Leiden
University

Foundations of Computer Science 1

Today:

Introduction

- Technicalities
- About the course: what, why

Course begins!

- Lesson 1: SETS

Introduction

Technicalities

- Lecturer (docent): Vedran Dunjko
  - few words about me

Course is in English, communication preferred in English

Will provide glossary of terms in dutch as well.

Technicalities

- Lecturer (docent): Vedran Dunjko
  - all information googlable;
  - email subject: “FCS: …” to v.dunjko [at] liacs.leidenuniv.nl
  - consultations: please email
  - anything unclear: email, ask (both admin and content)

Technicalities

- **Course announcements, updates, downloadables, check:**
- ***http://liacs.leidenuniv.nl/~dunjkov/FCS1.html***

- ***Go to the course page, link from there***

- **go to blackboard page, link from there**

- ***[google me, find personal page ("Quantum@LIACS"), go to teaching, follow FCS hyperlink]***

Technicalities

- **Teaching assistants: TBA**

Technicalities

Course will be taught via lectures (2x45 min p/w)
[Tuesdays 14-16]

and via tutorials (excercises) (2 x 45 min p/w)
[Tuesdays 16-18]

we will do 45min/15min break splits mostly.

Technicalities

Today: Just the lectures (cca. 3x45 min)

We stay in this room.

Next week, we will into 2-3 groups.

Technicalities

Sister course: Fundamentele informatica 1

Technicalities

Read this

- Study materials: book, lessons, slides, excercises
  - book: Schaum Discrete Mathematics — not all chapters, will connect lessons with chapters
  - lectures; "interactive slides"; will be made available at course web-page http://liacs.leidenuniv.nl/~dunjkov/FCS1.html
  - excercise list will be available there as well.

Technicalities

- course follows the stucutre of Fundamentele Informatica 1 of Prof. de Graaf. Slides contents match her slides. “Dutch version”
- can be found here: http://liacs.leidenuniv.nl/~graafjmde/FI1/

minor modifications to tailor to I&E and Bioinformatica.

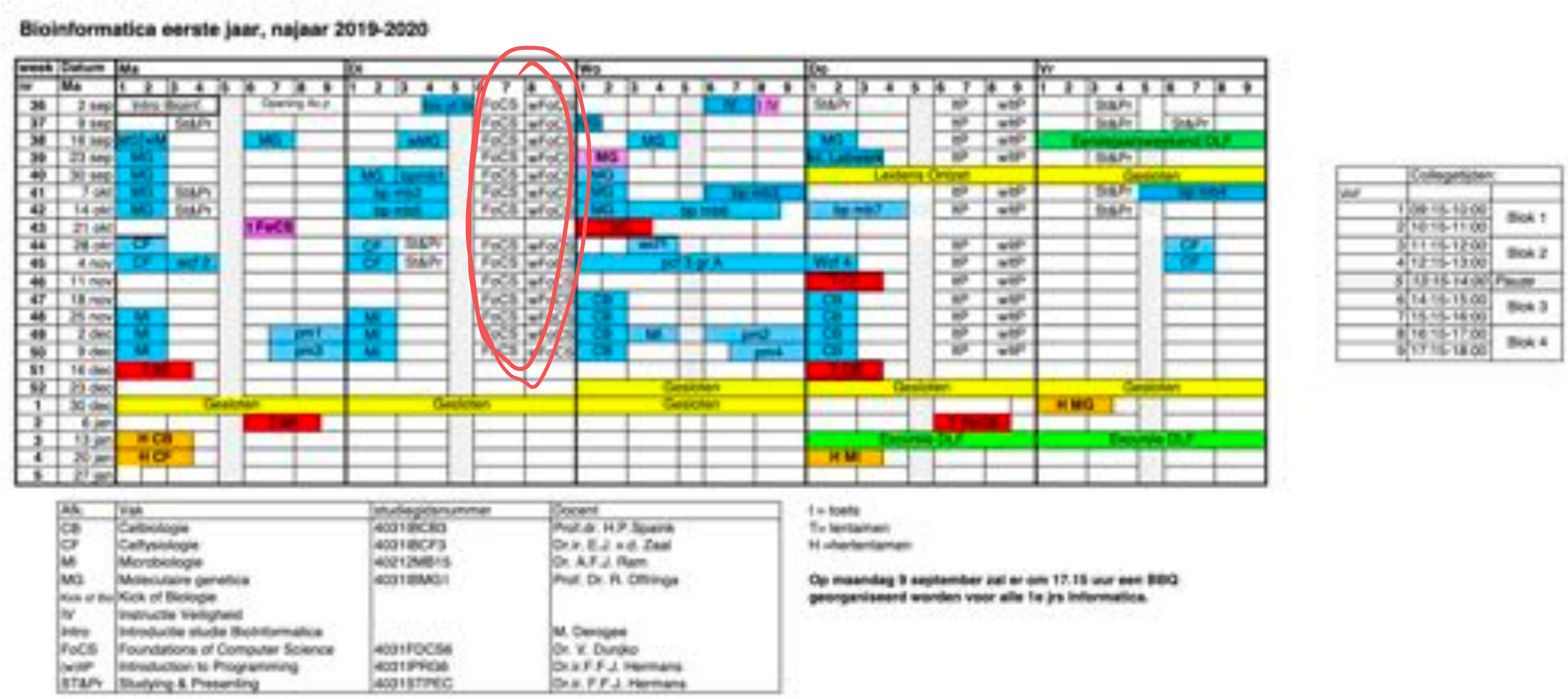
Technicalities

- *sign up in uSIS (needed for final grade)*
- **Blackboard: you need to enrole to this course.**
- **Blackboard will be used to inform you of your grades** ***(confidentiality)***
- ***all other important information on***
  course page http://liacs.leidenuniv.nl/~dunjkov/FCS1.html

