Periodic Table of Mathematical Structures (PTMS)

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Abstract

The Periodic Table of Mathematical Structures (PTMS) aims to systematically organize and classify mathematical structures by their levels of complexity and abstractness. Inspired by the periodic table of elements, this project seeks to create an ever-expanding framework that serves as an educational and research tool, highlighting the relationships and hierarchies among mathematical concepts.

1 Periodic Table of Mathematical Structures

Abstractness Complexity	**1**	**2**	**3**	**4**	**5**	**6**
1	Set: Distinct objects	Relation: Ordered pairs	Function: Mappings	Tuple: Ordered list of elements	Multiset: Elements with multiplicities	Sequence: Ordered list with repetitions
2	Ring: Two operations	Module: Generalized vector space	Vector Space: Vectors with ops	Algebra: Vector space with product	Lie Algebra: Non-associative product	Associative Algebra: Algebra where multiplication is associative
3	Topological Space: Neighborhoods	Manifold: Locally Euclidean	Symplectic Manifold: 2-form	Tensor Category: Tensor product	Fiber Bundle: Space with a projection	Vector Bundle: Vector space parameterized by another space
4	Chain Complex: Abelian groups	Derived Category: Complexes	Motivic Homotopy: Homotopy for varieties	Higher Category: Multiple morphisms	Exact Sequence: Chain of maps	Spectral Sequence: Sequence of exact sequences
5	Riemann Surface: 1D complex manifold	Modular Form: Analytic function	Automorphic Form: Invariant functions	Noncommutative Geometry: Noncommutative algebras	Complex Manifold: Multi-dimensional	Differential Form: Generalized function for integration
6	Graph: Vertices and edges	Hypergraph: Generalized graph	Matroid: Generalized independence	Simplicial Complex: Generalized graph	Polytope: Multi-dimensional shape	Convex Hull: Smallest convex set containing a set
7	Category: Objects and morphisms	Functor: Maps between categories	Natural Transformation: Functors of functors	Monoidal Category: Tensor category	Closed Category: Functors as objects	Higher Category: Multiple morphisms

8	Partial Order: Ordered pairs	Lattice: Ordered structure	Boolean Algebra: Boolean operations	Heyting Algebra: Generalizes Boolean algebra	Complete Lattice: All sup and inf	Continuous Lattice: Lattice with certain completeness properties
9	Propositional Logic: True/False	First-Order Logic: Quantifiers	Modal Logic: Neces- sity/Possibility	Intuitionistic Logic: Constructivist approach	Higher Order Logic: Quantifies over functions	Type Theory: Computation with types
10	CW Complex: Space decomposed into cells	Simplicial Complex: Collection of simplices	Differentiable Stack: Stack with smooth structure	Orbifold: Generalized manifold with singularities	Stratified Space: Space with stratification	Tame Space: Space with tame topology
11	Azumaya Algebra: Generalization of central simple algebras	Clifford Algebra: Algebra associated with quadratic forms	Witt Group: Group of quadratic forms over a field	Brauer Group: Group classifying division algebras	Quantum Torus: Noncom- mutative deformation of the torus	Quasi-Hopf Algebra: Generalization of Hopf algebra
12	Algebraic Surface: Two-dimensional algebraic variety	Calabi-Yau Manifold: Ricci-flat Kähler manifold	K3 Surface: Special type of Calabi-Yau manifold	Fano Variety: Variety with ample anticanonical bundle	Enriques Surface: Algebraic surface with certain properties	Abelian Variety: Projective variety that is also a group
13	A-Category: Category with A-morphisms	E-Category: Category with E-morphisms	Derived -Category: Generalization of derived categories	DG-Category: Differential graded category	Infinity-Category: Generalization of categories with infinite levels	-Category: Higher category with morphisms between morphisms
14	Hilbert Modular Form: Generalizes modular forms	Siegel Modular Form: Modular forms for symplectic groups	Automorphic Representation: Representation of automorphic forms	Theta Function: Special function of several complex variables	Moduli Space of Curves: Parameter space for algebraic curves	Hecke Algebra: Algebra associated with double cosets o a group
15	Matroid Theory: Generalizes linear independence	Greedoids: Generalizes matroids and antimatroids	Delta-Matroid: Generalizes matroids	Chow Ring: Intersection theory on algebraic varieties	Graph Homo- morphism: Map preserving graph structure	Graph Minor: Minor in a graph
16	Infinity-Topos: Generalization of topoi to -categories	(,1)-Category: Category with weak equivalences and higher morphisms	(,n)-Category: Generalization of (,1)-categories to n-levels	Double Category: Category with two types of morphisms	Tricategory: Generalization of bicategories to three levels	Pseudocategory Category with lax associativity and unit laws

