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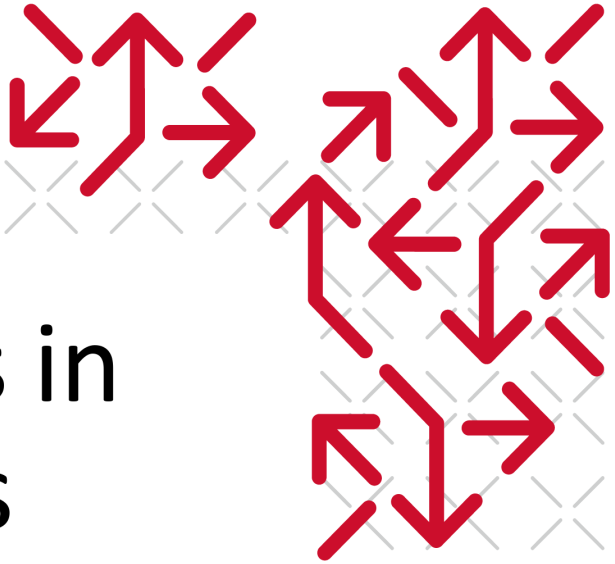

Artificial Voices in Human Choices

SIXTH MILESTONE

DR. CAROLIN KAISER, RENE SCHALLNER

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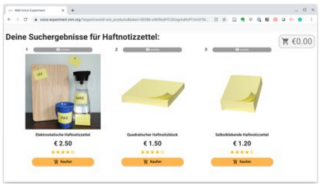

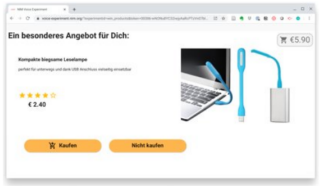

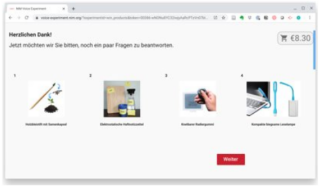

QuestionPro

2

Web Experiment & QuestionPro

TECHNICAL CHALLENGES

3000 participants in 3 parallel experiments on 3 continents

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- **Backend scaling**
  - Handling 3000+ participants in 3 parallel experiments
  - *(scaling work already done at previous milestone)*
- **English speech synthesis**
  - recording training samples
  - fine-tuning 3 emotion models
  - synthesizing speech in 3 emotions simultaneously
- **Translation of experiment to English**
  - voice prompts & questionnaire
  - 3 different currencies, 3 different pricing schemes
- **Additional Features**
  - QuestionPro- and panel-integration
  - Dynamic stimulus assignment
  - Support for all major browsers

- **Greatest challenge #1**
  - **Only 1 month to go!**
  - 3 months planned
  - luckily, we had worked ahead during our last milestone period
  - we still put ca. 3 months worth into 1
- **Greatest challenge #2**
  - **Unexpected complications with QuestionPro**
  - Technical expertise was hard to find
  - We had to take care of things the QuestionPro platform cannot handle
    - e.g. atomic counting
  - *"All browsers must be supported"*

English Speech Synthesis: Recording the Training Samples

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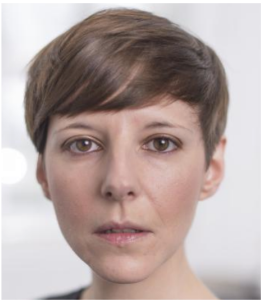
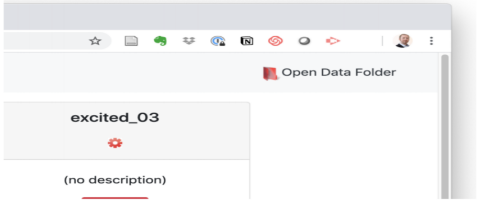
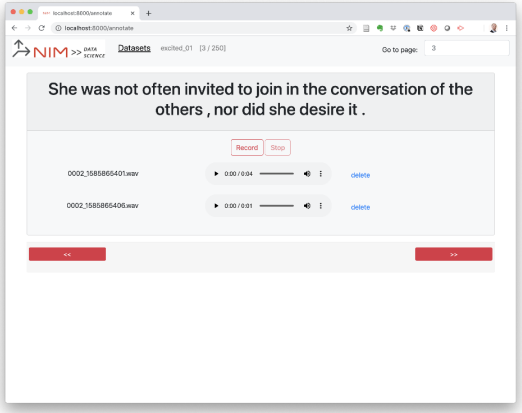


