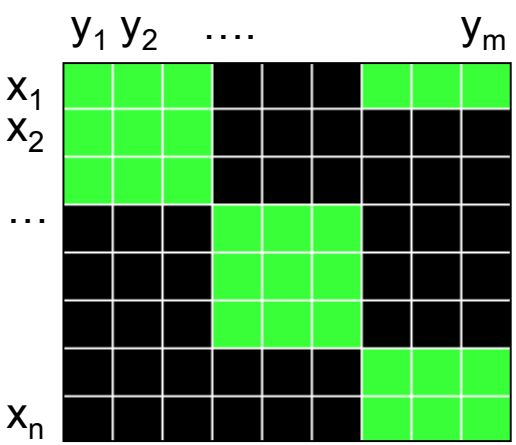
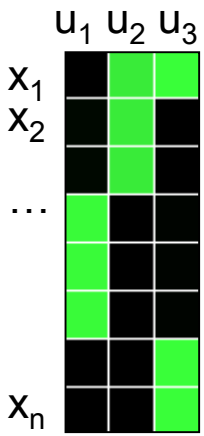
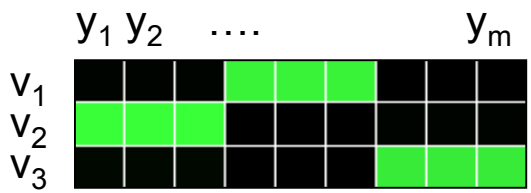
NMF Decomposition

V (n x m) ~ W (n x k) x H (k x m)





Basis Model



Encoding Coefficients

V, W and H > 0

k < n,m

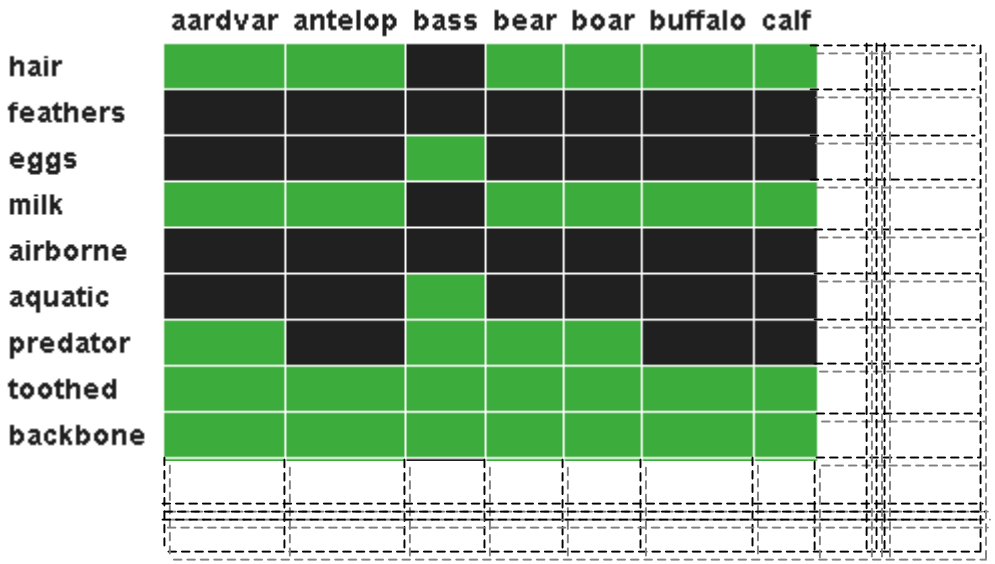
NMF Example: Database of Animals

101 Animals = aardvark, antelope, bear, boar, buffalo, calf, cavy, cheetah, deer, dolphin, elephant, fruitbat, giraffe, girl, goat, gorilla, hamster, hare, leopard, lion, lynx, mink, mole, mongoose, opossum, oryx, platypus, polecat, pony, porpoise, puma, pussycat, raccoon, reindeer, seal, sealion, squirrel, vampire, vole, wallaby,wolf, chicken, crow, dove, duck, flamingo, gull, hawk, kiwi, lark, ostrich, parakeet, penguin, pheasant, rhea, skimmer, skua, sparrow, swan, vulture, wren, pitviper, seasnake, slowworm, tortoise, tuatara, bass, carp, catfish, chub, dogfish, haddock, herring, pike, piranha, seahorse, sole, stingray, tuna, frog, frog, newt, toad, flea, gnat, honeybee, housefly, ladybird, moth, termite, wasp, clam, crab, crayfish, lobster, octopus, scorpion, seawasp, slug, starfish, worm

