HPI Hasso Plattner Institut
Digital Engineering · Universität Potsdam

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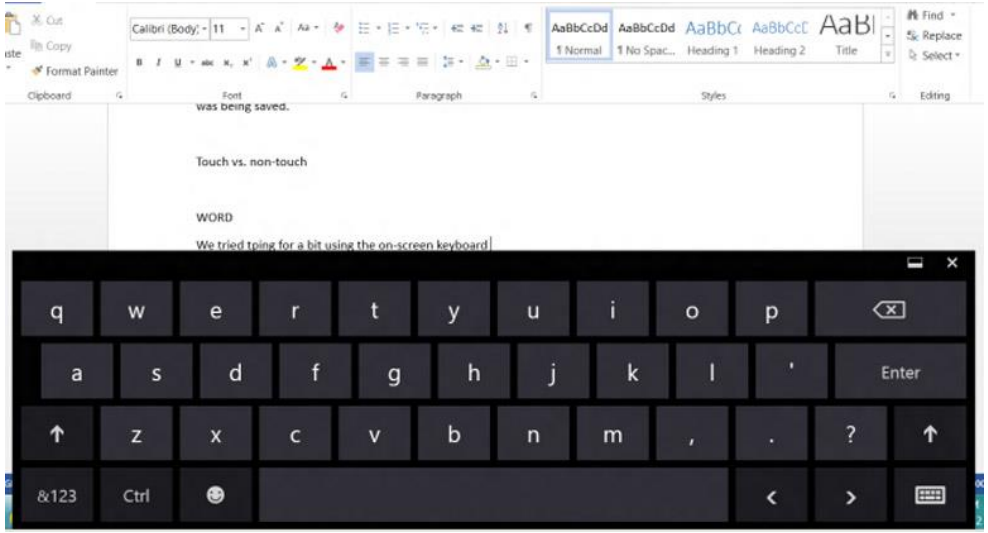
Web-based Development Environments
Software Architecture Group, HPI

Why do we need handwriting recognition?



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https://support.apple.com/library/content/dam/edam/applecare/images/en_US/iOS/ios10-iphone7-imessage-predictive-text-on.png

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30.01.2018
Chart **2**

Why do we need handwriting recognition?

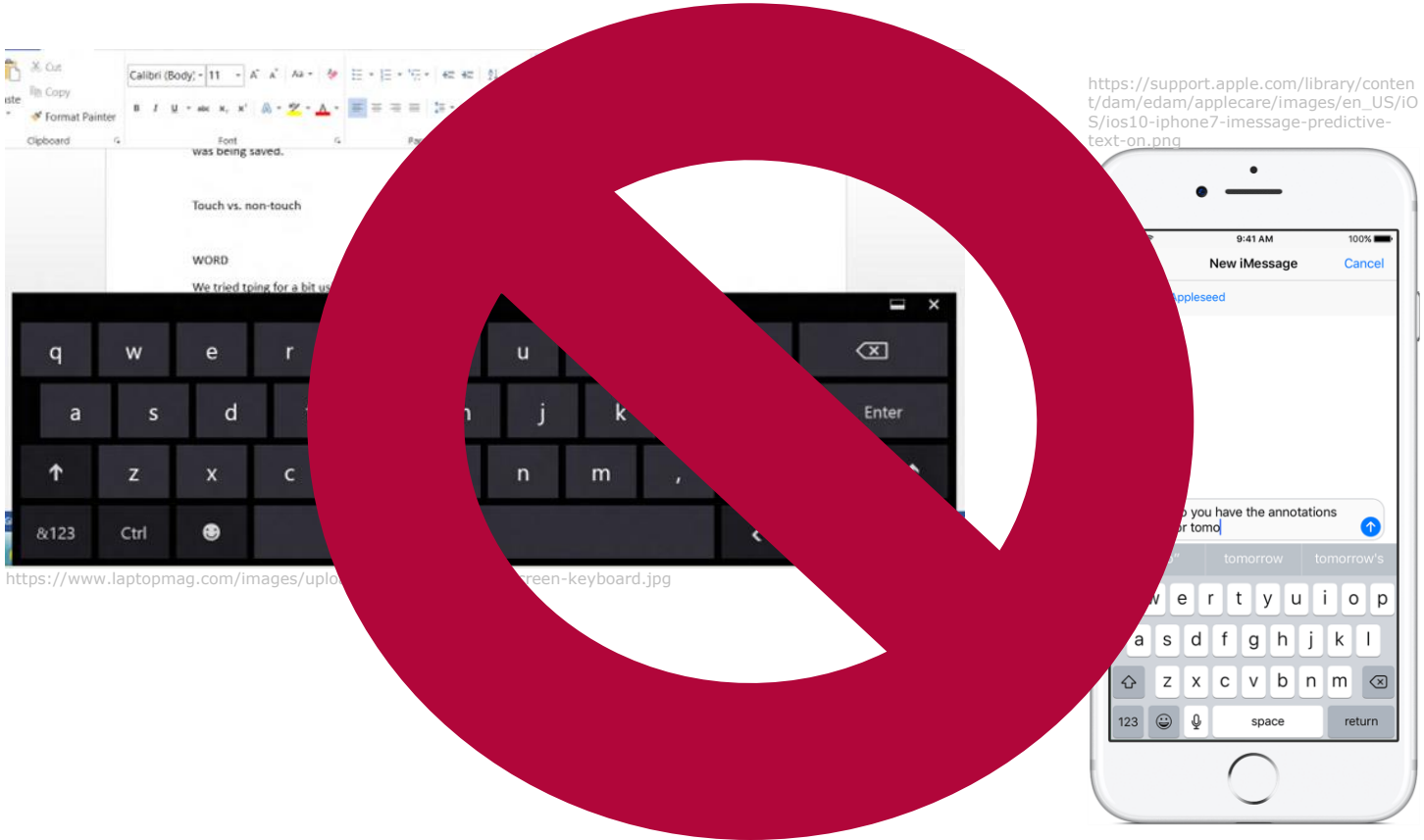

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Chart **3**

Why do we need handwriting recognition?

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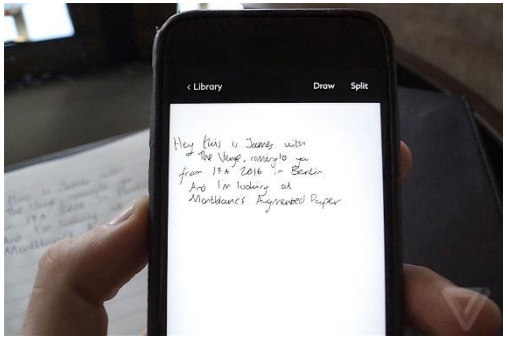

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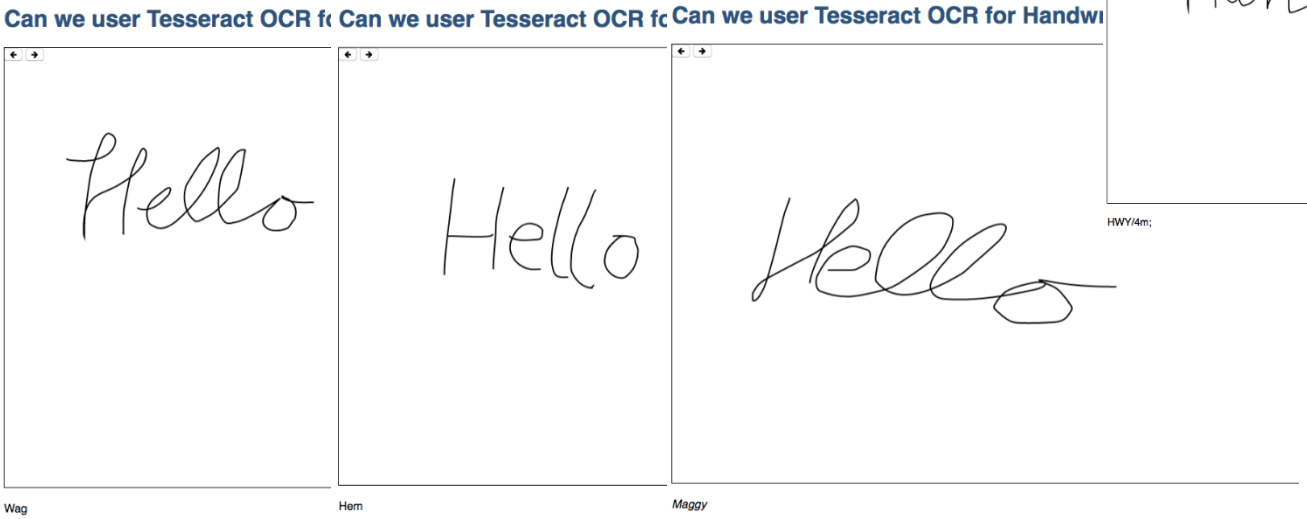
Problems to solve

