Energy-Aware Computing Systems (EASY)

Energy Models

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Energy Models

- Function: $X \mapsto E$
- Motivation:
  - Measurement simplification
  - Generalisation (interpolation, extrapolation)
  - Prediction
  - Dependency identification
  - Optimisation
  - ...

Precision and Accuracy („Genauigkeit”)

precise but not accurate

accurate but not precise

Precision and Accuracy („Genauigkeit") (ISO 5725)

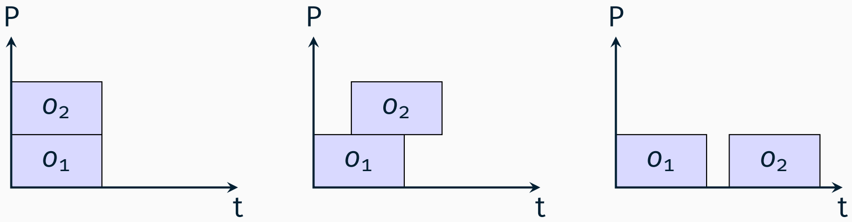
poor trueness

poor precision

Linearity

- Executing operations o_1 and o_2:

$$E(o_1; o_2) = E(o_1) + E(o_2)$$



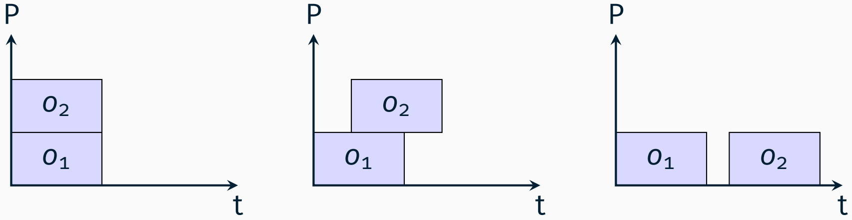
Linearity

- Executing operations o_1 and o_2:

$$E\left(o_1; o_2\right) = E\left(o_1\right) + E\left(o_2\right)$$

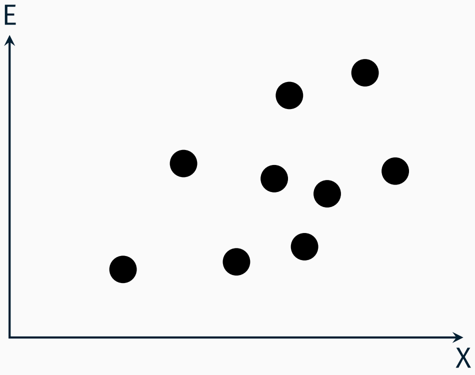
- Generalisation:

$$E\left(\vec{o}\right) = E\left(o_1\right) + E\left(o_2\right) + \ldots = n_A E\left(o_A\right) + n_B E\left(o_B\right) + \ldots$$



Error minimisation

- Model: parameterised function
- Optimisation problem:
  - Find function parameters that minimise an error metric



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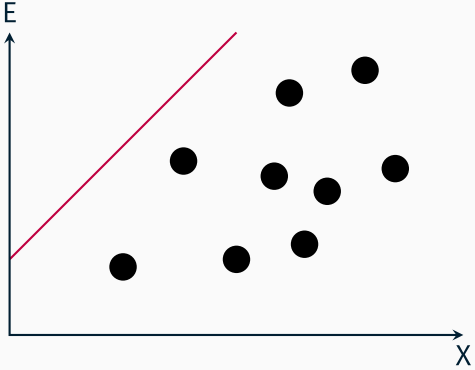

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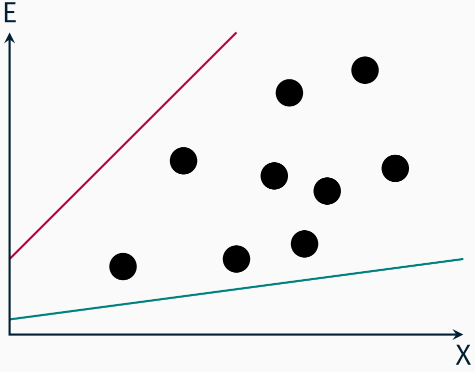

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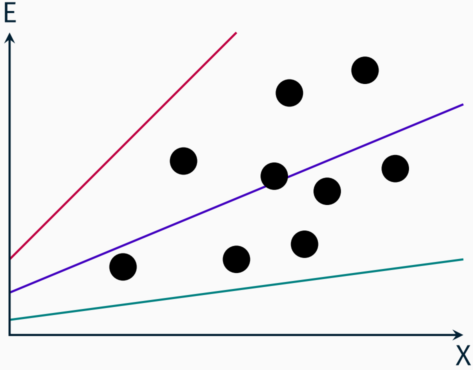

- Given: Measurements $\langle x_i, y_i \rangle$
- Goal: create a model $\forall i : y_i \approx \alpha x_i + \beta$
- Task: find best values for α and β (least-squares)

...

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  ...

$$\alpha = \frac{\sum_{i=1}^{n} (x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n} (x_i - \bar{x})^2}$$

$$\beta = \bar{y} - \alpha \bar{x}$$

- ... where ...

$$\bar{x} = \frac{1}{n} \sum_{i=1}^{n} x_i$$

$$\bar{y} = \frac{1}{n} \sum_{i=1}^{n} y_i$$

- Given: Measurements $\langle x_{A,i}, x_{B,i}, \ldots, y_i \rangle$
- Model: $\forall i : y_i \approx \mu_A x_{A,i} + \mu_B x_{B,i} + \ldots$

  ...

- Given: Measurements $\langle x_{A,i}, x_{B,i}, ..., y_i \rangle$
- Model: $\forall i : y_i \approx \mu_A x_{A,i} + \mu_B x_{B,i} + ...$

  ...
- Solve $X\vec{\mu} \approx \vec{y}$ for $\vec{\mu} = \langle \mu_A, \mu_B, ... \rangle$

  ...

- Given: Measurements $\langle x_{A,i}, x_{B,i}, ..., y_i \rangle$
- Model: $\forall i : y_i \approx \mu_A x_{A,i} + \mu_B x_{B,i} + ...$

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- Solve $X\vec{\mu} \approx \vec{y}$ for $\vec{\mu} = \langle \mu_A, \mu_B, ... \rangle$

  ...
- Solve $X^\top X\vec{\mu} = X^\top \vec{y}$ for $\vec{\mu}$ (least-squares)