Welcome to S2.

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Statistics

works with data

Probability

forward modelling. (uncertain)

Inference.

inverse problem.

θ any params of our model

x (random) data seen in experiment.

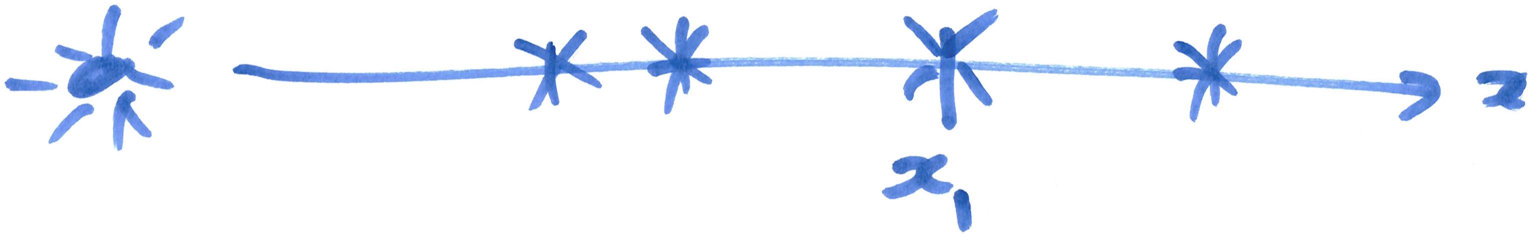
likelihood $P(x \mid \theta)$ prob. of data.

(forward modelling, probabilistic, depends on θ).

alt. notation $L(\theta)$ likelihood <u>function</u>

<u>example</u> :

distance (from) detector.



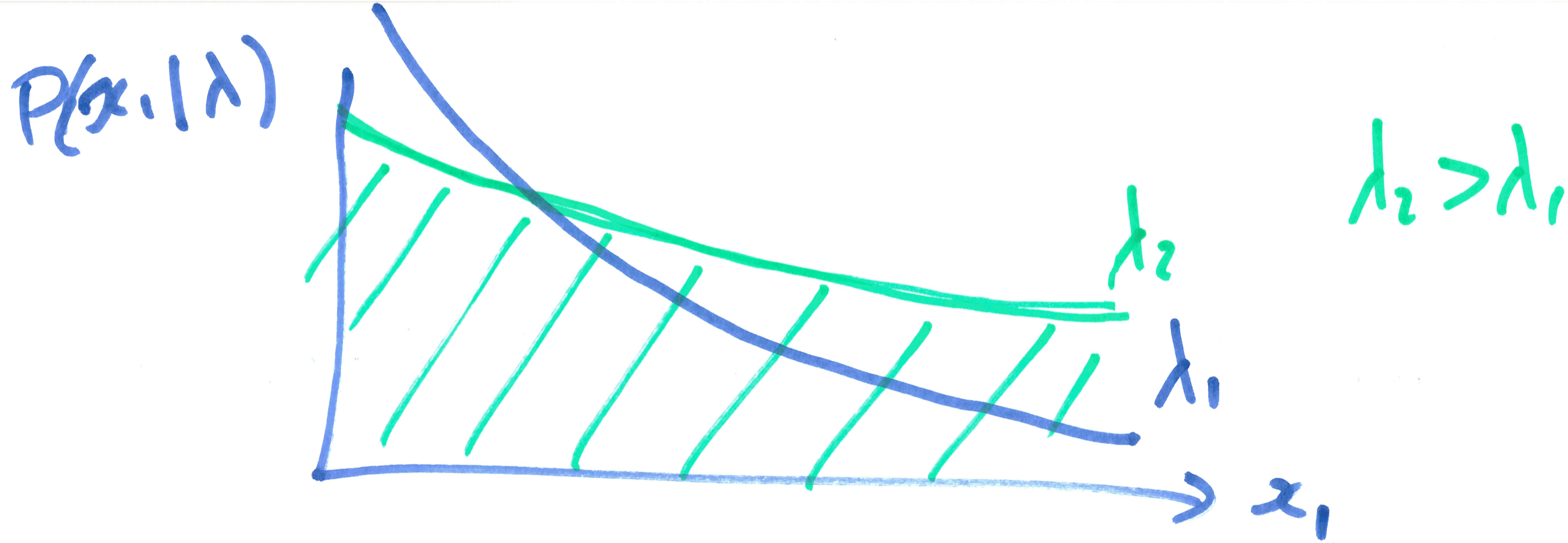
source

data flash locations $\{x_1, x_2, \dots, x_n\}$

$$x_i \mid \lambda \sim \mathrm{Exp}(\lambda)$$

likelihood $$P(x_i \mid \lambda) = \begin{cases} \dfrac{\exp\left(-x/\lambda\right)}{\lambda} & \text{if } x > 0 \\ 0 & \text{else.} \end{cases}$$

