HANDS ON EXERCISE MANUAL FOR LABVIEW PROGRAMMING D Latest Edition

Hands on Exercise Manual for LabVIEW Programming D

If you're venturing into the world of LabVIEW programming, especially focusing on the "D" version, a comprehensive hands-on exercise manual becomes an invaluable resource. This manual offers practical exercises designed to deepen your understanding of LabVIEW's graphical programming environment, enabling you to develop robust applications efficiently. Whether you're a beginner or an experienced programmer looking to sharpen your skills, this guide provides step-by-step exercises that make learning engaging and effective.

Introduction to LabVIEW Programming D

Before diving into practical exercises, it's essential to grasp the fundamentals of LabVIEW Programming D. This version emphasizes modular design, real-time data acquisition, and advanced control systems. The manual begins with an overview of LabVIEW?s interface, data flow paradigm, and core components to set a solid foundation for all subsequent exercises.

Understanding the LabVIEW Environment

- Front Panel and Block Diagram: Visual interfaces for user interaction and program logic
- Tools and Palettes: Essential tools for creating and editing programs
- Data Types and Wires: Connecting components with data flow principles

Setting Up Your Development Environment

- Installing LabVIEW D version
- Configuring hardware interfaces for data acquisition
- Creating your first project and saving your work

Core Hands-On Exercises for LabVIEW Programming D

This section offers detailed exercises that guide you through creating functional programs, from simple data displays to complex control systems. Each exercise builds on the previous, fostering a progressive learning experience.

Exercise 1: Building a Basic Digital Indicator

This foundational exercise introduces you to creating user interfaces and wiring data signals.

- Create a new VI (Virtual Instrument) and open the Front Panel.
- Add a Boolean control (e.g., switch) and a Boolean indicator (e.g., LED).
- Switch the Boolean control on and off, observing the indicator respond accordingly.
- Save and document your VI for future reference.

Exercise 2: Implementing a Simple Data Acquisition Loop

Learn how to acquire real-time data from hardware devices and display it dynamically.

- Set up your DAQ (Data Acquisition) hardware and configure the channels.
- Create a While Loop on the Block Diagram to continuously read data.
- Use a Waveform Chart to plot incoming data in real-time.
- Implement a stop condition using a Boolean control.
- Test the loop by running your VI and verify data updates on the chart.

Exercise 3: Developing a User-Interactive Temperature Controller

This exercise combines control logic with user inputs to regulate temperature readings.

- Design a Front Panel with controls for setpoint temperature and a start button.
- On the Block Diagram, read user inputs and initialize data acquisition.
- Implement a feedback loop that compares current temperature readings with the setpoint.
- Control a simulated heater's ON/OFF state based on the comparison.
- Display real-time temperature and heater status indicators.
- Test the control system by adjusting the setpoint and observing responses.

Advanced Exercises for LabVIEW Programming D

Once you've mastered the basics, the manual guides you through more sophisticated applications, including real-time control, data logging, and network communication.

Exercise 4: Creating a Real-Time Data Logger with File Storage

Learn how to record data over time for analysis and troubleshooting.

- Configure your data acquisition system to collect multiple sensor signals.
- Within a While Loop, continuously read sensor data at specified intervals.
- Use the Write to Measurement File Express VI to save data in CSV or TDMS formats.
- Implement a user control to start and stop logging sessions.
- Ensure data integrity and proper file handling during sessions.

Exercise 5: Developing a Networked Data Transmission System

This exercise focuses on sending and receiving data over a network, essential for remote monitoring systems.

- Set up a TCP/IP server and client within two separate VIs.
- Implement data serialization for transmitting sensor readings.
- Establish a reliable connection and handle potential errors.
- Create real-time displays on both server and client sides.
- Test the communication by sending mock data and verifying the display updates.

Best Practices and Tips for LabVIEW Programming D

To maximize your learning and develop efficient, maintainable code, consider the following tips:

Organize Your Block Diagrams

- Use clear wiring and comments to document your program logic.
- Break complex operations into subVIs for modularity.
- Label controls, indicators, and wires for easy identification.

Implement Error Handling

- Use the Error Out and Error In clusters to propagate and manage errors.
- Include error case structures to handle exceptions gracefully.
- Log errors for troubleshooting and system diagnostics.