- We hired a professional voice artist
- She recorded **500** sentences from public domain audio books in the 3 target emotions:
  - excited, neutral/happy, uninvolved
- Using our cross-platform recording software ensured an efficient workflow:
  - [SPACE] to start and stop recording
  - [->] and [<-] cursor keys to jump to next / previous sentence
  - Quick-jump to recording:
    - enter recording number and press [ENTER]
    - when resuming recording in mid-dataset after a break
  - Sending the recordings means just zipping a folder that is opened by clicking a link at the top right
- Quality of the recordings was very high --> no post-production steps needed!





English Speech Synthesis: Fine-tuning the Speech Models

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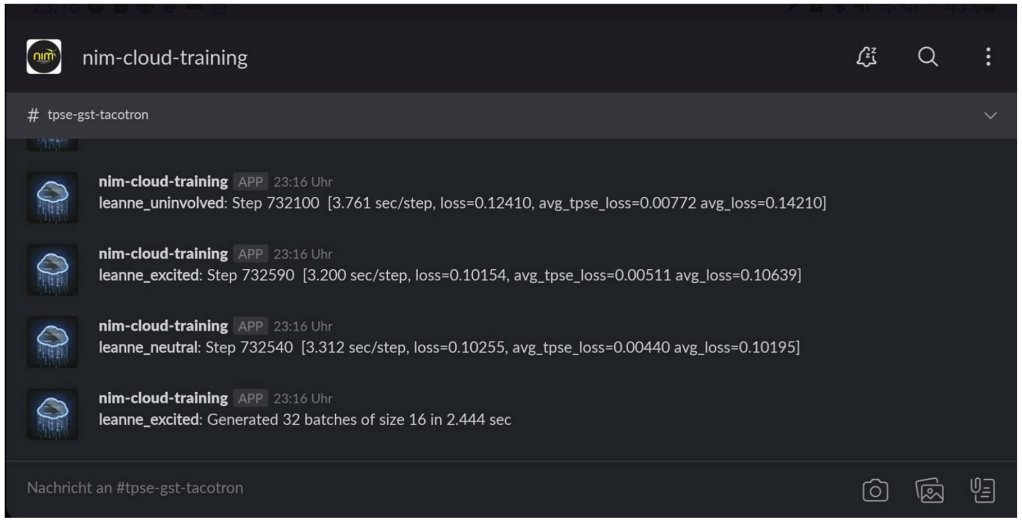
> We set up a 4xP100 GPU VM in the Azure cloud

> Pre-processing yielded the following datasets:
  > excited: 500 sentences, 1.28 hours
  > neutral: 500 sentences, 1.38 hours
  > uninvolved: 500 sentences, 1.43 hours

> We fine-tuned all 3 emotional speech models in parallel for ca **48 hours**
  > for uninvolved, batch-size had to be decreased from 16 to 12 because of GPU RAM limits



> Monitoring and automatic backups:
  > To protect us from losing valuable training progress in case anything goes wrong in the cloud
  > Training progress was live-streamed to our private Slack channel #tpse-gst-tacotron
    > --> we were able to monitor the training on-the-go via smartphone app
  > Model snapshots were uploaded to a private Dropbox folder at every 1000 training iterations
    > --> we would always have the latest snapshot for use or for resuming training on another machine

