Variability and Performances

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The Fast Bank Game

Maximise the output

Minimise the WIP (Qs)

Muda Mura Muri

Lean is mostly known for the wastes hunting (Muda), but the concepts of Mura (Variability) and Muri (overload) are equally important

Let's clarify the 3 categories considering the transport of 12000 kg of material through a pickup truck that can move 5000 Kg: how is it possible?

- 4 trips of 3000 kg — MUDA
- 2 trips of 6000 kg — MURI
- 2 trips of 5000 kg + 1trip of 2000 kg — MURA

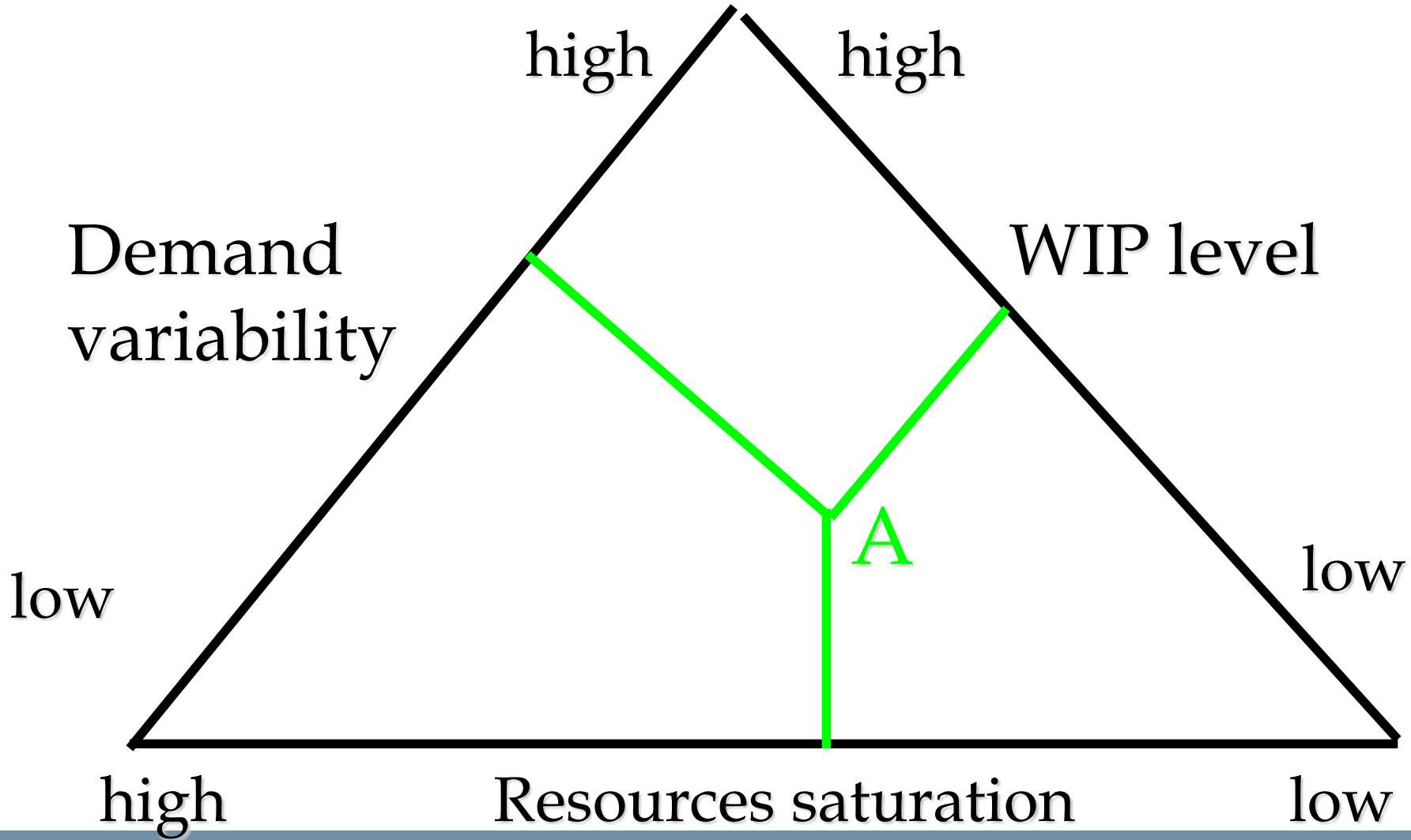
Muda Mura Muri

MURI problem is clear

Less clear is MURA: what are the problems?

