What are support (SVMs)?

Author

Eda Kavlakoglu

Business Development + Partnerships

IBM Research

What are SVMs?

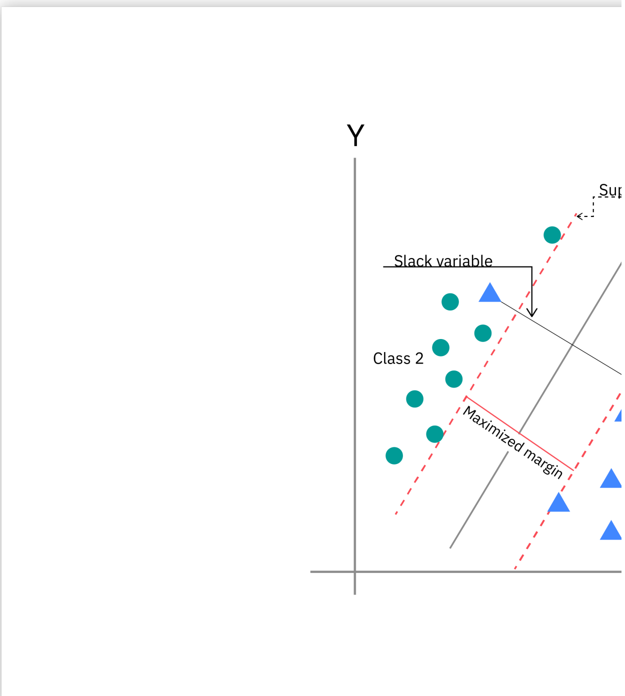
A support vector machine (SVM) is a algorithm that classifies data by find that maximizes the distance betwee space.

SVMs were developed in the 1990s by Vladin published this work in a paper titled "Support Regression Estimation, and Signal Processing

SVMs are commonly used within classificatio optimal hyperplane tha data points of opposite classes. The number

hyperplane is a line in a 2-D space or a plane
hyperplanes can be found to differentiate cla
enables the algorithm to find the best decisio
enables it to generalize well to new data and
lines that are adjacent to the optimal hyperpl
vectors run through the data points that dete

The SVM algorithm is widely used in machine
nonlinear classification tasks. However, wher
functions are used to transform the data high
separation. This application of kernel functior
the choice of kernel function, such as linear k
function (RBF) kernels, or sigmoid kernels, de
specific use case.



Types of SVM classi

Linear SVMs

Linear SVMs are used with linearly separable
to undergo any transformations to separate tl
boundary and support vectors form the appea

Winston from MIT uses the analogy of "fitting
this quadratic optimization problem. Mathem
represented as:

$wx + b = 0$

where *w* is the weight vector, *x* is the input ve

There are two approaches to calculating the r
classes, which are hard-margin classification
hard-margin SVMs, the data points will be pe
vectors, or "off the street" to continue with Pr
represented with the formula,

$(wx_j + b) y_j \geq a$,

and then the margin is maximized, which is re
the margin projected onto *w*.

Soft-margin classification is more flexible, all
use of slack variables (`ξ`). The hyperparam
narrows the margin for minimal misclassificat
allowing for more misclassified data[3].

Nonlinear SVMs

Much of the data in real-world scenarios are r
nonlinear SVMs come into play. In order to m
preprocessing methods are applied to the tra
dimensional feature space. That said, higher
complexity by increasing the risk of overfittin
taxing. The "kernel trick" helps to reduce son
computation more efficient, and it does this b
equivalent kernel function[4].

There are a number of different kernel types t
popular kernel functions include:

- Polynomial kernel
- Radial basis function kernel (also known a

– Sigmoid kernel

Support vector regressic

Support vector regression (SVR) is an extensi
problems (i.e. the outcome is continuous). Sir
with the maximum margin between data poin
prediction.

SVR differs from linear regression in that you
looking to understand between the independ
understanding of the relationships between v
when using linear regression. This is unneces
relationships on their own.