English Speech Synthesis: Synthesizing Speech in 3 Emotions

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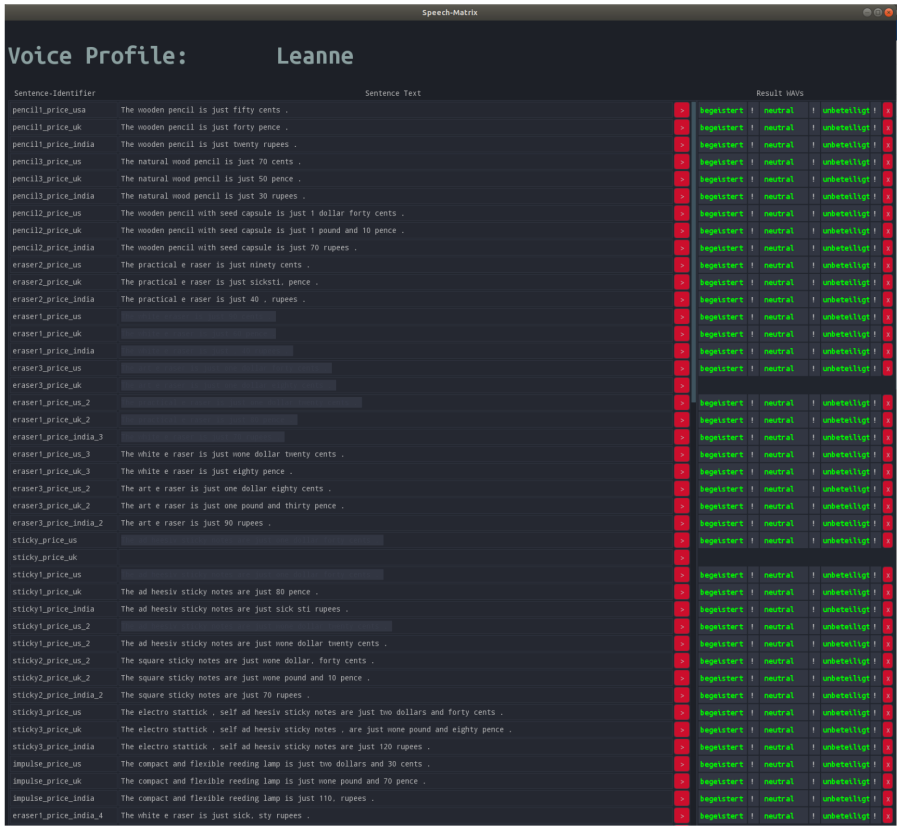
- Using our "speech matrix" tool, we synthesized all sentences in 3 emotions simultaneously on 3 server GPUs:
  - 171 sentences -> audio WAVs:
    - 27 voice prompts x 3 emotions = 81 WAVs
    - 10 prices x 3 emotions x 3 currencies = 90 WAVs

- Azure problems: our 4xP100 training VM "lost" 3 GPUs
  - as with the web server, we moved to Amazon Web Services
  - --> we set up a new VM in AWS with smaller M60 GPUS (like in our workstation) just for synthesis

- Due to high recording quality of training data, the synthesized speech needed ZERO post-production steps. Voice samples could be used as generated!



Integrating our platform with QuestionPro

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- Instead by clicking on an invitation link, participants get re-directed to our platform from QuestionPro - after a short survery.

- In the survey, their age groups and genders are captured.

- These 2 variables, plus the participant's country are sent to us via URL parameters:
  - *https://voice-experiment.nim.org… &custom1=ID&custom2=AGE&custom3=GENDER&custom4=COUNTRY*

- Instead of tokens from a pre-generated token-pool, we use the passed-in ID as tokens.
  - Since we track token usage, a dummy token pool for QuestionPro was set up.
  - This ID is also passed back to QuestionPro when sending the completion notification.

- Since we have 3 experiments, one for each country, the experiment to start is now determined by both the *experiment ID* parameter and the *custom4* parameter from the URL - if the experiment ID starts with *'qpro_'*.

- Our initial questionnaire was shortened, we don't ask for age group or gender anymore.
  - Instead, we save all parameters sent to us by QuestionPro for later use.

