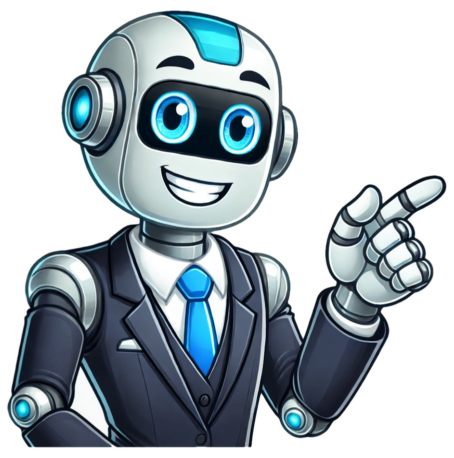

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The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. There are many numerical methods which can be used to solve the partial differential equations encountered in fluid dynamics. No single method is unequivocally better than others. Rather, the efficacy of each method depends on aspects of the case being simulated, e.g. its size, the required level of accuracy and the characteristics and complexity of the equations being solved. For a method to be useful, it needs to be programmed into software. Complex programs require good design and design relies on good concepts. So inevitably the concepts behind any method are as important as the details contained within. The finite volume method adopts the idea of control volumes used to create models of physical systems. A control volume represents a region of space, which is generally fixed, enclosed by a surface through which fluid flows in and out. It applies conservation equations, e.g. of mass, momentum and energy, by balancing fluxes, due to inflow and outflow at the bounding surface, with additional sources within the volume. Rather than using a single control volume to describe an entire physical system, e.g. a heating tank, the finite volume method splits the system domain, i.e. the tank, into multiple connected finite volumes. Conservation equations are applied to each volume, ensuring that the fluxes of mass, momentum and heat across surfaces are consistent between the volumes they connect. The perceived wisdom is that the finite volume method was first introduced in the early 1970's. But the PhD thesis of Runchal from 1969 describes a method which is clearly finite volume. He also published the figure reproduced below, which displays the computational mesh as a set of connected control volumes. Runchal credits the idea to his PhD supervisor Brian Spalding who provided an analogy of tanks connected by tubes in 1967. It captures the essence of finite volume, which uses a mesh to define a physical system of control volumes. Its emphasis is on calculating fluxes between volumes and ensuring conservation. By contrast, other methods, e.g. finite element, use the mesh to construct mathematical functions to calculate distributions of properties. The finite volume method does not do that. Notes on CFD: General Principles - 3.1 The finite volume concept Skip to main content arXiv is a free distribution service and an open-access archive for nearly 2.4 million scholarly articles in the fields of physics, mathematics, computer science, quantitative biology, quantitative finance, statistics, electrical engineering and systems science, and economics. 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Flowing in every day, these data are added to the Wayback Machine after an embargo period. Collection: alexa_web_2009 this data is currently not publicly accessible. View PDF Abstract:Computational fluid dynamics (CFD) is a branch of fluid mechanics that uses numerical methods to solve fluid flows. The finite volume method (FVM) is an important one. In FVM, space is discretized to many grid cells. When the number of grid cells grows, massive computing resources are needed correspondingly. Recently, quantum computing has been proven to outperform a classical computer on specific computational tasks. However, the quantum CFD (QCFD) solver remains a challenge because the conversion between the classical and quantum data would become the bottleneck for the time complexity. Here we propose a QCFD solver with exponential speedup over classical counterparts and focus on how a quantum computer handles classical input and output. By utilizing quantum random access memory, the algorithm realizes sublinear time at every iteration step. The QCFD solver could allow new frontiers in the CFD area by allowing a finer mesh and faster calculation. From: Zhaoyun Chen [view email] [v1] Sat, 6 Feb 2021 10:29:21 UTC (1,439 KB)