KARL-FRANZENS-UNIVERSITÄT GRAZ UNIVERSITY OF GRAZ



Introduction to Praat



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Aim of this short tutorial

- To give an **introduction** to Praat
- Tips and recommendations for obtaining good audio-recordings
- Demonstration of some key functions relevant for acoustic analysis
- Tips for producing and exporting high-quality pictures from Praat
- (Demonstration of how to **run a perception experiment** in Praat)

Praat: doing phonetics by computer



What is Praat?

- *Praat* = a computer program with which you can
 - visualize
 - analyze
 - synthesize
 - manipulate speech (or any other acoustic signal)
- Invented and further developed by **Paul Boersma** and **David Weenink** (Institute of Phonetic Sciences, University of Amsterdam) since 1992



The authors

Paul Boersma and David Weenink <u>Phonetic Sciences</u>, University of Amsterdam Spuistraat 210 1012VT Amsterdam The Netherlands



What is Praat?

- Updated versions are regularly available for various operating systems (Windows, Macintosh, Linux)
- It is a **free software**
- Very popular around the world for linguistic and phonetic research and beyond...(musicology, animal communication, etc.)

Why use Praat?

- It is the **most complete program** for phonetic research available at the moment
- There are **updates and improvements** of the program happening on a regular basis
- It is very good, i.e. algorithms are quite exact
- It is **user-friendly** and has a **GUI**. But it is also a **scripting language**!
- There is a **big (and helpful!) user community** as well as a Praat **mailing list**
- There are plenty of **tutorials and scripts freely available** on the internet

Step 1: Download Praat

- Where you can **download** it: <u>http://www.fon.hum.uva.nl/praat/</u>
- Download the version compatible with your operating system (e.g. for Windows: <u>http://www.fon.hum.uva.nl/praat/download_win.html</u>)
- Use the **64-bit edition** if possible (especially with newer computers, this is the one you almost certainly want)
- After downloading, you will see a **zip folder** in your downloads (or wherever you have decided to put it)



- **Double-click on the zip folder** and a file called **Praat** or **Praat.exe** will appear (this is the Praat program). You can use it right now or you can move it out of the zip folder to any location on your computer
- Remark: You are able to use Praat even if your system administrator does not allow you to install programs

Step 2: Open Praat

- Double-click on the **Praat.exe file** or the **Praat icon**
- Two windows will open up immediately

Praat Picture Window

	Praat P	icture									-		×
File	Edit	Margins	World	Select	Pen	Font							Help
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													-
-2													
1													
L													
-3													
-													
-4													
													-
•													

Praat Objects \times _ Praat New Open Save Help Objects: Rename. Inspect Remove

Praat Objects Window

Step 3: Open a sound file or record one

• You need to **import** the sound file(s) you want to work with

🔳 Pr	aat Obj	ects		-	_		×	
Praat	New	Open	Save				Help	
Objects:	:	R	ead from file					Ctrl-O
		C	pen long sound file					Ctrl-L
		R	ead separate channels f	rom soun	d file			
		R	ead from special sound	file				>
		R	ead Matrix from raw tex	t file				
		R	ead TableOfReal from h	eaderless	sprea	idsheet f	ile	
		R	ead Table from tab-sepa	arated file				
		R	ead Table from comma	-separated	d file.			
		R	ead Table from whitesp	ace-separ	ated	file		
		R	ead Strings from raw te	d file				
		R	ead from special tier file					>
Ren	name		Сору					
In	spect		Info					
Re	emove							

- ▶ "Read from file"
- Use "Open long sound file" for files that are too long to read into memory completely (Praat will only read so much of the file as needed to display parts of it)

Step 3: Open a sound file or record one

> Praat can handle a number of **standard audio file formats** such as:

✓ WAV (Waveform Audio File Format)
✓ AIFF (Audio Interchange File Format)
✓ MP3
(and some more)

- <u>Remark:</u> While Praat is able to *read* MP3 files, I would not recommend saving recorded audio files as MP3 files, if you want to do phonetic research
- <u>Reason:</u> MP3 uses lossy data compression (It encodes data using inexact approximations and partial discarding of data)

Step 3: Open a sound file or record one

• You can also **directly record speech in Praat** (an input device must be active, i.e. a microphone)

