

# How Not to Translate a Videogame

(using Azure)

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# whoami

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ryandavis.io



rdavis\_au



rdavisau

- essential-interfaces – use DI/mocking with Xamarin.Essentials
- jsondatacontext-linqpad – json data context driver for LINQPad
- sockets-for-pcl, sockethelpers – socket comms in a PCL

(today you should use netstandard sockets why are you all still installing this)

# to cover

- why i wanted to translate a videogame
- building a basic real-time translator
- improving translations with custom translator
- meeting our azure/buzzword quota
- resources

-= how not to translate a videogame =-

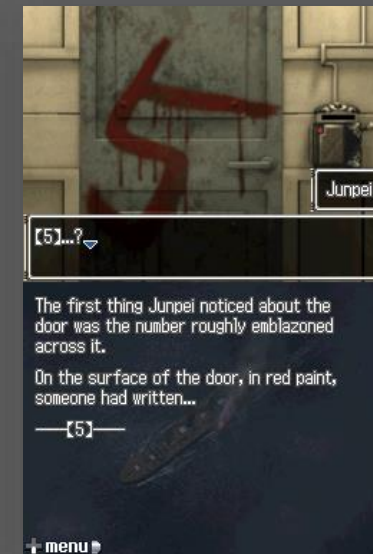
why

# i wanted to play another game like this one

**Nine Hours, Nine Persons, Nine Doors**  
2009, Spike Chunsoft / Aksys



- “Visual Novel” – like a choose your own adventure book with graphics, music and sound
- Multiple routes and endings
- Sci-fi, supernatural themes, crazy twists





# the infinity series

The internet recommended **Ever17**, the second game in the 'Infinity' series.



**Never7**

(KID, 2000)

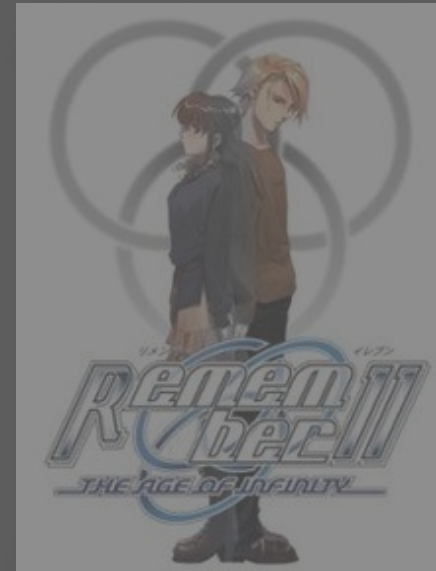
Fan Translated



**Ever17**

(KID / 5PB, 2002)

Officially Translated



**Remember11**

(KID, 2004)

Fan Translated

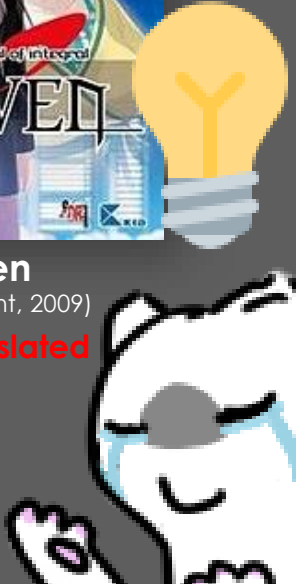


**12Riven**

(KID/CyberFront, 2009)

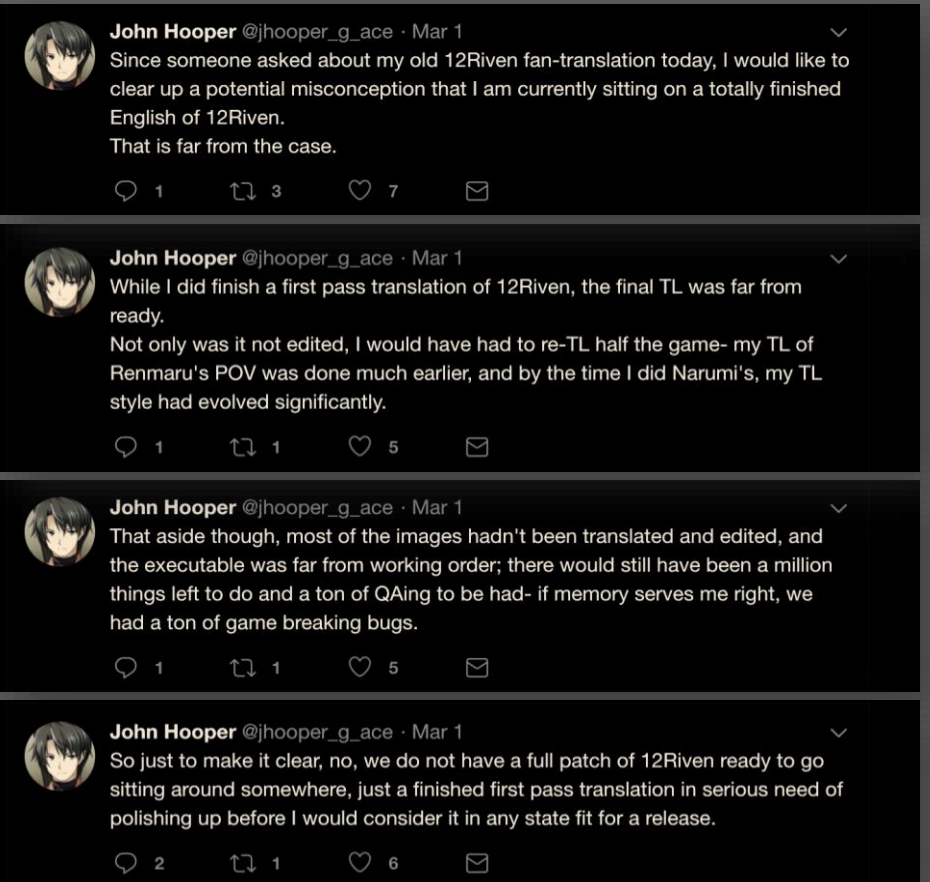
Never Translated

I decided I'd play the whole series, but tragically...