Technicalities

- Grading
  - Mid-term exam; if you get strictly more than 5.0, it provides a bonus for final exam. Bonus = 1/10 of grade (if >5.0)
    - Around week 43 (end of October).
  - Final exam: week of 6th January.
  - Final grade = final exam grade + bonus from mid-term (if applicable).

Bonus counts for re-sit.



Bioinformatica eerste jaar, najaar 2019-2020

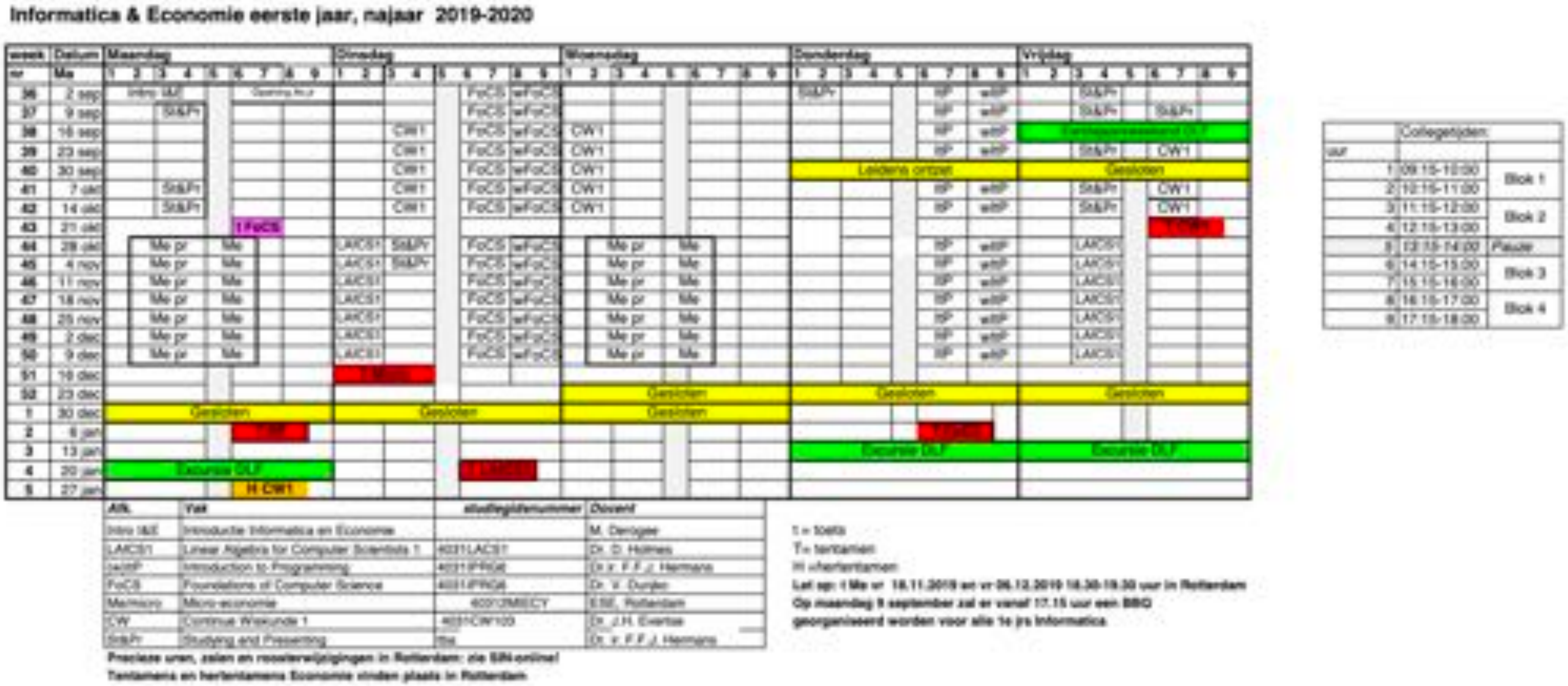
week nr	Datum Ma	Ma	Di	Wo	Do	Vr
36	2 sep	Intro Bioinf. Opening Ac.j.	Kick of Bio FoCS wFoCS	IV t IV	St&Pr IP wIP	St&Pr
37	9 sep	St&Pr	FoCS wFoCS	MG	IP wIP	St&Pr St&Pr
38	16 sep	MG / wM MG	wMG FoCS wFoCS	MG	MG IP wIP	Eerstejaarsweekend DLF
39	23 sep	MG	FoCS wFoCS	t MG	M. Labweek IP wIP	St&Pr
40	30 sep	MG	MG [illegible] FoCS wFoCS	MG	Leidens Ontzet	Gesloten
41	7 okt	MG St&Pr	tp mb2 FoCS wFoCS	MG tp mb3	IP wIP	St&Pr tp mb4
42	14 okt	MG St&Pr	tp mb5 FoCS wFoCS	MG tp mb6	tp mb7 IP wIP	St&Pr
43	21 okt	t FoCS		[illegible]		
44	28 okt	CF	CF St&Pr FoCS wFoCS	wCF	IP wIP	CF
45	4 nov	CF wCF 2	CF St&Pr FoCS wFoCS	pCF 1 gr A	WcF 4 IP wIP	CF
46	11 nov		FoCS wFoCS		[illegible] IP wIP	
47	18 nov		FoCS wFoCS	CB	CB IP wIP	
48	25 nov	MI	MI FoCS wFoCS	CB	CB IP wIP	
49	2 dec	MI pmi1	MI FoCS wFoCS	CB MI pmi2	CB IP wIP	
50	9 dec	MI pmi3	MI FoCS wFoCS	CB pmi4	CB IP wIP	
51	16 dec	T MG			T CB	
52	23 dec			Gesloten	Gesloten	Gesloten
1	30 dec	Gesloten	Gesloten	Gesloten		H MG
2	6 jan	T MI			T FoCS	
3	13 jan	H CB			Excursie DLF	Excursie DLF
4	20 jan	H CF			H MI	
5	27 jan					

