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Dasher – Character LM

PA154 Language Modeling (3.1)

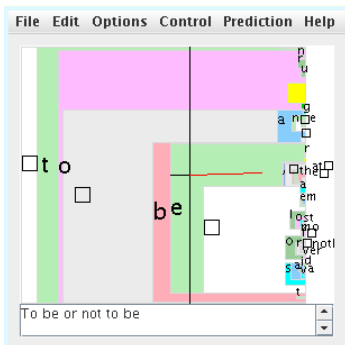**Pavel Rychlý**

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March 2, 2023

Dasher

- authors: David MacKay, David Ward
- Cambridge University; freeware
- support for highly efficient text input for using means other than a standard computer keyboard
- alternative for thousands of people with various physical disabilities
- on-screen text input using a positioning device (mouse, joystick ...)
- uses a probabilistic predictive language model
- is still under development (technology remains the same)

About Dasher

- Dasher is free
- open-source software
- GNU Generel Public License
- alphabet for more than 150 languages
- font colour setting
- system learns and offers letter combinations that are more used

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Areas of use

- assistive technology (disabilities - without hands, with one hand...)
- Pocket PC, iOS, Android, Linux, macOS, Microsoft Windows
- complex languages (e.g. Japanese)
- latest version 5.0.0 (beta) from April 8, 2016

Principle

- letters in alphabetical order, each letter is in a rectangle
- The rectangle with the selected letter contains again the complete alphabet from which the 2nd symbol can be selected, etc.
- basic idea: more probable letters are in a larger rectangle
- rectangle sizes are decided on the basis of the language model

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"Inverse" arithmetic coding

- arithmetic coding (text compression): codeword is a number from the interval (0,1), by successive encoding of symbols the intervals are refined in the ratio of the probabilities of occurrence of a character
- lossless data compression method
- in Dasher, the ypsilon coordinate represents the entire interval (0,1), where each alphabet symbol has an associated segment of length corresponding to the probability of its occurrence in a given context

Arithmetic coding - example for four-symbol model

- codeword is a number from the interval [0,1)
- 60 % for symbol NEUTRAL; interval is [0, 0.6)
- 20 % for symbol POSITIVE; interval is [0.6, 0.8)
- 10 % for symbol NEGATIVE; interval is [0.8, 0.9)
- 10 % for symbol END-OF-DATA; interval is [0.9, 1)
- symbol in END-OF-DATA section means that decoding is complete

Arithmetic decoding
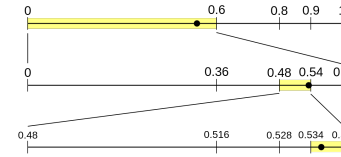
- message is encoded as the number 0.538
- encoder with interval [0,1) is divided into four subintervals; the message is in the NEUTRAL section
- interval [0, 0.06) is divided into four subintervals; the message is in the NEGATIVE section
- interval [0.48, 0.54) is divided into four subintervals; the message is in the END-OF-DATA section[8 / 33]

Encoding the message "WIKI" by arithmetic coding

- Each symbol has its probability in the interval [0, 1)
- The number of message symbols or terminal symbol must be known
- interval is represented in binary system

Encoding of message "WIKI" by arithmetic coding continued

6. [.0010101, .0010111) → .001011
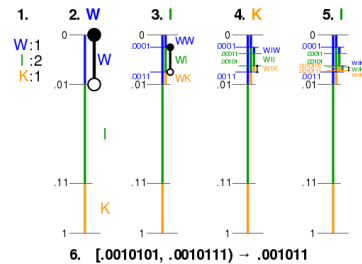
- interval "W" is [0, 0.01)
- interval "I" is [0.01, 0.11)
- interval "K" is [0.11,1)

Encoding of message "WIKI" by arithmetic coding continued

6. [.0010101, .0010111) → .001011
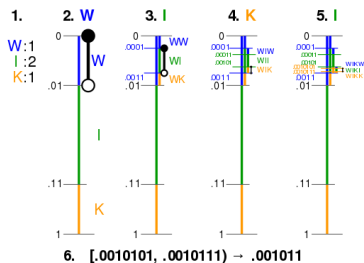
- encodes "W" [0, 0.1) first
- followed by "I" [0.001, 0.0011)
- then the "K" is [0.00101, 0.0011)
- and finally "I" [0.0010101, 0.0010111)
- the result is a number from the final interval

PPM (Prediction by Partial Match)

- The language model used in Dasher is not limited to the concept of words
- combines information about n-grams with probabilities of occurrence of each symbol from the dictionary
- context 4-5 symbols

PPM - 3 modes

- Standard letter-based PPM (calculates probability by partial matching)
- Word-based model (word dictionary with frequencies)
- Mixture model (PPM/dictionary)

Language Model (3)

- language model learns over time (learns new user's expressions or phrases)
- everything we write is automatically saved to a file as additional training data

Other features

- import of training data simply by loading the file
- data source for Czech: Institute of the Czech National Corpus, Faculty of Arts, Charles University
- any alphabet: e.g. also LaTeX, C, IPA
- other software - 2 modes: normal typing and word completion (user has to switch between them)
- Dasher has one mode which combines both

Input method types

- computer mouse
- touchpad
- touchscreen
- eyetracker
- headmouse
- trackball
- trackpad
- breath
- buttons
- tilt sensors
- ...