Optimize Performance

- Adjust loop timing to balance responsiveness and CPU load.
- Use queued message handlers for efficient communication.

- Limit data acquisition rate based on your application's needs.

Conclusion

A hands-on exercise manual for LabVIEW Programming D is essential for mastering the graphical programming environment through practical experience. By systematically working through exercises?from basic indicators to advanced networked systems?you'll develop the skills necessary to design, implement, and troubleshoot complex control and measurement systems. Remember to adhere to best practices, document your work thoroughly, and continually challenge yourself with new projects to deepen your understanding. With dedication and consistent practice, you'll become proficient in LabVIEW Programming D, opening doors to innovative automation and data acquisition solutions.

Hands-On Exercise Manual for LabVIEW Programming D: An In-Depth Review

Introduction to the Manual and Its Significance

In the realm of industrial automation, data acquisition, and system control, LabVIEW (Laboratory Virtual Instrument Engineering Workbench) by National Instruments has established itself as a cornerstone tool for engineers, scientists, and programmers. The Hands-On Exercise Manual for LabVIEW Programming D emerges as a vital resource for learners seeking practical, step-by-step guidance through complex programming concepts and real-world applications.

This manual is designed not just as a theoretical guide but as an interactive workbook that emphasizes experiential learning. Its primary aim is to reinforce understanding through practical exercises, which are crucial for mastering LabVIEW?s graphical programming environment.

Overview of the Manual?s Structure and Content

The manual is structured into multiple sections, each targeting specific aspects of LabVIEW programming. It typically includes:

- Introduction to Core Concepts
- Step-by-step Exercises
- Hands-On Projects
- Problem-Solving Scenarios
- Supplementary Tips and Best Practices

Each section begins with an overview, followed by detailed instructions, diagrams, and example code snippets. The progression from fundamental to advanced topics ensures learners build a solid

foundation before tackling complex projects.

Key Features of the Manual

1. Practical Approach

The hallmark of this manual is its emphasis on hands-on exercises. Instead of passive reading, learners immediately apply concepts through:

- Building virtual instruments (VIs)
- Debugging exercises
- Modifying existing code snippets
- Creating custom control and indicator interfaces

2. Step-by-Step Guidance

Each exercise is broken down into clear, manageable steps. This approach minimizes confusion, especially for beginners, and ensures participants can follow along without feeling overwhelmed.

3. Real-World Applications

The exercises simulate real-world scenarios such as:

- Data acquisition from sensors
- Signal processing
- Control systems design
- Data logging and visualization

This relevance increases engagement and helps learners see the immediate applicability of their skills.

4. Visual Aids and Diagrams

Flowcharts, block diagrams, and screenshots accompany instructions, making complex configurations easier to understand.

5. Troubleshooting and Optimization Tips

The manual often includes common pitfalls, debugging strategies, and performance optimization

techniques, fostering problem-solving skills.

Deep Dive into Specific Exercise Topics

1. Basic Data Types and Structures

Understanding data types is foundational. Exercises typically include:

- Creating and wiring numeric, string, and Boolean controls
- Using clusters to group related data
- Building arrays and graphs for data visualization

This section emphasizes the importance of data flow and type compatibility within LabVIEW?s graphical environment.

2. Looping and Event Structures

Exercises demonstrate how to implement:

- For and While loops for repetitive tasks
- Event structures for user interface interactions
- Timing and synchronization mechanisms

Practical tasks include creating a simple counter, a stopwatch, or a user-controlled toggle switch.

3. Signal Generation and Analysis

These exercises involve generating signals such as sine waves, square waves, and noise. Learners analyze signals using:

- Fast Fourier Transform (FFT)
- Filters (low-pass, high-pass)
- Signal visualization on graphs

They learn to manipulate signals and interpret data, essential skills for test and measurement applications.

4. Data Acquisition and Instrument Control

Using NI hardware interfaces, exercises cover:

- Configuring DAQ devices
- Reading analog and digital inputs
- Writing to outputs for control purposes

Participants often develop virtual instrumentation for monitoring real-world signals.

5. File I/O and Data Logging

Exercises teach students to:

- Save data to files in various formats (CSV, TXT, TDMS)
- Load and display stored data
- Automate logging processes for long-term data collection

6. User Interface Design

Creating intuitive dashboards is vital. Exercises guide learners through:

- Customizing front panels
- Using controls and indicators effectively
- Implementing user prompts and feedback mechanisms

Benefits of Practicing with This Manual

1. Reinforcement of Learning

Hands-on exercises solidify theoretical knowledge, enabling learners to efficiently translate concepts into functional code.