# how to translate a video game

- ✓ Extract the script from the game data files
- ✓ Have someone fluent in the source and target languages translate the script:
  - ✓ Account for puns
  - ✓ Account for cultural references and jokes
  - ✓ Employ a consistent tone
- ✓ Re-insert the translated script into the game
- ✓ Patch aspects of the game that made assumptions about the language
  - ✓ Fixed width font
  - ✓ Hardcoded character limits / timing assumptions



\* See the mother3 fan translation blog (link in resources) for just how crazy patching in a translation can be.

-= how not to translate a videogame -=

# building a basic translator



# our approach



**PPSSPP**

Emulate the game



**LINQPad / C#**

Capture frames, "Detect" text



**Azure Computer Vision OCR API**

Recognise characters



**Azure Text Translate API**

Translate text



迷いはなかった。ただ盲目的にそこに記された内容を信じていた。



迷いはなかった。ただ盲目的にそこに記された内容を信じていた。



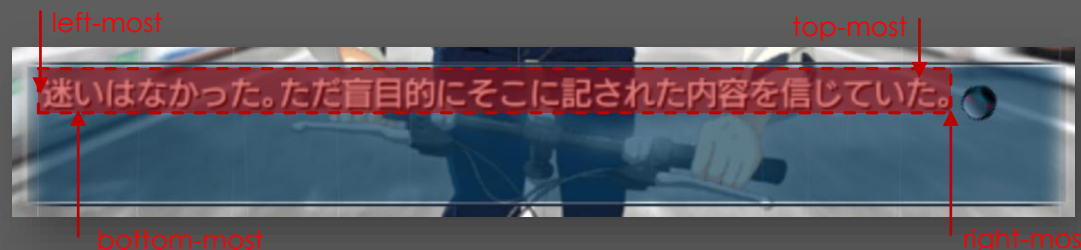
I didn't have any hesitation.  
I just blindly believed in what was written there.

# extracting the text

We can use simple, targeted techniques to effectively identify text-containing parts of the screen.



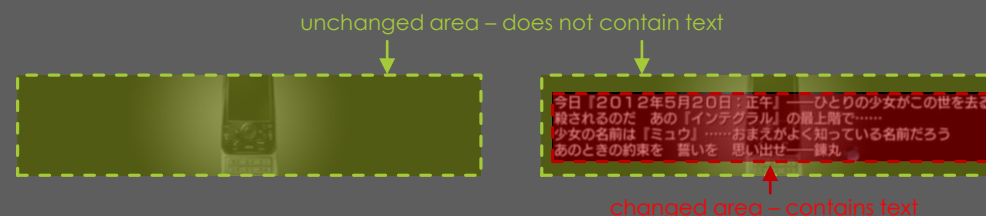
“Adventure Mode”



Find top-most, bottom-most, left-most and right-most white pixels within the known boundaries of the message dialog.



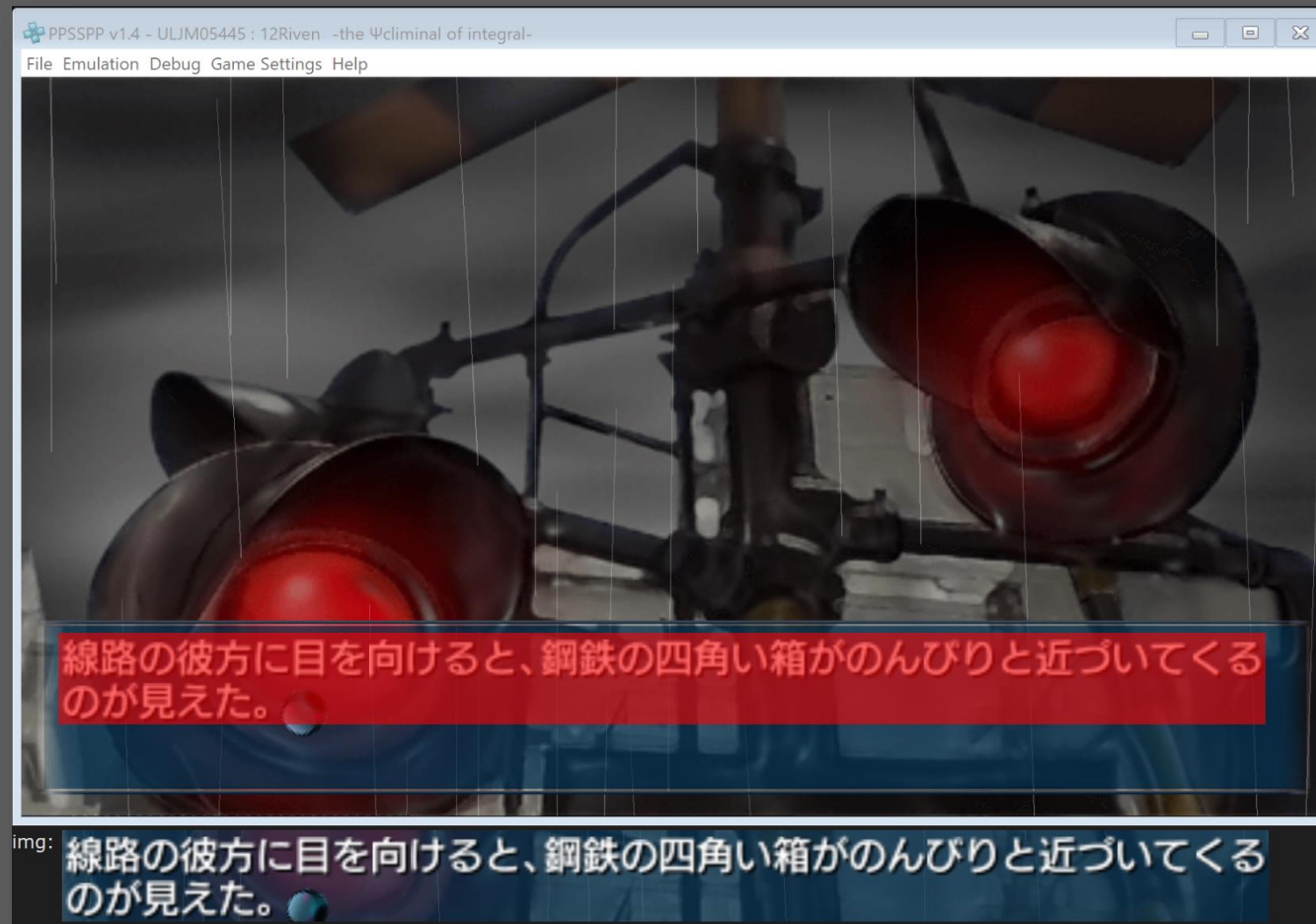
“Story Mode”  
(not implemented)