🔳 Pr	raat Objects	_		×			
Praat	New Open Save			Help	SoundRecorder		– 🗆 X
Objects:	Record mono Sound	Ctrl-R	1		File Query		Hel
	Record stereo Sound				Channels:	Meter	Sampling frequency:
L	Sound	>			 Mono Stereo 		 8000 Hz 11025 Hz
L	Matrix	>			(use Windows miver		C 12000 Hz
	Tables	>			without meters)		© 22050 Hz
	Tiers	>			,		O 24000 Hz
						Not recording	C 32000 Hz
	Create TextGrid						• 44100 Hz
	Create Strings as file list						© 64000 Hz
	Create Strings as directory list						96000 Hz
L							192000 Hz
	Articulatory synthesis	>					
	Create Permutation						
	Polynomial	>					
	Multidimensional scaling	>					
Ret	Acoustic synthesis (Klatt)	>			Record Stop	Play	Name: untitled
In	Constraint grammars	>				Close Save to list	Save to list & Close
Be	Symmetric neural networks	>					
	Feedforward neural networks	>					
	kNN classifiers	>					

Recording: Settings

SoundRecorder \times File Query Help Sampling frequency: Meter Channels: Mono. © 8000 Hz O Stereo ① 11025 Hz ► Use **"Mono"**: i.e. you ① 12000 Hz record one channel (use Windows mixer ① 16000 Hz O 22050 Hz without meters) Use Sampling O 24000 Hz frequency of 44100 Hz 32000 Hz Not recording. ④ 44100 Hz \blacktriangleright Watch for the meter to 48000 Hz stay in the green area 64000 Hz
 64000 Hz
 6 O 96000 Hz ① 192000 Hz Name: untitled Record Play

Close

Save to list

Save to list & Close

Remarks on sampling frequency

• How often do we measure the amplitude?



Sampling frequency = 53 Hz

Remarks on sampling frequency

The *sampling frequency* has to be **at least twice the highest frequency** we would like to record

- For speech recordings the standard is a sampling rate of 44.1 kHz (i.e. we are looking 44 100 times per second how big the amplitude is = CD-quality)
- So we can record frequencies up to 22.05 kHz

Recordings

Audacity

- An alternative free recording software I can recommend: *Audacity*
- <u>https://www.audacityteam.org/download/</u>



Tips for good recordings

- Find a suitable environment: a quiet room, small, with lots of soft surfaces (curtains, carpets, cushins etc.)
- Reduce background noise (close the windows, switch off the clock or any other noise-emitting device, get rid of creaky chairs, clinking jewelery etc.)
- Instruct your participant (and remind them if necessary) to not touch their faces while recording
- If you are using a **external microphone** (recommended for phonetic research!): **Do not hold it directly in front of your mouth** (keep a distance of approx. 20 cm). **Also don't be too far away**

ALWAYS MAKE TEST RECORDINGS!

Tips for good recordings

- Always ask for your participant's **consent**!
- Ask for **meta data** (depending on your reseach question) such as age, gender, native language, highest eduction, etc.
- Give your recordings sensible names
- Use **participant codes** (no full names!)
- Make the participant feel **comfortable**
- Explain the task exactly and let them ask questions for clarification
- Task ought to be suitable for your participants and your research question
- In general: Aim for **short recording sessions** (and have **breaks** in between!)

Summary: settings for recordings

For speech recordings suitable for phonetic analysis:

- 1 audio channel: Mono
- Sampling frequency: 44 100 Hz
- Bit: 16-bit
- Wav.file

- Once you have a sound file opened up in Praat, you can start inspecting it
- "View & Edit"

Praat Objects	- 🗆	×
Praat New Open Save		Help
Objects:	Sound help	1
1. Sound untitled	View & Edit	
	Play	
	Draw -	
	Query -	
	Modify -	
	Annotate -	
	Analyse periodicity -	
	Analyse spectrum -	
	To Intensity	
	Manipulate -	
	Convert -	
	Filter -	
	Combine -	
Rename Copy Inspect Info Remove Info		

1. Sound untitled

- 🗆 X

Help

File Edit Query View Select Spectrum Pitch Intensity Formant Pulses



> Zoom in to see the spetrogram as well



- The upper half of the window shows you the **wave form** of the sounds
- The lower half of the window shows you the **spectrogram**
- You can adjust the settings of the spectrogram in the menu (*Spectrum* > *Spectrogram Settings*)