- Inefficiencies
- Queues/stocks

Trade off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Demand variability
WIP level
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Resources saturation
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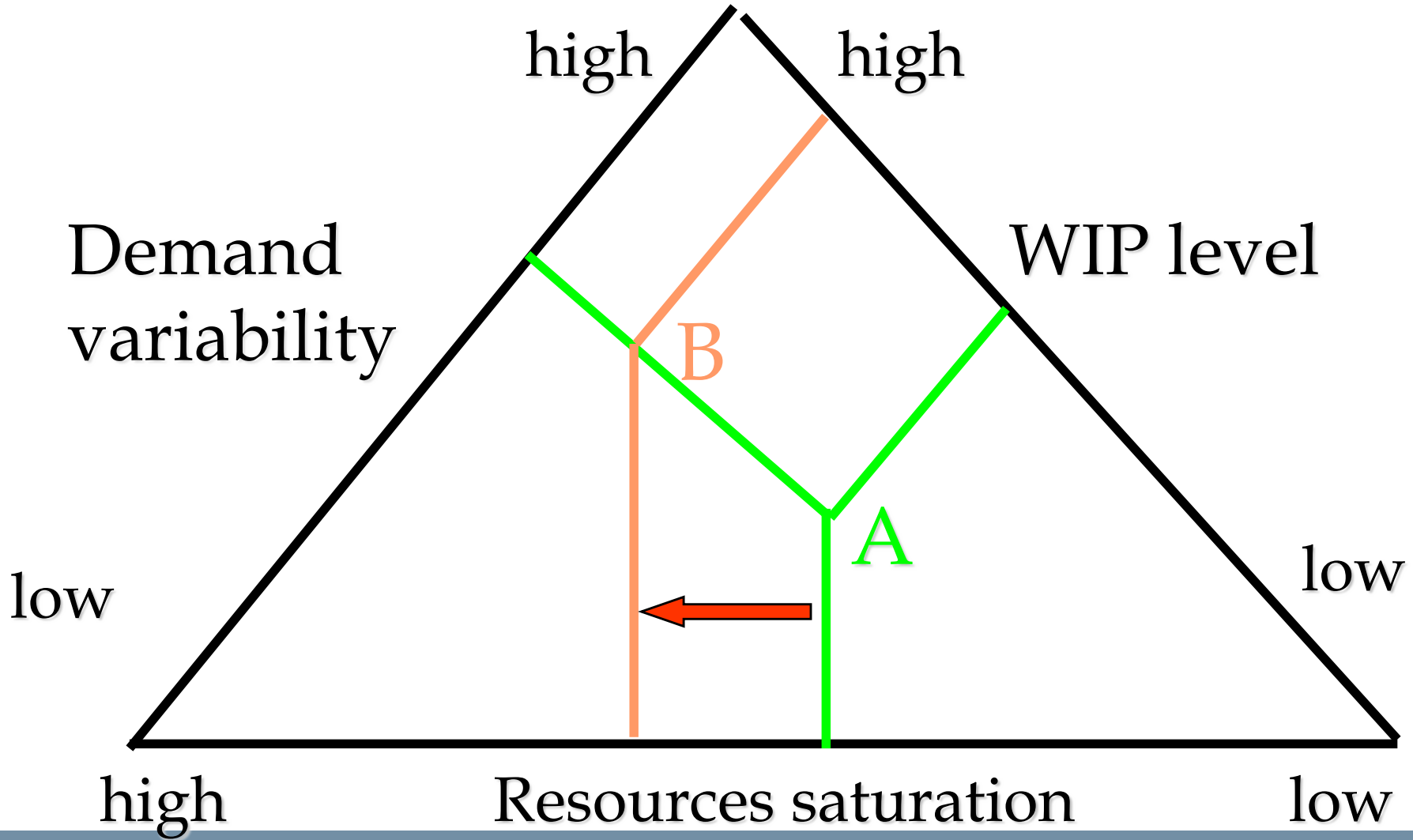