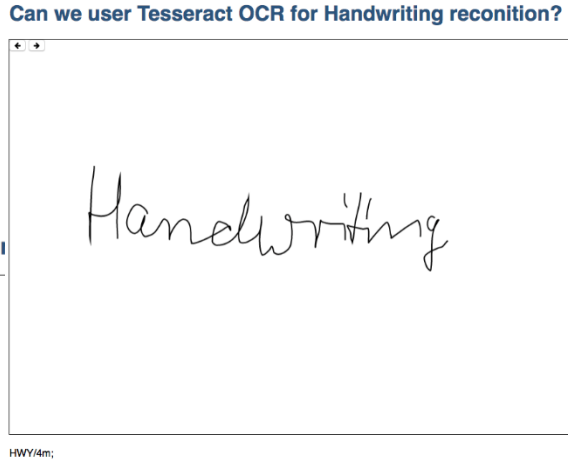
- Handwriting recognition is not very common as a web application
  - Standalone JavaScript libraries are practically non-existent
  - Current approaches for online recognition (such as *MyScript*) only offer an API and must be paid

- Our goals:
  - Find a **working** approach to integrate in **Lively** and free **self-hosting** on lively server

Current approaches: Tesseract (in Lively)

- Developed 1984-1994 by HP, since 2005 maintained by Google
- 2016: Introduced Neural nets
- Supports 100 languages, uses dictionaries
- Perfect for printed characters / typescript
- Can be trained with handwritten characters





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Current approaches: Grail

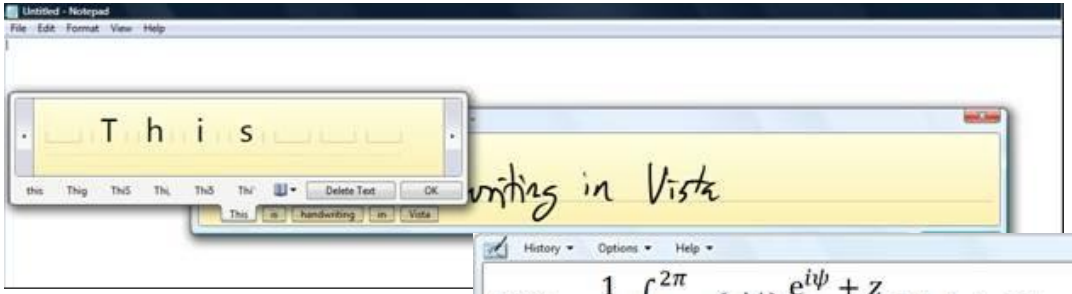
- Graphical Input Language
- Pen + tablet
- Integrated in Lively, not working (Grail, other example)
- Works for single letters only, requires exact movements/movement changes

Current approaches: Machine Learning

- Typically Convolutional Neural Net
- Good datasets: MNIST, NIST
- Excellent at detecting single characters (99.9% accuracy)
- No recognition of whole words
- Not integrated in Lively
- Example for MNIST

Current approaches: Windows

- Good results
- Closed software, not reusable in other projects out of the scope of windows



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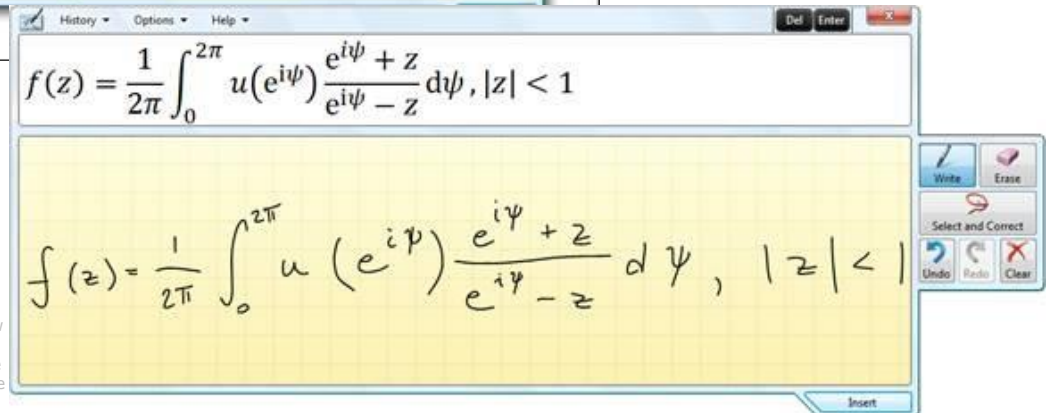

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Chart **9**

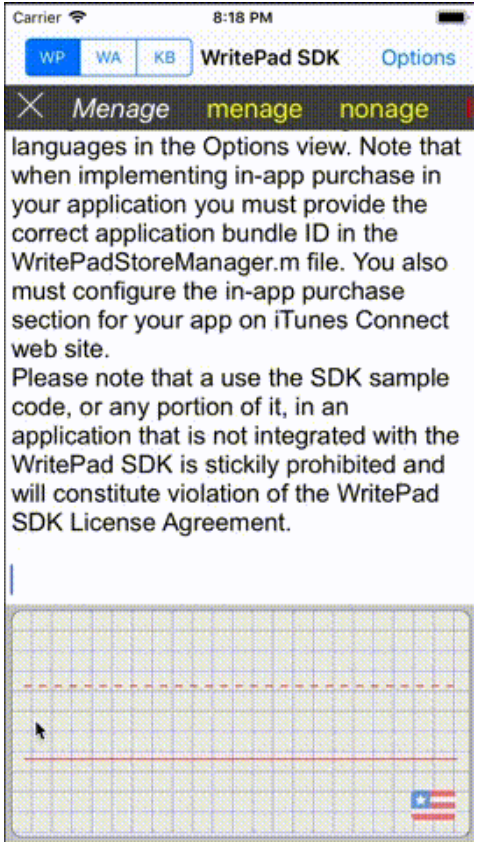
Current approaches: MyScript

- Good results, also for multiple sentences and even whole texts
- Only free for development, not even for testing certainly not for production

WritePad

- Multilingual handwriting recognition engine written in C++
- GNU General Public License v3.0

- Provides multiplatform library, such as macOS, Windows, **Linux**, iOS, Android