17 animal properties

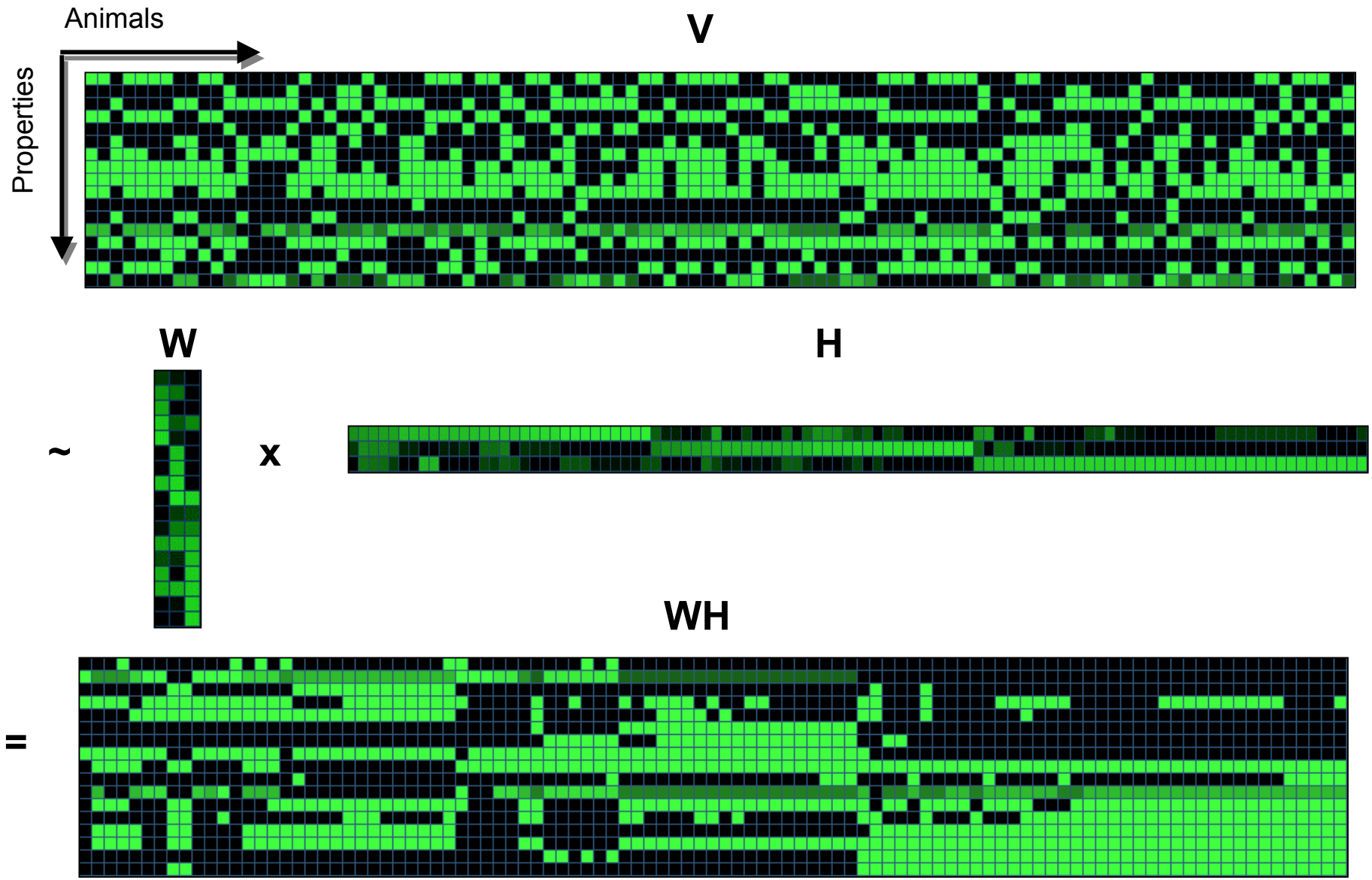
- Hair
- Feathers
- Eggs
- Milk
- Airborne
- Aquatic
- Predator
- Toothed
- Backbone
- Breathes
- Venomous
- Fins
- Legs
- Tail
- Domestic
- Catsize
- Type