	Collegetijden	
Uur		
1	09:15-10:00	Blok 1
2	10:15-11:00	
3	11:15-12:00	Blok 2
4	12:15-13:00	
5	13:15-14:00	Pauze
6	14:15-15:00	Blok 3
7	15:15-16:00	
8	16:15-17:00	Blok 4
9	17:15-18:00	

Afk.	Vak	studiegidsnummer	Docent
CB	Celbiologie	4031BCB3	Prof.dr. H.P. Spaink
CF	Celfysiologie	4031BCF3	Dr.ir. E.J. v.d. Zaal
MI	Microbiologie	40212MB15	Dr. A.F.J. Ram
MG	Moleculaire genetica	4031BMG1	Prof. Dr. R. Offringa
Kick of Bio	Kick of Biologie		
IV	Instructie Veiligheid		
Intro	Introductie studie Bioinformatica		M. Deroggee
FoCS	Foundations of Computer Science	4031FOCS6	Dr. V. Dunjko
(w)IP	Introduction to Programming	4031IPRG6	Dr.ir.F.F.J. Hermans
ST&Pr	Studying & Presenting	4031STPEC	Dr.ir. F.F.J. Hermans

t = toets
T= tentamen
H =hertentamen

Op maandag 9 september zal er om 17.15 uur een BBQ georganiseerd worden voor alle 1e jrs informatica.



Informatica & Economie eerste jaar, najaar 2019-2020

week nr	Datum Ma	Maandag 1	2	3	4	5	6	7	8	9
36	2 sep	Intro I&E					Opening ac.jr			
37	9 sep			St&Pr						
38	16 sep									
39	23 sep									
40	30 sep									
41	7 okt			St&Pr						
42	14 okt			St&Pr						
43	21 okt						t FoCS			
44	28 okt			Me pr		Me				
45	4 nov			Me pr		Me				
46	11 nov			Me pr		Me				
47	18 nov			Me pr		Me				
48	25 nov			Me pr		Me				
49	2 dec			Me pr		Me				
50	9 dec			Me pr		Me				
51	16 dec									
52	23 dec									
1	30 dec	Gesloten								
2	6 jan						[illegible]			
3	13 jan									
4	20 jan	Excursie DLF								
5	27 jan						H CW1			

week nr	Datum Ma	Dinsdag 1	2	3	4	5	6	7	8	9
36	2 sep						FoCS		wFoCS	
37	9 sep						FoCS		wFoCS	
38	16 sep			CW1			FoCS		wFoCS	
39	23 sep			CW1			FoCS		wFoCS	
40	30 sep			CW1			FoCS		wFoCS	
41	7 okt			CW1			FoCS		wFoCS	
42	14 okt			CW1			FoCS		wFoCS	
43	21 okt									
44	28 okt	LACS1		St&Pr			FoCS		wFoCS	
45	4 nov	LACS1		St&Pr			FoCS		wFoCS	
46	11 nov	LACS1					FoCS		wFoCS	
47	18 nov	LACS1					FoCS		wFoCS	
48	25 nov	LACS1					FoCS		wFoCS	
49	2 dec	LACS1					FoCS		wFoCS	
50	9 dec	LACS1					FoCS		wFoCS	
51	16 dec	T Micro								
52	23 dec									
1	30 dec	Gesloten								
2	6 jan									
3	13 jan									
4	20 jan						[illegible]			
5	27 jan									

week nr	Datum Ma	Woensdag 1	2	3	4	5	6	7	8	9
36	2 sep									
37	9 sep									
38	16 sep	CW1								
39	23 sep	CW1								
40	30 sep	CW1								
41	7 okt	CW1								
42	14 okt	CW1								
43	21 okt									
44	28 okt		Me pr			Me				
45	4 nov		Me pr			Me				
46	11 nov		Me pr			Me				
47	18 nov		Me pr			Me				
48	25 nov		Me pr			Me				
49	2 dec		Me pr			Me				
50	9 dec		Me pr			Me				
51	16 dec									
52	23 dec	Gesloten								
1	30 dec	Gesloten								
2	6 jan									
3	13 jan									
4	20 jan									
5	27 jan									