2. Development of Troubleshooting Skills

By working through practical problems, users learn to identify and resolve common issues such as wiring errors, data mismatches, or performance bottlenecks.

3. Building a Portfolio of Projects

Completing exercises provides tangible outputs that can be showcased professionally, demonstrating proficiency to employers or clients.

4. Accelerated Learning Curve

Structured exercises reduce the time required to become proficient, making the learning process more engaging and less intimidating.

5. Preparation for Certification and Advanced Topics

Mastery of foundational exercises paves the way for certifications like NI Certified LabVIEW Associate Developer and prepares learners for more advanced subjects such as FPGA programming or real-time systems.

Critical Evaluation of the Manual

Strengths

- Comprehensive Coverage: The manual covers a broad spectrum from beginner to intermediate levels, making it suitable for a wide audience.
- Practical Focus: Emphasizing hands-on exercises ensures active learning.
- Clear Instructions: Step-by-step guidance reduces ambiguity and aids independent learning.
- Relevant Content: Exercises mirror real-world applications, increasing motivation and applicability.
- Supplementary Resources: Inclusion of troubleshooting tips and best practices enhances problem-solving skills.

Areas for Improvement

- Advanced Topics: The manual might benefit from additional exercises on advanced topics such as FPGA programming, real-time applications, or network communication.
- Interactive Content: Incorporating quizzes or self-assessment sections could improve engagement.
- Digital Access: Availability in interactive digital formats with embedded videos or simulation environments would enhance usability.

Target Audience and Usage Recommendations

This manual is ideal for:

- Students studying control systems, instrumentation, or automation engineering.
- Practitioners seeking to improve hands-on proficiency.
- Educators designing curriculum modules or lab sessions.
- Engineers involved in system design, testing, or maintenance.

Usage Tips:

- Approach exercises sequentially to build confidence and competence.
- Supplement with official LabVIEW tutorials and online resources for broader understanding.
- Engage with community forums and user groups for troubleshooting and sharing insights.
- Keep hardware and software environments updated to ensure compatibility with exercises.

Conclusion

The Hands-On Exercise Manual for LabVIEW Programming D stands out as a meticulously curated resource for anyone eager to develop practical expertise in LabVIEW. Its structured, exercise-driven methodology bridges the gap between theoretical understanding and real-world application. Whether you are a beginner aiming to get started or an intermediate user seeking to deepen your skills, this manual offers a comprehensive pathway to mastering LabVIEW programming through active, experiential learning.

By systematically working through its exercises, users not only enhance their technical capabilities but also cultivate problem-solving skills essential for innovative automation solutions. Overall, this manual is a valuable investment in a learner?s journey toward becoming proficient in LabVIEW, empowering them to design, implement, and troubleshoot complex measurement and control systems with confidence.

End of Review

QuestionAnswer What are the key topics covered in a hands-on exercise manual for LabVIEW Programming D? The manual typically covers fundamental LabVIEW programming concepts, data acquisition, control structures, virtual instruments (VIs), debugging techniques, and practical lab exercises to reinforce learning. How can a hands-on exercise manual improve my LabVIEW programming skills? It provides practical, step-by-step exercises that help you apply theoretical knowledge, troubleshoot real-world problems, and develop a deeper understanding of LabVIEW's functionalities, thereby enhancing your proficiency. Are there specific exercises in the manual that focus on interfacing LabVIEW with hardware components? Yes, many manuals include exercises on interfacing LabVIEW with hardware such as DAQ devices, sensors, and actuators to facilitate real-world data acquisition and control applications. What are the benefits of using a hands-on manual for LabVIEW Programming D compared to online tutorials? Hands-on manuals offer

structured, comprehensive exercises with detailed instructions, allowing for progressive learning, better retention, and the ability to practice in a controlled environment, which may be more effective than scattered online tutorials. Can beginners effectively use a hands-on exercise manual for LabVIEW Programming D? Yes, most manuals are designed to cater to beginners by providing foundational exercises, clear explanations, and gradual complexity increases to help new users learn effectively. Where can I find the most trending and up-to-date hands-on exercise manuals for LabVIEW Programming D? You can find current manuals on NI's official website, educational platforms like Coursera or Udemy, or through trusted technical publishers specializing in LabVIEW and control systems training.