How SVMs work

In this section, we will discuss the process of
other supervised learning algorithms and its a

Building a SVM classifier

Split your data

As with other machine learning models, start
testing set. As an aside, this assumes that yo
analysis on your data. While this is technicall
good practice before using any machine learn
understanding of any missing data or outliers

Generate and evaluate the model

Import an SVM module from the library of yo
training samples on the classifier and predict
by comparing accuracy of the test set to the p
evaluation metrics, like f1-score, precision, o

Hyperparameter tuning

Hyperparameters can be tuned to improve th
hyperparameters can be found using grid sea
iterate through different kernel, regularizatio
combination.

SVMs vs. other supervise

Different machine learning classifiers can be
test out and evaluate different models to und
said, it can be helpful to understand the stren
application for your use case.

SVMs vs naive bayes

Both Naive Bayes and SVM classifies are com
SVMs tend to perform better than Naive Baye
That said, SVMs have to tune for different hyp
computationally expensive.

SVMs vs logistic regression

SVMs typically perform better with high-dime
image and text data, compared to logistic reg
overfitting and easier to interpret. That said, t

SVMs vs decision trees

SVMs perform better with high-dimensional c
compared to decision trees. That said, decisi
particularly with smaller datasets, and they a

SVM vs. neural networks

Similar to other model comparisons, SVMs ar
and less prone to overfitting, but neural netw
scalable.

Mixture of Experts | 21 November, epis

Decoding AI: Weekly News R

Join our world-class panel of engine
and more as they cut through the AI
news and insights.

Watch all episodes of Mixture of Experts

Applications of SVMs

While SVMs can be applied for a number of ta
applications of SVMs across industries.

Text classification
SVMs are commonly used in nat
such as sentiment analysis, spa
lend themselves to these data a
dimensional data.

Image classification
SVMs are applied in image classification tasks such as object detection and image retrieval. It can also be useful in security domains, classifying an image as one that has been tampered with.

Bioinformatics
SVMs are also used for protein classification, gene expression analysis, and disease diagnosis. SVMs are often applied in cancer research because they can detect subtle trends in complex datasets.

Geographic information system (GIS)
SVMs can analyze layered geophysical structures underground, filtering out the 'noise' from electromagnetic data. They have also helped to predict the seismic liquefaction potential of soil, which is relevant to field of civil engineering.

Ebook

Unlock the power of generative AI + ML

Learn how to confidently incorporate generative AI and machine learning into your business.

Read the ebook →

Resources

Report

IBM is named a Leader in Data Science & Machine Learning

Learn why IBM has been recognized as a Leader in the 2025 Gartner®

Magic Quadrant™ for Data Science and Machine Learning Platforms.

Read the report →

AI models

Explore IBM Granite

IBM Granite is our family of open, performant and trusted AI models, tailored for business and optimized to scale your AI applications. Explore language, code, time series and guardrail options.

Meet Granite →

Report

AI in Action 2024

We surveyed 2,000 organizations about their AI initiatives to discover what's working, what's not and how you can get ahead.

Read the report →

Explainer

Supervised learning models

Explore supervised learning approaches such as support vector machines and probabilistic classifiers.

Training

Hands-on with generative AI

Learn fundamental concepts and build your skills with hands-on labs, courses, guided projects, trials and more.

Learn generative AI →

Ebook

How to choose the right

1 / 2

Related solutions

IBM® watsonx Orchestrate™
Easily design scalable AI assistants and agents, automate repetitive tasks and simplify complex processes with IBM® watsonx Orchestrate™.

Explore watsonx Orchestrate →

Artificial intelligence solutions
Put AI to work in your business with IBM's industry-leading AI expertise and portfolio of solutions at your side.

Explore AI solutions →

Artificial intelligence consulting and services
IBM Consulting AI services help reimagine how businesses work with AI for transformation.

Explore AI services →

Take the next step

Whether you choose to customize pre-built apps and skills or build and deploy custom agentic services using an AI studio, the IBM watsonx platform has you covered.

Explore watsonx Orchestrate →

Explore watsonx.ai →