week nr	Datum Ma	Donderdag 1	2	3	4	5	6	7	8	9
36	2 sep	St&Pr					IIP		wIIP	
37	9 sep						IIP		wIIP	
38	16 sep						IIP		wIIP	
39	23 sep						IIP		wIIP	
40	30 sep	Leidens ontzet								
41	7 okt						IIP		wIIP	
42	14 okt						IIP		wIIP	
43	21 okt									
44	28 okt						IIP		wIIP	
45	4 nov						IIP		wIIP	
46	11 nov						IIP		wIIP	
47	18 nov						IIP		wIIP	
48	25 nov						IIP		wIIP	
49	2 dec						IIP		wIIP	
50	9 dec						IIP		wIIP	
51	16 dec									
52	23 dec	Gesloten								
1	30 dec									
2	6 jan						[illegible]			
3	13 jan	Excursie DLF								
4	20 jan									
5	27 jan									

week nr	Datum Ma	Vrijdag 1	2	3	4	5	6	7	8	9
36	2 sep			St&Pr						
37	9 sep			St&Pr			St&Pr			
38	16 sep	Eerstejaarsweekend DLF								
39	23 sep			St&Pr			CW1			
40	30 sep	Gesloten								
41	7 okt			St&Pr			CW1			
42	14 okt			St&Pr			CW1			
43	21 okt						T CW1			
44	28 okt			LACS1						
45	4 nov			LACS1						
46	11 nov			LACS1						
47	18 nov			LACS1						
48	25 nov			LACS1						
49	2 dec			LACS1						
50	9 dec			LACS1						
51	16 dec									
52	23 dec	Gesloten								
1	30 dec									
2	6 jan									
3	13 jan	Excursie DLF								
4	20 jan									
5	27 jan									

	Collegetijden:	
uur		
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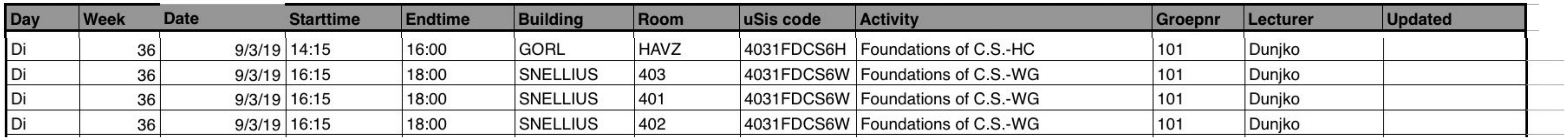
6	14:15-15:00	Blok 3
7	15:15-16:00	
8	16:15-17:00	Blok 4
9	17:15-18:00	

Afk.	Vak	studiegidsnummer	Docent
Intro I&E	Introductie Informatica en Economie		M. Derogee
LACS1	Linear Algebra for Computer Scientists 1	4031LACS1	Dr. D. Holmes
(w)IIP	Introduction to Programming	4031IPRG6	Dr.ir. F.F.J. Hermans
FoCS	Foundations of Computer Science	4031IPRG6	Dr. V. Duijko
Me/micro	Micro-economie	4031ZMIECY	ESE, Rotterdam
CW	Continue Wiskunde 1	4031CW103	Dr. J.H. Evertse
St&Pr	Studying and Presenting	tba	Dr. ir. F.F.J. Hermans

Precieze uren, zalen en roosterwijzigingen in Rotterdam: zie SIN-online!
Tentamens en hertentamens Economie vinden plaats in Rotterdam

t = toets
T= tentamen
H =hertentamen
Let op: t Me vr 15.11.2019 en vr 06.12.2019 18.30-19.30 uur in Rotterdam
Op maandag 9 september zal er vanaf 17.15 uur een BBQ georganiseerd worden voor alle 1e jrs Informatica



Day	Week	Date	Starttime	Endtime	Building	Room	uSis code	Activity	Groepnr	Lecturer	Updated
Di	36	9/3/19	14:15	16:00	GORL	HAVZ	4031FDCS6H	Foundations of C.S.-HC	101	Dunjko	
Di	36	9/3/19	16:15	18:00	SNELLIUS	403	4031FDCS6W	Foundations of C.S.-WG	101	Dunjko	
Di	36	9/3/19	16:15	18:00	SNELLIUS	401	4031FDCS6W	Foundations of C.S.-WG	101	Dunjko	
Di	36	9/3/19	16:15	18:00	SNELLIUS	402	4031FDCS6W	Foundations of C.S.-WG	101	Dunjko	

- **check course web-page for location if unsure**

Technicalities

- **Your obligations:**
- **To pass, you need to demonstrate knowledge in the contents of the course; you need to get a passing grade.**

- **You do need to *register in uSIS*, and *enrol in Blackboard.***

- **otherwise your exam may not be graded and you will fail…**

Technicalities

- Attendence not mandatory!
- Exam (and mid-term) comprises excercises of the type you will do in tutorials; ***useful***
- Lectures are here to help you. If you miss some or many, it is a good idea to review what you missed before attending (http://liacs.leidenuniv.nl/~dunjkov/FCS1.html)

Technicalities

- Your rights…

- Lectures are here to help you. If you miss some or many, it is a good idea to review what you missed before attending (http://liacs.leidenuniv.nl/~dunjkov/FCS1.html)

- Use the lectures. Ask questions.