Capture 'textless' screen and diff subsequent frames to determine the location of text using the boundaries of the changed area

In both cases we need to detect when text has finished 'typing out' before requesting OCR.

# extracting the text – demo



# extracting the text – improvements

- Improve processing speed
  - Use unmanaged bitmap access
- Reduce time to detect stabilisation
  - Make message dialogue window opaque
  - Mask out 'cursor' when detecting changes between frames

# recognising the characters – options

Azure currently has two classes of OCR services available for character recognition tasks:

## Old Busted

“OCR” API

- Uses an ‘earlier recognition model’
- Synchronous API
- Supports 25 languages and automatic language detection.



## New Shiny

“Read” API  
“Recognise Text” API

- Based on ‘Updated recognition models’
- Asynchronous APIs
- Still in preview
- English only (currently)

Given we need to recognise Japanese text, we’ll use the OCR API.



# recognising the characters – OCR API

## Key Features

- Recognises text in 25 languages
- Supports orientation and rotation detection
- Detects multiple regions of text if present
- Returns comprehensive information about the position and size of detected characters

## Pricing

INSTANCE	RATE LIMIT	PRICE
Free - Web/Container	20 per minute	5,000 transactions free per month
S1 - Web/Container	10 TPS	0-1M transactions — \$2.06 per 1,000 transactions 1M-5M transactions — \$1.373 per 1,000 transactions 5M-10M transactions — \$0.893 per 1,000 transactions 10M-100M transactions — \$0.893 per 1,000 transactions 100M+ transactions — \$0.893 per 1,000 transactions

## Sample Request

POST

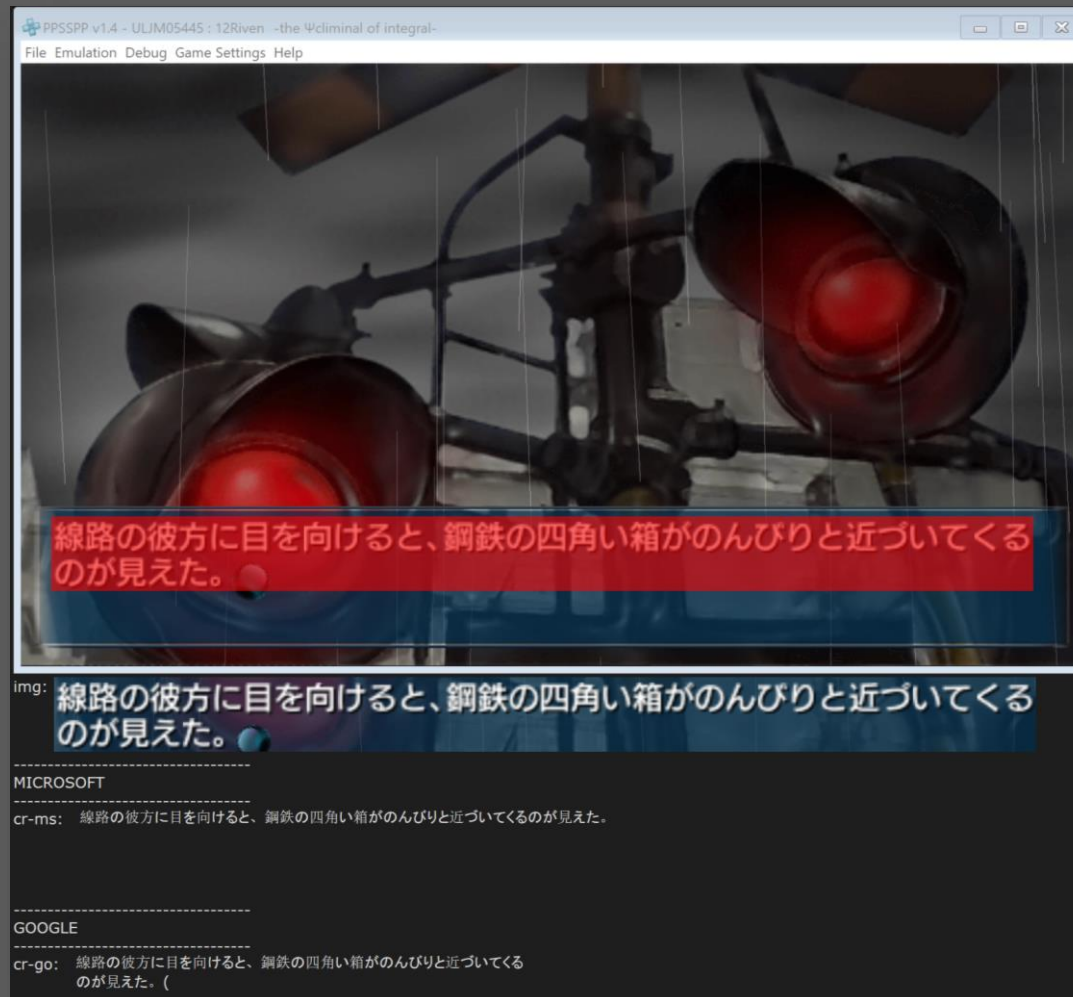
`api.cognitive.microsoft.com/vision/v1.0/ocr`



