Bayesian Statistics, Metabolomics and Covid-19

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Brief overview of Bayesian

Bayesian statistics began when Bayes theorem was first postulated by The Rev Thomas Bayes in 1763 [@bayes1763lii] @ref(eq:bayes). Bayes theorem has been described as a way of combining a prior distribution for a parameter with the likelihood to provide a posterior distribution for the parameter [@cox1979theoretical].

$$p\left(\theta \mid x\right) \propto p\left(x \mid \theta\right) (\#eq : bayes)$$

In other words, the computation of the posterior requires three terms: a prior $[p\left(\theta\right)]$, a likelihood $[p\left(x \mid \theta\right)]$ and an observation $[p\left(x \mid \theta\right)]$. The prior and likelihood can easily be computed as they are part of the assumed knowledge or model. The observation, which is a normalisation factor, requires complex integration that becomes intractable in high dimensions @ref(eq:bayesintegral).

$$p(x) = \int_{\theta} p\left(x \mid \theta\right) p\left(\theta\right) d\theta (\#eq : bayesintegral)$$

The process of Markov Chain Monte Carlo (MCMC) sampling

Slide with R Output

```
summary(cars)
```

```
##     speed            dist
## Min.   : 4.0    Min.   :  2.00
## 1st Qu.:12.0    1st Qu.: 26.00
## Median :15.0    Median : 36.00
## Mean   :15.4    Mean   : 42.98
## 3rd Qu.:19.0    3rd Qu.: 56.00
## Max.   :25.0    Max.   :120.00
```

Slide with Plot