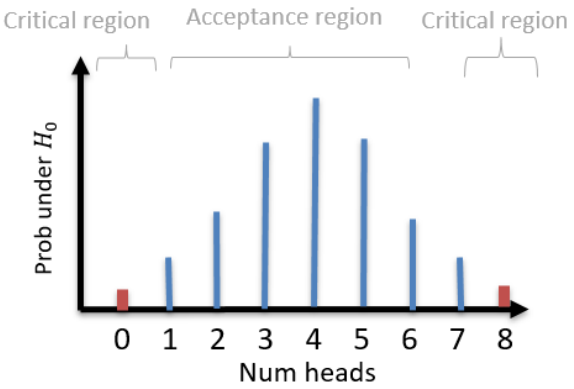
Two-tailed test

Suppose I threw a coin 8 times and was now interested in how may heads would suggest it was a **biased coin** (i.e. either way!). How do we work out the critical values now, with 5% significance?



Critical region at positive tail:

Critical region at negative tail:

C.D.F. Binomial table: $p = 0.5, n = 8$

x	$P(X \leq x)$
0	0.0039
1	0.0352
2	0.1445
...	...
6	0.9648
7	0.9961
8	1

Test Your Understanding

A random variable X has binomial distribution $B(40, p)$. A single observation is used to test $H_0: p = 0.25$ against $H_1: p \neq 0.25$.

The ≠ indicates bias either way, i.e. two-tailed.

a) Using the 2% level of significance, find the critical region of this test. The probability in each tail should be as close as possible to 0.01.

This means you find the closest to 0.01 (even if slightly above) rather than the closest under 0.01

b) Write down the actual significance level of the test.

a

b

C.D.F. Binomial table: $p = 0.25, n = 40$

x	$P(X \leq x)$
2	0.0010
3	0.0047
4	0.0160
5	0.0433
16	0.9884
17	0.9953
18	0.9983
19	0.9994

More on p-values

(Note that this is not covered in the Pearson textbook, but **is** in the specification)

Sheila wants to know if a coin is biased towards heads and throws it a large number of times, counting the number of heads. The p-value is less than 0.03. Conduct a hypothesis test at the 5% significance level.

Further Example

[Textbook] The standard treatment for a particular disease has a $\frac{2}{5}$ probability of success. A certain doctor has undertake research in this area and has produced a new drug which has been successful with 11 out of 20 patients. The doctor claims the new drug represents an improvement on the standard treatment.
Test, at the 5% significance level, the claim made by the doctor.

Test Your Understanding

Edexcel S2 Jan 2011 Q2

A student takes a multiple choice test. The test is made up of 10 questions each with 5 possible answers. The student gets 4 questions correct. Her teacher claims she was guessing the answers. Using a one tailed test, at the 5% level of significance, test whether or not there is evidence to reject the teacher's claim.

State your hypotheses clearly. **(6)**

Two-Tailed Tests

We have already seen that if we're interest in bias 'either way', we have two tails, and therefore have to split the critical region by **halving the significance level at each end**.

Over a long period of time it has been found that in Enrico's restaurant the ratio of non-veg to veg meals is 2 to 1. In Manuel's restaurant in a random sample of 10 people ordering meals, 1 ordered a vegetarian meal. Using a 5% level of significance, test whether or not the proportion of people eating veg meals in Manuel's restaurant is different to that in Enrico's restaurant.

Test Your Understanding

Edexcel S2 Jan 2006 Q7a

A teacher thinks that 20% of the pupils in a school read the Deano comic regularly.

He chooses 20 pupils at random and finds 9 of them read the Deano.

(*a*) (i) Test, at the 5% level of significance, whether or not there is evidence that the percentage of pupils that read the Deano is different from 20%. State your hypotheses clearly.

(ii) State all the possible numbers of pupils that read the Deano from a sample of size 20 that will make the test in part (*a*)(i) significant at the 5% level. **(9)**