## Sample Response

```
{ "language": "ja",  
  "textAngle": 0.0, "orientation": "Up",  
  "regions": [  
    { "boundingBox": "8,6,772,51",  
      "lines": [  
        { "boundingBox": "8,6,772,51",  
          "words": [  
            {  
              "boundingBox": "8,10,47,43",  
              "text": "い"  
            },  
            {  
              "boundingBox": "62,7,45,48",  
              "text": "き"  
            },  
            ... etc.  
          ]  
        }  
      ]  
    }  
  ]  
}
```

# recognising the characters – demo



# recognising the characters – improvements

- Use “Recognise Text” / “Read” API once out of preview

- Use Google OCR instead

# translating the text – text translate API

## Key Features

- Supports 64 languages and automatic language detection
- Multi input and output translation and transliteration
- Profanity marking and/or filtering
- Translation of HTML/markup content
- v3 introduces Neural Machine Translation (NMT)  
41 languages supported currently

## Sample Request / Response

### POST

[api.cognitive.microsofttranslator.com/translate?api-version=3.0&to=en](https://api.cognitive.microsofttranslator.com/translate?api-version=3.0&to=en)

```
[
  {
    "Text": "とっさにブレーキを絞った"
  }
]
```



```
[
  {
    "detectedLanguage": { "language": "ja", "score": 1.0 },
    "translations": [
      {
        "text": "I squeezed the brakes momentarily",
        "to": "en"
      }
    ]
  }
]
```

INSTANCE	PRICE
Free	2M chars of any combination of standard translation and custom training free per month
S1	\$13.73 per million chars of standard translation
S2	\$2,821.52/month Up to 250M chars per month Overage: \$11.29 per million chars

+S3, +S4

# translating the text – SMT vs NMT

Text Translate is moving from Statistical (SMT) to Neural (NMT) Machine Translation techniques. Both techniques do not translate individual words, rather words in a broader context.

## Statistical Machine Translation

- Standard technique used by machine translation providers for the last 10 years
- Uses advanced statistical techniques and large reference bodies of human-translated sentences to determine the likely best translation of a word, given words around it
- Limited context (3 – 5 surrounding words)
- Accuracy / performance has plateaued in the last decade.

## Neural Machine Translation

- Utilises advances in ML and deep learning techniques over the last few years
- Defines words as a feature vector of 500 concepts, specific to source/target language pair
- Encodes inputs as a 1,000 dimension vector (500 features representing the word + 500 representing its position in relation to words in the sentence - refined over several layers)
- Final vector used to select best translation from reference set, and next word to process
- Allows much broader context of surrounding words to inform the translation.



# translating the text – demo

PPSSPP v1.4 - ULJM05445 : 12Riven - the 'climinal of integral-

File Emulation Debug Game Settings Help



線路の彼方に目を向けると、鋼鉄の四角い箱がのんびりと近づいてくるのが見えた。

img: 線路の彼方に目を向けると、鋼鉄の四角い箱がのんびりと近づいてくるのが見えた。

MICROSOFT

cr-ms: 線路の彼方に目を向けると、鋼鉄の四角い箱がのんびりと近づいてくるのが見えた。  
en-ms: Look beyond the line and square steel box coming slowly appeared.

MICROSOFT (w/google OCR)

cr-go: 線路の彼方に目を向けると、鋼鉄の四角い箱がのんびりと近づいてくるのが見えた。  
en-ms: Look beyond the line and square steel box coming slowly appeared.  
(

GOOGLE

cr-go: 線路の彼方に目を向けると、鋼鉄の四角い箱がのんびりと近づいてくるのが見えた。  
en-go: Looking at the other side of the track, I saw a square box of steel coming close. (

# translating the text – improvements

📌 — Use Google translate instead

- Use the **includeAlignment** and **includeSentenceLength** parameters to increase the amount of context provided to the translation algorithm.

○ **alignment** : An object with a single string property named **proj**, which maps input text to translated text. The alignment information is only provided when the request parameter **includeAlignment** is **true**. Alignment is returned as a string value of the following format: `[[SourceTextStartIndex]:[SourceTextEndIndex]-[TgtTextStartIndex]:[TgtTextEndIndex]]`. The colon separates start and end index, the dash separates the languages, and space separates the words. One word may align with zero, one, or multiple words in the other language, and the aligned words may be non-contiguous. When no alignment information is available, the alignment element will be empty. See [Obtain alignment information](#) for an example and restrictions.

○ **sentLen** : An object returning sentence boundaries in the input and output texts.

- **srcSentLen** : An integer array representing the lengths of the sentences in the input text. The length of the array is the number of sentences, and the values are the length of each sentence.
- **transSentLen** : An integer array representing the lengths of the sentences in the translated text. The length of the array is the number of sentences, and the values are the length of each sentence.

Sentence boundaries are only included when the request parameter **includeSentenceLength** is **true**.

