Aalto University
School of Engineering

MEC-E1070 Selection of Engineering Materials

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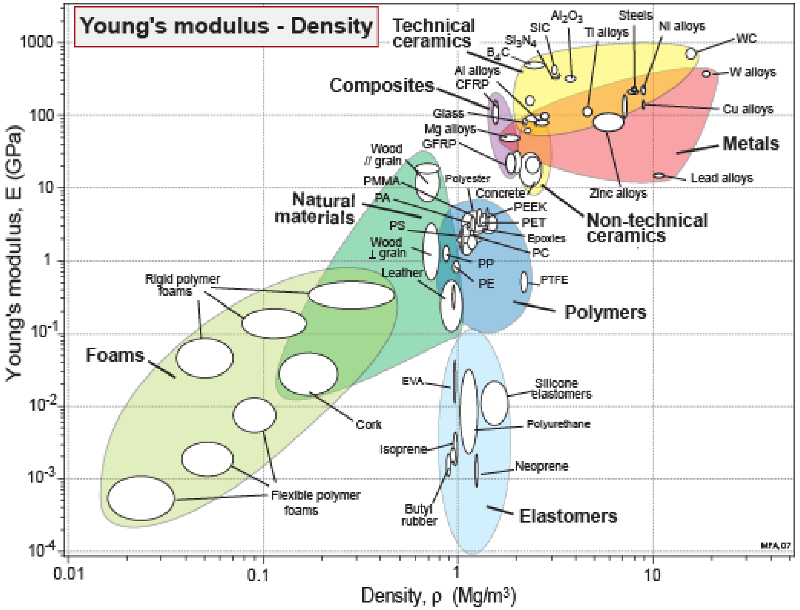
course assistant Zinan Li