https://github.com/phatware/WritePad-Handwriting-Recognition-Engine

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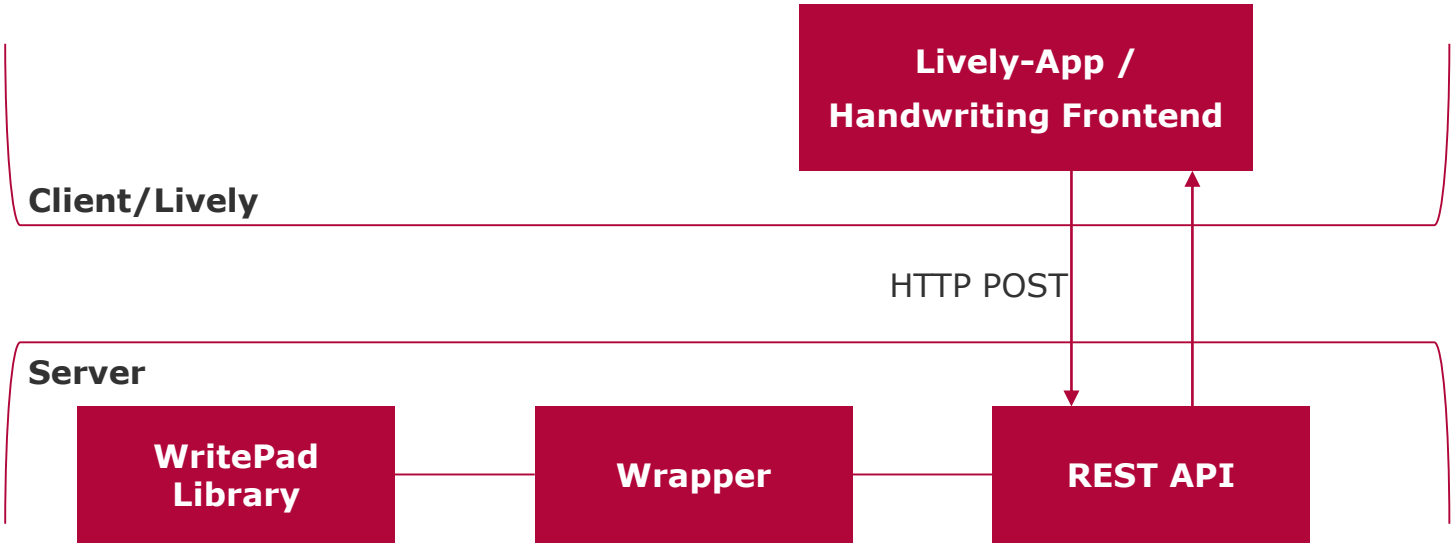
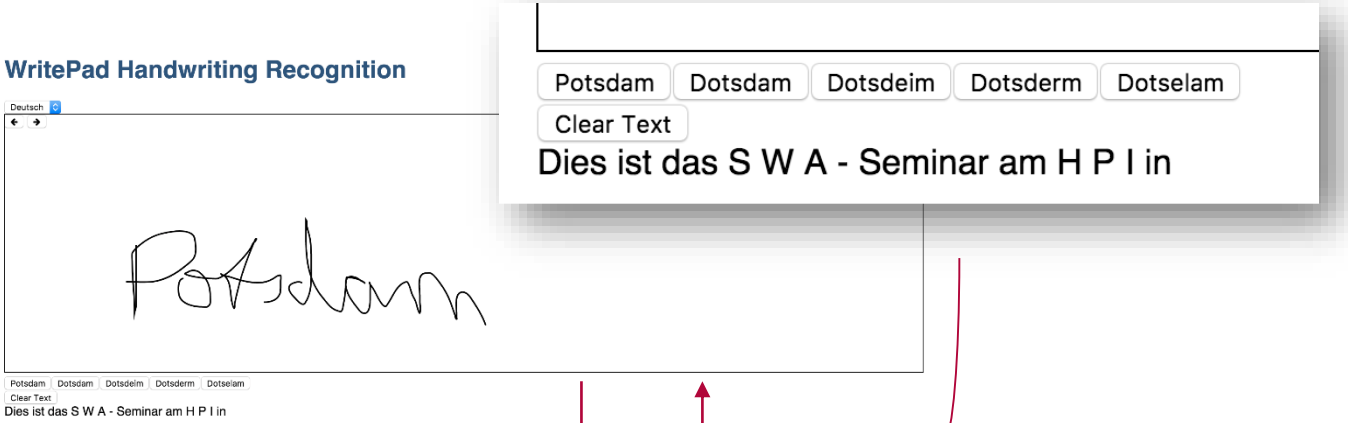
Architecture



Lively Integration

- Existing drawing canvas *(lively-paper)*
- Store drawn points **(x, y)** in chronological order
- Send points to our API in 1s interval



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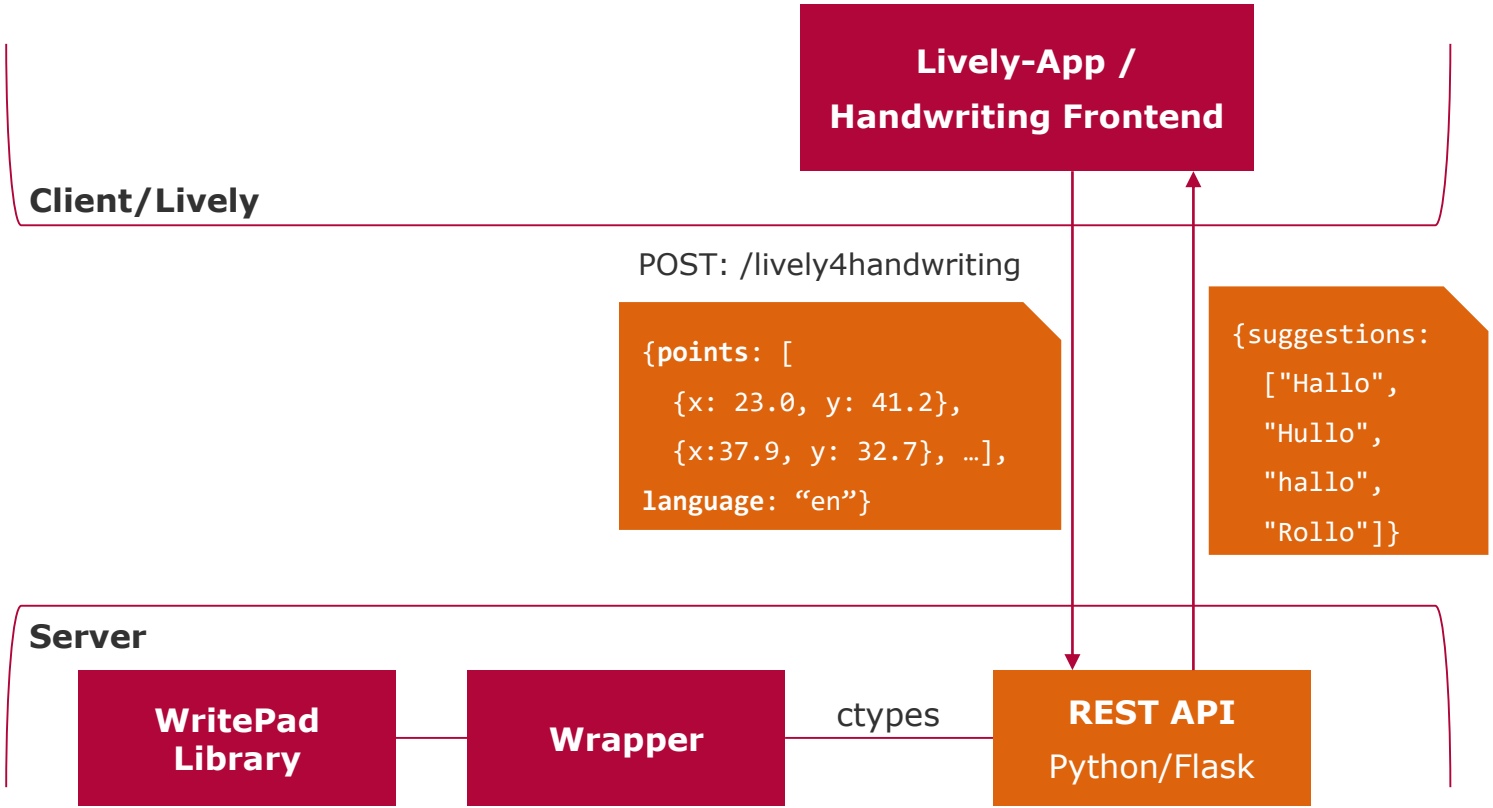
REST API



