



НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ  
УНИВЕРСИТЕТ

Факультет компьютерных наук,  
ОП Программная инженерия

# ПРЕДИКАТИВНЫЙ ВВОД

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# OBJECTIVE FUNCTION

Main metric – **KSPC** metric

**Keystrokes per character (KSPC)** is the number of keystrokes, on average, to generate each character of text in a given language using a given text entry technique

$$KSPC = \frac{\sum K_w \times F_w}{\sum C_w \times F_w} = \frac{\sum (C_w + O_w) \times F_w}{\sum C_w \times F_w}$$

where:

$K_w$  - the number of keystrokes required to enter a word,

$C_w$  - the number of characters in the word,

$F_w$  - the frequency of the word in the corpus,

$O_w$  - the ordinal number of a word among all words with the same code for a given layout sorted by frequency. (zero based)



# OBJECTIVE FUNCTION

Secondary metric – **Learning Performance (LP)**

**Learning Performance (LP)** is the numerical indicator of the learning rate (based on calculating the similarity of the proposed keyboard with the default)

$$\text{Similarity} = \sum_{i \in \alpha} (|k_{ix} - q_{ix}| + |k_{iy} - q_{iy}|)$$

where  $i$  is a letter in alphabet  $\alpha$ ,  
the set of lowercase letters  
from 'a' to 'я', and  $k_{ix}$   
and  $q_{ix}$   
are the x-indices of the  $i$  key  
on the given keyboard layout and default



# OBJECTIVE FUNCTION

$$KSPC = \frac{\sum K_w \times F_w}{\sum C_w \times F_w} = \frac{\sum (C_w + O_w) \times F_w}{\sum C_w \times F_w} = \frac{const + \sum O_w \times F_w}{const}$$

$$f = \left[ \sum O_w \times F_w \right] \times 1000 + lp$$



# ALGORITHM

Simulated annealing



Before starting simulated annealing we need to define 3 functions:

- **Energy function:** it's just our objective function
- **Decrease temperature function:**  $t_i = t_0 / i * 1.1$
- **Function that generates a new state:** select new random button for one random letter

Probability of going into a bad state:  $P(\Delta E) = e^{-\Delta E / t_i}$

# CONCLUSION

The best layout which was generated by algorithm (30000 steps)

```
{
  "s" : ["б", "и", "р"],
  "d" : ["д", "й", "о"],
  "f" : ["з", "т", "у"],
  "g" : ["г", "н", "ъ", "э", "я"],
  "h" : ["в", "е", "ф", "ш"],
  "j" : ["ж", "л", "с", "х", "ь"],
  "k" : ["к", "п", "ц", "щ", "ы", "ю"],
  "l" : ["а", "м", "ч"]
}
```

	kspc	lp
baseline-layout	1.015218	37
best-algorithm-layout	1.003498	136



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