Related keywords: LabVIEW programming, hands-on lab manual, LabVIEW exercises, graphical programming, data acquisition, control systems, virtual instrumentation, LabVIEW tutorial, hardware integration, programming examples

Shelly Cashman Programming

shelly cashman programming has established itself as a cornerstone in the world of computer science education, especially for beginners and students aiming to build a solid foundation in programming. As an educator and author, Shelly Cashman has contributed significantly to the development of comprehensive textbooks, online resources, and courses that simplify complex programming concepts. If you're exploring programming or enhancing your skills, understanding the role of Shelly Cashman programming resources can be highly beneficial. This article delves into the key aspects of Shelly Cashman programming, its history, curriculum, and why it remains a preferred choice for learners worldwide.

Understanding Shelly Cashman Programming

Shelly Cashman programming refers to a series of textbooks, online tutorials, and course materials authored primarily by the Shelly Cashman Series, designed to teach programming fundamentals across various languages and platforms. These resources are widely used in academic institutions and self-paced learning environments due to their clear explanations, practical approach, and step-by-step instructions.

The Origins and Evolution of Shelly Cashman Series

The Shelly Cashman Series was first introduced in the 1980s, focusing initially on computer literacy and basic programming. Over the decades, it has expanded to cover a broad range of programming languages such as:

- Python
- Java
- C++
- Visual Basic
- HTML/CSS
- JavaScript

This evolution reflects the changing landscape of technology and programming, ensuring learners are equipped with contemporary skills.

Key Features of Shelly Cashman Programming Resources

- Structured Learning Path: The materials are organized sequentially, starting from fundamental concepts to more advanced topics.
- Practical Exercises: Each chapter includes exercises, projects, and quizzes to reinforce learning.
- Real-World Applications: Concepts are linked to real-world scenarios to demonstrate their relevance.
- Visual Aids: Diagrams, screenshots, and step-by-step instructions facilitate better comprehension.
- Online and Digital Resources: Many textbooks come with companion websites, videos, and interactive content.

Core Programming Topics Covered

Shelly Cashman programming textbooks typically cover a comprehensive array of topics essential for budding programmers. These include:

Basic Programming Concepts

- Variables and Data Types
- Operators and Expressions
- Control Structures (if statements, loops)
- Functions and Procedures
- Arrays and Collections

Object-Oriented Programming

- Classes and Objects
- Inheritance and Polymorphism
- Encapsulation
- Interfaces and Abstract Classes

Web Development

- HTML and CSS fundamentals
- JavaScript basics
- Responsive design principles

Database Management

- Introduction to SQL
- Data Modeling
- CRUD Operations

Software Development Principles

- Debugging and Error Handling
- Version Control
- Software Testing

Why Choose Shelly Cashman Programming Resources?

Choosing the right learning materials is crucial for success in programming. Shelly Cashman resources stand out for several reasons:

1. Pedagogical Approach

The series emphasizes a learner-friendly approach, breaking down complex topics into manageable lessons. The gradual progression ensures that students build confidence as they advance.

2. Comprehensive Coverage

Whether you're a beginner or an intermediate programmer, Shelly Cashman textbooks offer material suitable for various skill levels, covering foundational to advanced concepts.

3. Practical Focus

By integrating real-world projects and exercises, learners gain hands-on experience, which is vital for understanding and retention.

4. Updated Content

The series regularly updates its content to reflect current industry standards, programming languages, and tools, ensuring learners stay relevant.

5. Supportive Learning Environment

Many resources include online tutorials, video lectures, and community forums that foster interactive learning.

Using Shelly Cashman Programming Resources Effectively

To maximize your learning experience with Shelly Cashman programming materials, consider the following tips:

- Follow the structured chapters sequentially to build a solid foundation.
- Complete all exercises and projects to reinforce your understanding.
- Utilize supplementary online resources for additional practice and clarification.
- Join study groups or online forums to discuss concepts and solve problems collaboratively.
- Apply learned skills to real-world projects or personal initiatives to solidify your knowledge.