Mouse, touchpad, touchscreen
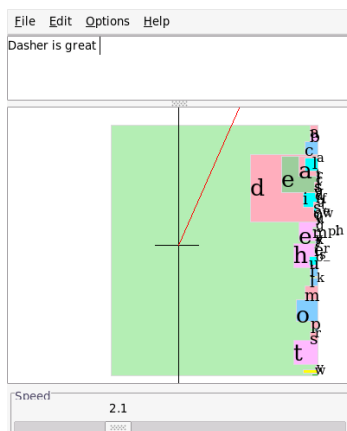
- writing speed using mouse: after 10 minutes of training 5-15 words/min., after an hour: 15-25 words/min., experienced users: 40 words per minute (as fast as typing by hand using a keyboard)
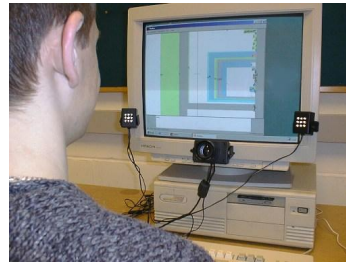- sample of Dasher
- video: ipaq

Eyetracker

- camera + sensors that detect where the user is looking on the screen
- initial price: $2000 - 4000$ USD

Eyetracker

- Tobii Eye Tracker 5
- price: 229 EUR
- Engineered for gaming
- also built in (gaming) laptops

Eye Dasher

- input speed: after ten minutes of training 7 words/minute, after an hour: 20 words/minute, experienced users: 30 words/minute
- eyetracking without Dasher, only with virtual (on-screen) keyboard: 15 words/min., error-rate 5x higher

Eye Dasher - User friendliness

- input using the virtual (on-screen) keyboard is discrete (waiting for the timer to expire, or blinking)
- Dasher provides continuous input
- video: eye_dasher

Headmouse

- IR camera
- reflexive points
- price: 500-1500 USD

Breath Dasher

- direct relation between lung volume and ypsilon coordinate value
- one-dimensional (cannto go back)
- therefore: Control mode
- Control area (Stop, Pause, Move, Delete)
- video: breath_dasher

Button Dasher

3 directions
- forward up
- forward down
- back

Dasher vs. speech recognition

- inapplicability of automatic speech recognition systems in noisy environments
- even with the best recognizers about 5 % error rate (difficult editing of errors)

Speech Dasher: Efficient speech recognition correction

- Step 1: text input using a combination of speech and navigation via pointing device (mouse)
- Step 2: Speech recognizer makes an initial estimate of the text, the user edits or confirms the output
- initial error rate of 22 %, users usually fix everything
- faster than repair using separate speech recognition (special commands)
- faster than a standalone Dasher
- video: speech_dasher

Other options - Swype

- virtual keyboard for smartphones and tablets
- developed by Nuance Communications
- typing by continuous stroke on QWERTY/QWERTZ/AZERTY/National keys
- word guessing using predictive dictionary (we can add our own words)
- more accuracy for longer words (short ones usually have more possibilities to interpret the stroke on the screen)
- typing without diacritics, offered variants with diacritics

Swype (2)

- typing speed up to over 50 words/min.
- handles simple punctuation (even smileys)
- app is able to learn from Facebook, Gmail, Twitter...
- also available in Czech
- possibility to dictate in different languages using Dragon Dictation module (also in Czech)
- video http://www.youtube.com/watch?v=SJ-RAefCG_c

Other options -SwiftKey

- free for Android, iOS, iPhone
- learns using previous text communication (SMS, Gmail, texts in RSS, it also adapts to letters that you repeatedly press slightly off)
- multiple languages (up to 5 simultaneous)
- typo correction
- next word prediction (offers the most likely variants of the following words)
- 800 emoji
- Emoji Prediction feature - learns to predict relevant emoji

SwiftKey (2)

- quality dictionaries (correspond to trends in communication)
- can be typed in Swype style
- English dictation functions can be turned on
- June 2012 release of SwiftKey Healthcare; prediction based on real clinical data
- April 2016 release of ShakeSpeak; emulating W. Shakespeare's speech to celebrate the 400th anniversary of his death
- year 2016 Microsoft buyout of SwiftKey
- video: http://www.youtube.com/watch?v=kA5Horw_SOE

Other options – SlideIT

- similar to Swype keyboard - typing by dragging between characters
- lower requirements for typing accuracy
- quality dictionaries (possibility to install more, including Czech)
- more than 70 language sets
- keyboard customisation option
- calculates the variants of the words the user wanted to type
- autocompletion of spaces and capital letters
-
  video:http://www.youtube.com/watch?v=Tp_7bWuvQwQ

Other options – GO Keyboard

- prediction in many languages
- possibility to change skins and backgrounds
- ability to import names and SMS into the dictionary
- support for Swype style text input
- detected a security issue in 2017; the app was sending user information back to China (language, location, network type, ...), more than 200 million users affected
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  video:http://www.youtube.com/watch?v=XQRRvSwpmWc

Other options

- Perfect keyboard
- TouchPal keyboard
- Google keyboard
- Siine Shortcut keyboard
- Adaptxt keyboard
- ShapeWriter keyboard
- ...