Sabbatical Report
Fall 2022/Spring 2023

David Ruby

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1 Introduction

The opportunity to take an extended period to reflect and grow is special benefit of working in academia. My sabbatical has been a unique experience that has combined many years of work experience, with a returning home. The opportunity has opened as many new questions as ideas, but has certainly been a period appreciated.

1.1 Context

After more than 10 years of experience at Fresno State as a lecturer in Computer Science my 1 year sabbatical was combined with a move back to the home where I grew up and lived when attending Fresno State as a student. Unfortunately, the move was to care for my mother with late stage Alzheimer's. Being back home in the old neighborhood was expected to help understand STEM outreach, being so close to the community I branched out from, but really raised more questions than answers.

2 Course Refresh

Course refresh focus was on improving engagement. Understanding student engagement across the varied social background for central valley students is a complex issue, but certain points stand out. For example, an important part of the college experience is social engagement. [1] [2] [3] This social engagement involves meeting students, as well as sharing something about themselves. Facilitating social engagement by ensuring students are able to share some elements of themselves with their classmates is an important part of my class engagement strategy. One way I include for this is the use of interesting online discussions combined with in class ones.

This ability for classes to provide mechanisms for students to explore interactions with each other, is an important part of the academic experience. It will also help promote the idea of interleaving personal components of life with work life, and important step towards understanding how to manage work/life balancing. The assignments need to include both content required elements, but also one that allow for the personal expressiveness.

2.1 Abstract Thinking

In looking to connect STEM to old neighborhood, I considered where symbols were being utilized. Neighbors expended much energy and thought into their home presentation, utilizing a variety of abstractions. Figure 1 is an image of my street from Google Street View, and illustrates a variety of common elements across many homes. Students will have same desire with classroom engagement.

Figure 1 Neighborhood Symbols: Cars, Fences, Plants, etc.

Figure 2 illustrates two code snippets that contain personalized elements. The left one indicates two car loans, while the right one shows a grate fence and a dog named “Dooky”. These types of shared elements not only allow students to connect with each other, but help them understand that code is read by humans and includes subtext.

```cpp
#include <iostream>
using namespace std;

int main() {

   double carLoan1, carLoan2;

   carLoan1 = 25000.00;

   return 0;
}
```

```cpp
#include <iostream>
#include <string>
using namespace std;

int main() {

   double fenceGratingCost;
   string dogName1 = "Dooky";

   fenceGrating = 10000.00;

   return 0;
}
```

