A DBDBD Primer on Notional Machines for Data Systems Education

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> A **notional machine** is a pedagogic device to assist the understanding of some aspect of programs or programming.
>
> Fincher et al. [3]

In education, the concept of scaffolding is central: to teach a student something new, it should build upon what they already know, otherwise it might seem unattainable [2]. One method to do this is to utilize analogies in the classroom [1]: equate the new concept to something they already know. Examples include explaining an algorithm as a recipe, variable as a box, or procedure as a worker [3]. In the context of computer science education research, we have adopted the term Notional Machine (NM) for such explanations about the inner workings of computing concepts. NMs can be based on analogies, such as the ones mentioned above, or they can be visual representations of inner workings, such as the creation of a trace table for variables. In the context of data systems, not much was known about NMs yet. Given its core role in the computer science curriculum, a team of researchers undertook the task to study common notional machines in data systems educational materials [4]. By analyzing fifteen commonly used data systems textbooks and nine different courses, we identified over 300 Notional Machines, of which 66 are unique. The majority of these were about query language basics (46), with the remainder distributed over the following data systems topics: advanced query language (3), information retrieval (3), conceptual modeling (7), data storage and indexing (6), and query optimization and planning (1).

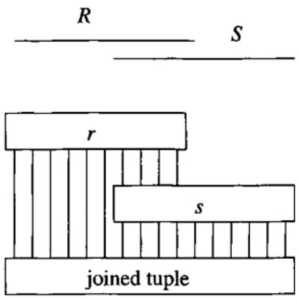

Figure 2.15: Joining tuples

JOIN as a diagram
Visual Representation

Discipline: Databases

CONCEPTUAL ADVANTAGE
Visualizes how the JOIN looks at intersections in data

DRAWS ATTENTION TO
The construction of joined tuples (in terms of attributes)

Symbol	Concept
boxes	relations / tuples
vertical lines	attributes

The unique NMs are published soon on `notionalmachines.github.io`. In a presentation or poster, I will share some examples that should be useful for all lecturers in the audience.

Take-aways. Although NMs can be tremendously helpful to both the students and the teachers, they must be of high quality to ensure correct interpretation. Some important elements to consider when designing notional machines include: 1) Prefer NMs that draw parallels to real-world context over those to previous course knowledge. 2) Start working with NMs in the first weeks, so students can benefit even more in later weeks for more difficult contexts. 3) Make sure NMs are in line with students technical and cultural background.

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