17	Continuous Lattice: Lattice with certain completeness properties	Algebraic Lattice: Lattice with certain algebraic properties	Stone Duality: Duality between topological spaces and lattices	Scott Domain: Continuous domain theory	Fuzzy Set: Generalizes set theory with degrees of membership	Complete Lattice: All sup and inf
18	Probabilistic Logic: Logic with probabilistic truth values	Temporal Logic: Logic for reasoning about time	Dynamic Logic: Logic for reasoning about programs	Epistemic Logic: Logic for reasoning about knowledge	Substructural Logic: Logic without certain structural rules	Higher Order Logic: Quantifies over functions
19	TQFT: Topological Quantum Field Theory	Vertex Algebra: Algebraic structure used in conformal field theory	Tensor Network: Network of tensors used in quantum computing	AdS/CFT Correspondence: Duality between a gravitational theory in Anti-de Sitter space and a conformal field theory	Quantum Gravity: Study of gravity in the context of quantum mechanics	String Theory: Theoretical framework in which particles are replaced by one-dimensiona strings
20	TQFT: Topological Quantum Field Theory	D-brane: Objects in string theory that boundaries of strings attach to	Quantum Cohomology: Cohomology theory using quantum mechanics principles	Seiberg-Witten Theory: Study of 4-manifolds using gauge theory	Floer Theory: Intersection theory for symplectic manifolds	Gromov-Witten Invariants: Counts of holomorphic curves in symplectic manifolds
21	Lie 2-Algebra: Generalization of Lie algebras with 2-categories	Lie Groupoid: Generalization of Lie groups to groupoids	Lie Supergroup: Supergroup structure extending Lie groups	Loop Group: Infinite-dimensional Lie group associated with loops in a Lie group	Virasoro Algebra: Infinite-dimensional Lie algebra related to conformal field theory	Kac-Moody Algebra: Generalization of finite-dimensional Lie algebras
22	-Groupoid: Generalization of groupoids to infinite levels	Simplicial Set: Combinatorial model for topological spaces	Cubical Set: Generalization of simplicial sets using cubes	Kan Complex: Special type of simplicial set used in homotopy theory	Model Category: Category with a notion of weak equivalences, fibrations, and cofibrations	Spectra: Sequence of spaces or spectra used in stable homotopy theory
23	Derived Scheme: Generalization of schemes in derived algebraic geometry	Derived Stack: Generalization of stacks in derived algebraic geometry	Perfectoid Space: Topological space used in p-adic Hodge theory	Berkovich Space: Non-Archimedean analytic space	Tropical Geometry: Study of piecewise linear structures that arise as limits of algebraic varieties	Non-Archimedean Geometry: Study of spaces with non-Archimedean metrics
24	Higher Topos Theory: Study of higher categories with topological structures	(,1)-Category: Category with weak equivalences and higher morphisms	(,n)-Category: Generalization of (,1)-categories to n-levels	-Topos: Generalization of topoi to -categories	Double Category: Category with two types of morphisms	Tricategory: Generalization of bicategories to three levels