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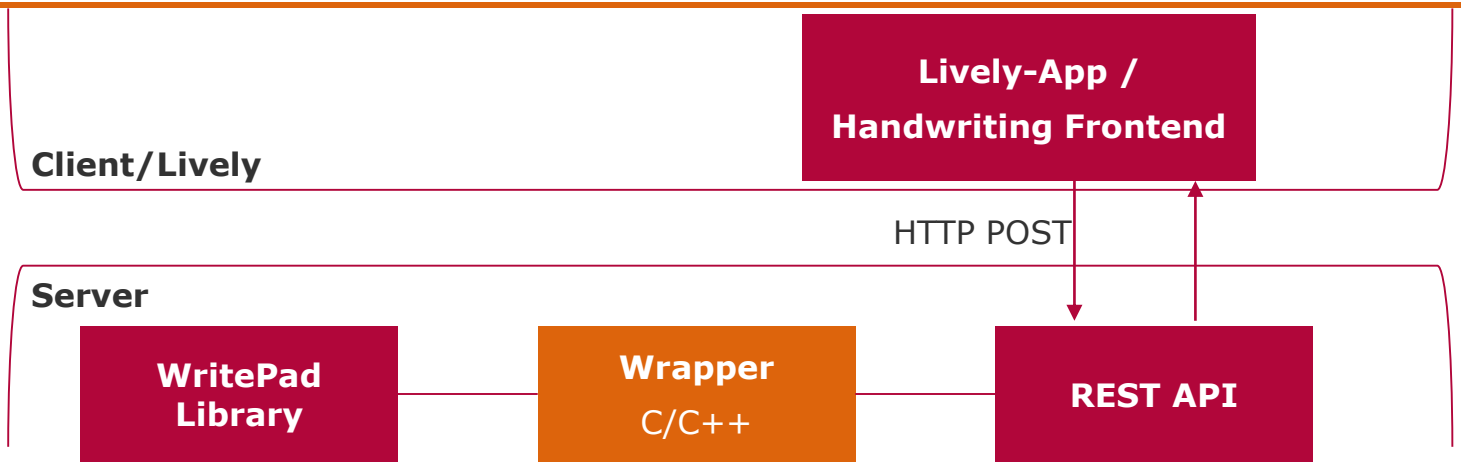
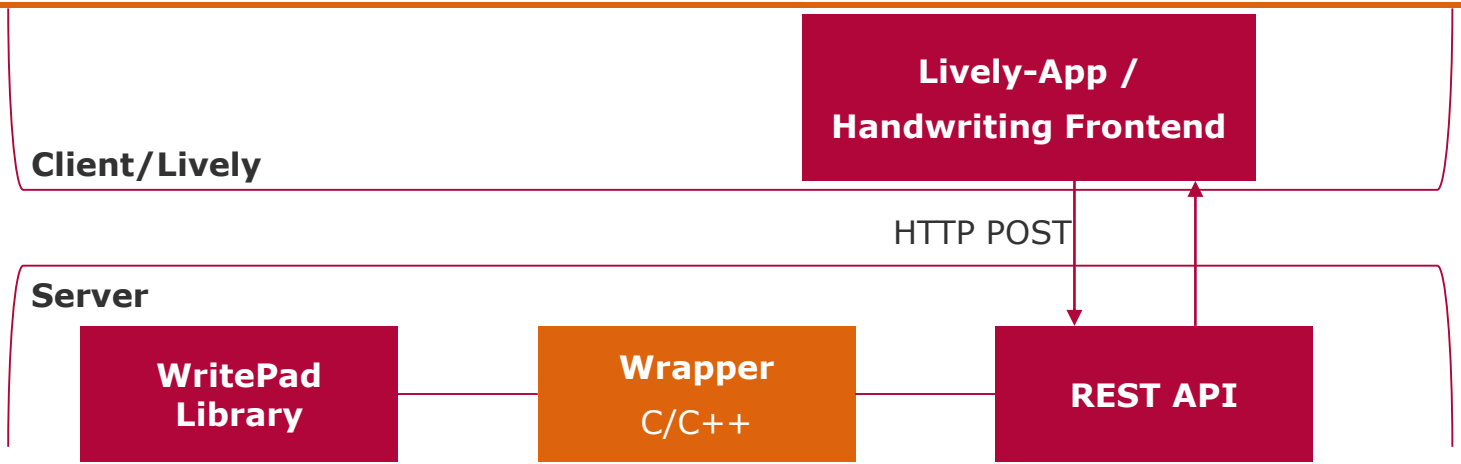
WritePad Wrapper



- Wraps WritePad library included as shared object
- Returns suggestion(s) for array of painted points
- Provides possibility to get suggestions for different languages
- Exports functions in C to provide compatibility with ctypes

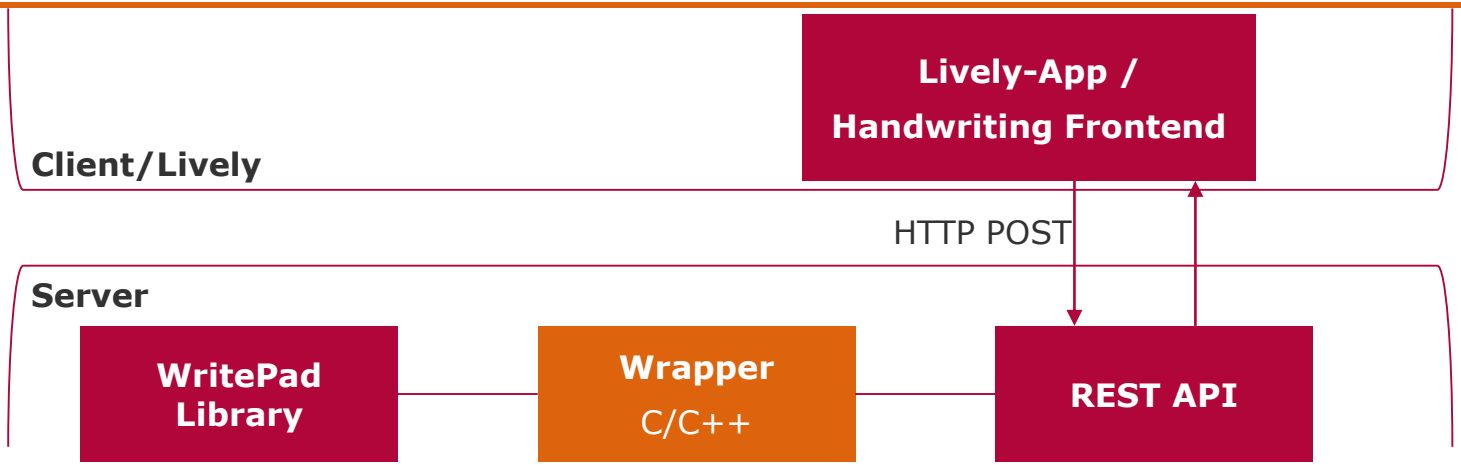
WritePad Wrapper



API:

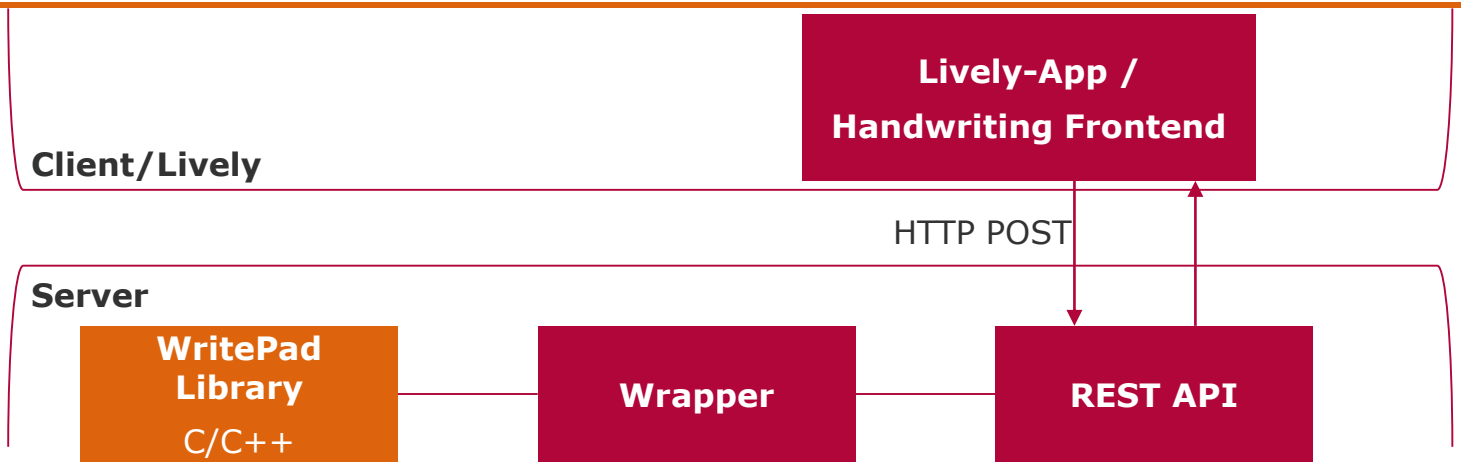
```
extern "C" {
  const wchar_t* recognizeMultipleSuggestions(const char *jsonString)
}
```

WritePad Wrapper



1. Extract Points & Language out of JSON string
2. Convert Points to WritePad-compatible format
3. Apply handwriting recognition in specified language
4. Collect results & build result JSON string
5. Return JSON