QuestionPro mode and support for currencies

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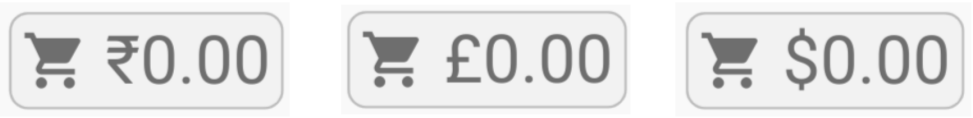
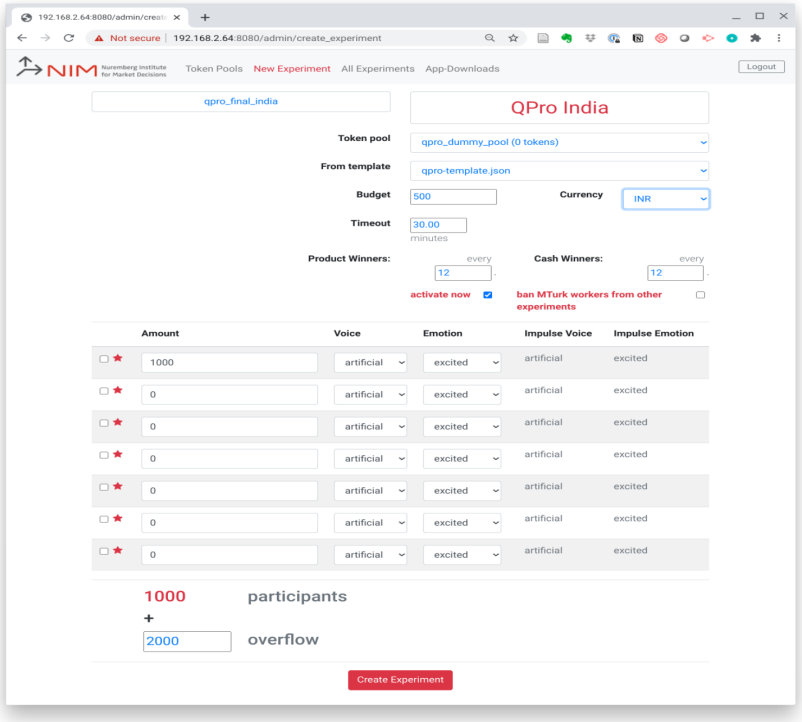
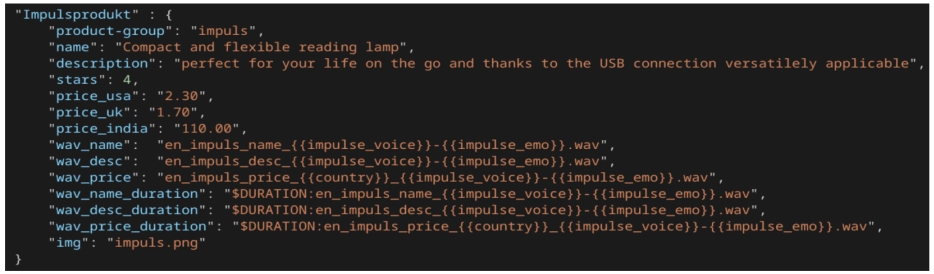
- QuestionPro mode is enabled automatically, if the experiment ID starts with qpro_
- For each country, a separate experiment is created
  - each experiment gets its own currency and budget
  - different prices are coded into the JSON template for QuestionPro experiments
- Note that
  - we use an empty dummy token pool
  - we configure 1000 participants with irrelevant voice (will be assigned dynamically)
- The experiment app displays currency symbols based on the configured currency





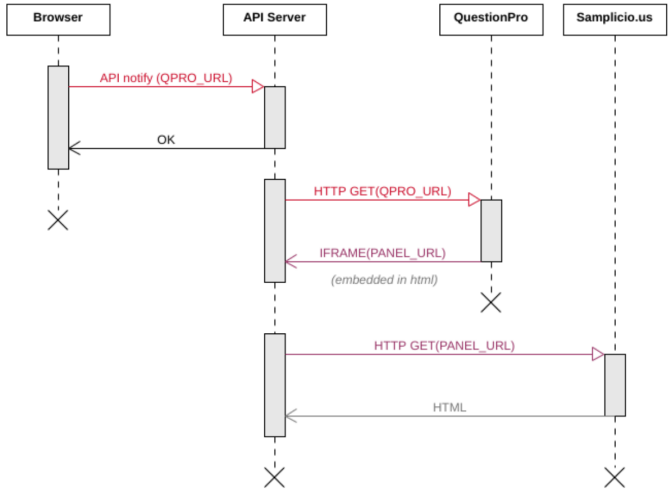


```
"Impulsprodukt" : {
    "product-group": "impuls",
    "name": "Compact and flexible reading lamp",
    "description": "perfect for your life on the go and thanks to the USB connection versatilely applicable",
    "stars": 4,
    "price_usa": "2.30",
    "price_uk": "1.70",
    "price_india": "110.00",
    "wav_name":  "en_impuls_name_{{impulse_voice}}-{{impulse_emo}}.wav",
    "wav_desc":  "en_impuls_desc_{{impulse_voice}}-{{impulse_emo}}.wav",
    "wav_price": "en_impuls_price_{{country}}_{{impulse_voice}}-{{impulse_emo}}.wav",
    "wav_name_duration": "$DURATION:en_impuls_name_{{impulse_voice}}-{{impulse_emo}}.wav",
    "wav_desc_duration": "$DURATION:en_impuls_desc_{{impulse_voice}}-{{impulse_emo}}.wav",
    "wav_price_duration": "$DURATION:en_impuls_price_{{country}}_{{impulse_voice}}-{{impulse_emo}}.wav",
    "img": "impuls.png"
}
```