25	Derived Category of Sheaves: Category of complexes of sheaves	Tate Cohomology: Cohomology theory for finite groups	Adams Spectral Sequence: Tool for calculating homotopy groups	Etale Cohomology: Cohomology theory for algebraic varieties	Crystalline Cohomology: Cohomology theory for p-adic varieties	De Rham Cohomology: Cohomology for smooth manifolds
26	Geometric Representation Theory: Study of representations using geometry	Categorical Representation Theory: Study of representations in higher categories	Quantum Group Representation: Study of representations of quantum groups	Hecke Algebra Representation: Study of representations of Hecke algebras	Affine Lie Algebra Representation: Study of representations of affine Lie algebras	Kac-Moody Algebra Representation: Study of representationsn of Kac-Moody algebras
27	Symmetric Tensor Category: Category with a symmetric tensor product	Braided Tensor Category: Category with a braided tensor product	Fusion Category: Tensor category with additional properties	Modular Tensor Category: Fusion category satisfying modularity conditions	Factorization Algebra: Algebraic structure used in quantum field theory	Vertex Algebra: Algebraic structure used in conformal field theory
28	Homotopy Type Theory: Homotopy theory interpreted in type theory	Stable Homotopy Theory: Study of stable homotopy groups of spheres	Chromatic Homotopy Theory: Study of periodic phenomena in stable homotopy theory	Motivic Homotopy Theory: Homotopy theory for algebraic varieties	Equivariant Homotopy Theory: Homotopy theory considering group actions	Algebraic K-Theory: Study of projective modules and vector bundles using homotopy theory
29	Quantum Field Theory: Study of quantum fields	Conformal Field Theory: Quantum field theory invariant under conformal transformations	Topological Quantum Field Theory: Quantum field theory invariant under topological transformations	String Theory: Theoretical framework in which particles are replaced by one-dimensional strings	M-Theory: Theory unifying the five superstring theories	Loop Quantum Gravity: Quantum theory of gravity
30	Calabi-Yau Manifold: Ricci-flat Kähler manifold	Kähler Geometry: Study of Kähler manifolds	Hermitian Symmetric Space: Symmetric space with Hermitian structure	Teichmüller Space: Space of complex structures on a surface	Moduli Space of Abelian Varieties: Parameter space for Abelian varieties	Differential Topology: Study of differentiable functions on manifolds
31	Loop Space: Space of loops in a topological space	Operad: Abstract structure for operations	PROPs: Generalization of operads	Monoidal Homotopy Theory: Study of homotopy theory with monoidal structures	Higher Bordism Theory: Study of manifolds up to cobordism	Higher Homotopy Groups: Study of higher homotopy groups

32	Symplectic Manifold: Manifold with a non-degenerate 2-form	Contact Manifold: Odd-dimensional counterpart to symplectic manifolds	Poisson Manifold: Generalizes symplectic manifolds with Poisson brackets	Hamiltonian Dynamics: Study of dynamical systems governed by Hamiltonian functions	Quantum Symplectic Geometry: Study of symplectic geometry in the quantum context	Symplectic Field Theory: Generalization of Floer homology
33	Noncommutative Algebraic Geometry: Generalizes algebraic geometry using noncommutative rings	Noncommutative Topology: Study of topological structures in a noncommutative context	Noncommutative Probability: Generalizes probability theory using noncommutative algebras	Quantum Groups: Algebraic structures underlying quantum symmetries	C*-Algebra: Study of Banach algebras with an involution	von Neumann Algebra: Algebra of bounded operators
34	Topological Field Theory: Field theory invariant under topological transformations	Knot Theory: Study of mathematical knots	Quantum Invariants: Invariants of knots and 3-manifolds from quantum field theory	Floer Homology: Homology theory for studying periodic orbits in symplectic geometry	Quantum Topology: Study of topological properties in the quantum context	Quantum Field Theory: Study of quantum fields
35	Differential Forms: Generalized functions for integration on manifolds	De Rham Cohomology: Cohomology theory using differential forms	Riemannian Geometry: Study of smooth manifolds with Riemannian metrics	Lorentzian Geometry: Study of manifolds with Lorentzian metrics	Finsler Geometry: Generalizes Riemannian geometry by relaxing the requirement for the metric to be quadratic	Complex Geometry: Study of complex manifolds and their properties
36	Algebraic K-Theory: Study of projective modules and vector bundles using homotopy theory	Quillen K-Theory: Quillen's approach to algebraic K-theory	Higher Algebraic K-Theory: Generalizes algebraic K-theory to higher dimensions	Motivic K-Theory: Study of algebraic K-theory in the motivic context	Topological K-Theory: Study of vector bundles on topological spaces	Higher Topological K-Theory: Generalization of topological K-theory
37	Banach Space: Complete normed vector space	Hilbert Space: Complete inner product space	Operator Algebras: Study of algebras of operators on a Hilbert space	Spectral Theory: Study of the spectrum of operators	Functional Calculus: Study of functions of operators	Banach Algebra: Normed algebra
38	Geometric Langlands Program: Geometric approach to the Langlands program	Derived Categories of Sheaves: Study of derived categories in the context of sheaves	Perverse Sheaves: Special type of sheaves used in representation theory	D-Modules: Modules over the ring of differential operators	Automorphic Forms: Generalization of modular forms to more general groups	Langlands Program: Conjectures relating Galois groups and automorphic forms