Charts

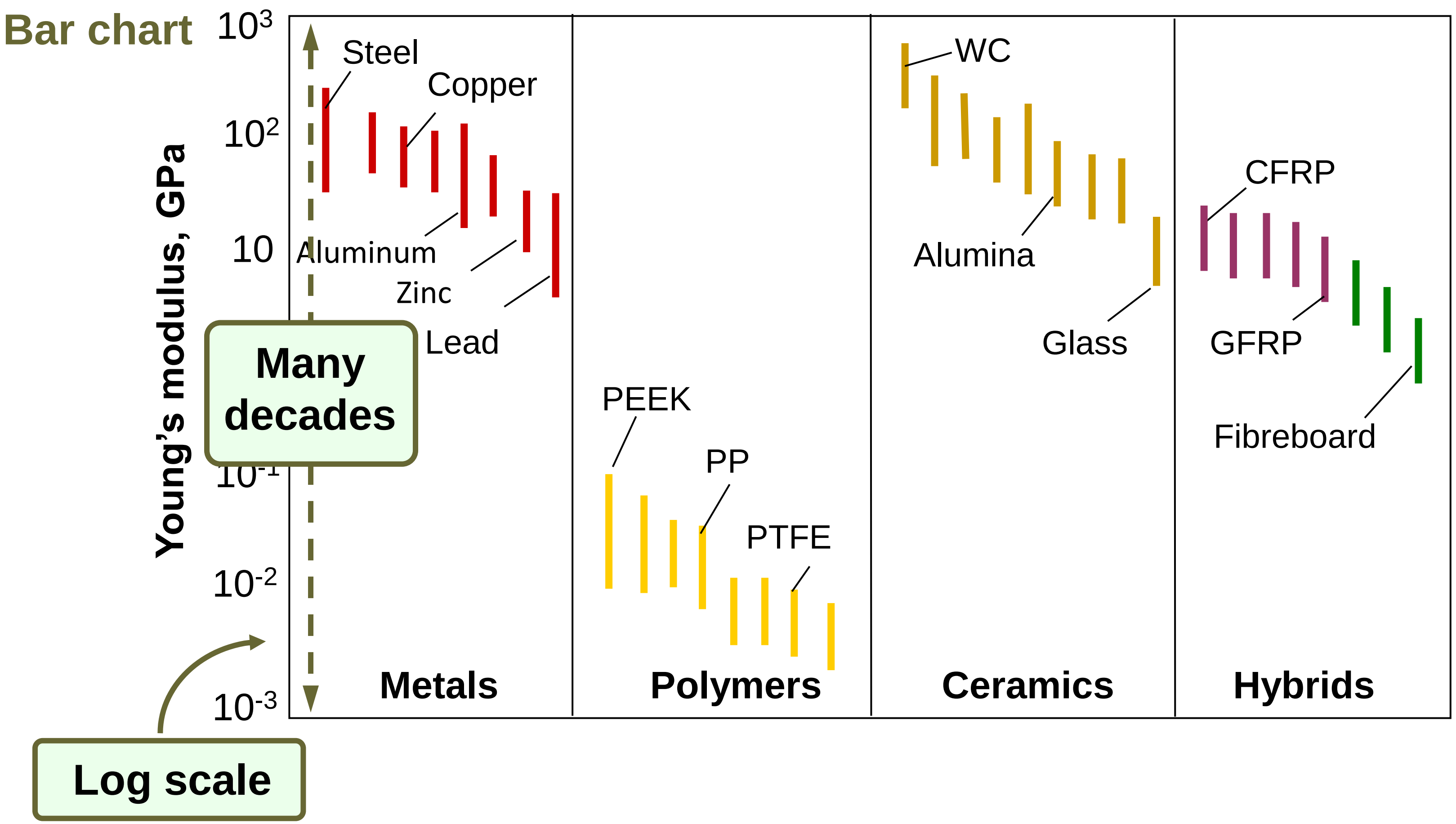


- Exploring relationships: property charts
- Making charts
- Custom subsets, adding your own materials
- Report writing