Figure 2 Code Subtext

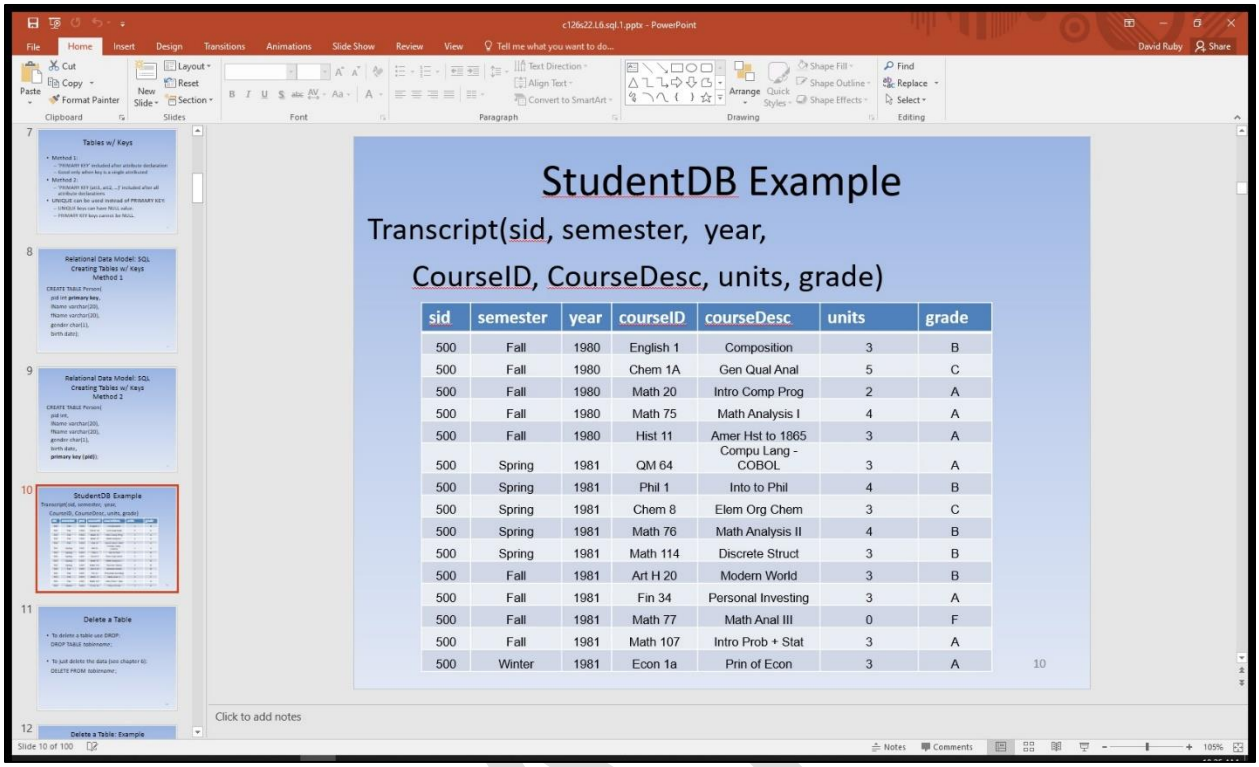
2.2 Teaching w/ Performance Art

When beginning to teach Advanced 'C' programming at UCLA extension in 1992, I decided I needed to develop a more relaxed and engaging teaching style. I looked to another UCLA extension course in Performance Art to help develop my public engagement style.

The course taken was offered by two Los Angeles based artists, Ms. Jackie Apple [4] and Ms. Rachel Rosenthal [5], as seen in Figure 3. This training emphasized awareness during teaching, and an understanding of how engagement between audience and instructor occurs. Consistent with the educational literature on engagement, social engagement important for communicating ideas.

Figure 3 Ms. Apple & Ms. Rosenthal

Understanding how events in our lives generalize with others is an important part of social engagement. In my course on Database systems I used a dataset generated from my own transcript as a student here at Fresno State, see Figure 4. The idea that this dataset told a story of my time here at Fresno State would happen organically. Seeing how this dataset forms part of my story leading to teaching opportunities, facilitates student understanding they can write their stories to include research contributions, and this realization is as important as the technical skills required to make it a reality.



sid	semester	year	courseID	courseDesc	units	grade
500	Fall	1980	English 1	Composition	3	B
500	Fall	1980	Chem 1A	Gen Qual Anal	5	C
500	Fall	1980	Math 20	Intro Comp Prog	2	A
500	Fall	1980	Math 75	Math Analysis I	4	A
500	Fall	1980	Hist 11	Amer Hst to 1865	3	A
500	Spring	1981	QM 64	Compu Lang - COBOL	3	A
500	Spring	1981	Phil 1	Into to Phil	4	B
500	Spring	1981	Chem 8	Elem Org Chem	3	C
500	Spring	1981	Math 76	Math Analysis II	4	B
500	Spring	1981	Math 114	Discrete Struct	3	B
500	Fall	1981	Art H 20	Modern World	3	B
500	Fall	1981	Fin 34	Personal Investing	3	A
500	Fall	1981	Math 77	Math Anal III	0	F
500	Fall	1981	Math 107	Intro Prob + Stat	3	A
500	Winter	1981	Econ 1a	Prin of Econ	3	A

Figure 4 D. Ruby CSUF Transcript Snippet

2.3 STEM Education

Ms. Arati Prabhakar, the director of the White House Office of Science and Technology Policy, assistant to the president for Science and Technology, and a member of President Biden's Cabinet, Washington, DC, has written of the critical importance of improving the vibrancy of American research and development. [6] Vice President Kamala Harris has written of the importance of the influence from her experience with her grandfather on his diplomatic mission to Africa when she was young, see Figure 5. [7] We here at Fresno State are in a unique opportunity to facilitate this goal by enriching our own local community, by building on important tools available through emerging areas such as Data-Centric Artificial Intelligence. The 2023 AI Index highlights the rise in demand for those trained in areas of AI. [8]

Figure 5 Vice President Kamala Harris w/ Grandfather

3 Data-Centric AI Survey

My research work quickly moved towards Deep Learning. [9] [10] [11] [12] [13] [14] [15] [16] As a breakthrough area generating headline grabbing results, it is clear that this is an area where our departments can help students understand the technology.