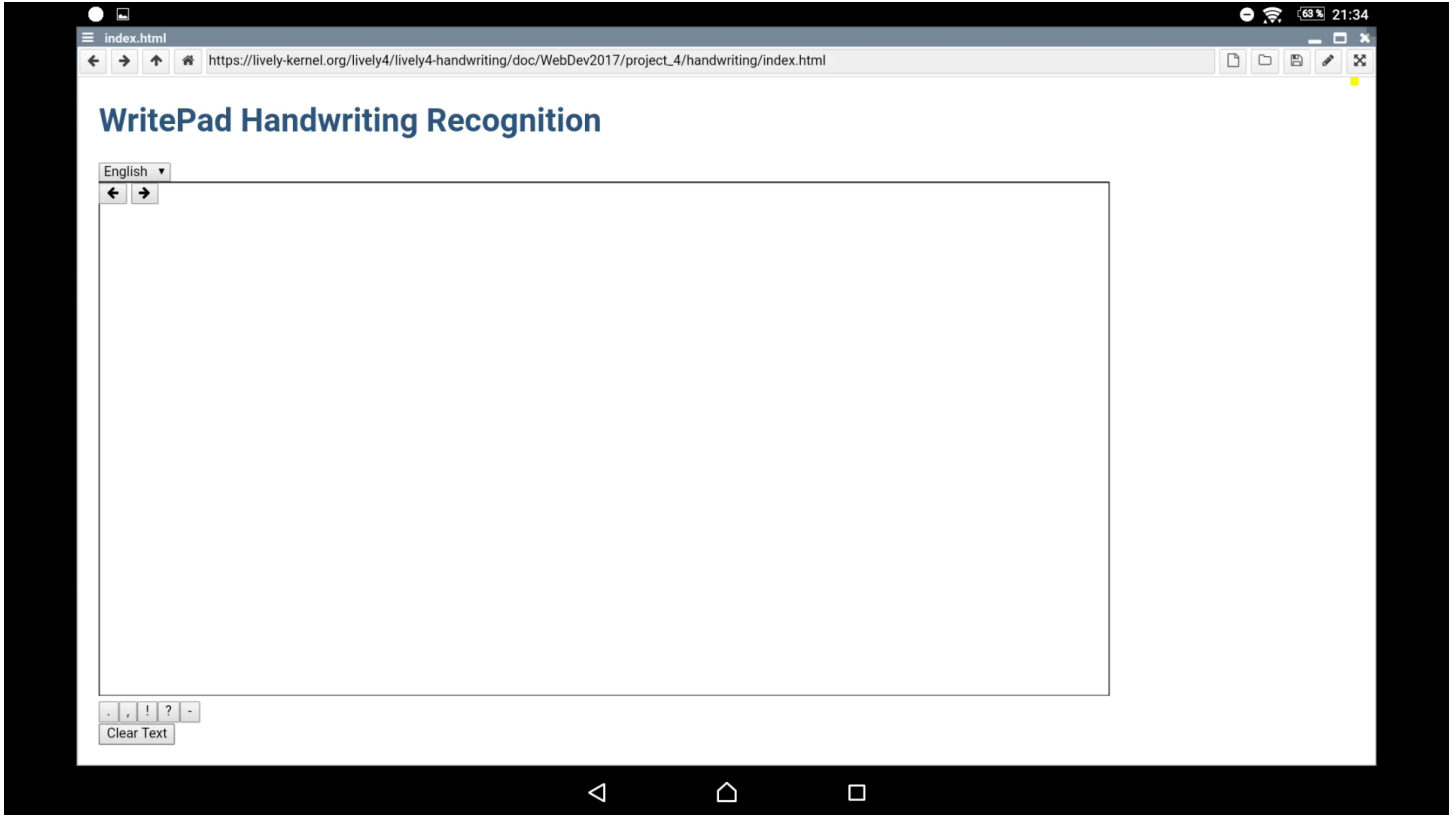
WritePad Library




```
typedef struct __tagTracePoint{
  CGPoint pt;
  int pressure;
} CGTracePoint;
```

```
struct CGPoint {
  CGFloat x;
  CGFloat y;
};
```

Screen Cast



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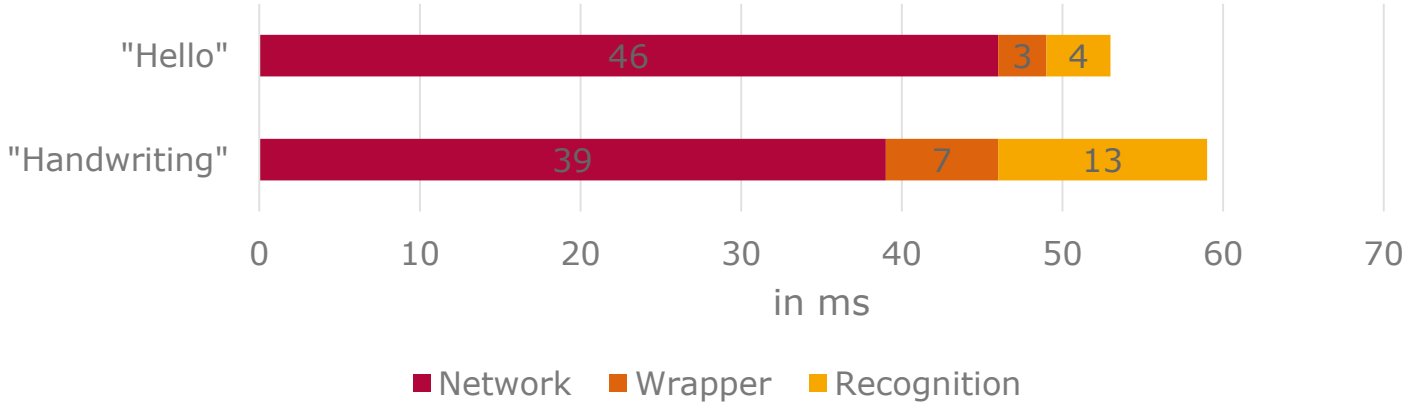
Limitations

- Pipeline speed:
  - 37 ms (empty canvas)
  - 53 ms (word: "Hello")
  - 59 ms (word: "Handwriting")
  - 110 ms (painted canvas)



Conclusion

- According to our experience, the recognition works much better than previous approaches of integrating handwriting recognition in an online/JavaScript environment

- However, there are still various difficulties
  - Writing large texts is ugly
  - Words need to be present in dictionary
  - Requires availability of another server(does not work in Lively standalone)

Future work

- Create lively component
- Support for multiple words
- Implementation of Lively interactions

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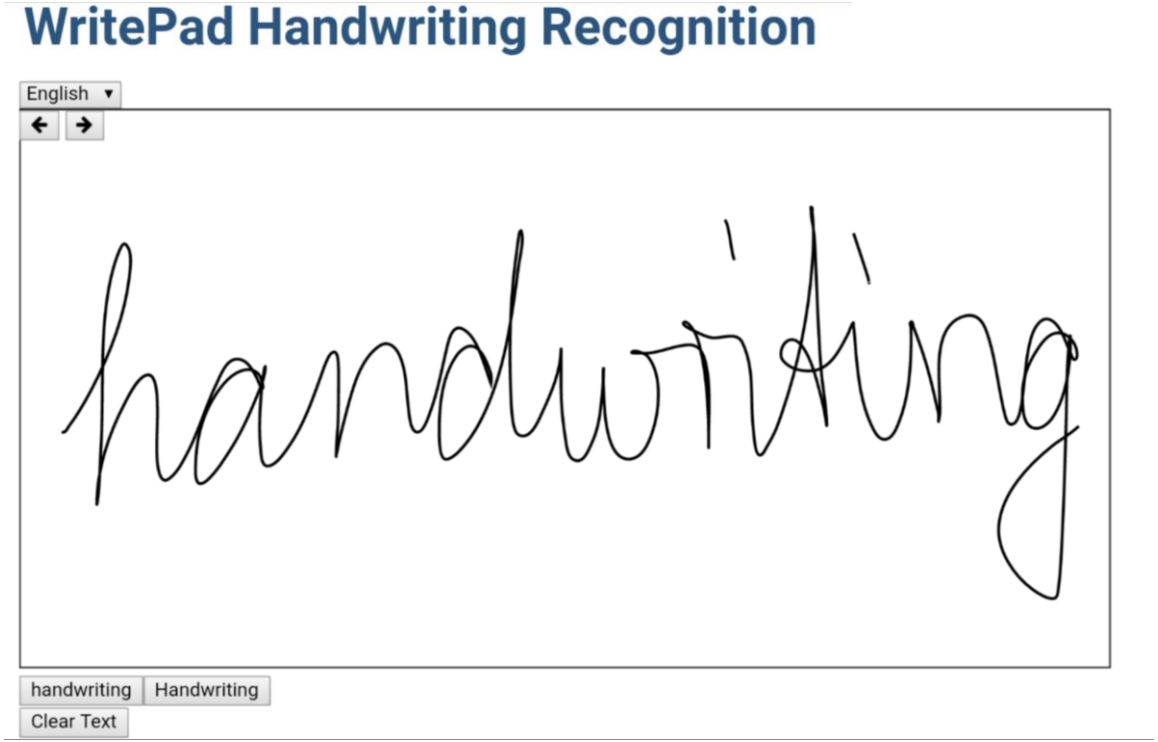
Examples