- Train a custom model using Azure Custom Translator

-= how not to translate a videogame -=

# building a custom translator

# why custom translate?

- Azure Text Translate models are trained and tested over a huge range of translation data and are optimised to perform well in the general case
- Many domains involve biases not reflected by or even trained on by the general case
- Azure provides a service that allows us to create a specialised translation model that includes domain bias – Custom Translator
- Maybe 12Riven still could be playable...



# custom translator

## Key Features

- Train and deploy models based on translations you that you provide
- Easy to use online portal with workspace sharing/collaboration options + an API that exposes upload, training and deployment
- Automatically performs 'alignment' on provided translations
- Provides a mechanism for you to assess the lift in domain relevance that your trained models provide (BLEU score)
- Supercedes the SMT-based Microsoft Translator Hub product

INSTANCE	PRICE
Free	2M chars of any combination of standard translation and custom training free per month
S1	<div>\$54.92 per million chars of custom translation</div> <div>\$13.73 per million source + target chars of training data (max. \$411.90/training)</div> <div>\$13.73 per hosted custom translation model per region, per month</div>
C2	<div>\$2,822/month</div> <div>Up to 62.5M chars per month</div> <div>Overage: \$45.15 per million chars</div> <div>\$11.29 per million source + target chars of training data (max. \$411.90/training)</div> <div>\$13.73 per hosted custom translation model per region, per month</div>

+C3, +C4



upload translation pairs



train and assess model



deploy model



consume



# sourcing translated content

- Custom translate requires at least 10,000 source -> target translation pairs
- **Fortunately**, the raw fan translation of Remember11 (3<sup>rd</sup> game in the series) was left on tlwiki.org - **perfect**
  - Many similarities in concepts between both games
  - Same author wrote both scripts
  - This could be good
- **Unfortunately**, tlwiki.org went down sometime last year and never came back up
- **Fortunately**, I first had the idea to try this a year or two back and had already scraped the site, I found the working files on an old laptop.



# preparing translated content

- R11 fan translation separated into chapters -> scenes -> text boxes - approx 36K pairs
- Contains **noise** and **control codes**, but is **already aligned** due to the nature of the game
- Straightforward to transform this into a format that Custom Translate can use.

Day 1	Day 2
<a href="#">R11:CO1_01.txt</a>	<a href="#">R11:CO2_01.txt</a>
<a href="#">R11:CO1_02.txt</a>	<a href="#">R11:CO2_02.txt</a>
<a href="#">R11:CO1_03.txt</a>	<a href="#">R11:CO2_03.txt</a>
<a href="#">R11:CO1_04.txt</a>	<a href="#">R11:CO2_04.txt</a>
<a href="#">R11:CO1_05.txt</a>	<a href="#">R11:CO2_05.txt</a>
<a href="#">R11:CO1_06.txt</a>	<a href="#">R11:CO2_06.txt</a>
<a href="#">R11:CO1_07.txt</a>	<a href="#">R11:CO2_07.txt</a>
<a href="#">R11:CO1_08.txt</a>	<a href="#">R11:CO2_08.txt</a>
<a href="#">R11:CO1_09.txt</a>	<a href="#">R11:CO2_09A.txt</a>
<a href="#">R11:CO1_10.txt</a>	<a href="#">R11:CO2_09B.txt</a>
<a href="#">R11:CO1_11.txt</a>	<a href="#">R11:CO2_10.txt</a>
<a href="#">R11:CO1_12.txt</a>	<a href="#">R11:CO2_11.txt</a>
<a href="#">R11:CO1_13.txt</a>	<a href="#">R11:CO2_12.txt</a>

R11:CO2 09A.txt

From TLWiki  
Jump to: [navigation](#), [search](#)

//EDITING NOTE: Any changes to this section must be synchronized with CO2\_01 (bad end).

気がつく。%KSP  
When I came to my senses—

私は暗黒に包まれていた。%KSP  
I was engulfed in darkness.

何も見えない。何も聞こえない。何も匂わない。何も感じない。%KSP  
I couldn't see anything. I couldn't hear anything. I couldn't smell anything. I couldn't feel anything.

『え？ これは……？』%KSP  
"Eh? What...?"

声さえ、出すことができない。%KSP  
I couldn't make a sound. Even my voice was gone.

闇の中に、さらに黒を溶かし込んだような、そんな完全な暗黒の中に私はいた。%KSP  
I found myself in a darkness so total, it was as if an even further blackness had been enfolded into the dark of night.

上下の感覚がない。%KSP  
I had no sense of up or down.

上を向いているのか、下を向いているのか、寝ているのか、起まっているのか、それすらわからない。%KSP  
I didn't know whether I was facing upward, downward, or even if I was awake or asleep.

何も私に触れていない。%KSP  
Nothing was touching me.

無重力の中を漂っているような感じだった。%KSP  
It was as if I was floating in zero gravity.