39	Arithmetic Geometry: Study of solutions to polynomial equations with integer coefficients	Iwasawa Theory: Study of number fields and Galois representations	Modular Forms: Complex analytic functions with specific transformation properties	Elliptic Curves: Study of cubic curves with a group structure	L-Functions: Complex functions associated with number fields and modular forms	Class Field Theory: Study of abelian extensions of number fields
40	Computational Group Theory: Study of algorithms for groups	Computational Number Theory: Study of algorithms for number theoretic problems	Computational Algebraic Geometry: Study of algorithms for algebraic geometry problems	Symbolic Computation: Study of algorithms for manipulating symbolic expressions	Computational Topology: Study of algorithms for topological problems	Computational Complexity: Study of the complexity of algorithms
41	Linear Programming: Optimization of linear functions subject to linear constraints	Integer Programming: Optimization of linear functions with integer variables	Combinatorial Optimization: Study of optimization problems on combinatorial structures	Network Flow: Study of flows in networks	Polyhedral Combinatorics: Study of combinatorial properties of polyhedra	Graph Theory: Study of graphs and their properties
42	Algebraic Graph Theory: Study of graphs using algebraic methods	Combinatorial Design Theory: Study of combinatorial designs	Matroid Theory: Study of matroids and their applications	Symmetric Functions: Study of symmetric functions and their applications	Representation Theory of Symmetric Groups: Study of representations of symmetric groups	Representation Theory of Finite Groups: Study of representations of finite groups
43	Homological Algebra: Study of homology and cohomology theories	Derived Functors: Functors constructed to measure the failure of another functor to be exact	Ext and Tor: Derived functors measuring extensions and torsion	Derived Categories: Categories of complexes of objects	Triangulated Categories: Categories equipped with a class of distinguished triangles	Derived Algebraic Geometry: Study of derived categories in algebraic geometry
44	Morse Theory: Study of critical points of smooth functions	Surgery Theory: Study of the modifications of manifolds	Cobordism Theory: Study of manifolds up to cobordism	Differential Structures on Manifolds: Study of different smooth structures on topological manifolds	Exotic Spheres: Study of spheres with exotic smooth structures	Homotopy Theory: Study of homotopies and their properties
45	Ergodic Theory: Study of dynamical systems with an invariant measure	Measure Theory: Study of measures and their properties	Probability Theory: Study of random events and their probabilities	Dynamical Systems: Study of systems that evolve over time	Statistical Mechanics: Study of large systems by statistical methods	Stochastic Processes: Study of processes that evolve randomly over time

46	Axiomatic Set Theory: Study of sets based on axioms	Large Cardinals: Study of large cardinal numbers	Descriptive Set Theory: Study of sets in descriptive terms	Forcing: Technique to prove consistency and independence results	Inner Models: Study of models of set theory inside other models	Infinitary Combinatorics: Study of combinatorial properties of infinite sets
47	Model Theory: Study of models of formal theories	O-Minimal Structures: Study of structures with a well-behaved definable set	Stability Theory: Study of stable theories and their models	NIP Theories: Study of theories without the independence property	Categoricity: Study of categorical theories	Definability: Study of definable sets and functions
48	Proof Theory: Study of the structure of mathematical proofs	Sequent Calculus: A logic system for proving validity	Natural Deduction: A method for deriving logical conclusions	Type Theory: Study of types in programming languages and logic	Automated Theorem Proving: Study of algorithms for proving theorems	Lambda Calculus: Computation with functions
49	Derived Algebraic Geometry: Study of derived categories in algebraic geometry	Noncommutative Algebraic Geometry: Study of algebraic geometry using noncommutative rings	Logarithmic Geometry: Study of log schemes and their applications	Tropical Geometry: Study of piecewise linear structures that arise as limits of algebraic varieties	Homotopical Algebraic Geometry: Study of algebraic geometry using homotopical methods	Higher Category Theory: Study of categories with higher-dimensional morphisms
50	Geometric Representation Theory: Study of representations using geometry	Categorical Representation Theory: Study of representations in higher categories	Quantum Group Representation: Study of representations of quantum groups	Hecke Algebra Representation: Study of representations of Hecke algebras	Affine Lie Algebra Representation: Study of representations of affine Lie algebras	Kac-Moody Algebra Representation: Study of representations of Kac-Moody algebras
51	Quantum Mechanics: Study of the behavior of particles at the quantum level	Quantum Field Theory: Study of quantum fields	Quantum Gravity: Study of gravity in the context of quantum mechanics	Quantum Computing: Study of computation using quantum-mechanical phenomena	Quantum Cryptography: Study of cryptographic systems using quantum mechanics	Quantum Information Theory: Study of information theory in the context of quantum mechanics
52	Graph Theory: Study of graphs and their properties	Hypergraph Theory: Study of hypergraphs and their properties	Matroid Theory: Study of matroids and their applications	Combinatorial Design Theory: Study of combinatorial designs	Finite Geometry: Study of finite geometric structures	Algebraic Combinatorics: Study of combinatorial structures using algebraic methods

