

6

LOCAL HOMOLOGICAL ALGEBRA

6.1 Notation

As usual, Λ denotes a ring with an identity element and we do not assume that Λ is commutative. When we wish to consider Λ as a left respectively right Λ -module, we denote it by Λ_l respectively Λ_r . In the latter part of this chapter, it will be necessary to pay special attention to the properties of *commutative* rings. A typical commutative ring (with identity element) will be denoted by S .

6.2 Projective covers

In this section we shall introduce the concept of a *projective cover*. This is the counterpart of the notion of an *injective envelope* which was defined in section (2.6). However, whereas a Λ -module always possesses an injective envelope, it is only in special circumstances that a projective cover will exist.†

Let B be a Λ -module.

Definition. A 'projective cover' for B is a pair (P, ψ) , where (i) P is a projective Λ -module, (ii) $\psi: P \rightarrow B$ is a Λ -epimorphism, and (iii) no proper submodule of P is mapped by ψ on to B .

For example, a projective module is its own projective cover with respect to the identity mapping. It should be noted that in some situations we omit a direct reference to the epimorphism ψ , but when this happens it will be clear from the context which is the relevant mapping.

The next theorem shows that projective covers (when they exist) are essentially unique.

Theorem 1. Let $u: B \xrightarrow{\sim} B'$ be an isomorphism of Λ -modules and let (P, ψ) resp. (P', ψ') be a projective cover for B resp. B' . Then there exists an isomorphism $v: P \xrightarrow{\sim} P'$, of Λ -modules, which satisfies $u\psi = \psi'v$.

† An account of rings for which every module has a projective cover will be found in H. Bass (3).

Course In Homological Algebra

Joseph J. Rotman



Course In Homological Algebra:

A Course in Homological Algebra P.J. Hilton, U. Stammbach, 2013-03-09 In this chapter we are largely influenced in our choice of material by the demands of the rest of the book However we take the view that this is an opportunity for the student to grasp basic categorical notions which permeate so much of mathematics today including of course algebraic topology so that we do not allow ourselves to be rigidly restricted by our immediate objectives A reader totally unfamiliar with category theory may find it easiest to restrict his first reading of Chapter II to Sections 1 to 6 large parts of the book are understandable with the material presented in these sections Another reader who had already met many examples of categorical formulations and concepts might in fact prefer to look at Chapter II before reading Chapter I Of course the reader thoroughly familiar with category theory could in principal omit Chapter II except perhaps to familiarize himself with the notations employed In Chapter III we begin the proper study of homological algebra by looking in particular at the group $\text{Ext}^n(A, B)$ where A and B are A modules It is shown how this group can be calculated by means of a projective presentation of A or an injective presentation of B and how it may also be identified with the group of equivalence classes of extensions of the quotient module A/B by the submodule B

A First Course of Homological Algebra Douglas Geoffrey Northcott, 1973-10-11 Designed to introduce the student to homological algebra avoiding the elaborate machinery usually associated with the subject

A Course in Homological Algebra Peter John Hilton (Mathematician, Great Britain), Urs Stammbach (Mathematician, Switzerland), 1971

A Course in Homological Algebra Peter John Hilton, Urs Stammbach, 1971

A Course in Homological Algebra Peter John Hilton, U. Stammbach, 1975

Lectures in Homological Algebra Peter Hilton, 1971 This volume constitutes a record of the course in homological algebra given at the Virginia Polytechnic Institute in July 1970 under the auspices of the National Science Foundation's Regional Conference project The nature of the audience required that the course begin with an introduction to the notion of modules over a unitary ring but permitted rapid development of the theory from that starting point The first three chapters may be regarded as containing material essential to any introductory course in homological algebra while the later chapters reflect the choices actually made by the audience among many possible special topics accessible to those who had mastered the early material Thus it may be claimed that the course achieved depth of penetration on a narrow front while it is admitted that breadth of coverage of the entire domain of homological algebra was neither attempted nor achieved

