $\Delta x \Delta p > h/2\pi$
  - $\psi(x)$ wave funtion expresses probability only (even if the Schrödinger eq. is deterministic)
  - there are no hidden parameters (Einstein:"God do not throw a dice")

1.3. What to do with noise?

- Try to remove or minimize? Could be important.
- Try to use as an information source!

Anyway: *learn as much as possible about noise*

1.4. Sources of noise in a system

- External and/or internal
- Noise is information source

Examples:

- Noise as info: boiling water, motor of a car

Scientific way:

- Noise in a system: information
- Noise itself is a physical quantity (T, P, etc.) => natural information source
- Monitoring atomic reactors (n flux)
- Non-destructive reliability tests of electronic components
- Biological systems: heart rate fluctuations

as indicators of diseases

- Social processes, economy, traffic, level of rivres, etc. ?