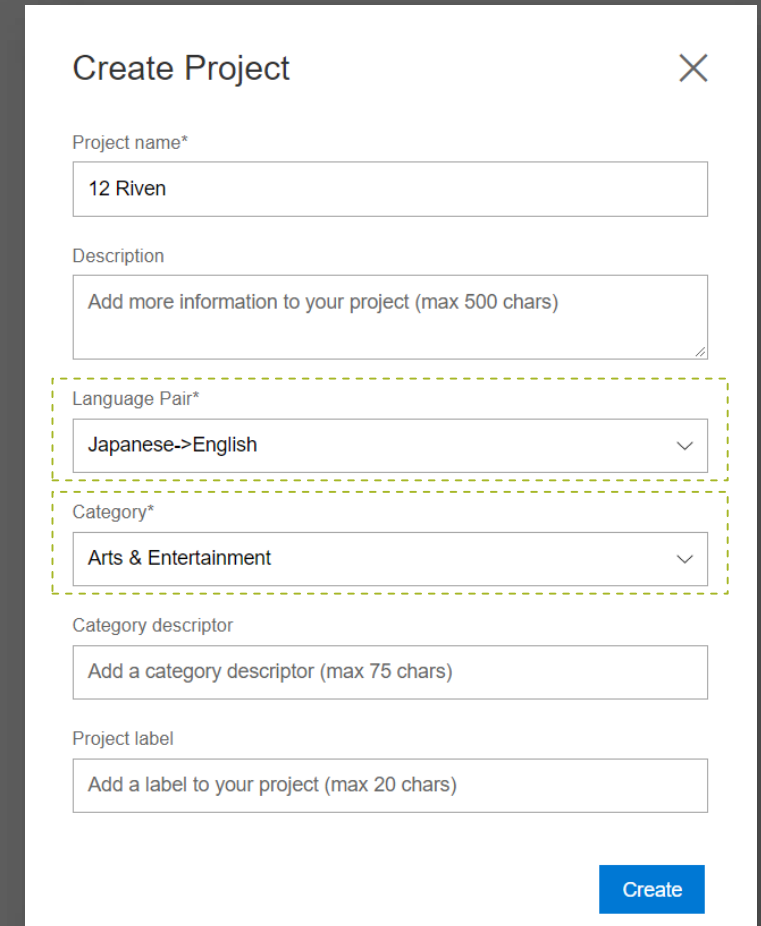
服をまとっている感触がない。%KSP

List<> (3787 items)	
ja	en
あまりの寒さで目が覚めた。	The frigid air woke me.
いつの間にか眠っていたようだ。	It seems I had fallen asleep without realizing it.
自分の体力がかなり落ちていることを思い知らされる。	It felt like I had gotten a lot weaker.
スフィアでの混乱の後、私の意識はすぐに小屋へと戻ってきた。	After the chaos at SPHIA, my consciousness returned to the cabin.
その時にはすでに夜更けが近づいていた。	At that time, it was already late at night.
『眠ると死ぬ』という固定観念があるため、私は眠らずに一夜を過ごすと思っていたのだが……。』	However, since I was fixated on the idea "go to sleep and you'll die," I
結局、何度もウトウトとしては、寒さで目が覚める、ということを繰り返していた。	In the end, no matter how many times I began to doze off, I was awak
時計を見ると、1時半だった。	Looking at my watch, it was half past 1.
眠る前の時間は確認していない。	I couldn't confirm the time before I fell asleep.
昼過ぎだというのは、外はとて暗かった。	Even though it was after noon, it seemed dark and gloomy outside.
太陽がなくなってしまうかのように。	It was as if the sun had disappeared.
私は——%p	I——
窓の外を眺めた	Look out the window
窓に近寄ってみた	Approach the window
私はベッドの上から窓の外を眺めた。	I looked outside from in bed.
すっかり雪がこびり付き、景色はほとんど見えない。	The window was completely frosted over with snow, so the outside sce

R11CO1_01.xlsx	19/11/2017 8:52 PM	Microsoft Excel W...	17 KB
R11CO1_02.xlsx	19/11/2017 8:52 PM	Microsoft Excel W...	15 KB
R11CO1_03.xlsx	19/11/2017 8:52 PM	Microsoft Excel W...	21 KB
R11CO1_04.xlsx	19/11/2017 8:52 PM	Microsoft Excel W...	21 KB
R11CO1_05.xlsx	19/11/2017 8:52 PM	Microsoft Excel W...	9 KB

# creating a custom translation project

- Custom models are hosted within a “Project”, which is linked to an Azure subscription. Custom translator exists outside the Azure portal at [customtranslator.ai](https://customtranslator.ai)
- Projects target a single source/target language pair
- Projects specify a base category, which may influence the behaviour of the model  
(currently only the “Technology” category is modelled differently)
- Projects can be shared between multiple users



The screenshot shows a 'Create Project' form with the following fields:

- Project name\***: Text input containing '12 Riven'.
- Description**: Text input with placeholder 'Add more information to your project (max 500 chars)'.
- Language Pair\***: Dropdown menu showing 'Japanese->English'.
- Category\***: Dropdown menu showing 'Arts & Entertainment'.
- Category descriptor**: Text input with placeholder 'Add a category descriptor (max 75 chars)'.
- Project label**: Text input with placeholder 'Add a label to your project (max 20 chars)'.

A blue 'Create' button is located at the bottom right of the form.

# uploading reference documents

- Uploading documents via the portal is intuitive enough for ordinary users to perform

Projects > 12R

Category ID: [REDACTED] -ARTSENT

Language Pair: Japanese - English

Category: Arts & Entertainment

[Edit project](#)

Data Models

Create model Upload files

<input type="checkbox"/>	Name	Document Pairing	Document Type	Language(s)	Japanese Sentences	English Sentences
<input type="checkbox"/>	CO1	Parallel	Training	Japanese - English	3,266	3,266
<input type="checkbox"/>	CO2	Parallel	Training	Japanese - English	2,950	2,950
<input type="checkbox"/>	CO3	Parallel	Training	Japanese - English	2,364	2,364
<input type="checkbox"/>	CO4	Parallel	Training	Japanese - English	2,647	2,647
<input type="checkbox"/>	CO5	Parallel	Training	Japanese - English	3,787	3,787
<input type="checkbox"/>	CO6	Parallel	Training	Japanese - English	939	939

The portal displays a summary of uploaded document/document pairs and their contents.

Upload Files ×

\*Maximum file size allowed is 100MB

Document Type: Training

Language Pair: Japanese->English

☐ Override document if it exists

Parallel Data

Source (ja) file:

Target (en) file:

.TXT|.HTML|.HTM|.PDF|.DOCX|.ALIGN file required.

Document Name:

or

Archive or Translation Memory File

Archive or TM File:

.TMX|.XLF|.XLIFF|.LCL|.XLSX|.ZIP file required.