Trade off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Resources saturation
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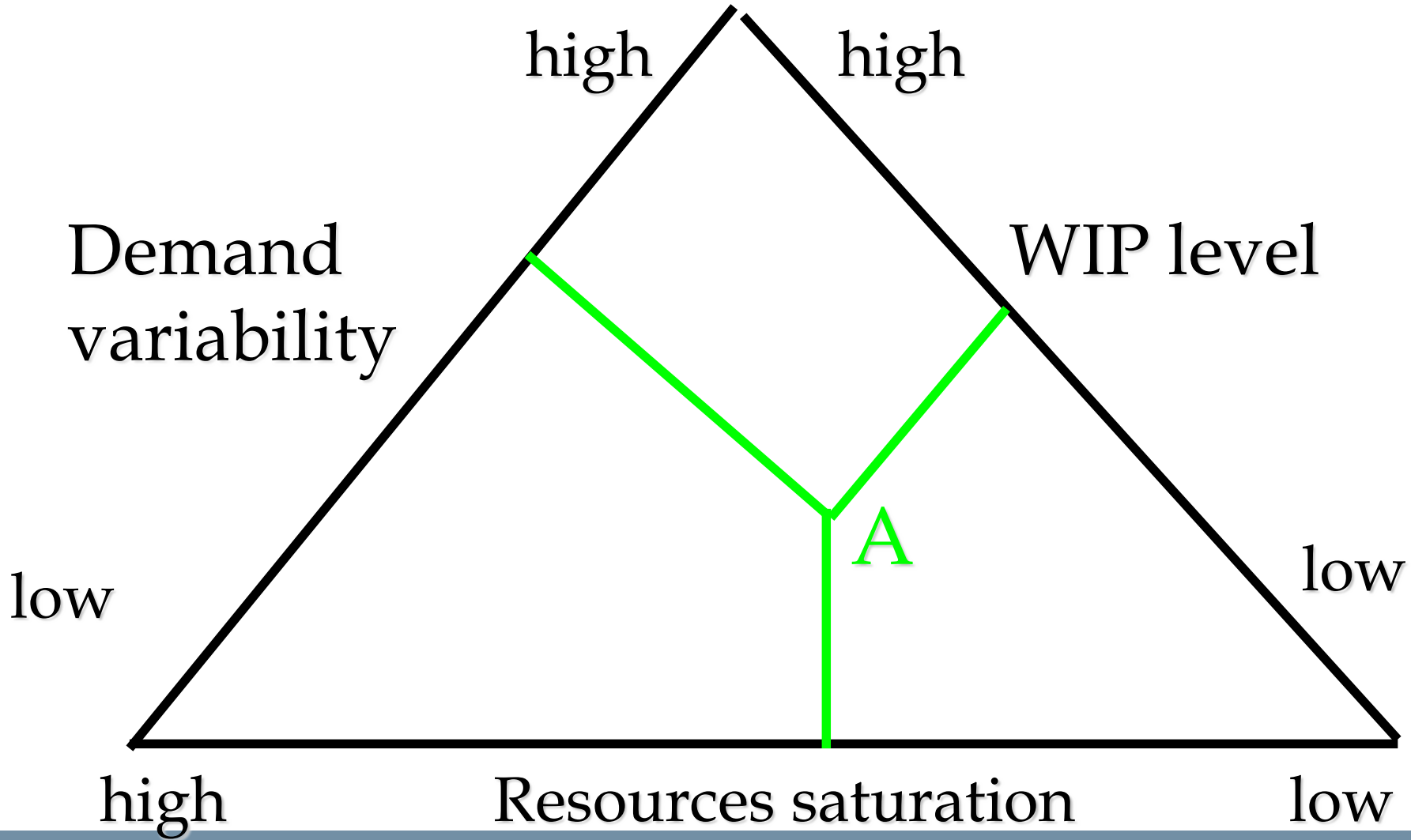
Trade off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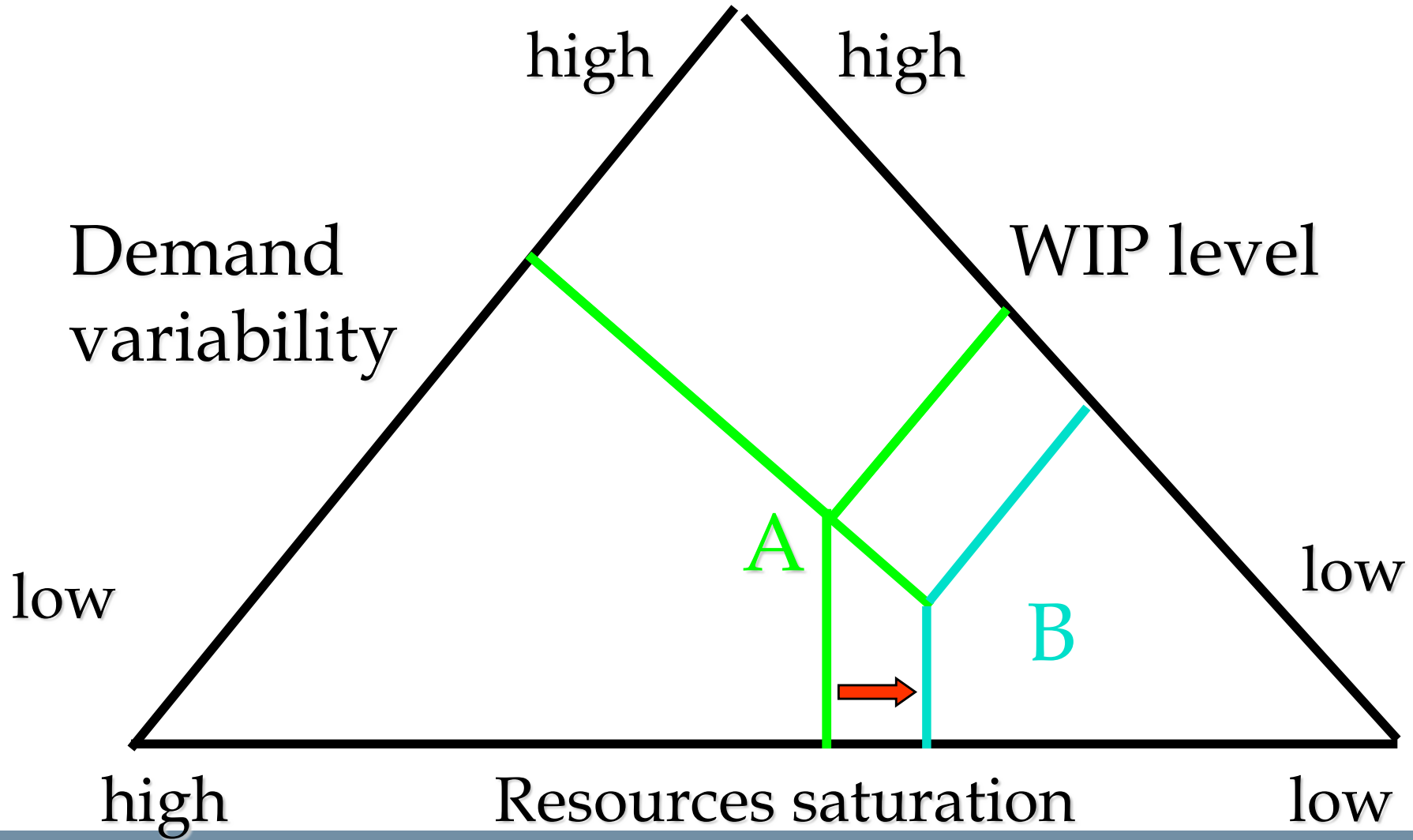