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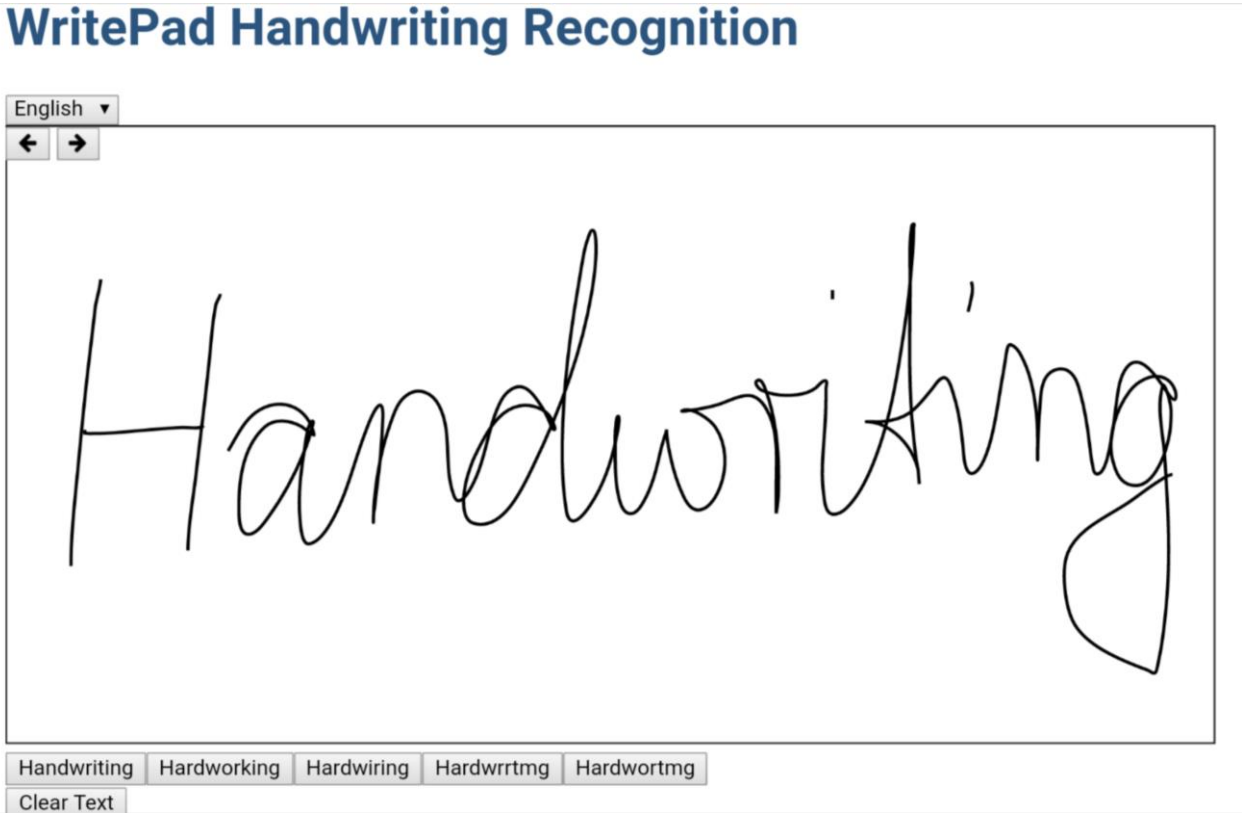
Examples



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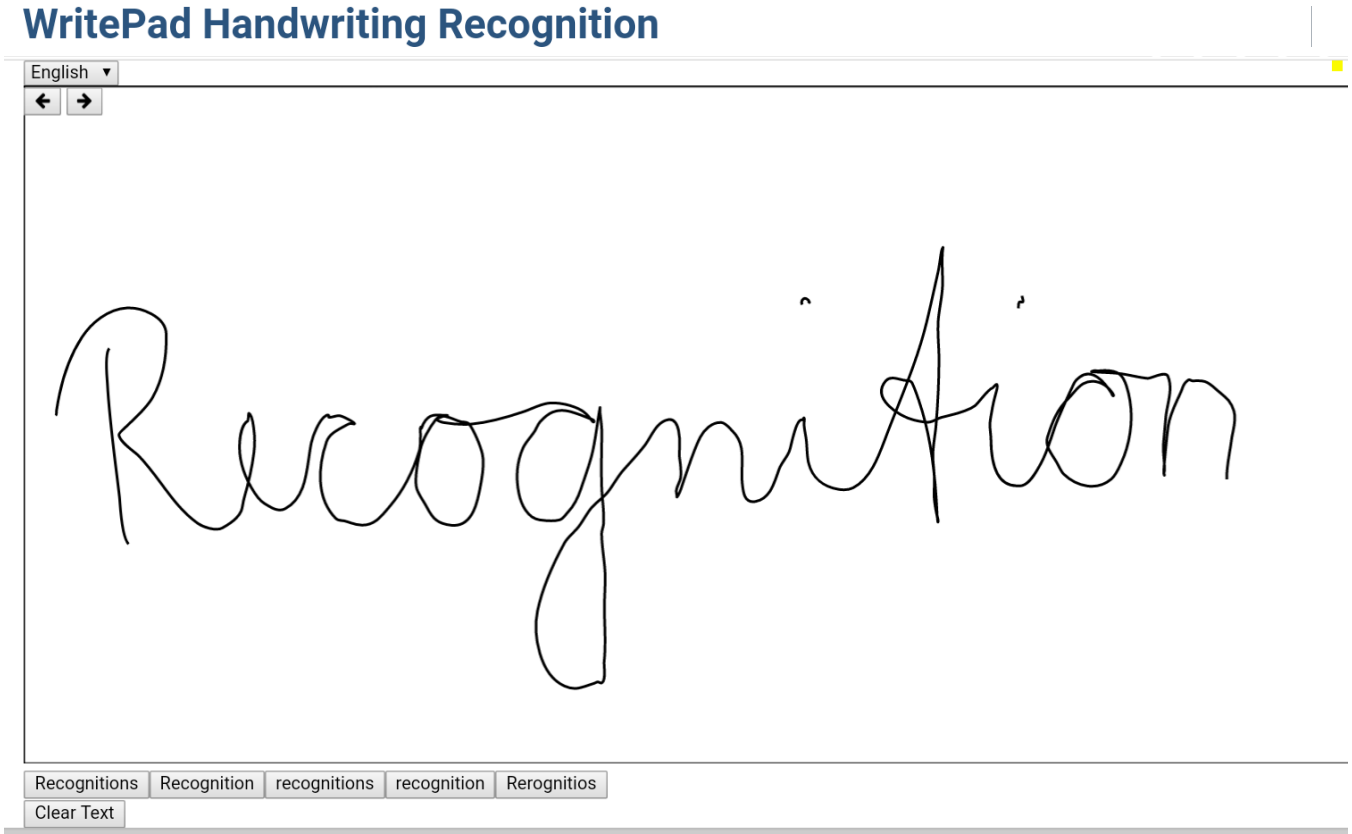
Examples