← You can explicitly specify whether to use a document for training, testing or tuning.

If not, custom translator will automatically withhold portions of training documents for testing and tuning purposes.

↖ You can upload parallel documents for custom translator to align.

↙ Or, you can upload a single, pre-aligned document.

Users can upload parallel documents or aligned documents in various formats.

# training a custom model

- A model can be trained on all or a subset of uploaded documents, and takes minutes
- Trained models include a BLEU score, giving a quantifiable/comparable indication of lift
- It's possible to view the outputs of the model against sentences in the test set
- Evaluating model effectiveness is important because deploying incurs immediate cost

Projects > 12R

Category ID: ARTSENT

Language Pair: Japanese - English

Data Models

Create model Upload files

✓ 17 documents selected, 35066 training sentences selected

<input checked="" type="checkbox"/>	Name	Document Pairing	Document Type	Japanese Sentences	English Sentences
<input checked="" type="checkbox"/>	CO1	Parallel	Training	3,266	3,266
<input checked="" type="checkbox"/>	CO2	Parallel	Training	2,950	2,950
<input checked="" type="checkbox"/>	CO3	Parallel	Training	2,364	2,364

Select documents to train

Projects > 12R > R11 Script

Bleu score: ▲ 25.85

Baseline bleu score: 17.27

Japanese - English

Edit model

View BLEU lift

ref.txt - Notepad

I didn't know where it was.  
No, I'll tell you later.  
I set my freezing feet in motion and started to walk.  
I used the gathered luggage and blankets and such to s  
gaping holes in the airframe.  
Without enough time to give even a baby's first cry—  
There was no wind, and the sun hanging in the western  
bright sunlight down at us.  
I couldn't feel pain anymore.  
Y, Yeah, I got it...  
Of course, I couldn't recall ever having met her.  
If I can't reach Satoru's room....  
I returned my eyes to Enomoto's corpse.  
Not only space, but the time axis differs as well.  
Isn't there a court to the east of the building?  
"I said it's fine, so..."  
The murderous aura she now emanated was no different f

custom.mt.txt - Notepad

I didn't know where it was.  
No, I'll tell you about this later.  
I began to walk, moving my freezing feet.  
I opened the gaping hole in the fuselage, and blocked it with a  
blanket and blankets.  
I couldn't even afford to cry --  
There was no wind, and the sun leaning toward the west was giving  
off an intense ray of light.  
There was no pain any longer.  
Ah, yeah, I understand...  
Of course, I didn't recognize her.  
If I hadn't habitat to Satoru's room like this....  
I glanced Enomoto's corpse again.  
The axes are different, not only the space, but also the time.  
There was a coat on the east of the building, wasn't it?  
"That's fine, because I said..."  
That kind of thing won't change any more than the mentally

View outputs against the test set



# deploying a custom model

- A trained model can be deployed with one click:

Data		Models								
Name	Status	Modified Date	Bleu Score	Baseline Bleu Score	Training	Dictionary	Tuning	Test	Model Action	
R11 Script	Trained	2019-02-23	▲ 25.85	17.27	29,533	0	1,636	1,554	<button>Deploy</button>	

This button costs \$13.73 per click

- Once deployed, a custom model can be used via the standard Text Translate API, by providing the appropriate **categoryId** as a query parameter:

## POST

[api.cognitive.microsofttranslator.com/translate?categoryId=08b1f19-xxxx-xxxx-xxxx-xxxxxxxxxxxx-ARTSENT](https://api.cognitive.microsofttranslator.com/translate?categoryId=08b1f19-xxxx-xxxx-xxxx-xxxxxxxxxxxx-ARTSENT)

# custom translator – demo

# custom translator – improvements

- Review scraped scripts for additional control characters or other errors
- Add scripts from additional translations?

-= how not to translate a videogame -=

adding more azure

# the problem

- We have only included 3 Azure services
- Not enough buzz words
- No time to add blockchain
- Can we add something else?

# 'improving' the experience

- Currently we need to look at the LINQPad window to view translated content - lame
- Lets use Azure Hosted SignalR, Azure App Service, Xamarin.iOS and ARKit to make this ~~even more stupid~~ more user friendly



# 'improved' solution design



**PPSSPP**

Emulate the game



**LINQPad / C#**

Capture frames,  
"Detect" text



**Azure Computer Vision  
OCR API**

Recognise characters



**Azure Text Translate API**

Translate text



Untranslated images

迷いはなかった。ただ盲目的にそこに記された内容を信じていた。

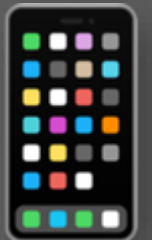
迷いはなかった。ただ盲目的にそこに記された内容を信じていた。

迷いはなかった。ただ盲目的にそこに記された内容を信じていた。

I didn't have any hesitation.  
I just blindly believed in what was written there.



**Hosted SignalR**  
Shuffle bytes



**Xamarin iOS  
+ ARKit**  
Augment Reality

Translated text

# 'improved' solution design

- The LINQPad translator script will forward untranslated images to the app via SignalR, which the app will use as AR Reference Images to detect the untranslated content
- When the app detects the untranslated text in 3D space, it will place a virtual message box over the real one
- When the app receives a translation, it will draw that onto the message box