Until the late 2000's deep neural nets were not able to shine against other machine learning methods. This changed in the late 2009-2010 with several simple but important algorithmic improvements: activation functions, weight initialization schemes, optimization schemes. With these improvements nets of 10 or more layers, allowing deep learning to start to shine. In 2014, 2015, 2016, further improvements introduced with batch normalization, residual networks, and depthwise separable convolutions. Now arbitrarily complex networks are possible. [12]

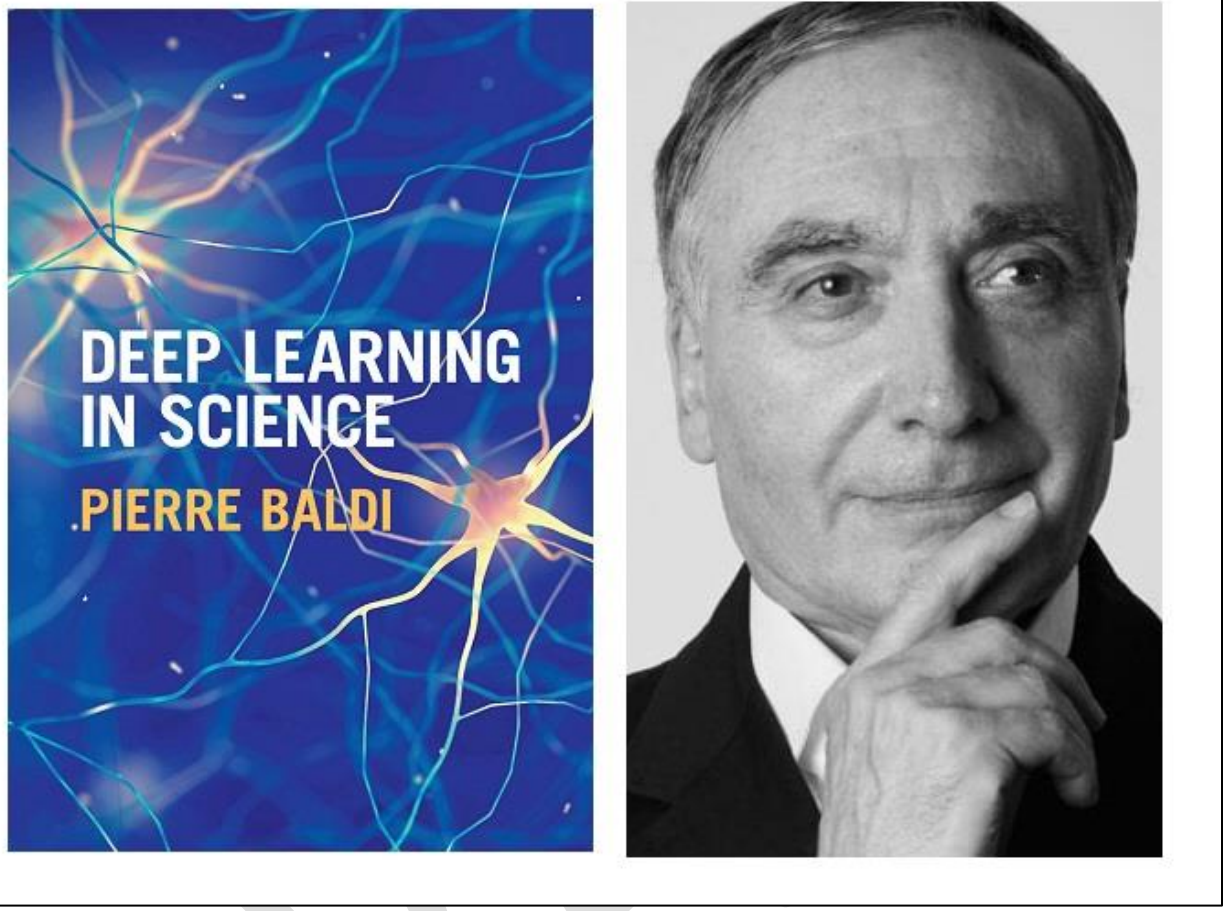


Figure 6 Deep Learning & Neuroscience [10]