Notifying QuestionPro

- QuestionPro needs to be informed about the following 3 conditions:
  - **complete**: when a participant finishes successfully
  - **dropout**: timeout after 30min
  - **over quota**: when the experiment is closed because target number of completions has been reached
- QuestionPro use a panel provider:
  - The panel provider needs to be notified, too
  - QuestionPro embed an invisible <iframe> in their HTML to notify samplicio.us

- Our approach to notify QuestionPro and panel
  - API request to our server containing QPro URL
  - for each URL the server acts as a browser and fetches the QPro web page
    - **now QuestionPro is notified**
  - we parse the response from QuestionPro for embedded iframes
  - we take the iframe target URLs and fetch their web page
    - **now the panel provider is notified, too**
  - we store all received HTTP, including headers and status codes in our DB
  - if anything goes wrong, we re-try
  - **==>** we have detailed response logs in the DB from QPro and panel provider requests



Assigning stimuli dynamically

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Challenge: On the web, we have to deal with drop-outs

- **Hamburg:** *for comparison*
  - pre-configured 1000 wanted participants with fixed stimuli (emotions)
  - pre-configured 9000 more dynamic participants with no pre-assigned stimuli
  - For the first 1000 the stimulus is fixed
    - after that, the stimulus is assigned in a round robin fashion, based on the missing stimuli

- **QuestionPro:**
  - Only dynamic participants, 3000 per country, number of wanted participants is set to 1000
  - We receive age group and gender => quota groups
    - stimuli must be distributed evenly across quota groups
    - So, for each combination of age- and gender group:
      - we keep a counter
      - we dynamically assign the stimuli in a round robin fashion:
        emo_id = counter[age, gender] % number_of_emotions
    - we maintain separate quota counters for each country
    - **Counter increments are atomic!**

Supporting all major browsers

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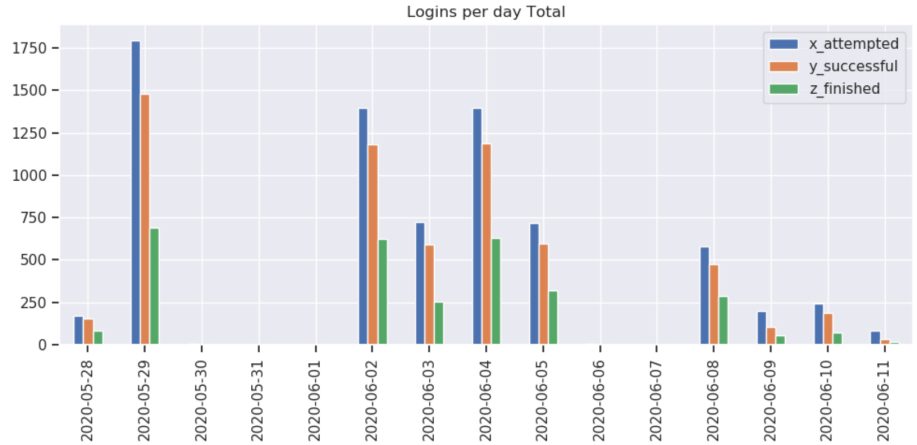
- Chrome and (new chromium-based) Edge worked out-of-the-box

- Firefox had issues rendering Markdown with correct line heights and line spacing
  - ***Symptom:*** *Text lines looked cut-off*
  - This is a bug in the Markdown renderer: line hight is not adjusted on lines that contain formatting
  - **Solution:** We patched the open source Flutter Markdown rendering plugin