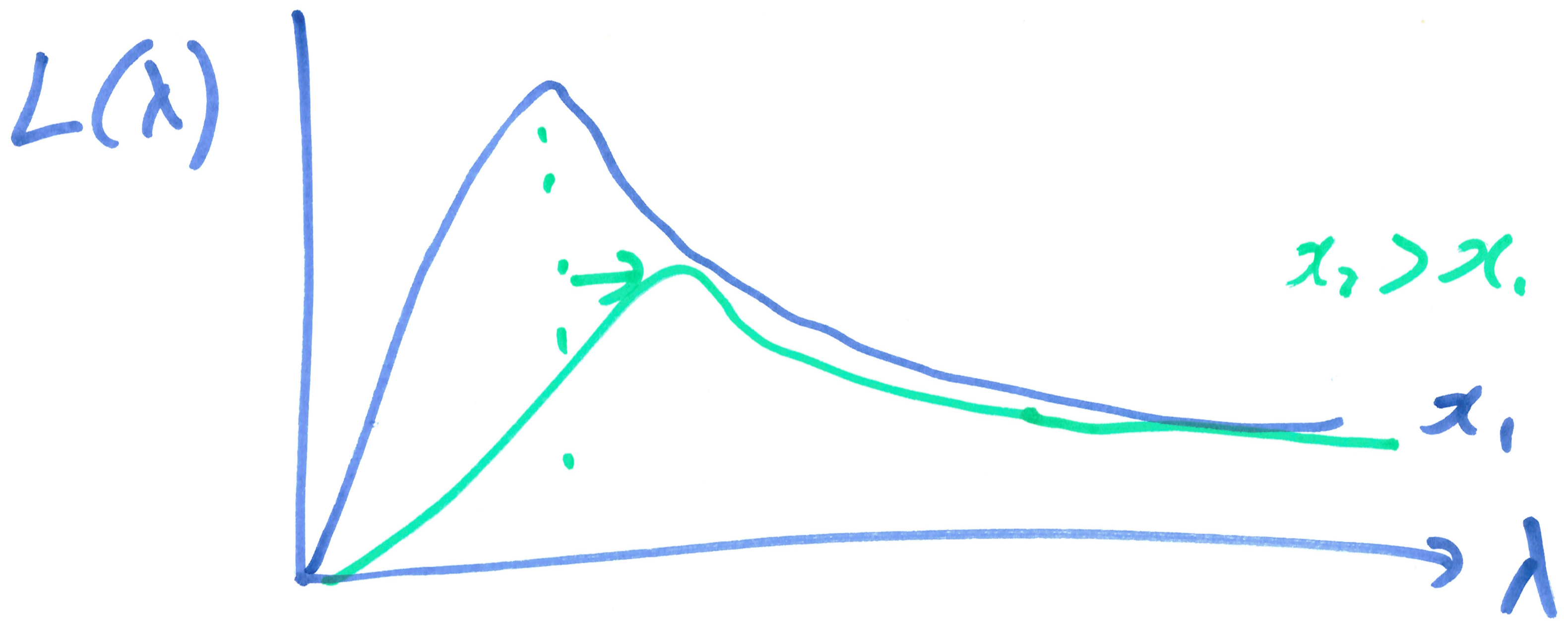
$$L(\{x_i\}|\lambda) = \prod_{i=1}^{n} L(x_i|\lambda)$$



normalized w.r.t. x

$$\int_0^\infty P(x_i|\lambda)\,dx_i = 1$$

$$P(x_1 \mid \lambda) = \frac{\exp(-x_1/\lambda)}{\lambda} \qquad x > 0.$$



is <u>not</u> normalised w.r.t. λ $\quad \int_0^\infty L(\lambda)\, d\lambda \neq 1.$

different possible notations

$$P(\{x\} \mid \lambda)$$

$$L(\lambda)$$

* $\underline{\mathcal{L}(\{x\} \mid \lambda)}$ my notation for likelihood.

example problem (use on Mon).

estimate # density of stars.

survey patch of area A.

count (all) stars above certain threshold in (apparent) mag.

data n the number of stars.

(discrete)

Poisson random variable. assuming independence/uniform density/etc.

$$\mathcal{L}(n \mid \underset{\substack{\uparrow \\ \text{num} \\ \text{density}}}{S}) = \frac{(AS)^n \exp(-AS)}{n!}$$

$[S] = \deg^{-2}$

AS (dimensionless) expected number.

Use this to $\frac{\text{find}}{\text{infer}}$ S in a Bayesian way.