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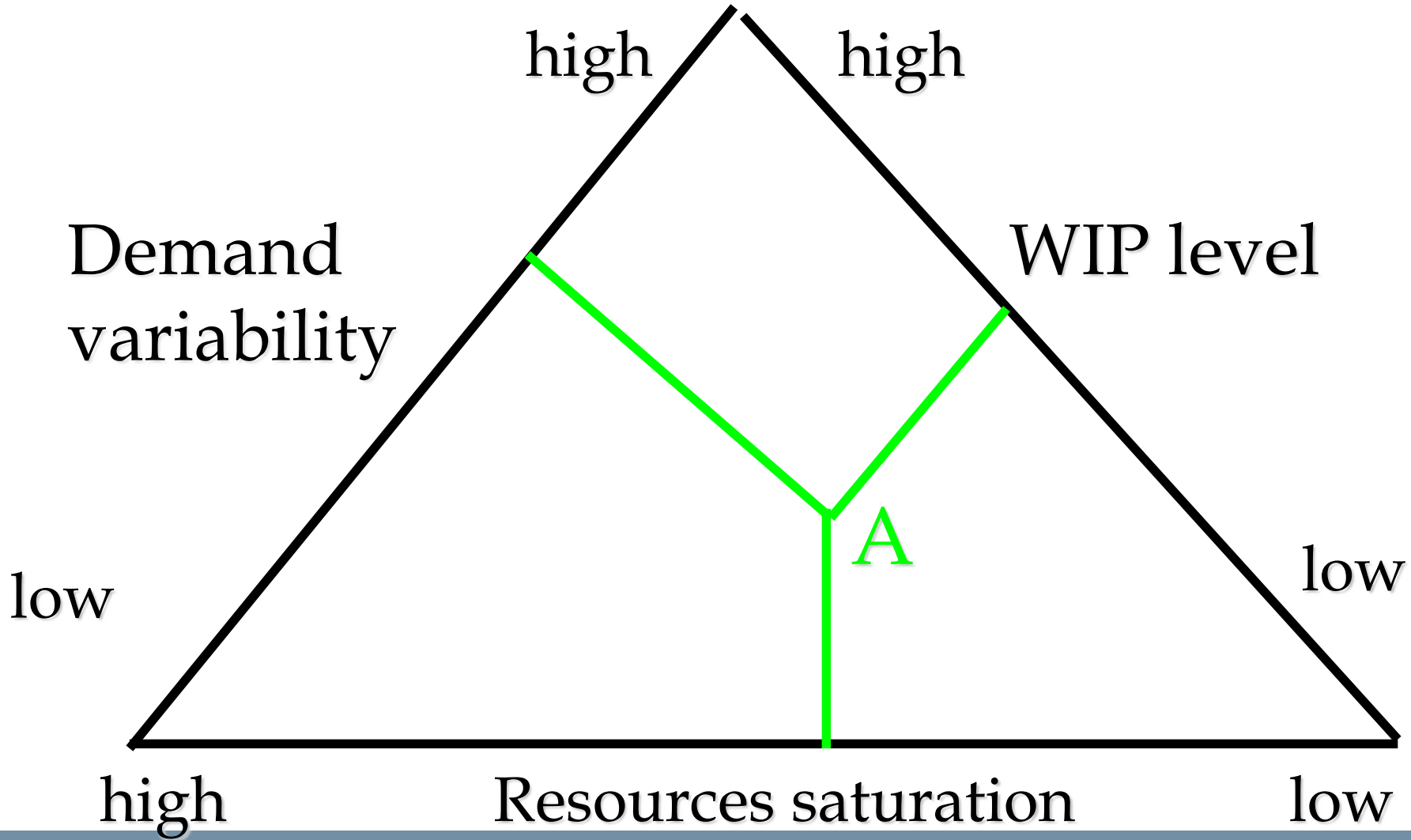
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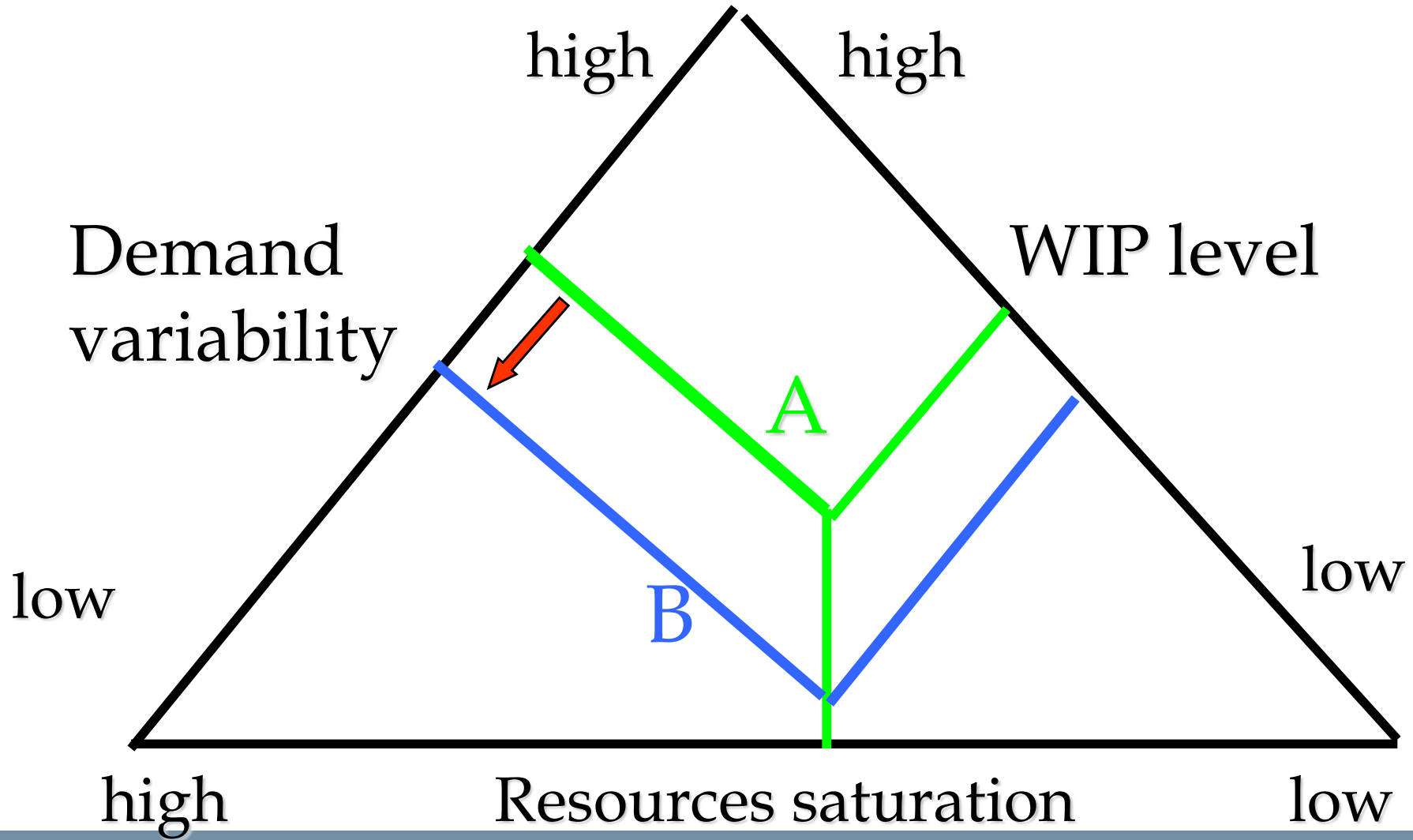
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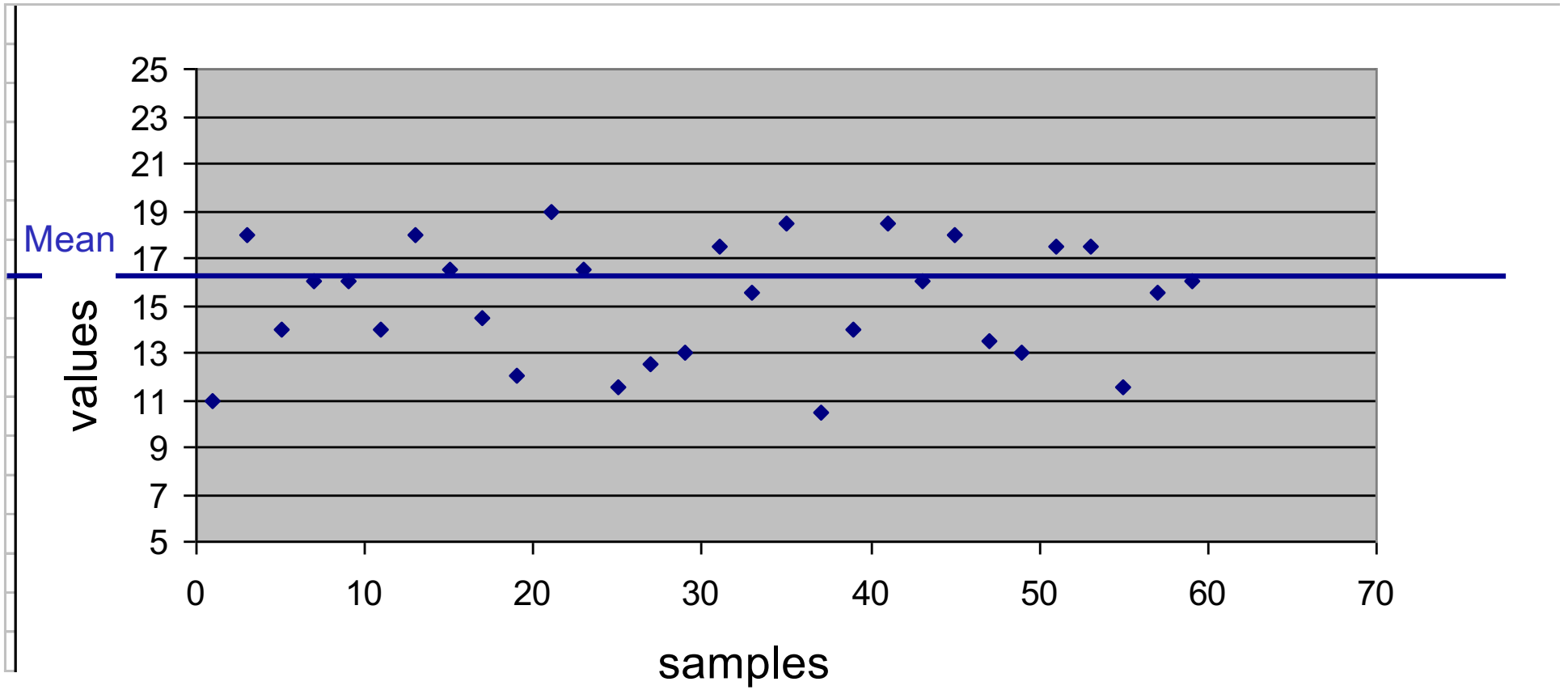
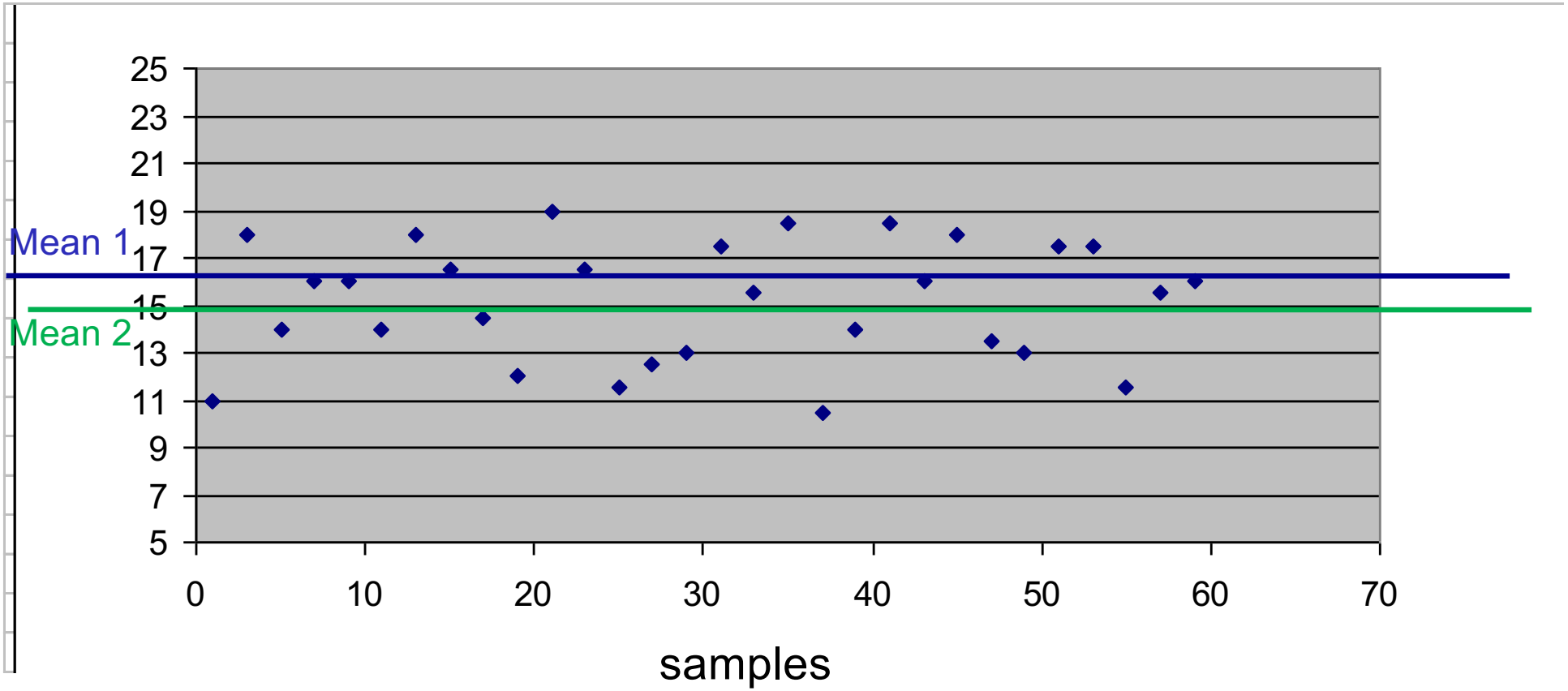
How to evaluate performance