Visualization of sounds

• Wave form: amplitude-time diagram



Visualization of sounds

• **Spectrogram**: frequency-time diagram plus energy by means of the colouring: the darker the more energy



Visualization of sounds

• There are 2 types of spectrograms (can be changed by means of the window length in the spectrogram settings)



• You can analyze certain acoustic features of your recordings:

+ You can measure duration: How long are certain parts of your recordings?
+ You can look at the pitch contour (*Pitch > Show pitch*): A blue line visualizing the F0 contour will appear in the spectrogram



+ You can look at formants (*Formant > Show fomants*)



• You can get the **average pitch in your selection**, you can **get minimum/maximum pitch**, you can **move the cursor** to the minimum/maximum pitch etc.



- Pitch settings: You can adjust the pitch range
- For a female speaker you can use a range of 100-500 Hz
- For a male speaker use 75-300 Hz
- The default unit is **Hertz** but you can change it to semitones etc. if you like

Pitch settings	×
Pitch range (Hz):	75.0 500.0
Unit	: Hertz
The extension with a stinion for interval	✓ Hertz
The autocorrelation method optimizes for intonation	n Hertz (logarithmic)
and the cross-correlation method optimizes for voice	ce mel
Analysis method:	logHertz
	semitones re 1 Hz
	semitones re 100 Hz
Drawing method:	semitones re 200 Hz
	semitones re 440 Hz
(all of your "advanced settings" have their standard	rd ERB
(your "time step strategy" has its standard value: au	automatic)
Help Standards	Cancel Apply OK

Effect of pitch range change



Effect of pitch range change



• You can add one or more **annotation grids** to your sound file:

Praat Objects	—	\times
Praat New Open Save		Help
Objects:	Sound help	
1. Sound 1_1	View & Edit	
	Play	
	Draw -	
	Query -	
	Modify -	
	Annotate -	
	Annotation tutorial	
	To TextGrid	
	To TextGrid (silences)	
	Manipulate -	
	Convert -	
	Filter -	
	Combine -	

- **Interval tiers:** for marking elements with a distinct span, e.g. words, sentences, phonemes, syllables etc.
- **Point tiers:** for marking single points, e.g. location of a high tone, peak in an intensity curve, turn change in a conversation etc.

Sound: To TextGrid	×
All tier names:	Wort Ton
Which of these are point tiers?	Ton
Help Standards	Cancel Apply OK

• Choose your **sound and your textgrid together** (ctrl/Strg + click on both) and go to *View & Edit*:

Praat Objects	- 🗆 ×
Praat New Open Save	Help
Objects:	View & Edit
1. TextGrid die banane 2. Sound die_banane	Draw
	Extract -
	Modify TextGrid
	Scale times
	Modify Sound
	Clone time domain



- You can also use **IPA symbols** in your annotation
- Install the fonts **Charis SIL** and **Doulos SIL** (from <u>www.sil.org</u> or from <u>www.praat.org</u>)
- Either type the symbols directly (if your computer has an input method for them), or use backslash sequences
- There are tables for vowels, consonants and diacritics:

(http://www.fon.hum.uva.nl/praat/manual/Phonetic_symbols.html)



 Example: backslash sequences for consonant symbols

• Praat can also be used to **manipulate sounds** (e.g. for experimental purposes)

х

ΟK

• Example: Pitch modification:

Praat Objects	– 🗆 X		
Praat New Open Save	Help		
Objects: 1. TextGrid ich_në he_mein_kostü m 2. Sound ich_në he_mein_kostü m	Sound help View & Edit		
3. Sound 1_1 4. Manipulation 1_1	Play		
5. Sound 1_1	Draw -		
	Query -	Sound: To Manipulation	
	Modify -		
	Annotate -	Time step (s):	0.01
	Analyse periodicity -		
	Analyse spectrum -	Minimum pitch (Hz):	75.0
	To Intensity	Mavimum pitch (Ha):	600.0
	Manipulate -	indamon picer (riz).	000.0
	To Manipulation To KlattGrid (simple)	Help Standards	Cancel Apply
	Lombine -		
Rename Copy Inspect Info Remove			