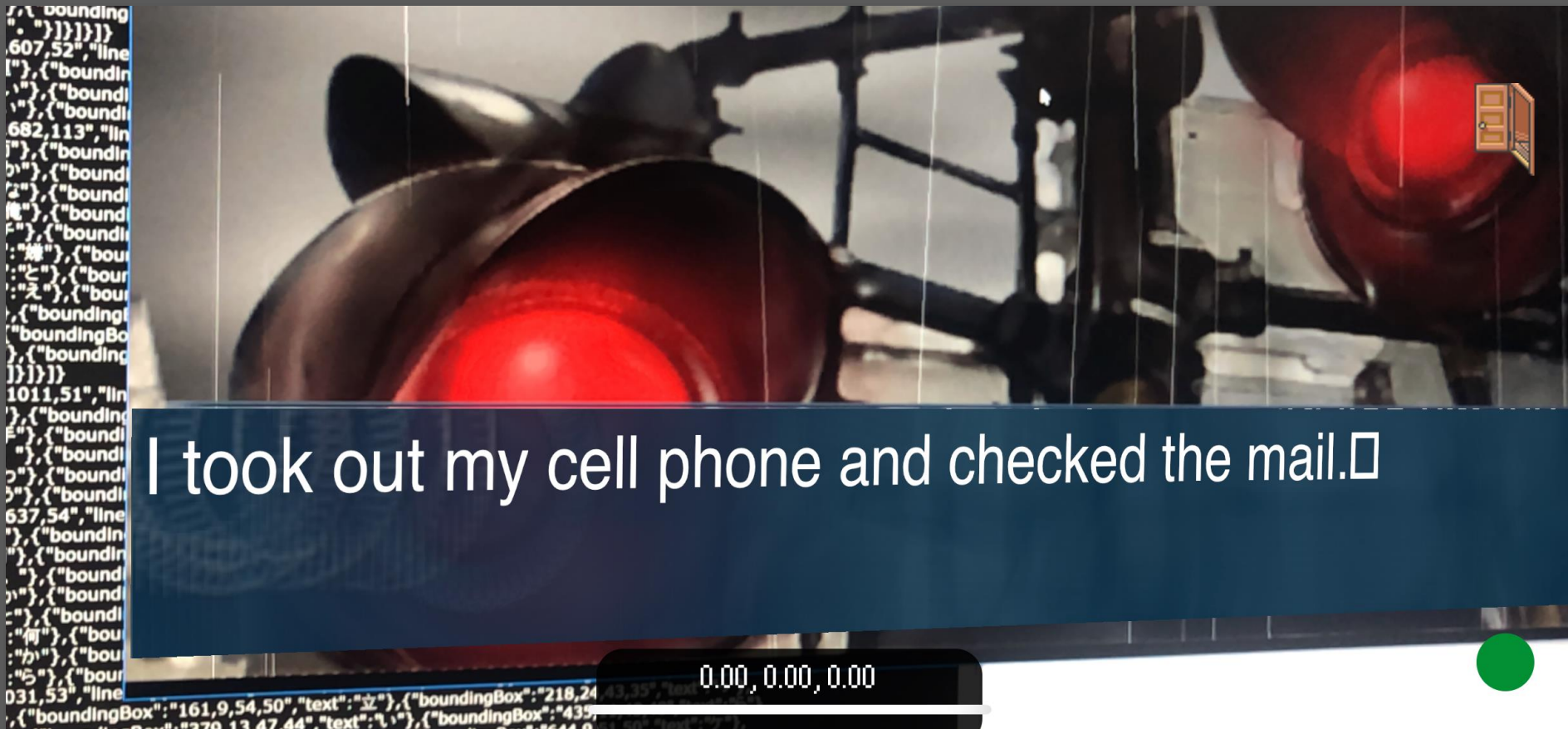
```
1 reference
public class TranslateHub : Hub
{
    1 reference | 0 exceptions
    public Task ExpectTranslation(string guid, byte[] imageData)
        => Clients.All.SendAsync(method: nameof(ExpectTranslation), arg1: guid, arg2: imageData);

    1 reference | 0 exceptions
    public Task CompleteTranslation(string guid, string translation)
        => Clients.All.SendAsync(method: nameof(CompleteTranslation), arg1: guid, arg2: translation);

    1 reference | 0 exceptions
    public Task SendKey(string key)
        => Clients.All.SendAsync(method: nameof(SendKey), key);
}
```

The SignalR hub really is just shuffling bytes,  
but it also gives us multiplayer support for free

# 'improving' the experience – demo



-= how not to translate a videogame =-

wrapping up

# how not to translate a video game

- ✓ Extract the script from the game data files ahead of time
- ✓ Have someone fluent in the source and target languages translate the script:
  - ✓ Account for puns
  - ✓ Account for cultural references and jokes
  - ✓ Employ a consistent tone
- ✓ Re-insert the translated script into the game
- ✗ Scrape game screen to detect and OCR text in realtime
- ✗ Use a machine translation service to translate the script
  - ✗ No awareness or accounting for puns
  - ✗ No awareness of references/jokes
  - ✗ Can robots feel?
- ✗ Display the text in a separate window in 3D space using AR

# How Not to Translate a Videogame

(using LINQPad, Azure OCR, Azure Text Translate, Azure Custom Translator, Azure Hosted SignalR, Azure App Service, Xamarin iOS and ARKit)

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# resources

- **Azure OCR**  
<https://docs.microsoft.com/en-us/azure/cognitive-services/Computer-vision/concept-recognizing-text>
- **Azure Text Translate**  
<https://azure.microsoft.com/en-us/services/cognitive-services/translator-text-api/>
- **Azure Custom Translate**  
<https://customtranslator.ai>
- **Azure Hosted SignalR**  
<https://docs.microsoft.com/en-us/azure/azure-signalr/signalr-overview>
- **Xamarin/ARKit**  
<https://docs.microsoft.com/en-us/xamarin/ios/platform/introduction-to-ios12/arkit2>
- **Infinity Series**  
[https://en.wikipedia.org/wiki/Infinity\\_\(video\\_game\\_series\)](https://en.wikipedia.org/wiki/Infinity_(video_game_series))
- **Mother 3 Fan Translation Notes** (start from the bottom)  
<http://mother3.fobby.net/blog/previews/archives/>

questions / comments