Introduction to Homological Algebra, 85 Joseph J. Rotman, 1979-09-07 An Introduction to Homological Algebra discusses the origins of algebraic topology It also presents the study of homological algebra as a two stage affair First one must learn the language of Ext and Tor and what it describes Second one must be able to compute these things and often this involves yet another language spectral sequences Homological algebra is an accessible subject to those who wish to learn it and this book is the author's attempt to make it lovable This book comprises 11 chapters with an introductory chapter that focuses on line integrals and independence of

path categories and functors tensor products and singular homology Succeeding chapters discuss Hom and projectives injectives and flats specific rings extensions of groups homology Ext Tor son of specific rings the return of cohomology of groups and spectral sequences such as bicomplexes Kunneth Theorems and Grothendieck Spectral Sequences This book will be of interest to practitioners in the field of pure and applied mathematics **A Course in Homological Algebra [by] P.J. Hilton [and] U. Stammbach** Peter John Hilton,1971

An Introduction to Homological Algebra Charles A. Weibel,1995-10-27 The landscape of homological algebra has evolved over the last half century into a fundamental tool for the working mathematician This book provides a unified account of homological algebra as it exists today The historical connection with topology regular local rings and semi simple Lie algebras are also described This book is suitable for second or third year graduate students The first half of the book takes as its subject the canonical topics in homological algebra derived functors Tor and Ext projective dimensions and spectral sequences Homology of group and Lie algebras illustrate these topics Intermingled are less canonical topics such as the derived inverse limit functor $\lim^1$ local cohomology Galois cohomology and affine Lie algebras The last part of the book covers less traditional topics that are a vital part of the modern homological toolkit simplicial methods Hochschild and cyclic homology derived categories and total derived functors By making these tools more accessible the book helps to break down the technological barrier between experts and casual users of homological algebra **Basic Homological Algebra** M. Scott Osborne,2012-12-06

Five years ago I taught a one quarter course in homological algebra I discovered that there was no book which was really suitable as a text for such a short course so I decided to write one The point was to cover both Ext and Tor early and still have enough material for a larger course one semester or two quarters going off in any of several possible directions This book is also intended to be readable enough for independent study The core of the subject is covered in Chapters 1 through 3 and the first two sections of Chapter 4 At that point there are several options Chapters 4 and 5 cover the more traditional aspects of dimension and ring changes Chapters 6 and 7 cover derived functors in general Chapter 8 focuses on a special property of Tor These three groupings are independent as are various sections from Chapter 9 which is intended as a source of special topics The prerequisites for each section of Chapter 9 are stated at the beginning Some things have been included simply because they are hard to find elsewhere and they naturally fit into the discussion Lazard s theorem Section 8.4 is an example Sections 4.5 and 7 of Chapter 9 contain other examples as do the appendices at the end *An Introduction to Homological Algebra* Joseph J.

Rotman,2008-12-10 Homological Algebra has grown in the nearly three decades since the first edition of this book appeared in 1979 Two books discussing more recent results are Weibel *An Introduction to Homological Algebra* 1994 and Gelfand Manin *Methods of Homological Algebra* 2003 In their Foreword Gelfand and Manin divide the history of Homological Algebra into three periods the first period ended in the early 1960s culminating in applications of Homological Algebra to regular local rings The second period greatly influenced by the work of A Grothendieck and J P Serre continued through the 1980s it involves

abelian categories and sheaf cohomology The third period involving derived categories and triangulated categories is still ongoing Both of these newer books discuss all three periods see also Kashiwara Schapira Categories and Sheaves The original version of this book discussed the first period only this new edition remains at the same introductory level but it now introduces the second period as well This change makes sense pedagogically for there has been a change in the mathematics population since 1979 today virtually all mathematics graduate students have learned something about functors and categories and so I can now take the categorical viewpoint more seriously When I was a graduate student Homological Algebra was an unpopular subject The general attitude was that it was a grotesque formalism boring to learn and not very useful once one had learned it

