# Neural network learns to identify group sizes without knowledge of numbers

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(PhysOrg.com) -- A cognitive sciences research duo out of Università di Padova, in Italy, have succeeded in building an artificial intelligence network that has through repetition, learned to identify relative group sizes, without counting. Ivilin Stoianov and Marco Zorzi describe in their paper published in *Nature Neuroscience*, how they built an AI system capable of approximate number sense (ANS).

ANS is the ability of living beings to estimate with reasonable accuracy the differences in sizes of different groups. Fish, for example, demonstrate an ability to join the larger of two schools without having to count. Getting a computer to do the same has until now, never been done.

To get their AI network to develop ANS, the researchers used a neural network that "learns" to recognize images and to respond based on what it's seen. The system used mimics the biological processes of the eyes and brain, where one layer artificially recreates the retina with neurons that fire when exposed to pixels in an image and another that attempts to recreate some of the functions associated with brain processing.

After feeding the network 51,800 images, where each was a unique layout of rectangles of various sizes, the researchers found that the new images generated by the system began to demonstrate an awareness of the relative size of different groups without having to perform any counting. The new images the system created showed more artificial neurons firing when presented with images that showed groups with

more elements in them.

Next, to demonstrate, ANS, the team fed the system another program that allowed the system to compare different groups that it had seen during the first run and found, based on new images generated, that the system was able to make educated guesses about which was bigger or smaller; indicating the system had, without any numerical programming, learned to make educated guesses about which groups were bigger than others. This they say, is an example of ANS in an artificial network.

In looking at how the system was able to learn to make educated guesses regarding relative group size, the team notes that the process appears to be very similar to that which occurs in the brains of living animals, including humans. Babies, for example have been found to be able to perform ANS, without any notion of counting.

Teaching computer systems to learn to use ANS is but one step towards creating machines that think rather than simply crunch numbers for us, and the hope is that one day, such systems can be put into robots to make them as useful as those we've seen in movies for decades.

**More information:** Emergence of a 'visual number sense' in hierarchical generative models, *Nature Neuroscience* (2012) doi:10.1038/nn.2996

**Abstract**
Numerosity estimation is phylogenetically ancient and foundational to human mathematical learning, but its computational bases remain controversial. Here we show that visual numerosity emerges as a statistical property of images in 'deep networks' that learn a hierarchical generative model of the sensory input. Emergent numerosity detectors had response profiles resembling those of monkey parietal neurons and supported numerosity estimation with the same behavioral signature

shown by humans and animals.