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Dear colleagues,

This letter is to express my enthusiastic support for Yan Karklin who is applying for a faculty position in your department. I was Yan's thesis advisor from 2000 to 2007 at Carnegie Mellon in the Computer Science Department and the Center for the Neural Basis of Cognition. In sum, I think Yan is an exceptionally talented researcher and would make an excellent colleague. He's the best student I've had in my career, and among the best I've known elsewhere. I also think he is a great match for this particular position, because of his broad computational background and record of strong work in developing testable computational models of visual information processing.

What most characterizes Yan is his ability to take on very difficult computational modeling challenges and work at them they're theoretically solid, computationally tractable, and provide interesting accounts and predictions of neural data. This type of theoretical work is fraught with dead ends and intractable (and therefore untestable) models, but it is a testament to both Yan's abilities and perseverance that he has been able to achieve significant results for models of visual information processing in both the cortex and the retina.

His thesis work provided one of the first functional explanations for non-linear response properties in visual cortex, including so-called complex cells. Earlier models were largely based on the neural response properties, which do not provide a means to make novel predictions and give little insight into the system at a functional level. Models that formed efficient codes of natural scenes could provide a functional explanation of the structure of V1 receptive fields, but could not provide any explanation for the numerous non-linearities or what problems the visual system might be solving beyond coding. Yan explored a range of computational problems in early vision, before settling on the problem of generalization -- how does the early visual system generalize from specific image features to form more abstract representations of visual structure?

For example, almost any contour in a natural scene is composed of a great variety of images due to the changing textures of the foreground and background surfaces. Therefore, to encode (or "recognize") a contour, the visual system must somehow generalize from these specific instances of edges to the more abstract notion of a contour. A similar problem exists for forming abstract representations of textured surfaces.

Yan developed a hierarchical statistical model that was a non-linear generalization of efficient coding models. Instead of forming a representation that (linearly) combines image features to form an efficient representation of a local image patch, Yan's model forms an efficient representation image distributions. This is a non-linear process, because the model must infer from a single image, what distribution that image came form. For example, it must generalize from an instance of an edge (a texture boundary) to the more abstract representation of a contour. By adapting the model to natural scenes, it learned representations for the distributions that occurred most commonly, which included contours, textures, and junctions. Not only could the model solve a difficult statistical generalization problem, but without any prior biasing, it captured several types of non-linear response properties, including insensitivity to phase, i.e. complex cells. More remarkably, the weights in the model also predicted those measured from spike-

triggered covariance models, which means that the model could predict the dimensions in stimulus space to which neurons were either sensitive or insensitive.

Yan's more recent work has brought this same degree of depth to develop more detailed theoretical models of information processing in the retina. By carefully modeling input and output noise, non-linear response functions, and metabolic cost of firing -- and doing the requisite mathematical and algorithmic work to achieve a tractable model -- Yan, with his postdoctoral advisor Eero Simoncelli, developed a model that predicted center surround receptive fields and non-linear rectification. This model provides a theoretical explanation for the structure of individual retinal ganglion cell receptive fields and how they are organized as a population. It also provides an explanation for why the are organized into on- and off-center types. Moreover, the model provides a general theoretical framework for predicting other types of retinal ganglion cell properties, or neurons in other modalities.

It goes without saying that Yan was an excellent student. In fact, from the beginning he was more of a colleague than a student. He needed little guidance beyond our discussions in our meetings and could always pick up the ball and run with it. He was always trying things out and would often go several steps ahead to explore related ideas. He was also exceptionally good at designing computational experiments and analyzing the results, which allowed him to boil things down to their essence and presents results in a way that focuses on the core issue.

Yan has considerable mathematical and implementation skills. Although it was not his background, he had no trouble learning the probability theory and matrix calculus necessary for developing and implementing the theoretical models. He was also very clever and creative at verifying the math and the correctness of the implementation, something most students struggle with. He took all of the machine learning classes at CMU and many of the advanced statistics and computational neuroscience classes and always excelled. Another of his strengths is that he has been very good at developing approximations and efficient implementations needed to run complex models on large amounts of data. He's something of virtuoso programmer as well. He implements very efficiently, and I've never seen anyone with quite the same ability to translate ideas into code. In meetings, he could often implement ideas that come out of our discussions right there on the spot.

Another side of Yan that set him apart was his exceptional discipline and work ethic. He got things done and did them very well. He was the most productive student I've had, and probably even of people I've known at similar stages. His publication record might not reflect this, but the numerous projects he took on were difficult in all aspects, from the conceptualization of the problem, to developing the mathematical framework, to the implementation. During graduate school, he had many interesting side projects that were never developed into a publication simply because he chose to focus elsewhere. One of the most interesting ones was an ambitious project on learning invariant image features. I'd estimate he spent a third of his graduate time on this and made progress, but in the end it was even in his thesis. Conceptually, I though this is his most interesting work, so I hope he goes back to it. But it is characteristic of Yan to work through a large number of ideas to find the best ones, which will serve him well in his career.

I think Yan has all the skills necessary to succeed as a faculty member. Yan will be an excellent advisor. He has lots of ideas, and a very deep understanding of many topics in the field. Yan is a very good writer, and is writes efficiently, which will serve him well when he applies for funding. I expect he will be a very good teacher. His presentations are excellent and he is very good at providing clear explanations of complex concepts.

If Yan has any weaknesses, I think it's that he is not one to sell himself. His talks are beautiful and clear, but he's not the most dynamic speaker, and he tends to undersell his results. Although he's highly motivated to do good work, he is at the same time is very cautious about over interpreting the results. As a result, he is not overly speculative, which can sometimes give people the wrong impression about the work. However, I think that also gives him a solid understanding of the limitations of his models and a clear basis for future work.

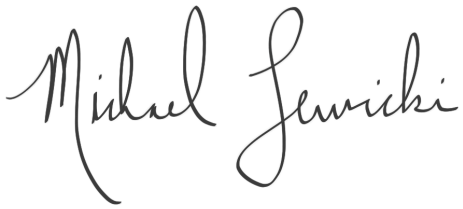
If anything about Yan requires explanation, it might be what appears to be a modest publication record. To that, I would urge the committee to consider the quality of the work and not the quantity. This is a very

difficult area to do good work in, and by that I mean work that is both theoretically solid and biologically relevant. It takes time, and Yan has not done minor variations on a common theme. He has an exceptional ability in being able to take on formidable challenges and stay with them. This might not yield a lot of papers, but it does yield good ones.

I sum, I think Yan is exceptional and will have a great career in science. I've very much enjoyed working with him and feel very fortunate to have had him as a student. I think he would be a great match and tremendous asset to your department.

If you have any specific questions, please do not hesitate to contact me.

Sincerely,



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