How to evaluate performance

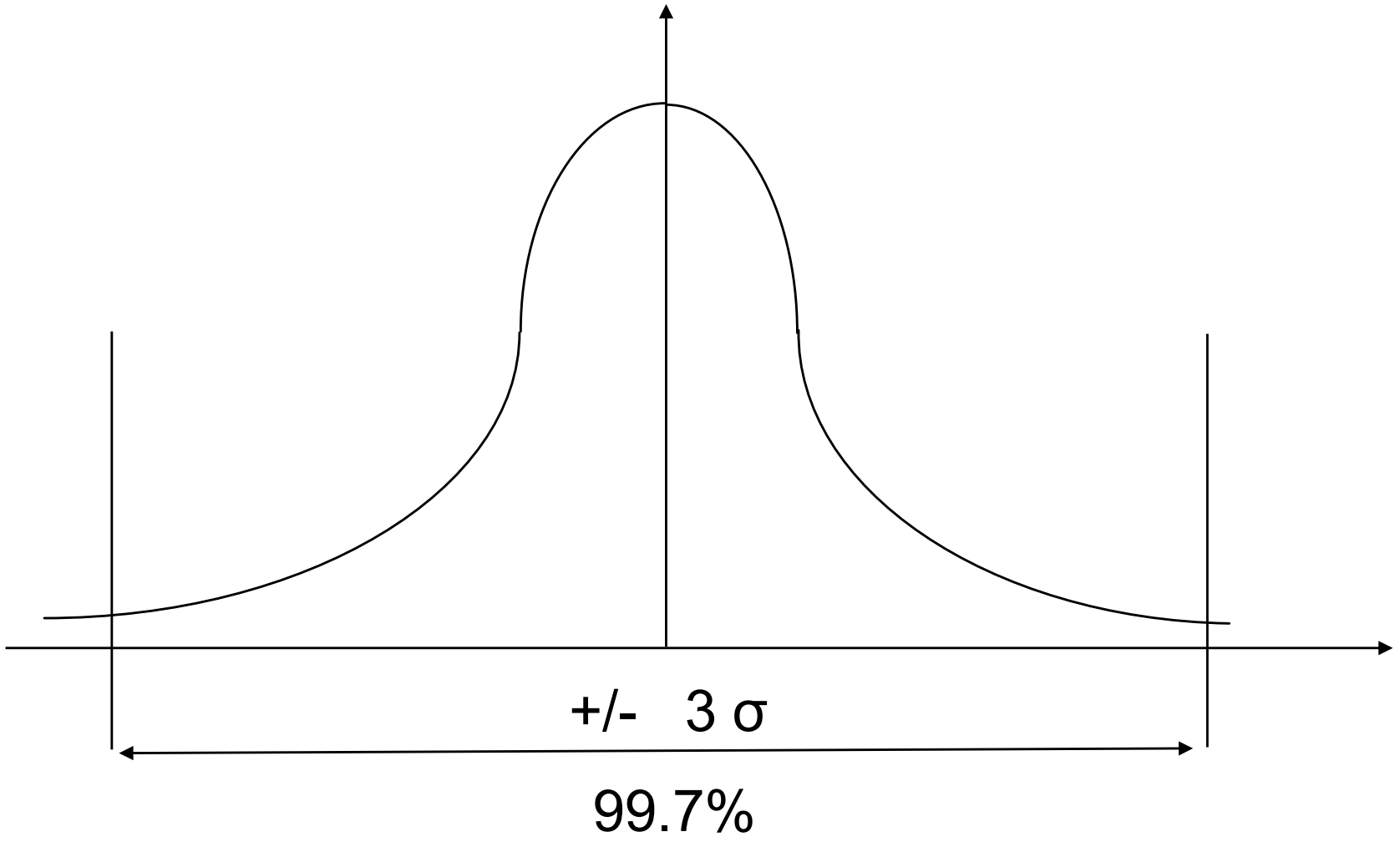


Complex systems have to be analysed in a systemic way

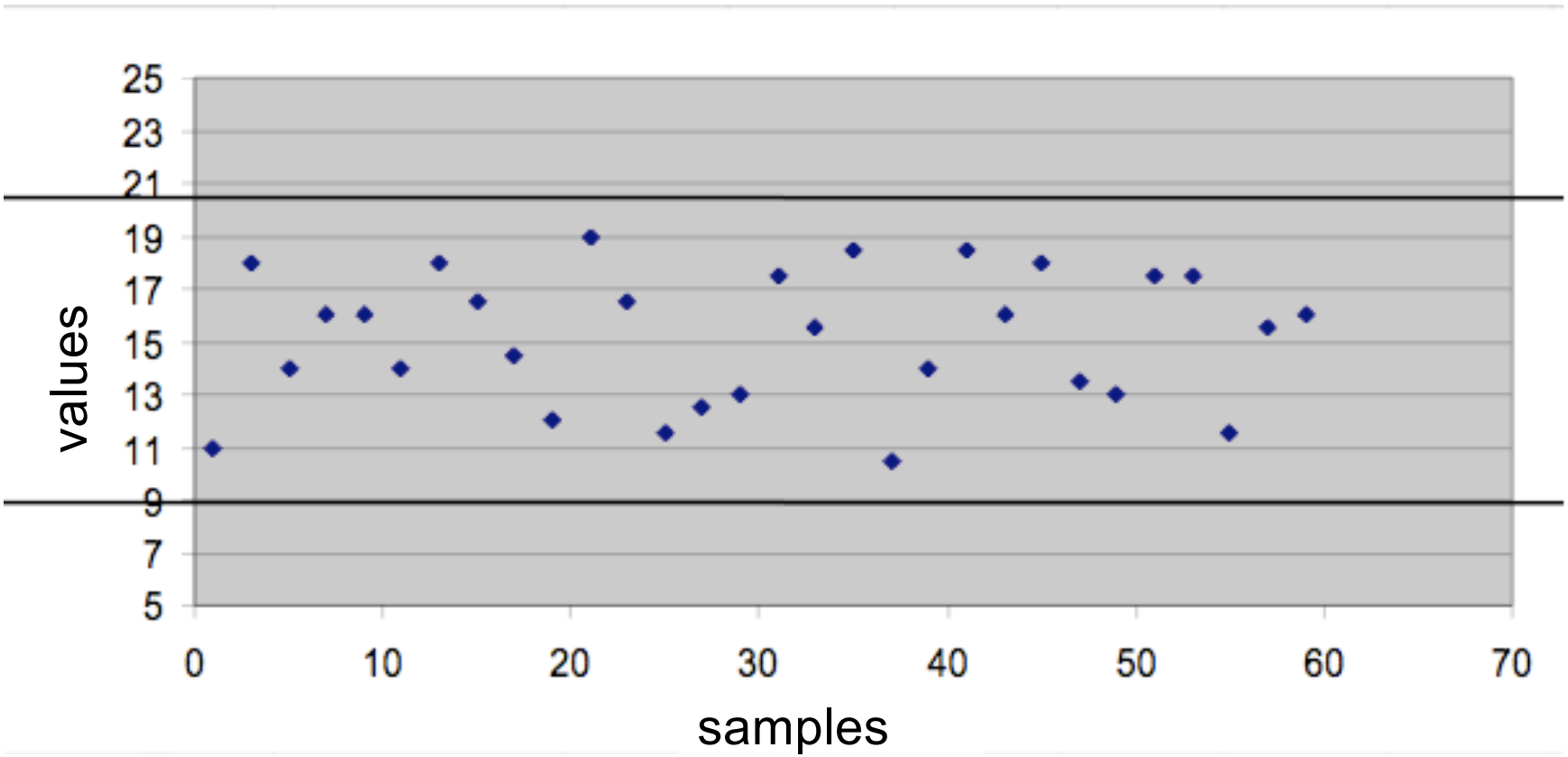
- All systems have an output variability (especially in services)
- Variability is not all the same:
  - ✓ Special causes: special events that influence the behavior of the system
  - ✓ Make the system unstable
    - – They are good occasions to identify waste and opportunities for improvement
    - – May be the responsibility of the operators
  - ✓ Common Causes: random events that are part of the normal operation of the system
    - – They are the responsibility of management
    - – The operating personnel must not set up measures to compensate them (it would only increase the variability)
    - – They cover the behaviour of the system (and therefore make it difficult to improve it)