Methods of Homological Algebra Sergei I. Gelfand, Yuri I. Manin, 2013-03-09 Homological algebra first arose as a language for describing topological properties of geometrical objects As with every successful language it quickly expanded its coverage and semantics and its contemporary applications are many and diverse This modern approach to homological algebra by two leading writers in the field is based on the systematic use of the language and ideas of derived categories and derived functors Relations with standard cohomology theory sheaf cohomology spectral sequences etc are described In most cases complete proofs are given Basic concepts and results of homotopical algebra are also presented The book addresses people who want to learn a modern approach to homological algebra and to use it in their work For the second edition the authors have made numerous corrections

An Elementary Approach to Homological Algebra L.R. Verma, 2003-05-28 Often perceived as dry and abstract homological algebra nonetheless has important applications in a number of important areas including ring theory group theory representation theory and algebraic topology and geometry Although the area of study developed almost 50 years ago a textbook at this level has never before been available An Elementary Approach to Homological Algebra fills that void Designed to meet the needs of beginning graduate students the author presents the material in a clear easy to understand manner with many examples and exercises The book's level of detail while not exhaustive also makes it useful for self study and as a reference for researchers

Homological Algebra S.I. Gelfand, Yu.I. Manin, 2013-12-01 This book the first printing of which was published as volume 38 of the Encyclopaedia of Mathematical Sciences presents a modern approach to homological algebra based on the systematic use of the terminology and ideas of derived categories and derived functors The book contains applications of homological algebra to the theory of sheaves on topological spaces to Hodge theory and to the theory of modules over rings of algebraic differential operators algebraic D modules The authors Gelfand and Manin explain all the main ideas of the theory of derived categories Both authors are well known researchers and the second Manin is famous for his work in algebraic geometry and mathematical physics The book is an excellent reference for graduate students and researchers in mathematics and also for physicists who use methods from algebraic geometry and algebraic topology

Homological Algebra Marco Grandis, 2012 In this book we want to explore aspects of coherence in homological algebra that already appear in the classical situation of abelian groups

or abelian categories Lattices of subobjects are shown to play an important role in the study of homological systems from simple chain complexes to all the structures that give rise to spectral sequences A parallel role is played by semigroups of endorelations These links rest on the fact that many such systems but not all of them live in distributive sublattices of the modular lattices of subobjects of the system The property of distributivity allows one to work with induced morphisms in an automatically consistent way as we prove in a Coherence Theorem for homological algebra On the contrary a non distributive homological structure like the bifiltered chain complex can easily lead to inconsistency if one explores the interaction of its two spectral sequences farther than it is normally done The same property of distributivity also permits representations of homological structures by means of sets and lattices of subsets yielding a precise foundation for the heuristic tool of Zeeman diagrams as universal models of spectral sequences We thus establish an effective method of working with spectral sequences called crossword chasing that can often replace the usual complicated algebraic tools and be of much help to readers that want to apply spectral sequences in any field

Notes on Homological Algebras Joseph J. Rotman, 1970 These notes were developed in the course of teaching a graduate course on homological algebra at the University of Illinois Urbana during the spring of 1968 The reader proceeds at a leisurely pace prerequisites are algebra courses that include exact sequences tensor products over commutative rings and direct and inverse limits

A Course in Modern Algebra Peter Hilton, Yel-Chiang Wu, 1989-01-18 This classic work is now available in an unabridged paperback edition Hilton and Wu's unique approach brings the reader from the elements of linear algebra past the frontier of homological algebra They describe a number of different algebraic domains then emphasize the similarities and differences between them employing the terminology of categories and functors Exposition begins with set theory and group theory and continues with coverage categories functors natural transformations and duality and closes with discussion of the two most fundamental derived functors of homological algebra Ext and Tor