Technicalities

Advice:

- do follow the course regularly.
- do use the book.
- do use other materials and the internet.
- do communicate with each other.

Technicalities

Advice:

- do follow the course regularly.

- do use the book.

- do use other materials and the internet.

- do communicate with each other.
  (please not during exams)

About the course

- *Mathematical* foundations of *theoretical* computer science

About the course

- *Mathematical* foundations of *theoretical* computer science

Questions:

- What is an algorithm?
- What is a computer?
- What makes one algorithm better than another?
- Can I know my algorithm is *best*?
- Can a computer solve *all problems*?
- What kinds of programming languages do we have, is there a best one?

About the course

- *Mathematical* foundations of *theoretical* computer science

Quest

- Wh
- Wh
- Wh
- Can
- Can
- Wh ,
  is th

Will not answer all of these, this is the content of other courses

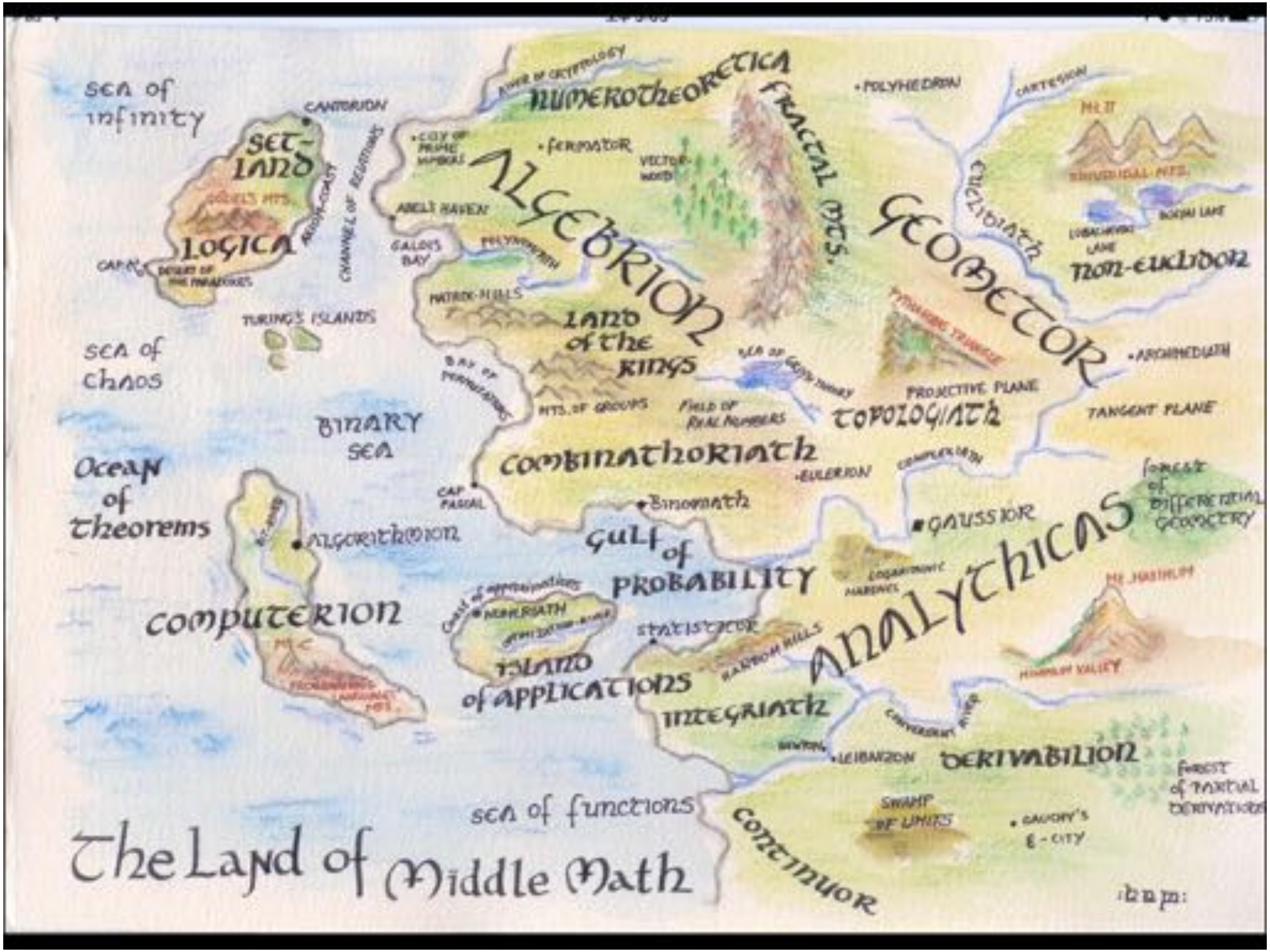
This course provides tools to begin answering such questions