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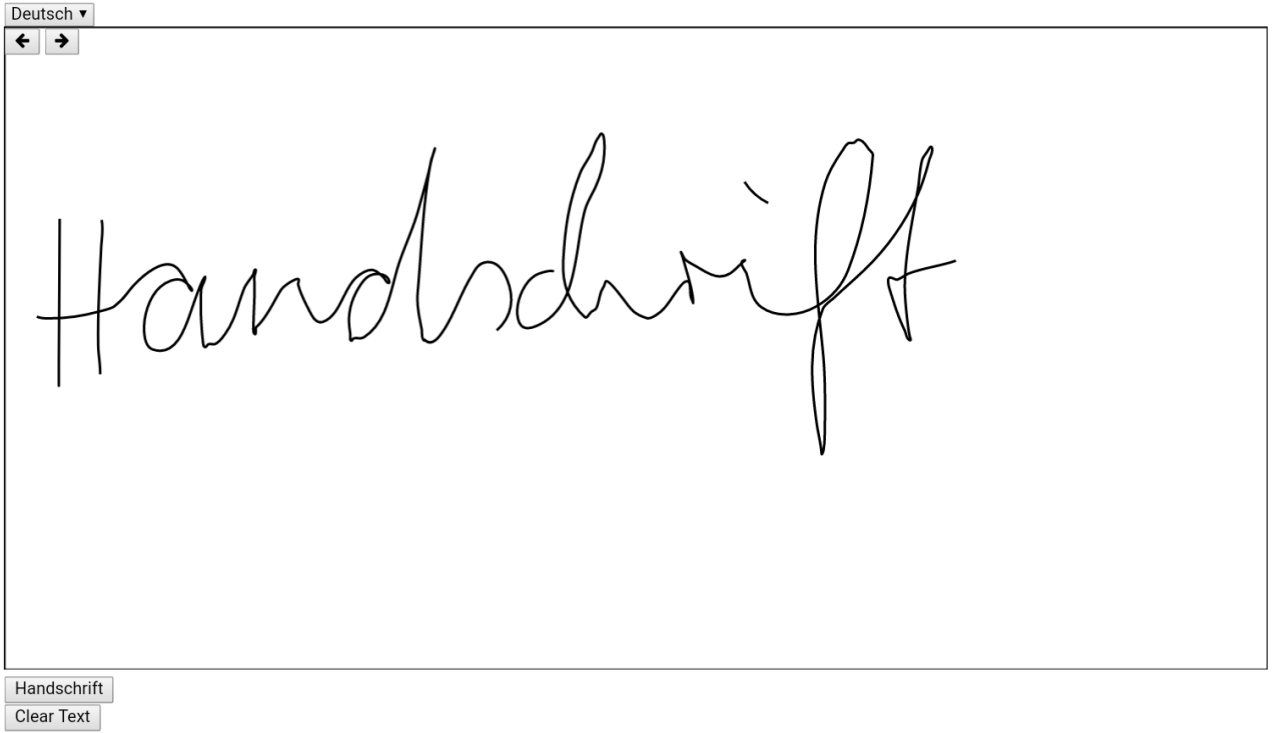
Examples

WritePad Handwriting Recognition



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Examples

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Chart **28**

Examples

WritePad Handwriting Recognition

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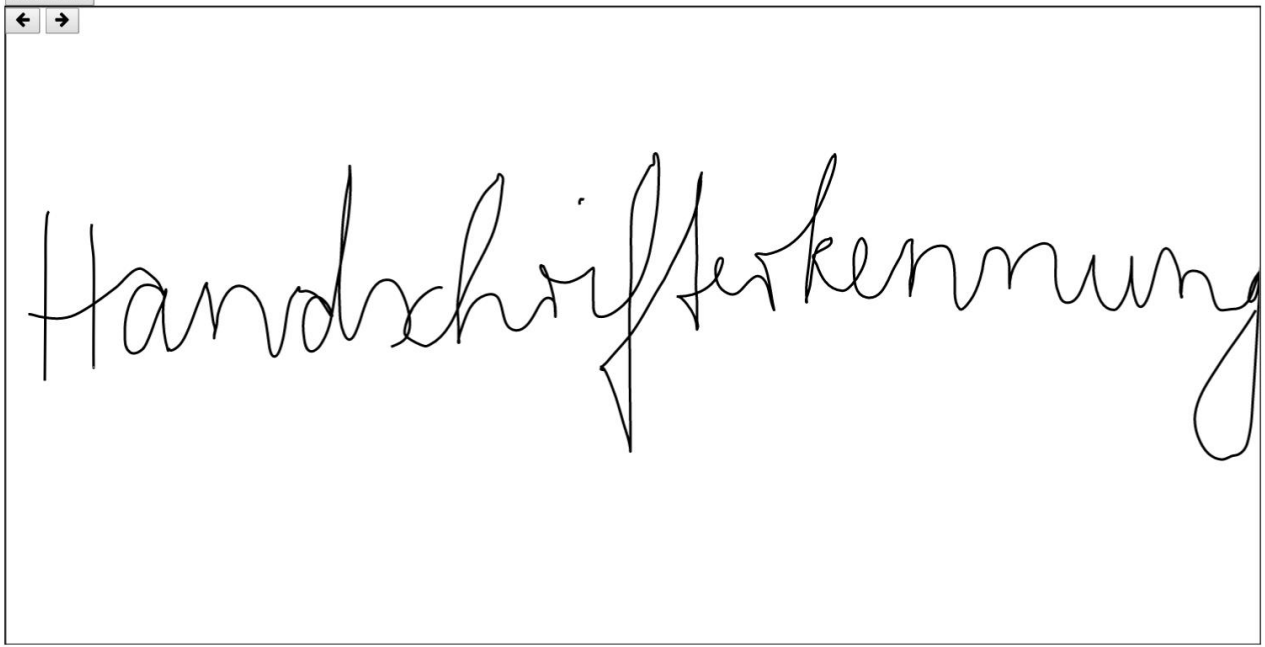
Chart **29**

Examples

WritePad Handwriting Recognition

Deutsch ▾



Armdsehrrffertrenrumg | Armdsehrrfferkenrumg | Aundsehrrfferkenrumg | Aundsehrrffertrenrumg | Arindsehrrfferkenrumg