How to recognize one from the other?

Statistical control



Limits of natural variability: +/- 3 σ

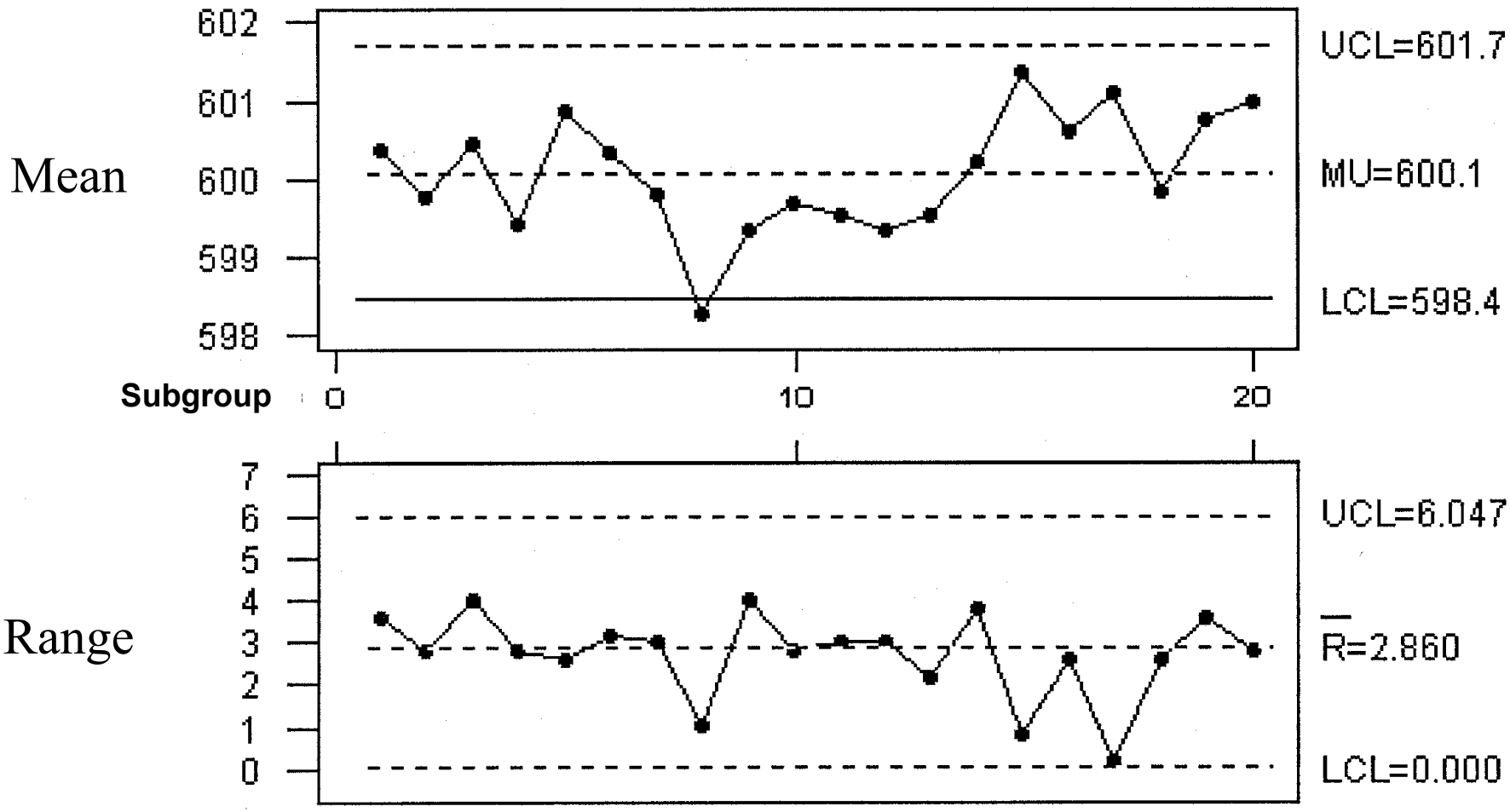


Sampling

If you take samples from a population:

- The sample mean is a proper estimator of the population mean
- The distribution of the averages of the samples tends to a normal distribution
- The variance of the averages of the samples is equal to the population variance divided by the sample size
- The variance of the sample can be used to obtain more information

Control charts



Indications

If there are points outside the limits the system is not in control. It is not stable

If an item is outside the limits there are less than 0.15% chance that it is a random effect -> worth investigating

Although the system is not in control, you can identify the limits and they show the points out of control.

Samples (e.g. n. 5)

$$\overline{X}_1 = (x_1+x_2+x_3+x_4+x_5)/5$$

$$\overline{X}_2 = (x_6+x_7+x_8+x_9+x_{10})/5$$

$$\overline{X}_3 = (x_{11}+x_{12}+x_{13}+x_{14}+x_{15})/5$$

…. Etc.