About the course

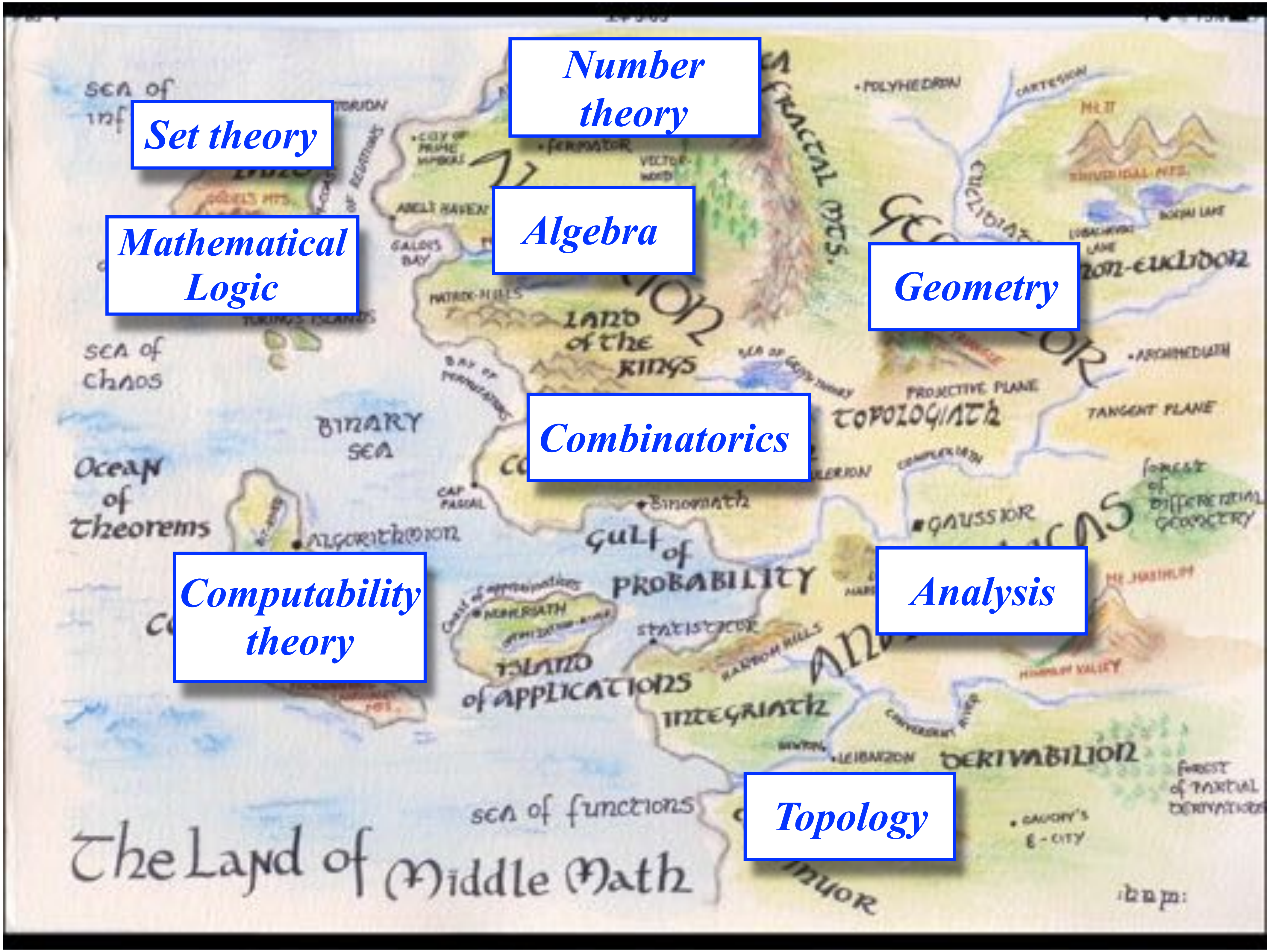
- ***Mathematical*** **foundations of *theoretical* computer science**

  - **What is mathematics?**
  - **First and foremost: a very precise language.**
  - **Why math for CS?**