Clear Text

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Examples

WritePad Handwriting Recognition

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Chart **31**

Examples

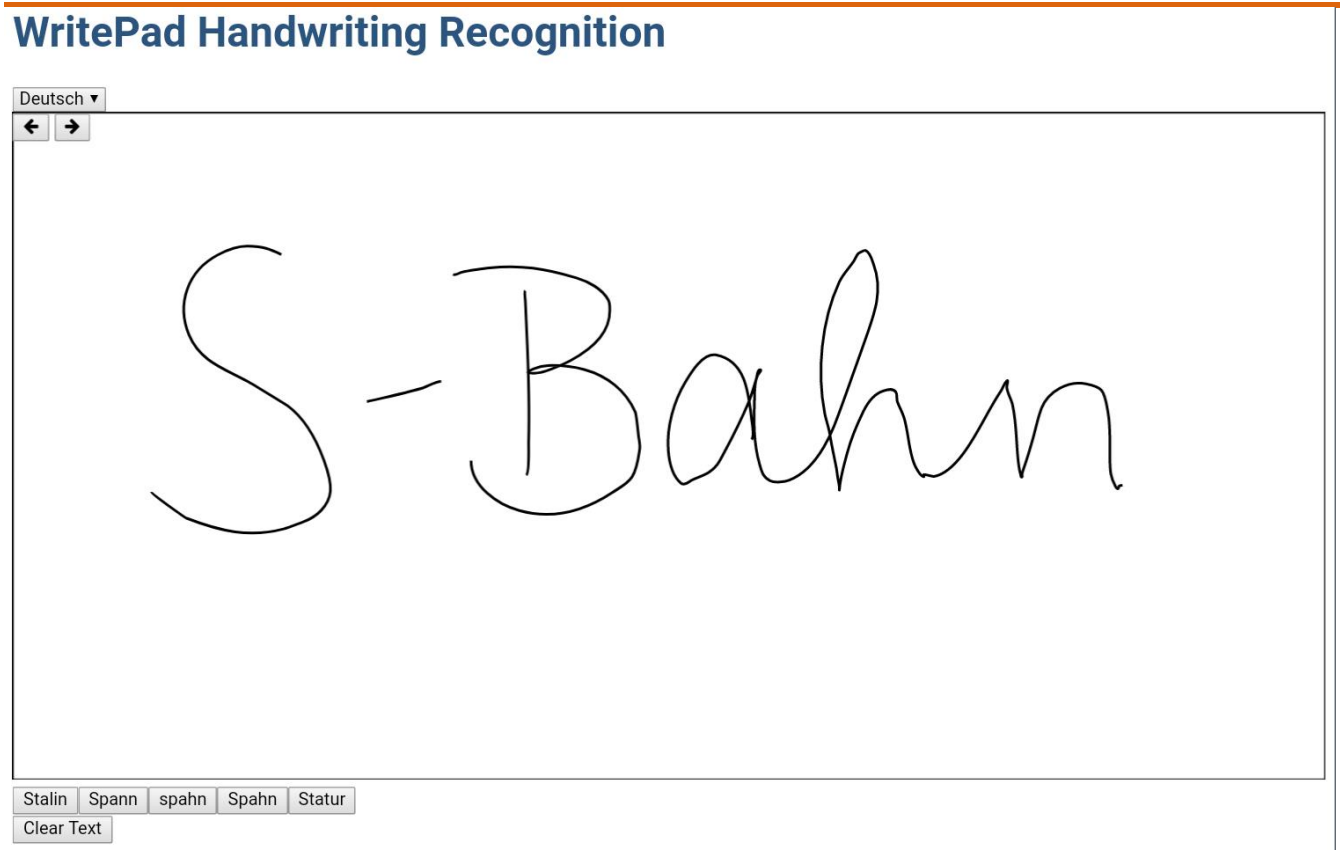

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Chart **32**

Examples

WritePad Handwriting Recognition

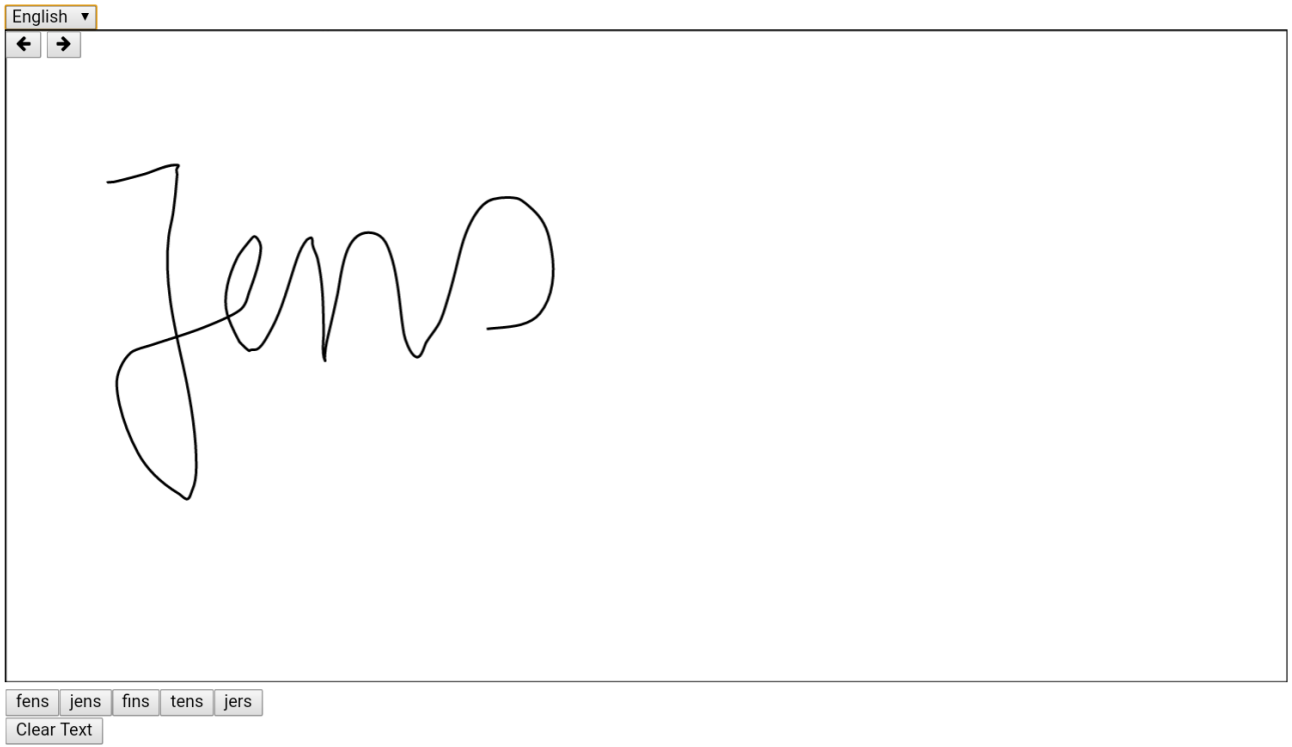

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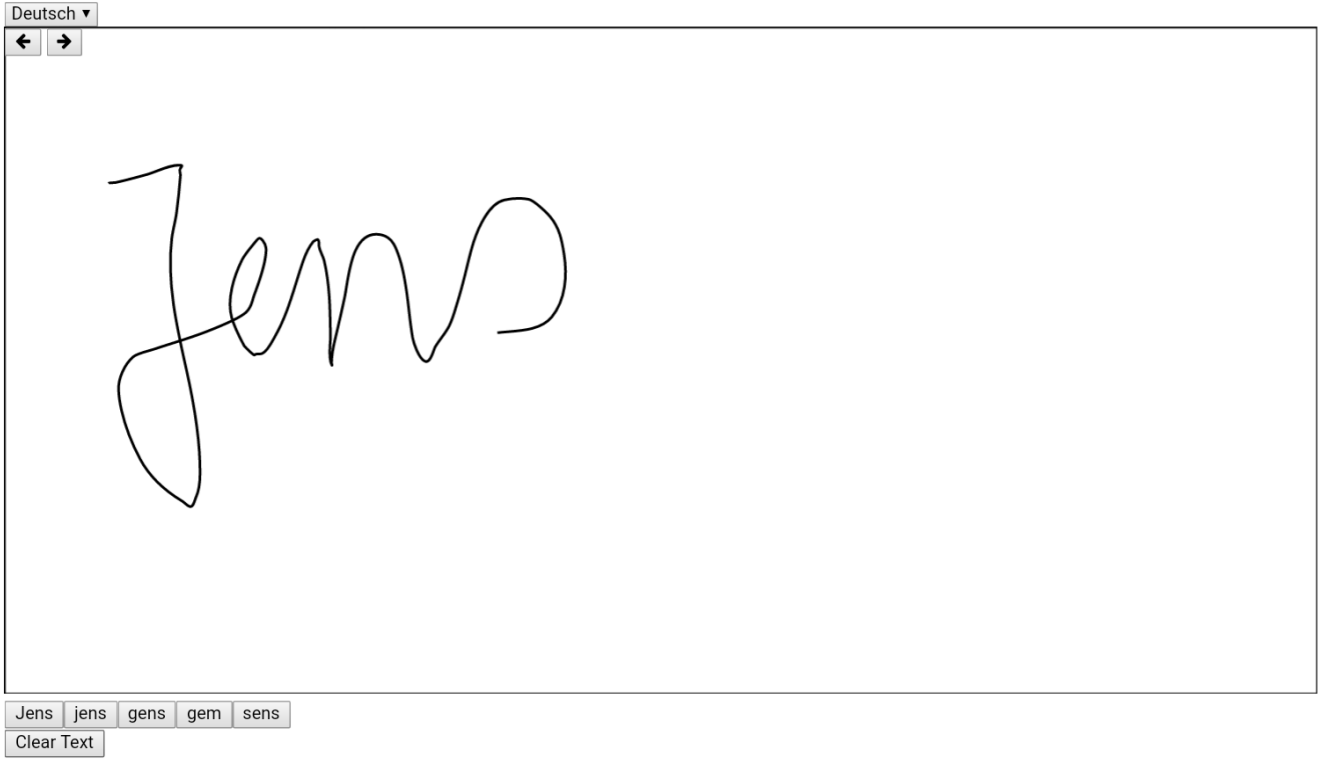
Chart **33**

Examples

WritePad Handwriting Recognition



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Representative image