Increased reuse within Second Hand with support from Al

Swedish Red Cross

20240413

AnnaCarin af Forselles Swedish Red Cross



















Challenges and background to the project

260 second-hand stores run by 220 local branches (own entities).

High local dependency on second hand, the main part of the branch's revenue comes from the second-hand stores.

Little cooperation between the stores – what is donated to one store is sold in the same store – if sharing data and goods new business opportunities will arise.

Lack of volunteers for sorting for second hand.

Increased competition as market for second hand grows, but also new opportunities.

Within Swedish Red Cross a national system for recycling of textiles are in place since long ago but no system for other materials, which will be needed.

A common sorting facility for unlocking new value streams are under discussion – if implemented, a system for collecting and sharing data is needed.

Could Al-sorting support us solving our challanges?



A project for investigating how AI can increase the value of donations to Red Cross Second hand

Purpose

- To support us as second-hand actor and support increased sale within our 260 stores.
- Increased reuse of donations that cannot be sold in stores.

Project goal

 \checkmark An AI-supported system that automatically categorize, weight and catch materials in donations.

Effect of project

- ✓ Higher and common knowledge of donated goods when it comes to product and materials.
- ✓ A national program for common handling of materials for recycling will be set in place.
- ✓ Curiosity from our local branches and confidence that new technology like AI can support our organisation to higher local cooperation and finding new value streams



Vision

At the sorting facility goods are automatically sorted based on category and materials. Goods that has to low quality to be sold in a store is sorted in an own flow and will be sold for recycling. All donated goods are logged in a system with searching functionality. The number of volunteers needed for sorting is lower. More time can be used for securing that the goods is sorted to the store where the value can be unlocked.



Project implementation and process

Project

- Project financed by Sweden's Innovation Agency
- Project lead by Swedish Red Cross, Team Local fund raising and second hand
- Technical participation and solution by Chalmers Industriteknik, an organisation close to Chalmers University of Technology which focuses on innovative research and development for sustainable society.
- > Branch participation by Örebro Redcross.

Implementation

- > At the store warehouse in Örebro
- Preparation of system, workplace and AI model by Chalmers Industriteknik
- 1 sorter at place at Örebro during 10 month for learning the system

Process at warehouse

- > The sorter pickes up the donations
- \succ The sorters puts the donation at a scale
- > Two cameras takes photos of the donation
- The sorter gives information to the system; sellable/not sellable, materials and brand

Result and learnings

Result

- > 30 000 donations (60 000 images) have been scanned into an image database and registered as:
 - Sellable/not sellable in store
 - What donation and its weight
 - What material
- An AI algorithm has been developed that with 75-80% certainty tells what it is and what material it is and can say with 96% certainty if we recommend taking the item out of the store.
- > A database for continuing work.

Learnings

- > When implementing the model, we were soon able to see result from the AI-model and understood how to benefit from it.
- > There are a lack of open databases where to retrieve and compare information, so we are dependent on our own database.
- We cannot find information about any similar project. Most likely there are systems in use, but used for sorting of second-hand clothing, where there are more commercial actors involved.
- During the project we understood how to further benefit from a system like this. Additional data and functionality would increase the value of the model.
- > A person is faster than the system to value but by only using a person we don't get the data



Next steps – not yet decided

Customized warehouse management system connected with the cashier system

Developing of the model

- Add model with other categories
- Add model with brands
- Add the model with open sources

Developing of distribution - create an app for each Red Cross store to use and connect to the system

- Each store could upload images in the common data base.
- Each store could search for items in other Red Cross stores or warehouse to support customers
- Unified way of presenting articles in a future online shop
- Possible to find missing object in a set (for example coffee cups, plates..)
- Using foundation models for finding out the real value of secondhand object for bigger revenue
- Getting better statistics for the gifts what red cross obtains





Technical solution



Data collection

Data

- Approx. ~10 months of data collection:
- Labelling of data
- 59 342 images of 29 671 objects
- Personal experience of decision: sellable or non-sellable