  - **Learned similarly to how you learn languages!**
  - **Various branches**



Credit: Franka Miriam Brückler



Set theory

Number theory

Mathematical Logic

Algebra

Geometry

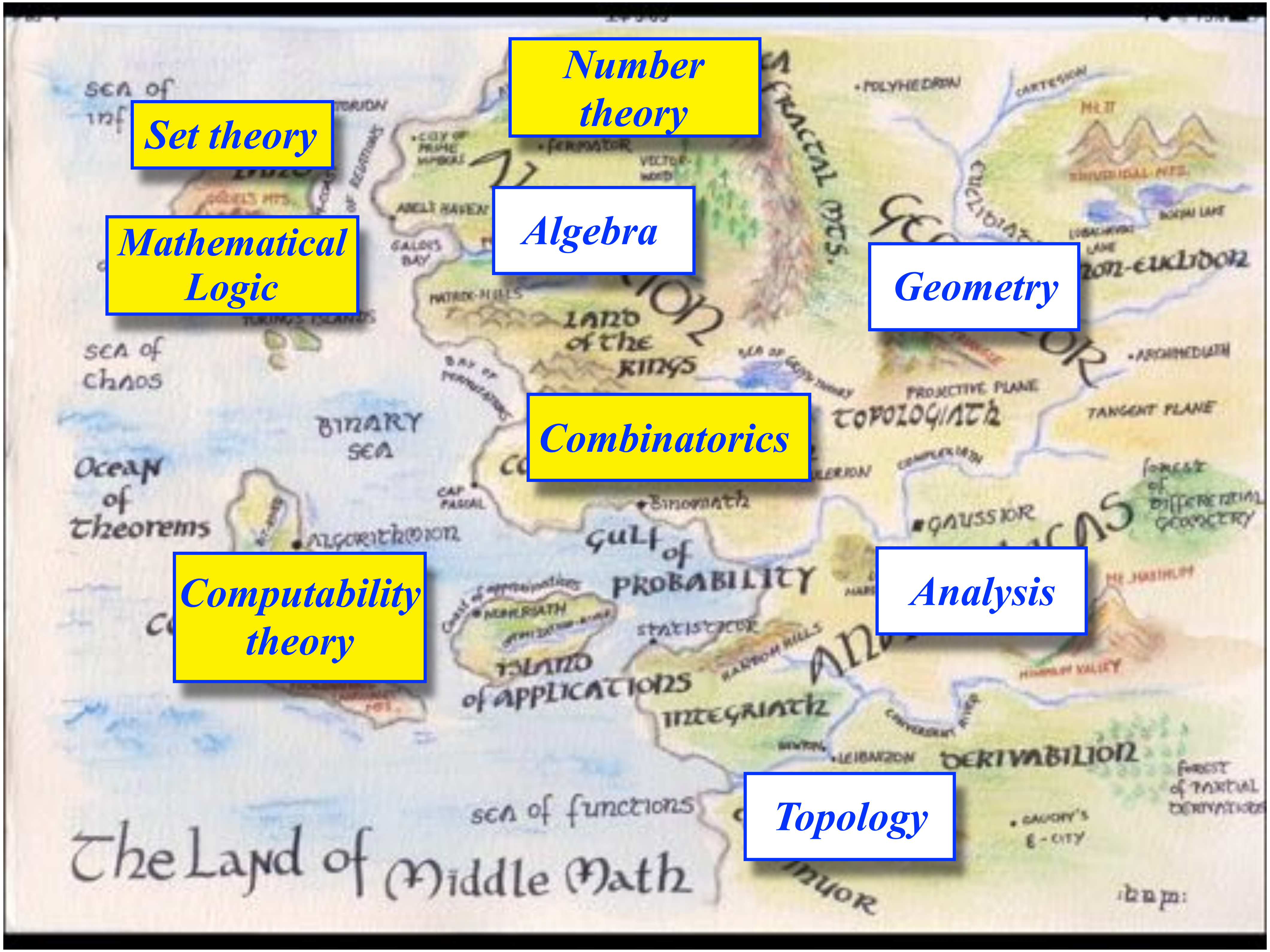
Combinatorics

Computability theory

Analysis

Topology

Credit: Franka Miriam Brückler



Set theory

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Algebra

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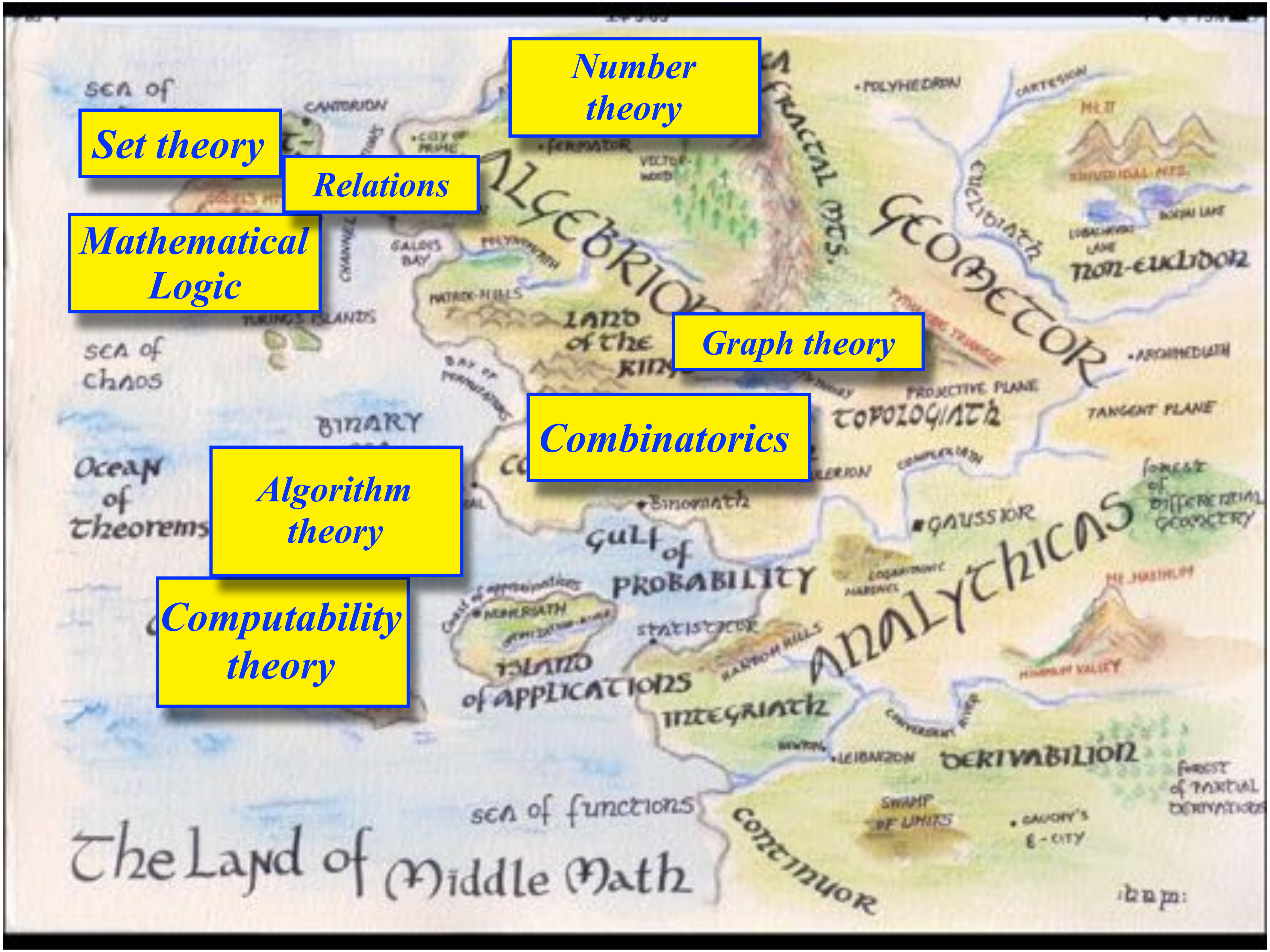