- Safari had audio problems:
  - It has a very low limit of Audio resources : **only 1 audio resource!** *(compare: other browsers have 8)*
    - ***Symptom:*** *No audio after the audio test screen*
    - In addition, Safari does not follow the web audio standard: shutting down an audio resource and (quickly) opening a new one is not supported, Safari still runs out of audio resources
    - **Solution:** We switched to **re-using a single audio resource**
  - Its JavaScript performance during animations degraded so much that audio timing was affected
    - ***Symptom:*** *speech was cut off at the end*
    - **Solution:** we now **synchronize audio plugin calls with audio timing**
      We start the cut-over timer at the time the audio starts playing, as opposed to after initiating playing

Server load and participant numbers



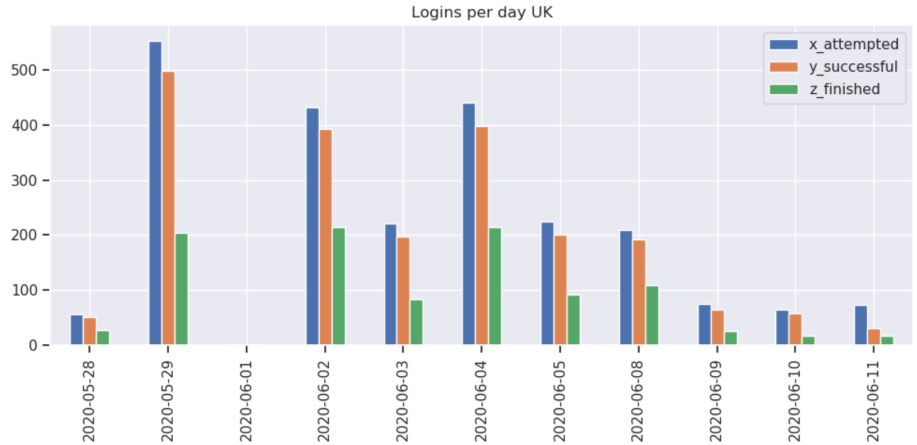
7315
Attempts

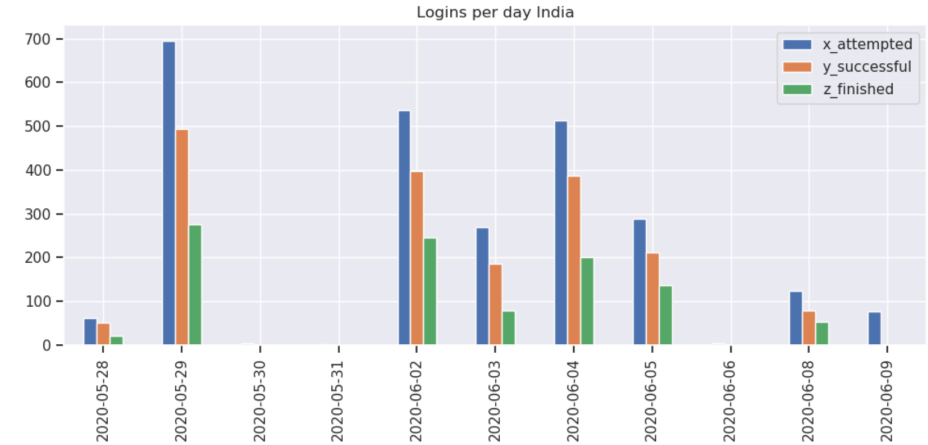
6091
Logins

3161
Partici-
pants

11
days

14 days incl. weekends





Recap of main development efforts for our research

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- **we researched and implemented** an efficient deep learning method for emotional speech synthesis
  - pre-processing, training, cloud monitoring, …
- **we wrote many tools**, e.g. for:
  - annotation of audio and video datasets
  - recording speech datasets
  - multi-GPU parallel speech synthesis
  - objective evaluation of synthesized speech
- **we developed a pilot study** web app and -server
  - plus an MTurk pilot study
- **we developed the experiment platform**
  - a native Android experiment app for tablets
  - native Android video and heart rate recording apps
  - an entire backend with API server
  - an administration Web interface
- then **we ported it to the web**
- then **we scaled it up** to handle thousands of participants in multiple concurrent experiments
  - and added features like lotteries
- then **we integrated it with QuestionPro** and their panel provider
  - and added support for all major browsers
- not to forget, we **processed and evaluated** all that data
- in the process, **we fixed bugs and submitted patches** to 3 open source projects
- we wrote ca. 23 000 lines of Python, Dart, Go, JS
  - most of which worked flawlessy

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THANK YOU FOR YOUR ATTENTION

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Time spent in experiment