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The index of coincidence is invariant under monoalphabetic cyphers and we estimate under this condition that $N_\alpha = N * p_{\sigma(\alpha)}$ for some permutation of the alphabet σ and so

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&= \frac{N(.065) - 1}{N-1} \\
&\approx .065
\end{aligned}
$$

If the cyphertext was obtained from a polyalphabetic cipher then the index of coincidence can also be used to estimate the period of the cipher.

Let p be the period of the cyphertext and place the letters of the cyphertext into groups of p so that the letters in the i^{th} position of the groups are all encrypted with the same key.

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- If there are M groups of p, then $\sum_{\alpha=A}^{Z} M_\alpha^{(i)} = M$
- We also have $N = Mp$
- Also we can estimate that $M_\alpha^{(i)} \approx Mp_{\sigma(\alpha)}$ (again for some permutation for the alphabet σ)

Now, we calculate that

$$2D_c = \sum_{i=1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)}(M_\alpha^{(i)} - 1) + 2\sum_{i=1}^{p} \sum_{j=i+1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)} M_\alpha^{(j)}$$

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&= \sum_{i=1}^{p} \sum_{\alpha=A}^{Z} (M_\alpha^{(i)})^2 - \sum_{i=1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)} + 2 \sum_{i=1}^{p} \sum_{j=i+1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)} M_\alpha^{(j)}
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&\approx M^2 \sum_{i=1}^{p} \sum_{\alpha=A}^{Z} p_\alpha^2 - \sum_{i=1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)} + 2 \sum_{i=1}^{p} \sum_{j=i+1}^{p} \sum_{\alpha=A}^{Z} M_\alpha^{(i)} M_\alpha^{(j)}
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&\approx M^2 \sum_{i=1}^{p}(.065) - \sum_{i=1}^{p}\sum_{\alpha=A}^{Z} M_\alpha^{(i)} + 2\sum_{i=1}^{p}\sum_{j=i+1}^{p}\sum_{\alpha=A}^{Z} M_\alpha^{(i)} M_\alpha^{(j)}
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Now, we calculate that

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$$\approx M^2 p(.065) - pM + 2M^2 \sum_{i=1}^{p}\sum_{j=i+1}^{p}\sum_{\alpha=A}^{Z} p_\alpha^{(i)} p_\alpha^{(j)}$$

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&\approx M^2 p(.065) - pM + M^2(.038)p(p-1) \\
&= \frac{N^2}{p}(.027) - N + N^2(.038)
\end{aligned}
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Note that because $I_c = \frac{D_c}{\binom{N}{2}}$, we have that

$$2D_c = N(N-1)I_c.$$

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And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

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$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$N(N-1)I_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

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$$2D_c = N(N-1)I_c.$$

And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$(N-1)I_c \approx \frac{N}{p}(.027) - 1 + N(.038)$$

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And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$(N-1)I_c + 1 \approx \frac{N}{p}(.027) + N(.038)$$

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$$2D_c = N(N-1)I_c.$$

And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$(N-1)I_c + 1 - N(.038) \approx \frac{N}{p}(.027)$$

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And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$p((N-1)I_c + 1 - N(.038)) \approx N(.027)$$

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$$2D_c = N(N-1)I_c.$$

And we just derived that

$$2D_c \approx \frac{N^2}{p}(.027) - N + N^2(.038)$$

Therefore,

$$p \approx \frac{N(.027)}{(N-1)I_c + 1 - N(.038)}$$

Lets see how accurate this is (it gives an approximation to the period, not the actual period) with text that contains about 21K letters. We use the same text and vigenere cipher with period 3 through 7.

`indcoin < plaintext`

Index of coincidence : 0.063616

Estimate of the period : 1.052158

Lets see how accurate this is (it gives an approximation to the period, not the actual period) with text that contains about 21K letters. We use the same text and vigenere cipher with period 3 through 7.

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.044720
  Estimate of the period : 3.990527

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- `indcoin < cyphertextvig3`
  Index of coincidence : 0.044720
  Estimate of the period : 3.990527
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.042903
  Estimate of the period : 5.455495

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- `indcoin < cyphertextvig4`
  Index of coincidence : 0.042903
  Estimate of the period : 5.455495
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.042236
  Estimate of the period : 6.304608

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  Estimate of the period : 5.455495
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.042236
  Estimate of the period : 6.304608
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.041899
  Estimate of the period : 6.842702

Lets see how accurate this is (it gives an approximation to the period, not the actual period) with text that contains about 21K letters. We use the same text and vigenere cipher with period 3 through 7.

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- `indcoin < cyphertextvig5`
  Index of coincidence : 0.042236
  Estimate of the period : 6.304608
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.041899
  Estimate of the period : 6.842702
- `indcoin < cyphertextvig7`
  Index of coincidence : 0.041434
  Estimate of the period : 7.757924

Lets do another experiment with less letters (precisely 3183 letters).

```
indcoin < plaintext
```

Index of coincidence : 0.069377

Estimate of the period : 0.852563

Lets do another experiment with less letters (precisely 3183 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045386
  Estimate of the period : 3.512710

Lets do another experiment with less letters (precisely 3183 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045386
  Estimate of the period : 3.512710
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.045457
  Estimate of the period : 3.480884

Lets do another experiment with less letters (precisely 3183 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045386
  Estimate of the period : 3.512710
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.045457
  Estimate of the period : 3.480884
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.045034
  Estimate of the period : 3.681678

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  Estimate of the period : 3.480884
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.045034
  Estimate of the period : 3.681678
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.043903
  Estimate of the period : 4.352677

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  Index of coincidence : 0.045386
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- `indcoin < cyphertextvig4`
  Index of coincidence : 0.045457
  Estimate of the period : 3.480884
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.045034
  Estimate of the period : 3.681678
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.043903
  Estimate of the period : 4.352677
- `indcoin < cyphertextvig7`
  Index of coincidence : 0.043281
  Estimate of the period : 4.836937

Lets do another experiment with less letters (precisely 14590 letters).

`indcoin < plaintext`

Index of coincidence : 0.064586

Estimate of the period : 1.013137

Lets do another experiment with less letters (precisely 14590 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045976
  Estimate of the period : 3.357689

Lets do another experiment with less letters (precisely 14590 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045976
  Estimate of the period : 3.357689
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.042790
  Estimate of the period : 5.560689

Lets do another experiment with less letters (precisely 14590 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045976
  Estimate of the period : 3.357689
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.042790
  Estimate of the period : 5.560689
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.041953
  Estimate of the period : 6.718174

Lets do another experiment with less letters (precisely 14590 letters).

- `indcoin < cyphertextvig3`
  Index of coincidence : 0.045976
  Estimate of the period : 3.357689
- `indcoin < cyphertextvig4`
  Index of coincidence : 0.042790
  Estimate of the period : 5.560689
- `indcoin < cyphertextvig5`
  Index of coincidence : 0.041953
  Estimate of the period : 6.718174
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.041019
  Estimate of the period : 8.752510

Lets do another experiment with less letters (precisely 14590 letters).

- `indcoin < cyphertextvig3`
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- `indcoin < cyphertextvig5`
  Index of coincidence : 0.041953
  Estimate of the period : 6.718174
- `indcoin < cyphertextvig6`
  Index of coincidence : 0.041019
  Estimate of the period : 8.752510
- `indcoin < cyphertextvig7`
  Index of coincidence : 0.040397
  Estimate of the period : 10.963194