53	Algebraic Number Theory: Study of algebraic structures related to algebraic numbers	Class Field Theory: Study of abelian extensions of number fields	Iwasawa Theory: Study of number fields and Galois representations	Modular Forms: Complex analytic functions with specific transformation properties	L-Functions: Complex functions associated with number fields and modular forms	Diophantine Geometry: Study of Diophantine equations
54	Nonlinear Dynamics: Study of systems governed by nonlinear equations	Chaos Theory: Study of chaotic systems and their properties	Bifurcation Theory: Study of changes in the structure of dynamical systems	Fractal Geometry: Study of fractals and their properties	Soliton Theory: Study of solitons and their interactions	Dynamical Systems: Study of systems that evolve over time
55	Topological Data Analysis: Study of the shape of data using topology	Persistent Homology: Study of homology over varying scales	Mapper Algorithm: Technique for topological data analysis	Sheaf Theory: Study of sheaves and their applications	Discrete Morse Theory: Study of discrete analogs of Morse theory	Computational Topology: Study of algorithms for topological problems
56	Mathematical Physics: Study of mathematical methods in physics	Statistical Mechanics: Study of large systems by statistical methods	Quantum Mechanics: Study of the behavior of particles at the quantum level	General Relativity: Study of gravitation in the context of relativity	String Theory: Theoretical framework in which particles are replaced by one-dimensional strings	Quantum Field Theory: Study of quantum fields
57	Computational Geometry: Study of algorithms for geometric problems	Geometric Modeling: Study of the representation of geometric shapes	Mesh Generation: Study of algorithms for generating meshes	Voronoi Diagrams: Study of Voronoi diagrams and their applications	Convex Hulls: Study of convex hulls and their properties	Triangulations: Study of the division of geometric objects into simplices
58	Geometric Group Theory: Study of groups using geometric methods	Hyperbolic Geometry: Study of hyperbolic spaces and their properties	CAT(0) Spaces: Study of spaces with non-positive curvature	Teichmüller Theory: Study of the Teichmüller space of a surface	Geometric Invariant Theory: Study of group actions on algebraic varieties	Low-Dimensional Topology: Study of topological spaces of low dimension
59	Homotopy Theory: Study of homotopies and their properties	Stable Homotopy Theory: Study of stable homotopy groups of spheres	Chromatic Homotopy Theory: Study of periodic phenomena in stable homotopy theory	Motivic Homotopy Theory: Homotopy theory for algebraic varieties	Equivariant Homotopy Theory: Homotopy theory considering group actions	Homotopical Algebra: Study of algebraic structures using homotopy theory
60	Algebraic Topology: Study of topological spaces with algebraic methods	Homology Theory: Study of homology and cohomology theories	Cohomology Theory: Study of cohomology theories	Spectral Sequences: Tools for computing homology and cohomology groups	Higher Homotopy Groups: Study of higher homotopy groups	Fiber Bundles: Study of bundles with fibers over a base space

