

Arbeitsjournal

All links that are not clickable in this text reference chapters in Appendix D from the main documents or other documents that were uploaded to the student portal.

This journal is not very detailed as I often thought about things without actively working only on them.

Also, I and Ms Sprunger once discussed that the first part was too detailed, so I started writing down less often and less detailed (maybe too much).

date	time	work type	working steps	result	notes
17.10.2023 - 26.10.2023	2h	planning	- Find a theme	Found provisory working question: I want to study the connection between formal languages of the Chomsky hierarchy and finite model theory. In particular, I would look at logics describing multiple levels and try to find one for type-1 languages.	
26.10.2023	10 min	planning	- ask Reto Schmid to be my Matura project teacher	Rejected	→ ask Aline Sprunger
10.11.2023	10 min	planning	- ask Aline Sprunger to be my Matura project teacher	Accepted	
13.01.2024	1h	planning	- write "Vorvertrag"	Vorvertrag_Maturaarbeit.pdf	From the discussion, articles for different formal language types: >Der Artikel über regular languages ist https://homepages.inf.ed.ac.uk/libkin/ft/fmt.pdf , S.124 (136 im online-dokument), >der für context-free languages ist https://link.springer.com/chapter/10.1007/BFb0022257 , >und das wo ich gefunden habe für recursively enumerable languages ist https://csttheory.stackexchange.com/a/52616
19.01.2024	1h	planning	- write "Arbeitsvereinbarung"	Arbeitsvereinbarung.pdf	
21.03.2024	30 min	planning	- provisory time plan - planning the practical part and the gathering of information	Prov. Zeitplan MA During the information-gathering, already start writing	→ write to Dr. Dennis Komm for information / help / intuitions
22.03.2024	20 min	research	- write to Dr. Dennis Komm	MA/Anhang > Email Dr. Dennis Komm , no response (28.03.2024)	→ write to Prof Gaby Röger (Uni basel) → ask ETH students if they know someone else → wait for email from other Prof.

date	time	work type	working steps	result	notes
				response on 03.04.2024 MA/Anhang > Response Dr. Dennis Komm	
22.03.2024	1.5 h	research	- get books from university library	got - Formal languages and automata theory - Automata theory and formal languages - Logic works : a rigorous introduction to formal logic - Elements of finite model theory - Introduction to languages, machines and logic : computable languages, abstract machines and formal logic - Finite automata, formal logic, and circuit complexity	
27.03.2024	1h	research	- start reading Introduction to languages, machines and logic : computable languages, abstract machines and formal logic	no new information (basics know from "Theory of computer science" at Uni Basel)	
28.03.2024	1h	planning	- write missing steps in "Arbeitsjournal"		
28.03.2024	20 min	research	- write to Prof Gaby Röger (Uni Basel) - ask ETH students if they know someone else	MA/Anhang > Email Dr. Gabriel Röger	→ write to Angelika Steger
28.03.2024 - 02.04.2024	4h	research	- finish reading Introduction to languages, machines and logic : computable languages, abstract machines and formal logic	context-sensitive languages can also be defined as those with only rules with $y \rightarrow x$ and $y \in (\Sigma \cup V)^* V (\Sigma \cup V)^*$, $x \in (\Sigma \cup V)^*$ and $\ x\ \leq \ y\ $ (with exception of empty word for the start variable)	→ get book in "Further Readings": Introduction to automata theory, languages, and computation
04.04.2024 - 23.04.2024	20 h	research	- read Finite automata, formal logic, and circuit complexity	- regular languages are defined by monadic second order logic, or even $\exists MSO$ We can use algebraic structures such as Monoids, Categories and Semigroups to describe regular languages - description of different	