Advantages of Learning Programming with Shelly Cashman

Learning programming through Shelly Cashman resources offers numerous benefits:

- **Clarity and Simplicity:** Clear explanations make complex topics accessible.
- **Structured Learning Path:** Organized content guides learners from basics to advanced topics.
- **Practical Approach:** Emphasis on hands-on exercises enhances real-world readiness.
- **Flexibility:** Suitable for classroom settings, self-study, or online courses.
- **Industry-Relevant Skills:** Focus on current programming languages and tools prepares learners for the job market.

Conclusion

shelly cashman programming remains a trusted resource for students, educators, and self-learners aiming to develop programming skills efficiently and effectively. Its comprehensive curriculum, pedagogical strengths, and practical orientation make it an excellent choice for anyone embarking on a coding journey or seeking to deepen their understanding of computer programming. By leveraging Shelly Cashman?s structured approach and extensive resources, learners can gain confidence and competence in various programming languages and concepts, paving the way for academic success and professional growth.

Whether you're just starting or looking to expand your expertise, Shelly Cashman programming resources provide a solid foundation and continuous support to help you achieve your goals in the dynamic world of technology.

Shelly Cashman Programming

In the realm of computer education, few brands have established as enduring a reputation as Shelly Cashman. Renowned primarily for their comprehensive instructional materials in computer science and programming, the Shelly Cashman Programming series has become a cornerstone for both students and educators seeking a structured, accessible approach to learning programming fundamentals. This article offers an in-depth review of Shelly Cashman Programming, exploring its history, structure, content, pedagogical approach, and the key features that make it a standout resource in the world of programming education.

Overview and Historical Context

Founded in the late 20th century, the Shelly Cashman Series was originally developed to supplement classroom instruction with textbooks that emphasized clarity, practical application, and step-by-step guidance. Over the years, the series expanded to encompass a wide array of IT and computer science topics, with programming being a significant focus area.

Shelly Cashman Programming materials are typically authored by experienced educators and industry professionals, ensuring that the content remains current and relevant. The series has adapted to technological shifts, from early BASIC and Pascal programming to modern languages such as Python, Java, C++, and C. Its longevity and adaptability underscore its effectiveness as an educational tool.

Core Components of Shelly Cashman Programming Resources

The Shelly Cashman Programming suite generally comprises textbooks, supplementary workbooks, online resources, and instructor-led materials. Each component is designed to reinforce learning and facilitate mastery of programming concepts.

Textbooks

The textbooks serve as the backbone of the series, offering comprehensive coverage of programming concepts, syntax, and problem-solving techniques. They are characterized by:

- Clear Language: Concepts are explained using straightforward language, avoiding unnecessary jargon, making complex ideas accessible to beginners.
- Structured Chapters: Each chapter builds upon the previous, gradually increasing in complexity, with logical progression from basic syntax to advanced topics.
- Visual Aids: Diagrams, flowcharts, and screenshots help illustrate programming logic and user interface design.
- Practical Examples: Real-world scenarios and mini-projects reinforce understanding and show practical applications.

Supplementary Materials

To enhance the learning experience, Shelly Cashman offers:

- Workbooks and Practice Exercises: These provide hands-on opportunities to practice coding skills, often with step-by-step guided exercises.
- Online Resources: Interactive tutorials, coding labs, quizzes, and video lectures are available to supplement the textbooks.
- Instructor Resources: For educators, there are slides, test banks, and solution manuals that facilitate classroom instruction.

Pedagogical Approach and Effectiveness

One of the distinguishing features of the Shelly Cashman Programming series is its pedagogical philosophy, which emphasizes clarity, logical progression, and active learning.

Step-by-Step Instruction

The series excels at breaking down complex programming tasks into manageable steps. Each concept is introduced with a simple explanation, followed by illustrative examples, and then reinforced through practice exercises. This scaffolded approach helps students develop confidence and competence gradually.

Hands-On Learning

Practical exercises are woven throughout the materials, encouraging students to write code, debug, and analyze programs actively. The inclusion of real-world projects helps students see the relevance of their skills.

Visual Learning Aids

Visual aids such as flowcharts and diagrams clarify program flow and logic, catering to visual learners and reinforcing comprehension.

Progressive Complexity

The curriculum is carefully structured so that foundational concepts are mastered before moving to more advanced topics, reducing cognitive overload and building a solid knowledge base.