Number theory

Set theory

Relations

Mathematical Logic

Graph theory

Combinatorics

Algorithm theory

Computability theory

Credit: Franka Miriam Brückler

Set theory

Relations

Functions

Graph theory

Combinatorics

Number theory

Algorithm theory

Computability theory

- *Discrete* mathematics
- used to describe and reason about computation
- math = underlying computer science
  (also math is *amazing*)
- math language = common language of all courses
- precision *necessary*

Set theory

Relations

Functions

Graph theory

Combinatorics

Number theory

Algorithm theory

Computability theory

- *Contents of the course:*
  - *Sets*
  - *Relations*
  - *Functions*
  - *Graphs*
  - *Combinatorics*
  - *Recursion and induction*
  - *Trees (special graphs)*
  - *Formal languages*
  - *Finite automata*

- ***How does one teach mathematics?***

Generic structure

- **basic concepts (*definitions*; <u>vocabulary</u>)**
- **trivial, complicated and counter-example**
- **relationships and properties (*theorems*)**
- **convince you they are true (*proofs of theorems)***

- ***motivation***
- ***perspectives (tip of the iceberg)***

Generic structure example

- **Assuming:** integers (whole numbers), real numbers, division, square roots

Generic structure example

- **Definition.** A non-negative integer p is ***prime*** if it is larger than 1, and is divisible only by 1 and itself.

- **Definition**. A non-negative integer which is not prime is **composite**.

Generic structure example

- **Definition.** A non-negative integer p is ***prime*** if it is larger than 1, and is divisible only by 1 and itself.

- **Definition**. A non-negative integer which is not prime is **composite**.

- **Trivial examples of composite:** even integers greater than 2, numbers ending with zero

$$a^2-1=(a-1)(a+1)$$

- **Trivial counterexamples: 2,5,7,11,13**

- **More complicated example:** $\underline{a^2-1}$, for integer $a > 2$ is composite

- **More complicated counterexample: $2^{82,589,933}-1$**

Generic structure example

- **Definition.** An integer p is ***prime*** if it is divisible only by 1 and itself.

- **Definition**. An integer which is not prime is **composite**.

- **Theorem.** *Fundamental theorem of arithmetic:* any number is a product of powers of prime numbers, and this decomposition is unique, up to permutation.

- **Theorem.** There are **infinitely many prime numbers**

Generic structure example

Let’s prove one!

$$p_1, p_2, p_3 \ldots p_n$$

$$P = \underline{p_1 \times p_2 \times p_3 \cdots p_n}$$

$$Q = P + 1$$

$$\exists k \quad p_k | Q \qquad p_k | P$$

$$\boxed{\frac{Q}{p_k}} = \frac{P+1}{p_k} = \frac{p_1 \cdot \overset{\downarrow}{p_2} \cdots p_n}{p_k} + \frac{1}{\underline{\underline{p_k}}}$$

$$Q = \underline{\overset{k_1}{p_1} \times \overset{k_2}{p_2} \times \overset{k_3}{p_3} \cdots \overset{k_n}{p_n}}$$

$$p_1^{k} = \underbrace{p_1 \times p_1 \times p_1 \cdots p_1}_{k}$$

Generic structure example

- **Theorem.** Fundamental theorem of arithmetic: any number is a product of prime powers

- **Motivation.** Cryptography. Number theory. Gödel's encoding.

- **Perspectives**: Factorization. Quantum computing. Algebra. Number theory. Computability theory.

Generic structure:

- concept (definition),
- examples and counter examples,
- main properties (theorems and lemmas)

- motivation/perspectives

First three: you can use math to solve problems…
This is also how you <u>learn</u> mathematics

This is the goal, and what will be checked.

Objective of course

- teach you “to think mathematically” - just a new language!
- get a feel for “abstraction”

- teach you the basic concepts of (discrete) mathematics
  - (these are also the basic concepts of computer science!)

- how to solve problems using discrete mathematics

- how to prove stuff, and what that means
  - (how to *argue your ideas precisely and convincingly*)

Questions?