- Select the Manipulation object in the object window and click *View & Edit Pitch > Stylize pitch*
- 19. Manipulation 1_1 File Edit Query View Select Pulse Pitch Dur Synth Help Ctrl-T Add pitch point at cursor 0.541485 Add pitch point at time slice Sound 0.6541 Add pitch point at... Ctrl-Alt-T Remove pitch point(s) Set pitch range... Set pitch units... Set pitch dragging strategy... Shift pitch frequencies... Multiply pitch frequencies... All: Stylize pitch... Stylize pitch (2 st) Ctrl-2 -0.9496 Interpolate quadratically... Pitch manip Pitch from pulses 600.0 Hz Interpolate quadratically (4 pts) Ctrl-4 215.4 Hz• 197.0 Hz 25.0 Hz

• Now you can move the green dots around to change the pitch contour



• Now you can move the green dots around to change the pitch contour



- You can produce high quality pictures of the speech signal in Praat
- Now we need the **Praat Picture Window**



With the pink margins you decide where your picture will be located

• Example: Sound wave with text grid



Select sound and textgrid in the object window together and click Draw

• Example: Spectrogram with f0 contour



Spectrum > Paint visible spectrogram and *Pitch > Draw visible pitch contour* The colour can be changed in the picture window (*Pen*) **before** you do the drawing



• Example: Text grid with f0 contour



Pitch > Extract visible pitch contour

Select the pitch contour and the text grid in the Praat object window and click *Draw*

Convert pitch contour

• Tip: How to get rid of "crazy" intonation curves



Convert pitch contour

- *Pitch > Extract visible pitch contour*
- *Convert > Hack > Kill octave jumps*

Praat Objects Praat New Open Save	− □ × Help
Objects:	Pitch help
2. Sound ich_nä he_mein_kostü m 3. Sound 1_1	View & Edit
4. Manipulation 1_1 5. Sound 1_1	Sound -
19. Manipulation 1_1 20. Sound 1_1_changeGender	Draw -
22. Sound 1_1_changeGender 23. Sound 1_1_changeGender	Query -
25. TextGrid ich_nä he_mein_kostü m 26. Spectrogram untitled	Modify -
27. Pitch untitled 30. Pitch untitled	Annotate -
31. Pitch untitled 32. Pitch untitled	Analyse -
	Convert -
	Interpolate
	Smooth
	Subtract linear fit
	Hack > Kill octave jumps
	Down to PitchTier
	To Matrix

Convert pitch contour







Interpolate (Praat will connect the pitch contour so that it does not get interrupted by voiceless parts)

with octave jump removed

original

Step 7: Export pictures

• I would recommend *"Edit > Copy to clipboard"* or *"File > Save as 600-dpi PNG file"* for high quality



- You can also run simple **perception experiments** in Praat
- Identification and discrimination tests are possible



- You need a simple text file with a certain structure <u>http://www.fon.hum.uva.nl/praat/manual/ExperimentMFC_2_1_T</u> <u>he_experiment_file.html</u>
- The first two lines have to stay the same, the rest depends on your stimuli, on the response categories and on the way the experiment is presented to the listener
- The order of the lines in the file cannot be changed and nothing can be skipped

"ooTextFile"	Don't change th	hese two lines!
"ExperimentMFC 7"		
blankWhilePlaying? <no></no>		
stimuliAreSounds? <yes></yes>		
stimulusFileNameHead = ""		
stimulusFileNameTail = ".wa	V''	
stimulusCarrierBefore = ""		
stimulusCarrierAfter = ""		
stimulusInitialSilenceDuration	n = 0.5 seconds	Here, you can define the duration of silence before, within
stimulusMedialSilenceDuration	$\operatorname{on} = 0$	(for discrimination tests) and after a stimulus
stimulusFinalSilenceDuration	= 0.5 seconds	
numberOfDifferentStimuli = 4	4	
"heed" ""		Write the file names of you wav-Files (they have to be in
"hid" ""		the same folder as the textfile)
"hood" ""		
"hud" ""		Indicate how often a stimulus should be presented in the
numberOfReplicationsPerStir	nulus = 3	indicate now often a stimulus should be presented in the
brook After Every - 0		experiment and after now many trials there should be a break

breakAfterEvery = 0

randomize = < PermuteBalancedNoDoublets>

startText = "This is a listening experiment.

