MATH MATTERS

Apply It.

The math behind... Feeding Pigs

Technical terms used:

Optimization, bilinear problem, nonconvex problem, multi-objective optimization, global minimum.

Uses and applications:

This model determines an optimal diet for pigs. It minimizes feed cost and phosphorus and nitrogen excretions, and has many benefits for the pork production industry.

How it works:

More than 70% of the production cost in the pig industry is devoted to the cost of feed. In the current economic context, it is important to reduce this cost. One method of doing so is to mathematically model the cost feeding of pigs and use this model to find a diet that minimizes cost.
In current industrial feeding models, pigs are fed in three separate phases as they grow from 20kg to 130kg. From 20 kg to 50 kg pigs are fed with feed A, from 50 kg to 90 kg they are fed with feed B and from 90 kg to 130 kg they are fed with feed C. With this feeding model, the cost can be modelled linearly and the global minimum can be easily determined. However, this feeding system results in an excessively rich diet in the last days of each phase, leading to an excess of nutrients.

This nutrient waste can be prevented by creating a more efficient feeding system. One such diet uses a combination of two feeds whose ratio changes daily in order to satisfy the nutritional needs of the growing pig. This feeding system is modeled by a bilinear problem and is nonconvex. It is much harder to find a global minimum than the previous one but some efficient algorithms exist to solve it locally.
The pig industry is frequently cited as heavily contributing to pollution, mainly due to the phosphorus and nitrogen contained in manure. Typically, reducing these pollutants leads to an increase of feed cost. However, by solving a multi-objective optimization problem on both systems we can find an industrial model that reduces both cost and pollutants.

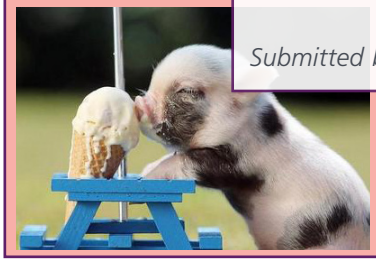
Interesting facts:

Using the new feeding system could reduce feed cost by 4% and phosphorus and nitrogen pollutants by 3.3 % and 14.8%, respectively. Reducing cost and pollutants can lead to a feeding system that has the same cost as the one used today but decrease phosphorus and nitrogen excretion by 11.1% and 22.4%, respectively.

References:

E. Joannopoulos, F. Dubeau, J.-P. Dussault, C. Pomar. Diet problems. In: Plà-Aragonés L. M. (Ed), Handbook of Operations Research in Agriculture and the Agri-Food Industry (Springer-Verlag, New York, 2015), 397-417.

C. Pomar, J. Pomar, F. Dubeau, E. Joannopoulos, J.-P. Dussault. The impact of daily multiphase feeding on animal performance, body composition, nitrogen and phosphorus excretions, and feed costs in growing-finishing pigs. Animal, 8, 704-713 (2014).



Submitted by Emilie Joannopoulos, IRMAR-INSA Rennes, France, Math Matters, Apply it! Contest, February 2017

Society for Industrial and Applied Mathematics
www.siam.org
www.siam.org/careers/matters.php
siam.