Input Matrix



From Richard S. Forsyth's PC/BEAGLE User's Guide. |

NMF Animals Example



W Matrix - Discovered Animal Groups

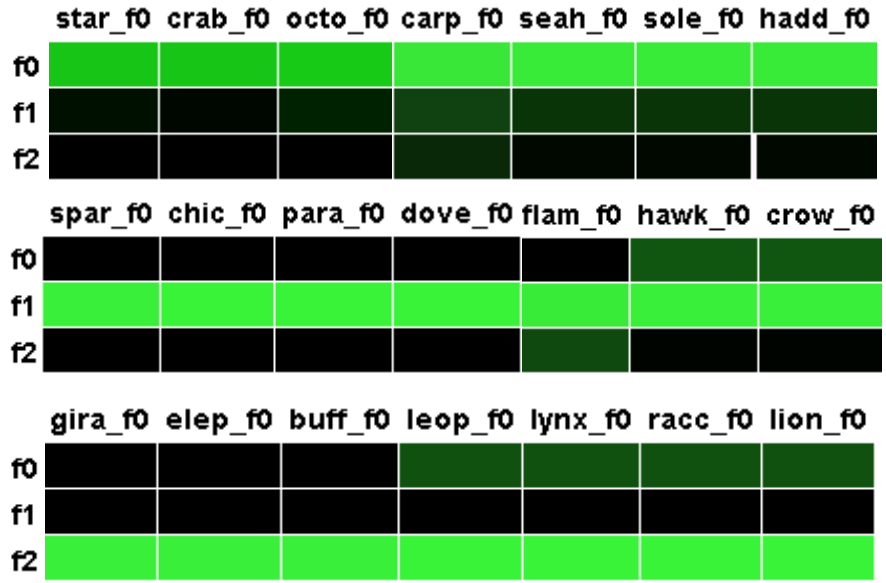
The 17 characteristics are represented in 3 factors. For Example:

> **Factor 0**: abstracts and discovers the notion of **fish-like** as it is made mainly of *fins, predator aquatic, eggs, tail, toothed* and *backbone.*
>
> **Factor 1**: abstracts and discovers the notion of a **bird-like** as it is made mainly of *feathers, airborne, eggs, breathes, tail and backbone.*
>
> **Factor 2**: abstracts and discovers the notion of a **mammal-like** as it is made mainly of *legs*, *tail, backbone, breathes, milk, hair* and *toothed*.

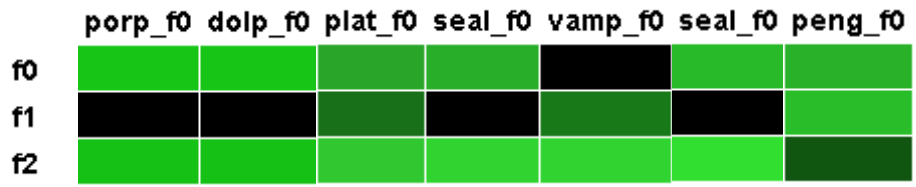
Notice for example how *tail, backbone* and *breathes* are common properties of bird-like and mammal-like and eggs, tails and backbone are common between fish-like and bird-like .

H Matrix - Examples of Animal Decomposition

"Pure" Animals



"Composite" Animals



Projecting the Animals in NMF “MDS” Space