# A Support Vector Regression Model Can Predict Maximal Mass Lifted During a Military Manual Materiel Handling Assessment

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**Summary**

Machine learning (ML) models are revolutionising how organisations like the military predict personnel performance outcomes. Preliminary ML models are often developed using general population data but are not validated or refined in military-specific populations, limiting their applicability. Our results show that models must be retrained with a complete retraining cycle when introducing military-specific data sets to predict a maximal lift assessment. When predicting unseen datasets for general and military populations, the retrained support vector regression (SVR) model resulted in a root mean square error (RMSE) of ±3.20 kg compared to ±9.95 kg for a SVR model trained only on general populations. Military organisations can have confidence in the predictive abilities of the models upon validation.

**Introduction**

The ability to move materiel such as stores and ammunition is essential for military personnel [1]. Knowledge of the lift-to-place capacity of personnel can help military organisations ensure manual material handling tasks can be performed safely [1]. However, specific testing of lift-to-place tasks is associated with a time burden and may not always be easily prioritised amongst other established and broadly useful screening tests. Utilising an individual's physical characteristics like strength, power, and body composition from a standard physical screening approach can provide data inputs for training ML models like SVRs to predict lift-to-place performance and may avoid the need to include specific lift-to-place testing. However, model validity must be carefully considered before it can be deployed. A model's validity reflects its generalisability, the ability to predict the outcome precisely across multiple unseen data sets [2]. Therefore, this study aimed to cross-validate a developed SVR model and development methodologies for their ability to predict maximal mass lifted across general and military-specific cohorts.

**Methods**

Dataset 1 included 35 general population participants and Dataset 2 included 16 military personnel (male: 42, female: 9, age 28.8 years ± 8.02, height 1.75 m ± 0.08, mass 76.7 kg ± 12.3). For Dataset 1, participants completed a test battery measuring physical fitness, body composition, and a maximal lift with a dumbbell to a 1.5 m platform. Data were processed, cleaned, and then split into 80/20% training and testing datasets. In Python (V. 3), a leave-one-out cross-validation sequential backward selection (SBS) was performed on the training dataset to predict the maximal lift. The RMSE and normalised RMSE (NRMSE) were calculated to evaluate the SVR model from Dataset 1. Dataset 2 included a specific physical test battery based on the Dataset 1 SBS findings and the maximal lift assessment. A cross-validation of the model developed from Dataset 1 against Dataset 2 was based on two approaches: (1) the ability of Dataset 1 SVR developed model to predict maximal lift for an even split of 10 unseen participants from mixed populations and (2) the comparative ability of a SVR model retrained from the beginning stage using the combined datasets of 1 and 2. RMSE and NRMSE were compared for all developed models.

**Results and Discussion**

The optimal features selected from the SBS function based on Dataset 1 were isometric mid-thigh pull peak force, bicep circumference, loaded countermovement jump (LCMJ) velocity at peak power, LCMJ concentric peak velocity, LCMJ peak power, and sex. The retrained model did not require LCMJ peak power but required age, height, and mass. RMSE and NRMSE for all models can be seen in Figure 1. SVR model RMSE for Dataset 1 was ± 1.77 kg. When predicting both populations, SVR approach 2 demonstrated superior results to SVR approach 1, with a RMSE of ± 3.20 kg versus ± 9.95 kg, respectively. NRMSE followed a similar trend (Figure 1). The results demonstrate the effectiveness of machine learning models in predicting maximal lift outcomes when retraining the models across multiple populations.

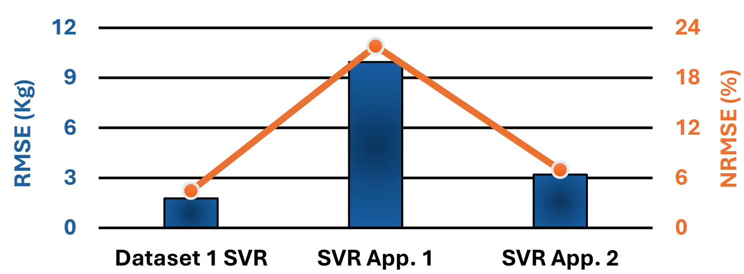


*Figure 1. Displaying the Root Mean Square (RMSE) and Normalised RMSE of the Support Vector Regression (SVR) Models Approaches (App.).*

**Conclusions**

The military can use SVR model approach 2 as a tool to predict mass lifted and assess a military and/or a general population's potential manual material handling ability [1].

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**References**

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