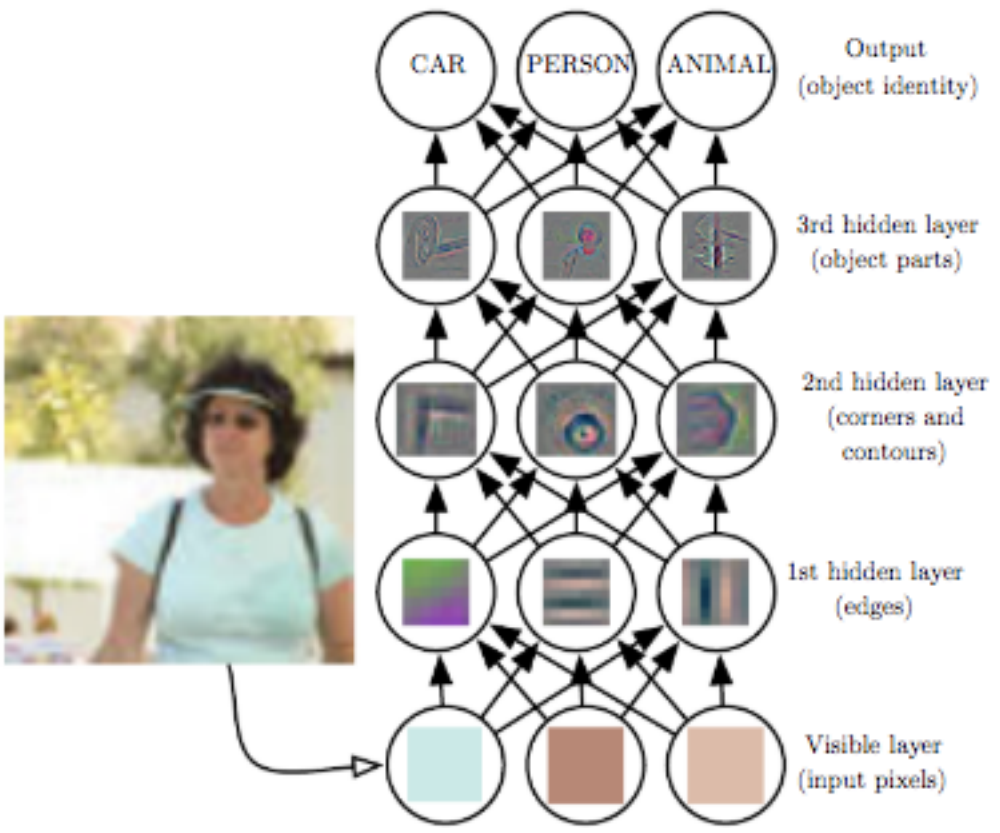
1. 기존의 머신러닝은 사람이 feature를 디자인했다.
   -> 하지만, 사람이 실제로 특성을 추출하기 어려운 경우들이 있다.
      ex) 이미지 속 차에 대한 pixel 설명

2. 이에 대한 해결책으로 기계가 결과만이 아니라 feature까지 학습하는 학습 방법이 고안되었다.
   - Representation learning

3. Factor of Variation
   - feature 학습 시에 가장 난해한 것은 factors of variation과 feature를 분리해내는 것이다.
   ex) 같은 차라고 해도 배경, 색 등이 달라져서 feature of variation이 있다.

4. Deep Learning
   - Deep Learning은 factor of variation 문제를 representation을 더 간단한 representation들의 nested mapping으로 해결한다.
   - Deep learning solves this central problem in representation learning by introducing representations that are expressed in terms of other, simpler representations. Deep learning enables the computer to build complex concepts out of simpler concepts.



Deep learning resolves this difficulty by breaking the desired complicated mapping into a series of nested simple mappings, each described by a different layer of the model. The input is presented at the visible layer, so named because it contains the variables that we are able to observe. Then a series of hidden layers extracts increasingly abstract features from the image. These layers are called “hidden” because their values are not given in the data; instead the model must determine which concepts are useful for explaining the relationships in the observed data. The images here are visualizations of the kind of feature represented by each hidden unit. Given the pixels, the first layer can easily identify edges, by comparing the brightness of neighboring pixels. Given the first hidden layer’s description of the edges, the second hidden layer can easily search for corners and extended contours, which are recognizable as collections of edges. Given the second hidden layer’s description of the image in terms of corners and contours, the third hidden layer can detect entire parts of specific objects, by finding specific collections of contours and corners. Finally, this description of the image in terms of the object parts it contains can be used to recognize the objects present in the image. Images reproduced with permission from Zeiler and Fergus (2014).

5. Deep Learning이 발전한 계기

- Deep learning has become more useful as the amount of available training data has increased.
- Deep learning models have grown in size over time as computer infrastructure (both hardware and software) for deeplearning has improved.
- Deep learning has solved increasingly complicated applications with increasing accuracy over time.