Although many researchers approach Deep Learning purely from an algorithmic perspective, some researchers do emphasize the connection to biological neurological systems. Dr. Pierre Baldi with his Deep Learning text encourages researchers to understand these ties. [10]

3.1 Neurons and Deep Learning

Deep learning has its root in traditional machine learning, which in turn has multiple roots. One root definitely includes the work from neurobiology in understanding brain functioning, and the basic unit the neuron. The perceptron, and its perceptron learning algorithm has always been an important part of machine learning history. [16] Later Yann LeCun took inspiration from animal visual cortex architecture such as the early work of Hubel & Wiesel with cats to with his work with hand-written character recognition. [17] [18]

3.2 Data-Centric AI

Within the context of Deep Learning, the data suddenly can take on much more profound roles. Problems with the learned models can frequently be traced to issues with the training data.

Work with engineering the data used to train models can suddenly become much more important that the particulars of the model. This work in understanding learning with a focus on the data becomes is suddenly an important research topic. [19] [20]

3.3 Large Language Models

Large Language Models started raising waves in November of 2023 with ChatGPT. [21]

4 Course Proposal: Introduction to Deep Learning

Sabbatical work with deep learning lead to realization that my current Machine Learning course really needed a modification to provide a better lean into deep learning. My proposal was:

> *The Department of Computer Science is currently offering a Machine Learning undergraduate topics course. The demand from students for the course has been strong since its first offering in Spring of 2013. That first semester the enrollment was 17. When offered the second time, in Fall of 2016, enrollment was 40. Our third offering was Spring 2018 when enrollment was 27. Our fourth offering was in Spring 2019 with an enrollment of 42. Our last offering was Fall of 2021 with 22 students. Our proposal now is to convert this topics course to a regular course, but with a slight rebranding as Introduction to Deep Learning.*
>
> *Machine Learning is a fundamental area in computer science, with a wide range of applications such as the data classification (images, signals), with Deep Learning being extensions of core machine algorithms. Student interest is high to learn about this technology from its fundamentals as it can be applied on various problems, biomedical signals, neuroimaging,... . The maturity of many of the tools for Deep Learning is making its application potential continue to grow. Interestingly these tools build upon many classical mathematical frameworks such as linear regression and gradient descent, making them well suited for curriculum course.*
>
> *This proposal to convert the Machine Learning topics course to a regular course is well justified at this time, and supports department goals. Placing the focus for course on Deep Learning allows for an early entry into this area, providing opportunity to establish strength in this area for the College and University. Once converted we will be able to continue to develop the content and educational tools to best meet the needs of our students and the community these students will serve once they graduate.*

While the response to the proposal was positive, the request was to further the focus on Deep Learning, and modify title to “Introduction to Deep Learning”, which the department approved as CSci 167, with new course description:

> *This introductory course on deep learning will give an overview of many concepts, techniques, and algorithms in machine learning with special attention to concepts underlying modern deep learning. This course will cover fundamental concepts, techniques, and algorithms, including logistic regression, backpropagation, diminishing gradients issue, batch normalization, residual networks, convolutional networks, recurrent networks, and hyperparameter tuning. Hands-on experience through machine learning experiments using popular learning frameworks.*

5 Final Summary

My sabbatical has strengthened my resolve to continue to work to give back to my community for as long as I am able. My mother has continued to decline this past year, but is still with us. Having grown up in the valley, and now returning there, I firmly resolve to work to provide as many of my peers as possible the same opportunities that I have been afforded.

6 References

[1] M. R. Witkow, C. Gillen-O'Neel and A. J. Fuligni, "College social engagement and school identification: Differences by college type and ethnicity," *Journal of Applied Developmental Psychology,* vol. 33, pp. 243-251, 2012.

[2] C. G.-O. Neel and A. Fuligni, "A Longitudinal Study of School Belonging and Academic Motivation Across High School," *Child Development,* vol. 84, pp. 678-692, 2013.

[3] C. Gillen-O'Neel, "Sense of Belonging and Student Engagement: A Daily Study of First- and Continuing-Generation College Students," *Research in Higher Education,* vol. 62, p. 45–71, 2021.

[4] J. McMahon, "Jacki Apple 1941–2022," *https://artillerymag.com/jacki-apple-1941-2022/,* June 2022.

[5] T. R. R. Company, "Rachel Rosenthal," *https://www.rachelrosenthal.org/rachel-rosenthal,* 2023.