date	time	work type	working steps	result	notes																				
				<p>subsets of regular languages through logic / structures:</p> <table><tr><th></th><th>+1</th><th><</th><th>Reg</th></tr><tr><td>FO</td><td>$M(L)$ aperiodic; $esfses^nf = es^nf s'esf$ for $e = e^2, f = f^2$, $s, s', s'' \in \eta_L(A^+)$</td><td>$M(L)$ aperiodic</td><td>$\eta_L(A^+)$ aperiodic</td></tr><tr><td>FO + MOD(P)</td><td>$M(L)$ satisfies $x^{k+1}mod(P) = x^k$, $esfses^nf = es^nf s'esf$ for $e = e^2, f = f^2$, $s, s', s'' \in \eta_L(A^+)$</td><td>$M(L) \in M_P$</td><td>$\eta_L(A^+) \in S_P$</td></tr><tr><td>MOD(P)</td><td>$M(L)$ satisfies $x^{k+1}mod(P) = x^k$, $e \cdot M(L) \cdot e$ is an abelian group for $e = e^2 \in \eta_L(A^+)$</td><td>$M(L) \in G_P$</td><td>$\eta_L(A^+) \in S_P$, U_L not in $\eta_L(A^+)$</td></tr><tr><td>SOM</td><td>L regular</td><td>L regular</td><td>L regular</td></tr></table> <p>- We can extend the expressive power of a logic by adding predicates.</p>		+1	<	Reg	FO	$M(L)$ aperiodic; $esfses^nf = es^nf s'esf$ for $e = e^2, f = f^2$, $s, s', s'' \in \eta_L(A^+)$	$M(L)$ aperiodic	$\eta_L(A^+)$ aperiodic	FO + MOD(P)	$M(L)$ satisfies $x^{k+1}mod(P) = x^k$, $esfses^nf = es^nf s'esf$ for $e = e^2, f = f^2$, $s, s', s'' \in \eta_L(A^+)$	$M(L) \in M_P$	$\eta_L(A^+) \in S_P$	MOD(P)	$M(L)$ satisfies $x^{k+1}mod(P) = x^k$, $e \cdot M(L) \cdot e$ is an abelian group for $e = e^2 \in \eta_L(A^+)$	$M(L) \in G_P$	$\eta_L(A^+) \in S_P$, U_L not in $\eta_L(A^+)$	SOM	L regular	L regular	L regular	
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SOM	L regular	L regular	L regular																						
04.04.2024	1h	research	<ul style="list-style-type: none">- write to Dr. Angelika Steger- write to former SOI participant / leaders for contacts	MA/Anhang > Email Dr. Angelika Steger	→ write to Juraj Hromkovic, Hans Joachim Böckenhauer, Thomas Studer																				
06.04.2024	30 min	research	<ul style="list-style-type: none">- got email from Dr. Kráľovič	MA/Anhang > Response Dr. Kráľovič MA/Anhang > Further Communication with Dr. Kráľovič	→ see DSpace(f(n)) and bound from above / below → get book Descriptive complexity																				
23.04.2024 - 24.04.2024	3h	research	<ul style="list-style-type: none">- read https://link.springer.com/chapter/10.1007/BFb0022257	<ul style="list-style-type: none">- context-free languages can be defined using existential first order logic over binary matching relation and other similar constructs (quantification over tree-definable linear orders, the same thing for MSO logic)	Found accessible version under internet archive																				
24.04.2024 - 1.06.2024	40 h	research	<ul style="list-style-type: none">- read Descriptive complexity	<ul style="list-style-type: none">- There is already a characterisation using SO-logic $SO(arity\ k, TC)$	→ Add "using first order logic" to question																				
13.05.2024	30 min	planning	<ul style="list-style-type: none">- discussion with Ms. Sprunger about time plan and start of the written part	<ul style="list-style-type: none">- Write to Kaspar Hui and Tommaso Pedocci for Latex Template / how to write a mathematical MA	- https://github.com/techlabksbg/matura-arbeit-vorlage-latex from Hannah																				
31.05.2024	20 min	planning	<ul style="list-style-type: none">- Ask for official permission to write in English	MA/Anhang > Question for writing MA in English																					
05.06.2024	3 h	research	<ul style="list-style-type: none">- understand equivalence of type 0 grammars and $FO(\exists\mathbb{N})$ using Matiyasevich's theorem																						

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06.06.2024	3h	solving	- make notes and ideas for further thought in a central file : MA/Notes		
10.06.2024	4h	solving	- think about possibilities to extend proof of $DSPACE[s(n)]$ MA/Notes > Extending $\Sigma_{\{t\}}(\overline{x}, \overline{b})$ (not possible) - make "easy" conversion of SO to FO with extended variables MA/Notes > Direct transformation of $\text{SO}(\text{arity}_k)(TC)$ to $\text{FO-VAR left}[1, \frac{n}{k} \log n \text{ right}](TC)$		
14.06.2024	3h	solving / research	- Try to prove that no better characterisation is possible under some constraints using TC MA/Notes > Can we prove that there is no way to use TC with a FO language that has less then $\text{O}(n^k)$ variables?		- Use/read Arity hierarchy
24.06.2024	4h	writedown	- make latex template conform to requirement - upload to https://github.com/42kangaroo/maturarbeit-documentation		
25.06.2024	3h	writedown	- make chapter outlines - start Mathematical background		
26.06.2024	3h	writedown	- write appendix		
27.06.2024	3h	writedown	- finish appendix - start writing chapter formal languages - write with Kaspar Hui and Tommaso Pedocci to get their MA paper, read these as an inspiration		
30.06.2024 - 05.07.2024	10 h	research	- continue reading Arity hierarchy		- look at Generalized Quantifiers , double arity
06.07.2024 - 10.07.2024	4 h	solving	- try to fix the problem that the above article holds only for unordered structures		
15.07.2024 - 30.07.2024	30 h	writedown	- write all theory chapters, introduction and foreword	More details in Commit History	
01.08.2024 - 16.09.2024	50 h	solving / research	- Look into generalised quantifiers, search and read papers on hierarchies - Try to port results of double arity too ordered structures, read about ordered structure Ehrenfeucht-fraïssé games in descriptive-complexity book. - Try restrictions of FO-VAR to use only very little existential	MA/Notes > Generalised quantifiers existential fo MA/Notes > Somewhat	- double arity - SO-gg

date	time	work type	working steps	result	notes
			quantification - Generalize to use restricted universal quantification, but less iterations - Look at Alternating Turing machines and hierarchy theorem for them	unrelated stuff	
16.09.2024	45 min	planning	- MA-discussion with Ms. Sprunger on further steps - Discuss appendix - Look at how Copy-Stop version should look	- Stop research, start writing - move unrelated sections to appendix - Document only needs to be send digitally	
17.09.2024 - 04.09.2024	15 h	writedown	- write personal contribution - write conclusion and directions - write Acknowledgements - finish introduction	More details in Commit History .	
05.09.2024 - 13.10.2024	30 h	review	- ask for reviews from friends, family and colleagues of my mother - check spelling and grammar with texidote , grammarly and language tool - rewrite all sections for clarity - check formal aspects - add appendices of notes and communication - fix formatting and representation of special characters - rewrite according to proof reader suggestions - make passive / active voice + tenses consistent - add acronym definitions - reread to check that all phrases are logical - conversion to word for copy-stop version - uploading documents	7 different people reviewing More details in Commit History .	