Result

- 1. Object detection model ~95% accuracy
- 2. Object classification model ~75-80% accuracy for category and material
- 3. Sellable: ~96% for sellable and ~32% for non sellable



category	
4727	Uppläggningsfat och skålar
2836	Ljusstakar, ljuslyktor
2280	Köksredskap
2210	Glas
2139	Tallrikar
2041	Kannor, karaffer, flaskor
1926	Vaser
1752	Muggar
1382	Blomkrukor
1342	Prydnadsfigurer
1261	Burkar
856	Övriga prydnadsföremål
734	Grytor och kastruller
721	Brickor och skärbrädor
546	Kaffekoppar
527	Bestick
515	Kaffefat
437	Prydnadsskålar
399	Övrigt kök
382	Bakning
377	Prydnadsfat
148	Äggkoppar
17	Bakningsmaskiner
3	Kaffemaskiner
3	Vispmaskiner
7	Övrigt maskiner
2	Kaffeservis
2	Ljus

	material
Porslin	9626
Glas	83 <mark>9</mark> 5
Rostfritt	2730
Keramik	1853
Plast	1550
Trä	1189
Övrig metall	1003
Mix material	550
Järn	509
Mässing	428
Aluminium	412
Koppar	354
Silver, nysilver	336
Övrig material	244
Sten	176
Tenn	125
Emalj	68
Betong	34





Hardware setup

Basic components:

- 2 Cameras from different angles
- Scale for weight measurement
- Router for saving to cloud
- Computer and screen





Graphical User Interface for data collection

Data labelling:

- City: where the gift comes from
- Sellable/Not sellable
- Category
- Material
- Brand





Object detection model

- Customized pretrained object detection model 95% accuracy
- Localize the object in the image
- Crop image the object according the localization
- Minimizing the surrounding artifacts
- The surrounding effects leads to the confusion for the classifier model











Object classification model

- Transformer based Multilabel Model
- Input: Image, Weight (optional)
- Output : Category, Material, Sellable



Hidden



Confusion Matrix

- Organizing the predicted values compared to the real values
- Accuracy: Number of correct predictions made by model divided by total number of predictions

Accuracy =	TP + TN
	TP + TN + FP + FN

	Predicted Cancer	Predicted No Cancer
Cancer	TP	FN
No Cancer	FP	TN



Confusion Matrix: Category

- Organizing the predicted values compared to the real values
- Accuracy: the diagonal gives the accuracy per class
 - 1- Baking: 71%
 - 2- Cutlery: 85%

```
...
6- Glasses: 91%
```

. . .