Control limits

X bar chart

$$UCLx = \overline{\overline{X}} + A_2 * \overline{R}$$

$$LCLx = \overline{\overline{X}} - A_2 * \overline{R}$$

$$UCLr = D_4 * \overline{R}$$

$$LCLr = D_3 * \overline{R}$$

Factors for computing Control Chart Limits

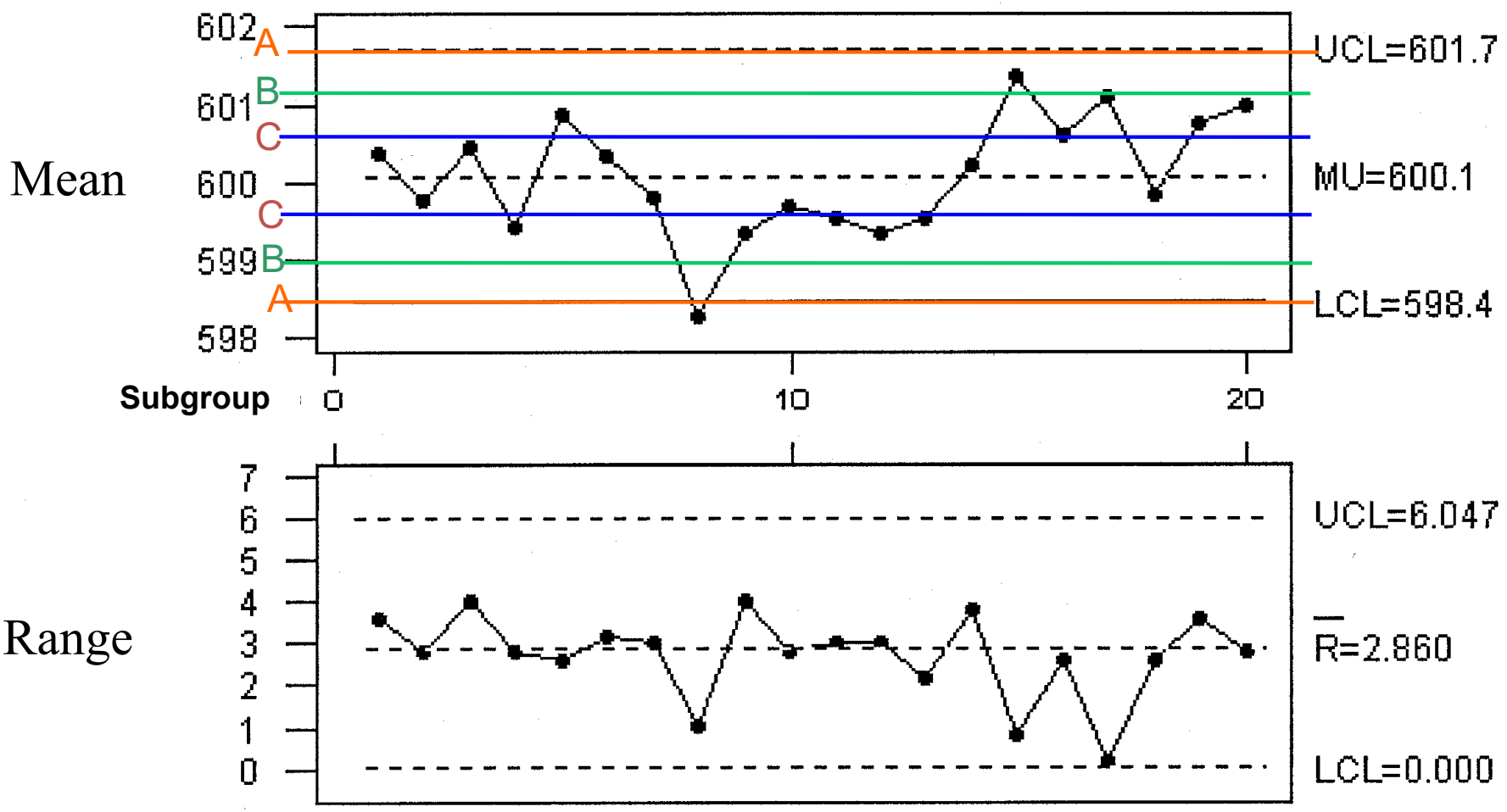
Sample size	Mean factor A2	Upper Range D4	Lowe Range D3
2	1.880	3.268	0
3	1.023	2.574	0
4	0.729	2.282	0
5	0.577	2.114	0
6	0.483	2.004	0
7	0.419	1.924	0.076
8	0.373	1.864	0.136
9	0.337	1.816	0.184
10	0.308	1.777	0.223

Outside the limits

X outside the limits are evidence of a general change affecting the sistem

R outside the limits are evidence that the uniformity of the process has changed. Typical causes are change in personnel, increased variability of material, attempts to compensate natural variability

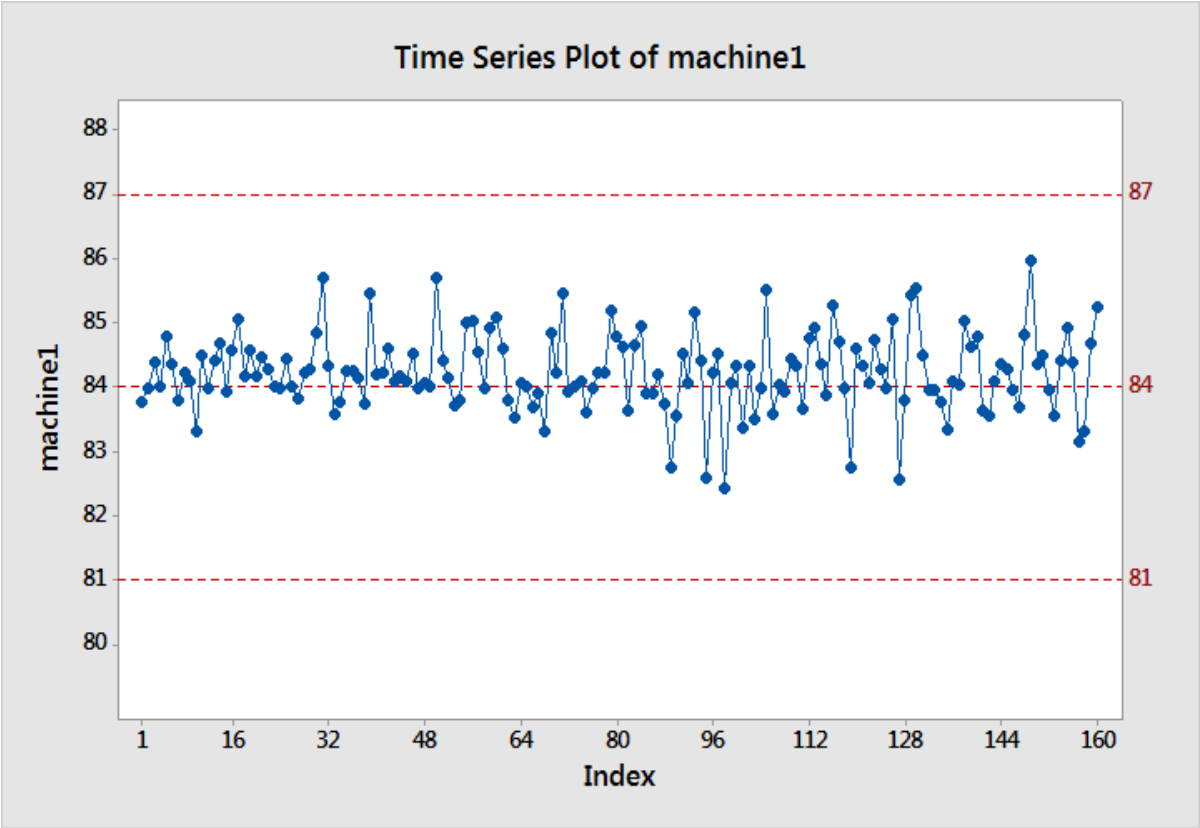
Processes in statistical control



Processes in statistical control

1. 9 point in a row in zone C or beyond (all above or below central line)
2. 6 points in a row steadely increasing or decreasing
3. 14 point in a row alternating up and down
4. 2 out of 3 points in a row in zone A or beyond
5. 4 out of 5 points in a row in zone B or beyond
6. 15 points in a row in zone C (above and below central line)
7. 8 points in a row not folling in zone C (all are in zone B or A on both side of central line)