Commutative Algebra Oscar Zariski, Pierre Samuel, 2013-11-11 This second volume of our treatise on commutative algebra deals largely with three basic topics which go beyond the more or less classical material of volume I and are on the whole of a more advanced nature and a more recent vintage These topics are a valuation theory b theory of polynomial and power series rings including generalizations to graded rings and modules c local algebra Because most of these topics have either their source or their best motivation in algebraic geometry the algebro geometric connections and applications of the purely algebraic material are constantly stressed and abundantly scattered through out the exposition Thus this volume can be used in part as an introduction to some basic concepts and the arithmetic foundations of algebraic geometry The reader who is not immediately concerned with geometric applications may omit the algebro geometric material in a first reading see Instructions to the reader page vii but it is only fair to say that many a reader will find it more instructive to find out immediately what is the geometric motivation behind the purely algebraic material of this volume The first 8 sections of Chapter VI including 5bis deal directly with properties of places

rather than with those of the valuation associated with a place These therefore are properties of valuations in which the value group of the valuation is not involved

Combinatorics and Commutative Algebra Richard P. Stanley, 2007-12-13 Some remarkable connections between commutative algebra and combinatorics have been discovered in recent years This book provides an overview of two of the main topics in this area The first concerns the solutions of linear equations in nonnegative integers Applications are given to the enumeration of integer stochastic matrices or magic squares the volume of polytopes combinatorial reciprocity theorems and related results The second topic deals with the face ring of a simplicial complex and includes a proof of the Upper Bound Conjecture for Spheres An introductory chapter giving background information in algebra combinatorics and topology broadens access to this material for non specialists New to this edition is a chapter surveying more recent work related to face rings focusing on applications to f vectors

Commutative Algebra David Eisenbud, 2013-12-01 Commutative Algebra is best understood with knowledge of the geometric ideas that have played a great role in its formation in short with a view towards algebraic geometry The author presents a comprehensive view of commutative algebra from basics such as localization and primary decomposition through dimension theory differentials homological methods free resolutions and duality emphasizing the origins of the ideas and their connections with other parts of mathematics Many exercises illustrate and sharpen the theory and extended exercises give the reader an active part in complementing the material presented in the text One novel feature is a chapter devoted to a quick but thorough treatment of Grobner basis theory and the constructive methods in commutative algebra and algebraic geometry that flow from it Applications of the theory and even suggestions for computer algebra projects are included This book will appeal to readers from beginners to advanced students of commutative algebra or algebraic geometry To help beginners the essential ideals from algebraic geometry are treated from scratch Appendices on homological algebra multilinear algebra and several other useful topics help to make the book relatively self contained Novel results and presentations are scattered throughout the text

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such as length or area consider the given diagram

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web jan 11 2023 lesson summary now that you have explored this lesson and a little geography you are able to explain the concept of probability ranging from 0 to 1 recall and state a definition of geometric probability and use the formula for geometric probability to calculate the likelihood of an outcome involving flat shapes

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web geometric distributions jeremiah makes $\frac{4}{5}$ of the free throw shots he attempts in basketball jeremiah likes to shoot free throws until he misses one let f be the number of shots it takes jeremiah to miss his first free throw assume that the results of each shot are independent

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web two events or behaviors within the system can be seen to be independent if the probability of one of them happening is unaffected by changes made to the other in shorthand code independent is when $p(a|b) = p(a)$ in human words a is going to do whatever it does regardless of what b does

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web when attempting to catch the ball the probability gary is successful is $\frac{3}{4}$ during the game gary attempts two catches find the probability gary is successful with both catches $\frac{2}{2}$ helen is taking part in a quiz on tv the probability she answers a question correctly is $\frac{4}{5}$ helen is asked two questions

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web firstly if there are two independent events then we multiply the probability of the first event with the probability of the other for instance if there are three dice then what is the probability of getting three 5s the probability of getting a single 5 is $\frac{1}{6}$ then the probability of getting 3 5s is $\frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} = \frac{1}{216}$

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web as seen above the geometric probability distribution is given by $p(x) = \binom{n-1}{x-1} p^x (1-p)^{n-x}$ for $x = 1, 2, \dots, n$ to obtain $p(x)$

quad p x 2 1 p p quad p x 3 1 p 2 p quad p x n 1 p n 1 p we note that the above are the terms of a geometric sequence hence
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