Bakning -0	1 0	0.013	0.033	0 0	0.02	0 0	0.01	3 0.02 0	033 (0 0.0065	.0065	0 0	0.130	0065	0.006	5 0	- 1	.0
Bestick -	0.8	5 0	0	0 0	0.014	0 0	0	0.110.	0047 (0 0 0	0047	0 0	0.0040	0047	0.009	95 0		
Blomkrukor	36.00	180.63	0.009 1 0.	0160.01	10.0036	0 0	0.001	8 .00360	0420.0	340.0036	00720.0	0270.00	36 0.1 (0.087	0 0.01	10.0054		
kor och skärbrädor 🗕 🛛	0	0	0.82 0.0	0035 0	0.0035	0069 0	0	0.01 (0.01 (0 0.0069	0	0 0.00	690.09	0	0 0.02	40.017		
Burkar – 0	0	0.014	0.016 0	.77 <mark>0.00</mark>	മ.009ഇ	.0020.0	020.02	80.00790	0.03 0.0	04 0	0 0.0	0990.00	040.0560	0.026	0 0.007	90.004	- 0	.8
Glas _ 0	0	0	0 0.0	00680.91	0	0 0	0.004	500	0310.0	11 0	0 0.0	010.00	10.0045	0.032	0 0	0.0023		
ytor och kastruller	69 0	0.006	900	.01 0	0.84	0 0	0.01	7 0.010.	0035 (0.0035	0	0 0.00	350.08	0	0 0.01	0.0035		
Kaffefat _ 0	0	0	0	0 0	0 0).84 <mark>0.0</mark> 0	49 0	0 0	.019 (0 0.0097	0 0.0	0490.1	10.0049	0049	0 0	0		
Kaffekoppar – 🛛	0	0	0 0.0	0046 0	0 0	.023 0.7	4 0	0	0 0.3	190.0046	0	0 0.00	920.014	0 0.0	046.004	16 0	- 0	6
or, karaffer, flaskor 🗕 🛛	0	0	0 0.	0230.007	0 .0037	0 0	0.78	0.00610	0.02 0.0	15 0 0	007 0 .0	025.00	120.0380	0.088	0 0.004	9.003		
Köksredskap00	550.01	8.003	9.00880.	0130.004	0.0088	0010.00	0110.02	0.81 0	0120.00	011 0	0.020.0	038.00	110.0290	0066	0 0.01	40.024		
usstakar, ljuslyktor).00	128000	828005	9.00350.	0120.03	8 0 0.	0035 0	0.00	80.0088	0.8 0.0	044 0	0.0180.0	0555000	0880.03 (0.039	0.008	80.008		
Muggar – O	0	0.004	3 0 0.0	00140.01	70	0 0.0	66 0.01	0.0010	00430.8	B7 0	0 0.0	029 0	0.0170	0071	0 0.001	0 .0014		
Prydnadsfat _ 0	0	0.006	50.0660.	013 0	0.00660	0130.00	66 0	0.00660	.033 (0.38	0 0.0	0660.1	2 0.31	0	0 0.02	0.0066	- 0	.4
Prydnadsfigurer – 0	0	0	0	0 0	0.0019	0 0	0.001	9.00370	021 (0.0019	0.91	0 0	0.0075	0.015	0.03	70.0019		
Prydnadsskålar – <mark>0.0</mark>	11 0	0.023	0.00570.	057 0	0.0050	0057 0	0 (0.023	0.11 0.0	230.0057	0.017 0.	28 0.0	17 0.27 (0.0860.0	17 0.04	0		
Tallrikar – O	0	0.001	0.0010.0	00120.01	4 0 0	0150.00	23 0	0 0.0	0029.0	0350.0180	0010.0	0120.7	9 0.14 (0.007	0.001	2 0		
ningsfat och skålar).00	37 0	0.011	0.0220.	0140.01	50.0110.	0016.00	42.003	0.00530	0230.00	0740.010	0.00370.0	0120.0	63 0.77 0	0.0150.0	016.005	B.0010	- 0	.2
Vaser – O	0	0.032	0 0.	0170.04	8 0	0 0	0.03	90.00260	0620.0	013 0	0.010.0	091 0	0.021	0.73	0 0.01	60.0026		
Äggkoppar – 🛛	0	0	0	0 0.01	700	0170.0	170.01	70.017	0.1 0.0	170.017	0.017	0 0	0.085	0 0.	66 0.01	70		
a prydnadsföremål	8 8 .00	29.008	8.00880.	0320.01	20.018	0 0	0.03	50.0320	094	0.0088	0.12 0.0	0180.00	290.041	0.050.0	0290.49	0.015		
Övrigt kök	69.00	630.013	0.0690.	0440.006	530.019	0 0	0.04	4 0.17	0.110.00	063 0	0.0440.0	019 0	0.0870	0.0190.0	0630.04	4 0.29	- 0	0
Bakrang	estick .	sukor pro	dor aska	Gas	uner Kartetz	exopper	asses	acas inustakts	teories	adistat	ret statkällar	Blirikar	skillion uns	akoppar	orembl	KOK		
80	CKOT OC	U 3.	Grano	N OCT	Karmor.	satatter	HUSSTOKE	<i>k</i> - <i>n</i>	610	ydna prydn	abaanina	stat our	Pinatan I	prydryada	Q.			
							-	an al Ca		UP	-		<u> </u>	_				

Confusion Matrix: Material

- Organizing the predicted values compared to the real values
- Accuracy: the diagonal gives the accuracy per class
 - 1- Aluminium: 64%
 - 2- Enamel: 39%
 - 3- Glass: 94%
 - • •

. . .





Confusion Matrix: sellable

- Organizing the predicted values compared to the real values
- Accuracy: the diagonal gives the accuracy per class
 - 1- non-sellable: 32%
 - 2- sellable: 95%



Thank you for your interest!

If you have further question, please contact annacarin.af.forselles@redcross.se