In general look for patterns


Time Series Plot of machine1
machine1
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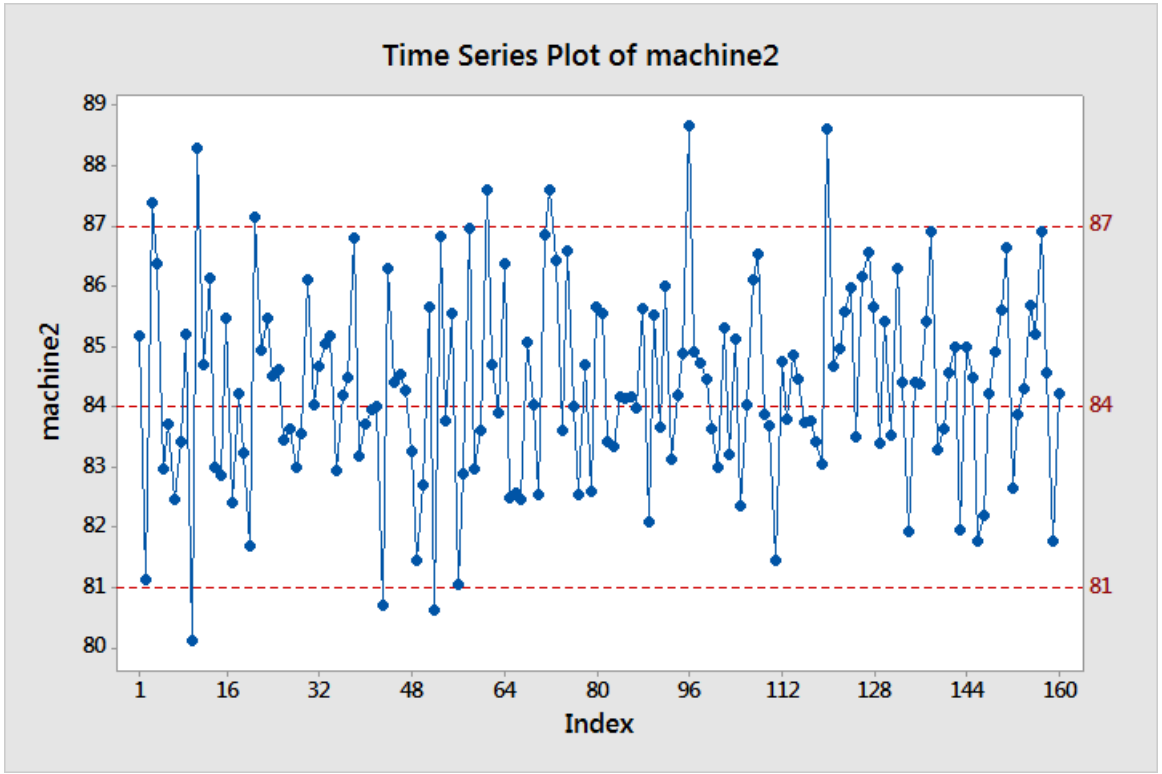
Time Series Plot of machine2
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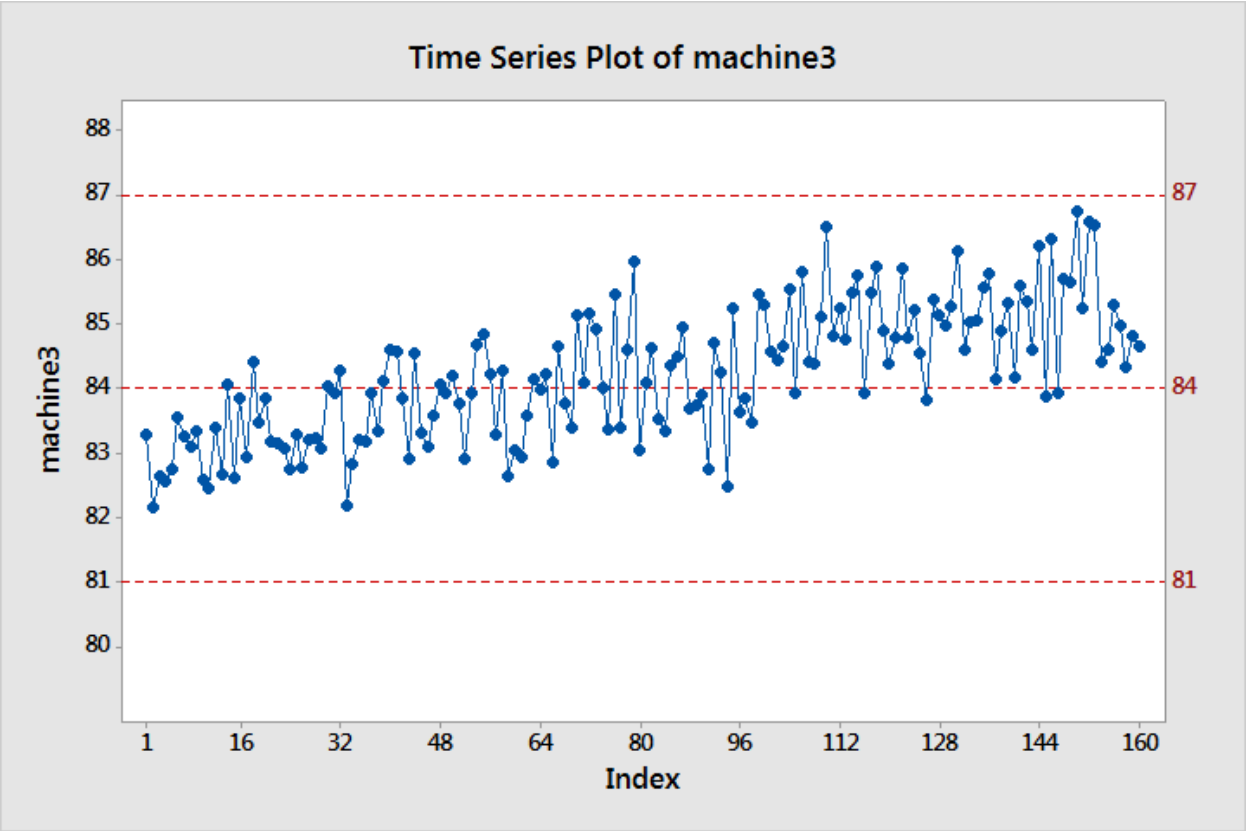
Time Series Plot of machine3
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Variability

- A process with lower variability allows better forecasts on its performance (it is more predictable)

- A process with lower variability makes easier to understand the problems

- A process with lower variability is easier to understand and to manage

Responsability

- If a system is in control, the responsibility for the improvement lies with the management (as well as the responsibility for the quality in output)

- If the system is in control it does not make sense to give improvement targets to the operators, if they can not act on the method/process/procedures

- If operators have improvement objectives, without being able to act on the method: they either play with the numbers, or they try to intervene and compensate for the variability, causing an increase of it.

Responsability

95% of the errors depend on the system, only 5% is caused by the operators

95% of managers' attention is towards operators (and their management), and only 5% to the management of the system

People management, work management, system management

Managers usually manage workload, sometime people, but rarely manage the system.

Examples

Schedule shifts agaist demand in a call center

Allocate operating rooms to different specilities in accordance with the waiting lists

Manage the work (system), not the worker

Focus on measures rather than methods is a primary source of stress

Make the end-to-end performance visible to the operators and give them the chance to change the system

Measurement systems

- Measures should help in understanding and in improving performances
- Measures should relate to purpose
- Measures must be integrated with work

Manage the system: customer demand

Service systems are designed to respond to demand, nonetheless, when managers manage service systems are most worried about resource planning and efficiency, and disregard demand analysis and management

Failure demand is the demand generated by the failure to do something or do something right for the customer

Managers do not focus on understanding Demand characteristics

Demand characteristics

Type: what are the reasons the customer is calling, from her point of view (opportunity to understand which process has failed)

Frequency: runners, repeaters, strangers

Pareto analysis to prioritise

Find the root causes and eliminate them

Manage variations

In a service systems variations have to be managed at the front office

The higher the variability, the higher the competences and authonomy of the front office

A command and control system is highly inefficient (an often ineffective) in managing service variations

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