Coverage of Programming Languages

The series has evolved to include a variety of programming languages, each tailored to different learning objectives and industry needs:

- Python: Known for simplicity and readability, Python is ideal for beginners and rapid application development.
- Java: Widely used in enterprise applications, Java materials focus on object-oriented programming and platform independence.
- C++: For students interested in systems programming and performance-critical applications, C++ coverage includes memory management and advanced data structures.
- C: Popular in game development and Windows applications, C tutorials emphasize event-driven programming and .NET framework integration.
- JavaScript: As a cornerstone of web development, JavaScript modules cover client-side scripting and interactive web pages.

Each language section typically includes syntax fundamentals, control structures, data types, functions, object-oriented principles, and project-based exercises.

Strengths and Unique Features

Shelly Cashman Programming distinguishes itself through several key strengths:

Clarity and Accessibility

The materials are designed to be approachable for newcomers, with jargon minimized and

explanations detailed yet concise.

Structured Learning Path

The logical sequence of topics enables learners to build a robust understanding incrementally, reducing frustration and confusion.

Integration of Theory and Practice

The series balances theoretical concepts with practical coding exercises, fostering both understanding and skill acquisition.

Multi-Platform and Language Support

Offering resources across various programming languages and platforms accommodates diverse learning needs and interests.

Supplemental Digital Resources

Interactive online labs, quizzes, and videos enhance engagement and cater to different learning styles.

Limitations and Considerations

While Shelly Cashman Programming is highly regarded, potential limitations include:

- Curriculum Scope: As with any textbook series, some topics may be simplified for beginners, requiring supplementary materials for advanced learners.
- Language Focus: Depending on updates, some languages may not be covered in depth or may lag behind industry trends.
- Pedagogical Style: The step-by-step approach, while accessible, might lack the depth necessary for students seeking more rigorous or theoretical understanding.

Ideal Audience and Usage Context

Shelly Cashman Programming is particularly well-suited for:

- Beginner programmers: Those new to coding or programming concepts.
- High school or introductory college courses: As primary textbooks or supplementary resources.

- Self-learners: Individuals seeking structured guidance and practice.
- Instructors: Looking for comprehensive, ready-made teaching materials.

Conclusion: A Valuable Educational Tool

In summary, Shelly Cashman Programming stands out as a comprehensive, user-friendly resource that effectively bridges the gap between theoretical understanding and practical application. Its structured approach, clear explanations, and extensive supplementary materials make it a reliable choice for beginners and educators aiming to foster foundational programming skills.

While it may not replace more advanced or specialized texts for experienced programmers, its strengths lie in its accessibility and pedagogical design, making programming less intimidating and more approachable for learners at various stages. As the landscape of programming continues to evolve, the Shelly Cashman series remains a trusted companion?adapting its content to meet the needs of new generations of programmers and continuing its legacy of quality technical education.

QuestionAnswer What are the key topics covered in Shelly Cashman Programming textbooks? Shelly Cashman Programming textbooks typically cover programming fundamentals, including syntax, algorithms, data structures, object-oriented programming, and popular languages like C++, Java, and Python, along with practical problem-solving exercises. How can I effectively use Shelly Cashman Programming resources for learning coding? To effectively utilize Shelly Cashman Programming resources, follow a structured approach by completing all exercises, reviewing example code, participating in online forums, and practicing coding regularly to reinforce concepts and improve problem-solving skills. Are Shelly Cashman Programming textbooks suitable for beginners? Yes, Shelly Cashman Programming textbooks are designed to be accessible for beginners, providing clear explanations, step-by-step instructions, and practical examples to help new learners grasp programming fundamentals. What are some popular Shelly Cashman Programming titles for advanced programmers? For more advanced learners, titles such as 'Programming with C++,' 'Java Programming,' and 'Python Programming: A Comprehensive Guide' offer in-depth coverage of complex topics and advanced programming techniques. Where can I find online supplementary materials for Shelly Cashman Programming courses? Online supplementary materials for Shelly Cashman Programming courses are usually available through the publisher's website, educational platforms like MyITLab, or through instructor-provided resources that include practice quizzes, labs, and coding projects.

Related keywords: Shelly Cashman, programming tutorials, computer science education, programming textbooks, beginner programming, programming courses, coding lessons, programming exercises, software development, programming fundamentals

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