61	Probability Theory: Study of random events and their probabilities	Stochastic Processes: Study of processes that evolve randomly over time	Martingales: Study of martingales and their properties	Markov Chains: Study of Markov chains and their properties	Brownian Motion: Study of Brownian motion and its properties	Measure Theory: Study of measures and their properties
62	Riemannian Geometry: Study of smooth manifolds with Riemannian metrics	Lorentzian Geometry: Study of manifolds with Lorentzian metrics	Symplectic Geometry: Study of manifolds with a symplectic structure	Finsler Geometry: Generalizes Riemannian geometry by relaxing the requirement for the metric to be quadratic	Complex Geometry: Study of complex manifolds and their properties	Algebraic Geometry: Study of solutions to polynomial equations
63	Topological Groups: Study of groups with a topology	Topological Vector Spaces: Study of vector spaces with a topology	Fiber Bundles: Study of bundles with fibers over a base space	Principal Bundles: Study of bundles with a group action	Sheaf Theory: Study of sheaves and their applications	Homotopy Theory: Study of homotopies and their properties
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90	Mathematical Logic: Study of formal logical systems	Set Theory: Study of sets and their properties	Model Theory: Study of models of formal theories	Proof Theory: Study of the structure of mathematical proofs	Recursion Theory: Study of computable functions and Turing degrees	Constructivist Logic: Logic based on constructive mathematics

91	Algebraic Geometry: Study of solutions to polynomial equations	Commutative Algebra: Study of commutative rings and their ideals	Homological Algebra: Study of homology and cohomology theories	Representation Theory: Study of algebraic structures through their representations	Category Theory: Study of mathematical structures through categories	Higher Category Theory: Study of categories with higher-dimensional morphisms
92	Differential Geometry: Study of geometry using differential calculus	Algebraic Geometry: Study of solutions to polynomial equations	Riemannian Geometry: Study of smooth manifolds with Riemannian metrics	Symplectic Geometry: Study of manifolds with a symplectic structure	Topology: Study of topological spaces and continuous functions	Geometric Topology: Study of manifolds and topological spaces with geometric methods
93	Combinatorics: Study of counting, arrangement, and combination	Graph Theory: Study of graphs and their properties	Matroid Theory: Study of matroids and their applications	Design Theory: Study of combinatorial designs	Finite Geometry: Study of finite geometric structures	Enumerative Combinatorics: Study of counting combinatorial structures
94	Numerical Analysis: Study of algorithms for numerical approximation	Computational Geometry: Study of algorithms for geometric problems	Symbolic Computation: Study of algorithms for manipulating symbolic expressions	Cryptography: Study of secure communication techniques	Complexity Theory: Study of the complexity of algorithms	Computational Number Theory: Study of algorithms for number theoretic problems
95	Real Analysis: Study of real-valued functions and sequences	Complex Analysis: Study of complex-valued functions and sequences	Functional Analysis: Study of vector spaces with infinite dimensions	Harmonic Analysis: Study of functions and signals using Fourier series	Nonlinear Analysis: Study of nonlinear equations and their solutions	Geometric Analysis: Study of geometry using differential and integral calculus
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98	Applied Mathematics: Application of mathematical methods to other fields	Mathematical Biology: Application of mathematics to biological problems	Mathematical Physics: Application of mathematics to physical problems	Financial Mathematics: Application of mathematics to financial problems	Computational Mathematics: Application of computational methods to mathematical problems	Industrial Mathematics: Application of mathematics to industrial problems

99	Mathematical Neuroscience: Application of mathematics to neuroscience	Mathematical Epidemiology: Application of mathematics to the study of epidemics	Mathematical Ecology: Application of mathematics to ecological problems	Mathematical Economics: Application of mathematics to economic problems	Mathematical Psychology: Application of mathematics to psychological problems	Mathematical Sociology: Application of mathematics to sociological problems
100	Topological Quantum Field Theory: Study of quantum field theories invariant under topological transformations	Higher Category Theory: Study of categories with higher-dimensional morphisms	Higher Algebraic Geometry: Generalization of algebraic geometry to higher dimensions	Higher Symplectic Geometry: Study of symplectic geometry in higher dimensions	Higher Representation Theory: Study of representations in higher categories	Higher Homotopy Theory: Study of homotopy theory in higher dimensions