[6] A. Prabhakar, "Let's change what's possible," *Science,* vol. 379, pp. 1069-1069, 2023.

[7] "The Progressive Grandfather Who Inspired Kamala Devi Harris," *India Abroad,* Oct 30, 2019.

[8] N. Maslej, L. Fattorini, E. Brynjolfsson, J. Etchemendy, K. Ligett, T. Lyons, J. Manyika, H. Ngo, J. C. Niebles, V. Parli, Y. Shoham, R. Wald, J. Clark and R. Perrault, *The AI Index 2023 Annual Report,* AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, April, 2023.

[9] E. Alpaydin, Introduction to Machine Learning, MIT Press, 2014.

[10] P. Baldi, Deep Learning in Science, Cambridge University Press, 2021.

[11] E. Charniak, Introduction to Deep Learning, MIT Press, 2019.

[12] F. Chollet, Deep Learning with Python, Second Edition, Manning, 2021.

[13] D. P. Friedman, A. Mendhekar, Q. Su, G. L. Steele and P. Norvig, The Little Learner: A Straight Line to Deep Learning, MIT Press, 2023.

[14] A. Geron, Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow: Concepts, Tools, and Techniques to Build Intelligent Systems, 2nd ed., O'Reilly Media, Inc., 2019.

[15] I. Goodfellow, Y. Bengio and A. Courville, Deep Learning, MIT Press, 2016.

[16] S. J. Russell, S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, Pearson, 2020.

[17] Y. LeCun, L. Bottou, Y. Bengio and P. Haffner, "Gradient-Based Learning Applied to Document Recognition," in *Proceedings of the IEEE*, 1998.

[18] D. H. Hubel and T. N. Wiesel, "Receptive fields, binocular interaction and functional architecture in the cat's visual cortex," *The Journal of Physiology,* vol. 160, pp. 106-154, 1962.

[19] N. Seedat, F. Imrie and M. van der Schaar, *DC-Check: A Data-Centric AI checklist to guide the development of reliable machine learning systems,* arXiv, 2022.

[20] D. Zha, Z. P. Bhat, K.-H. Lai, F. Yang and X. Hu, *Data-centric AI: Perspectives and Challenges,* arXiv, 2023.

[21] E. Mollick, "How to use AI to do practical stuff: A new guide," *https://oneusefulthing.substack.com/p/how-to-use-ai-to-do-practical-stuff,* 2023.

[22] Y. Zhang, W. Han, J. Qin, Y. Wang, A. Bapna, Z. Chen, N. Chen, B. Li, V. Axelrod, G. Wang, Z. Meng, K. Hu, A. Rosenberg, R. Prabhavalkar, D. S. Park, P. Haghani, J. Riesa, G. Perng, H. Soltau, T. Strohman, B. Ramabhadran, T. Sainath, P. Moreno, C.-C. Chiu, J. Schalkwyk, F. Beaufays and Y. Wu, *Google USM: Scaling Automatic Speech Recognition Beyond 100 Languages,* arXiv, 2023.

[23] J. D. Ullman and J. Widom, A First Course in Database Systems, Pearson/Prentice Hall, 2008.

[24] K. P. Murphy, Probabilistic Machine Learning: An Introduction, MIT Press, 2022.

[25] M. Mohri, A. Rostamizadeh and A. Talwalkar, Foundations of Machine Learning, second edition, MIT Press, 2018.

[26] C. Meisel and K. A. Bailey, "Identifying signal-dependent information about the preictal state: A comparison across ECoG, EEG and EKG using deep learning," *EBioMedicine,* vol. 45, p. 422–431, 2019.

[27] D. Koller and N. Friedman, Probabilistic Graphical Models: Principles and Techniques, MIT Press, 2009.

[28] E. Ghirardini, G. Sagona, A. Marquez-Galera, F. Calugi, C. Navarron, F. Cacciante, S. Chen, F. Di Vetta, L. Dadà, R. Mazziotti, L. Lupori, E. Putignano, P. Baldi, J. Lopez-Atalaya, T.

Pizzorusso and L. Baroncelli, "Cell-specific vulnerability to metabolic failure: the crucial role of parvalbumin expressing neurons in creatine transporter deficiency," *Acta Neuropathologica Communications,* vol. 11, March 2023.