After hearing a sound, choose the vowel that is most similar to what you heard.

This text will appear on the screen at the beginning of the experiment

Click to start."

This text will appear during the experiment, during the break and at runText = "Choose the vowel that you heard." pauseText = "You can have a short break if you like. Click to proceed." the end of the experiment endText = "The experiment has finished." maximumNumberOfReplays = 0replayButton = 0 0 0 0 "" "" You can give participants the opportunity to replay a okButton = 0 0 0 0 "" "" stimulus and also to change their response ("oops button") oopsButton = 0 0 0 0 "" "" responsesAreSounds? <no> "" "" "" "" 0 0 0 numberOfDifferentResponses = 5 0.2 0.3 0.7 0.8 "h I d" 40 "" "i" These are the response options displayed on the screen 0.3 0.4 0.5 0.6 "h E d" 40 "" "e" 0.4 0.5 0.3 0.4 "h A d" 40 "" "a" 0.5 0.6 0.5 0.6 "h O d" 40 "" "o" 0.6 0.7 0.7 0.8 "h U d" 40 "" "u" numberOfGoodnessCategories = 5 0.25 0.35 0.10 0.20 "1 (poor)" 24 "" You can also add a goodness rating (i.e. participants are 0.35 0.45 0.10 0.20 "2" 24 "" asked to tell how "good" they think a stimulus was/or how 0.45 0.55 0.10 0.20 "3" 24 "" "certain" they were about their response) 0.55 0.65 0.10 0.20 "4" 24 "" 0.65 0.75 0.10 0.20 "5 (good)" 24 ""

- Open the text file (Open > read from file)
- ➢ Run it
- After the experiment finishes, you choose *Extract results*

Praat Objects		_	×
Praat New Open Save			Help
Objects:	R	lun	
35. ExperimentMFC Experiment_Identifikation	Extrac	t results	
Rename Copy			
inspect into			
Remove			

- Collect to Table
- Save > Save as commaseparated file or Save as tab-separated file

Praat Objects		_		×			
Praat New Open	Save						Help
Objects:		Save as text file			help		- 1
35. ExperimentMFC Expe		Save as short text file		nop		-	
37. ResultsMFC Experime		Save as binary file		k Edit	_	_	
					w -		
	Save as tab-separated file			- Iy -			
		Save as comma-separated file			ifu .		
	_						-
				An	alyse -		_
				Syn	thesize -		
				Ger	nerate -		
				E×	ktract -		
				Down to T	ableOfR	eal	
				Down	i to Matrix	(
	~	1					
Hename	сору						
Inspect	Info						
Remove							
	_						

> Output

- The first column contains the names of the *subject* (actually the name of the text file), the second column the *stimulus names*, the third column the *responses*, and the last column the approximate *reaction times* (However, I would recommend different programs than Praat if you are interested in reaction time!). If there are *goodness ratings* as well, they will be displayed in the fourth column
- > Open the texfile in Excel, SPSS, R etc. and do statistical analysis

subject	stimulus	response	goodness	reactionTime
SUBJ_01	heed	i	5	1.424453409781563
SUBJ_01	hood	u	5	0.3100557906436734
SUBJ_01	heed	e	5	1.0524721151014091
SUBJ_01	hid	i	5	1.787820853991434
SUBJ_01	hud	u	5	1.0343763243145077
SUBJ_01	heed	i	4	1.1687852420873241
SUBJ_01	hud	e	3	1.0476764482300496

Thank you for your attention!

Links and useful literature

- Will Styles: Using Praat for Linguistic Research <u>https://phonetique.uqam.ca/upload/files/LIN2623/Styler_2013_2.pdf</u> (handbook about Praat for linguists; highly recommendable!)
- Jörg Mayer: Die Praatpfanne <u>http://praatpfanne.lingphon.net/</u> (handbook, scripts and other resources about Praat in German; also highly recommendable!)

<u>Tutorials on Praat scripting:</u>

Antje Schweitzer: <u>http://www.ims.uni-stuttgart.de/institut/arbeitsgruppen/phonetik/helps/praat-scripting/praat.tutorial.pdf</u>

Ingmar Steiner: <u>http://www.coli.uni-saarland.de/~steiner/teaching/2007/winter/praat/praat_lecturenotes.pdf</u>