7

Tests

(2012 – 2013 Academic Year: Tutorial Questions)

Exercises

7.1 Given the data $\Omega(x) = \{0.00, 0.1, 0.15, 0.20, 0.21\}$, use Bayes theorem to compare the hypothesis that the data are uniformly distributed against the hypothesis that the data are distributed with a mean of 0.15 and a Gaussian spread of 0.9. Which hypothesis agrees with the data best.

7.2 A test for an infection returns a positive result 98% of the time for someone with an infection. The same test reports a positive result 0.05% of the time for patients who are not infected. If 0.01% of the population are infected what is the probability that someone with a positive test result is actually infected? Is this a good test?

7.3 A test for an infection returns a positive result 99.99% of the time for someone with an infection. The same test reports a positive result 0.01% of the time for patients who are not infected. If 0.1% of the population are infected what is the probability that someone with a positive test result is actually infected? Is this a good test?

7.4 A test for an infection returns a positive result 99.99% of the time for someone with an infection. The same test reports a positive result one in a million times for patients who are not infected. If 10% of the population are infected what is the probability that someone with a positive test result is actually infected? Is this a good test?

7.5 The following results are all measurements of the height of the same person: 1.83 ± 0.01m, 1.85 ± 0.01m, 1.87 ± 0.01m. Are they compatible with each other?

7.6 The data given by $\Omega = \{0, 1, 2, 4, 6\}$ is for a Poisson process. Which value of λ, either 3 or 4 is a better description of the data?

7.7 The data given by $\Omega = \{1, 2, 3, 5, 7\}$ is for a Poisson process. Which value of λ, either 3 or 4 is a better description of the data?

7.8 Which hypothesis agrees with the data $\Omega = \{1, 2, 3, 4, 5\}$ better, a Binomial distribution with $p = 0.4$, or a Gaussian distribution with a mean of 3 and width of 1?

7.9 What is the p-value obtained for a rare decay experiment where one expects one event and observes five? Does this result contradict expectations?

7.10 What is the p-value obtained for a rare decay experiment where one expects one signal event, with two background and observes five? Does this result contradict expectations?

7.11 When searching for an effect expected to be small, at the level of five events in your data, you observe 15 events. What is the p-value for this outcome? Does this result contradict expectations?

7.12 What is the p-value obtained for a Gaussian observable to be non-zero given the measurement $x = 0.5 \pm 0.1$?

7.13 Measurements of the W boson mass from the MARK-2 and OPAL experiments are 91.14±0.12 and 91.1852 ± 0.0021 GeV/c^2, respectively. At what level do they agree with each other?

7.14 Measurements of the mass of the new particle discovered in summer 2012 by the ATLAS and CMS experiments at CERN are $126 \pm 0.4 \pm 0.4$ and $125.3 \pm 0.4 \pm 0.5$ GeV/c^2, respectively. The first uncertainty quoted is statistical and the second is systematic in nature. At what level do these mass measurements agree with each other?

7.15 Can both of the following results be correct (explain your reasoning) $x < 1.0 \times 10^{-6}$ at 90% CL, and $x = (1.5 \pm 1.0) \times 10^{-6}$, where $x \geq 0$?