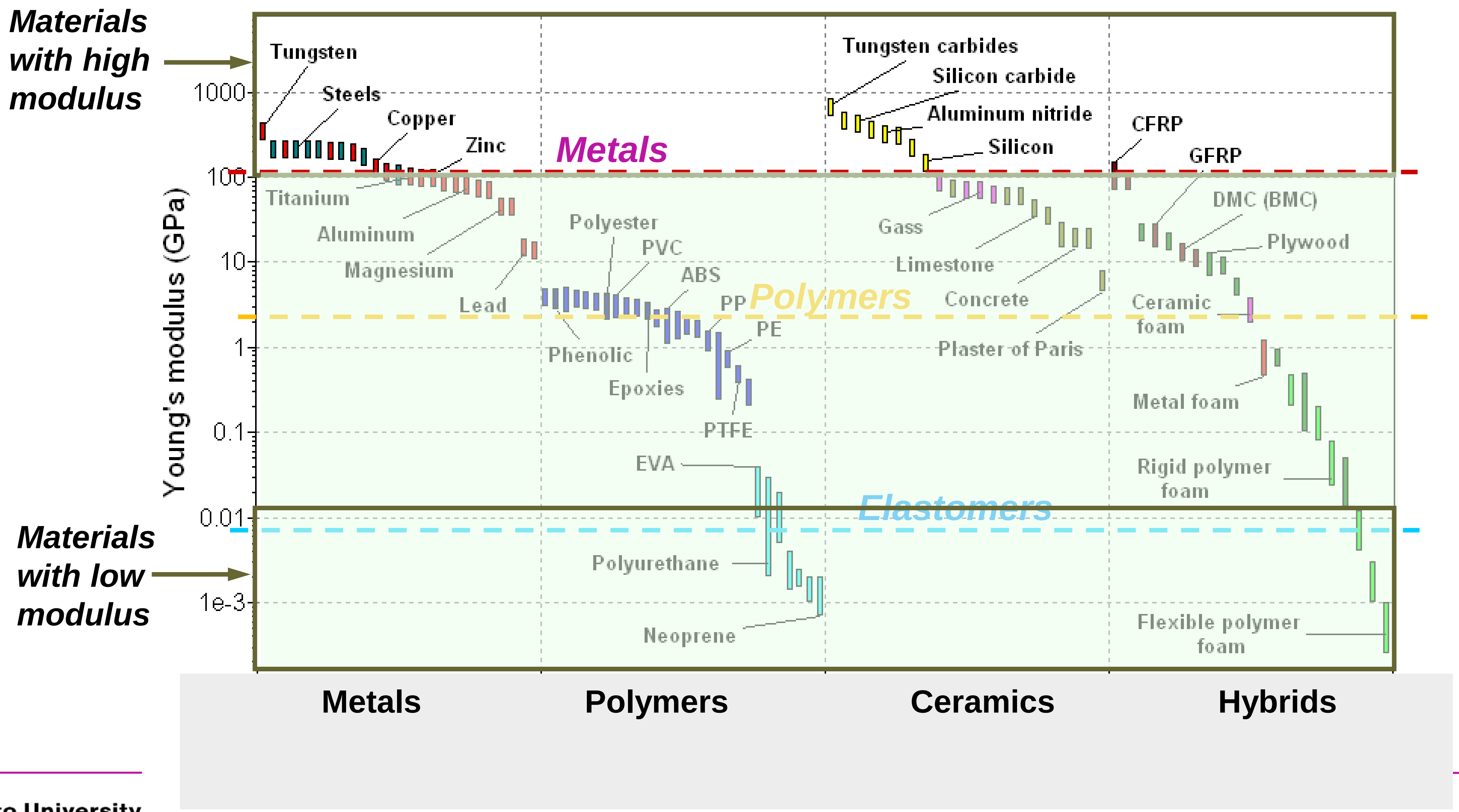
Bar charts

Data sheets = numbers, words

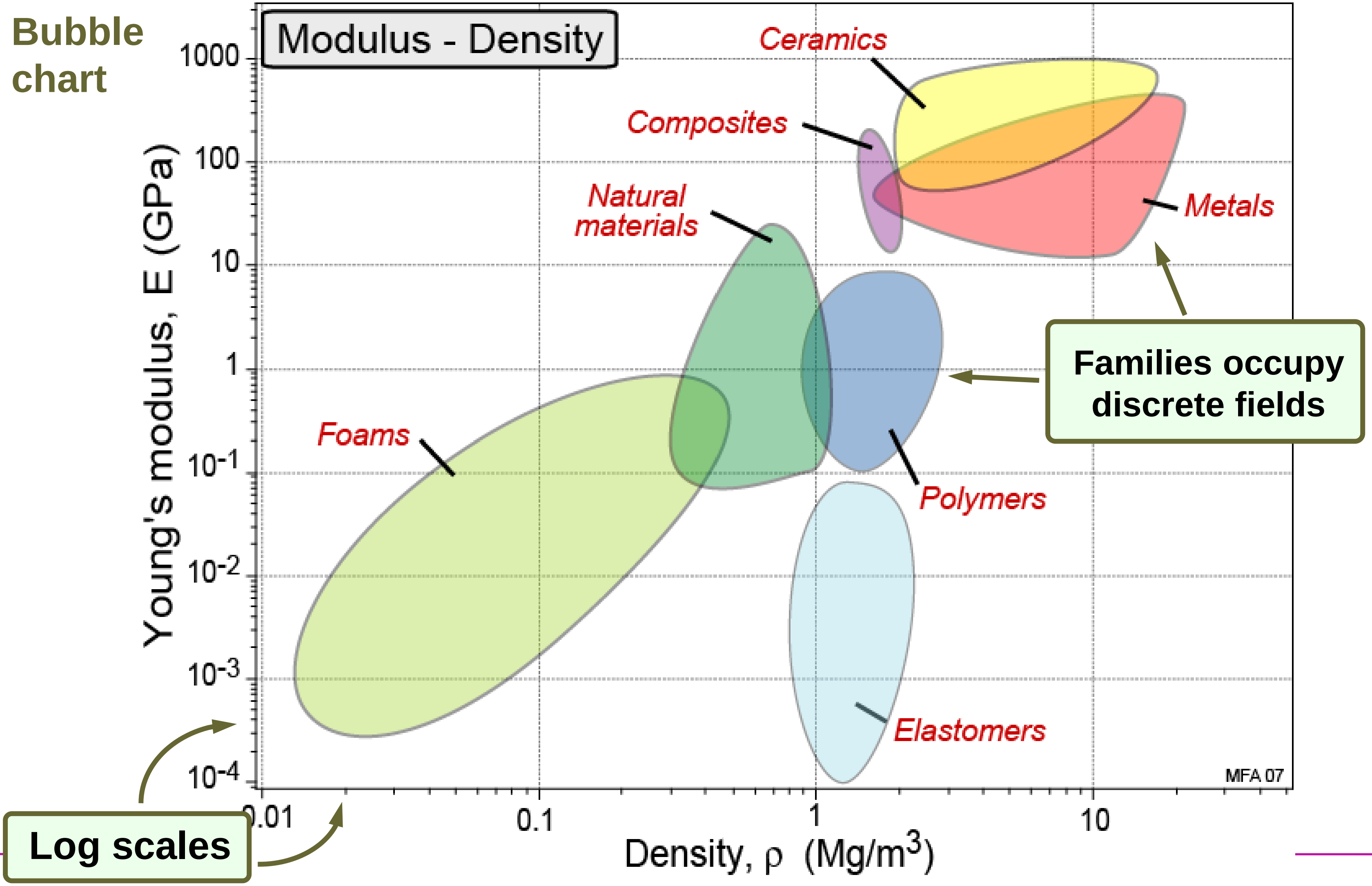
*We want **meaning*** → **Property charts**



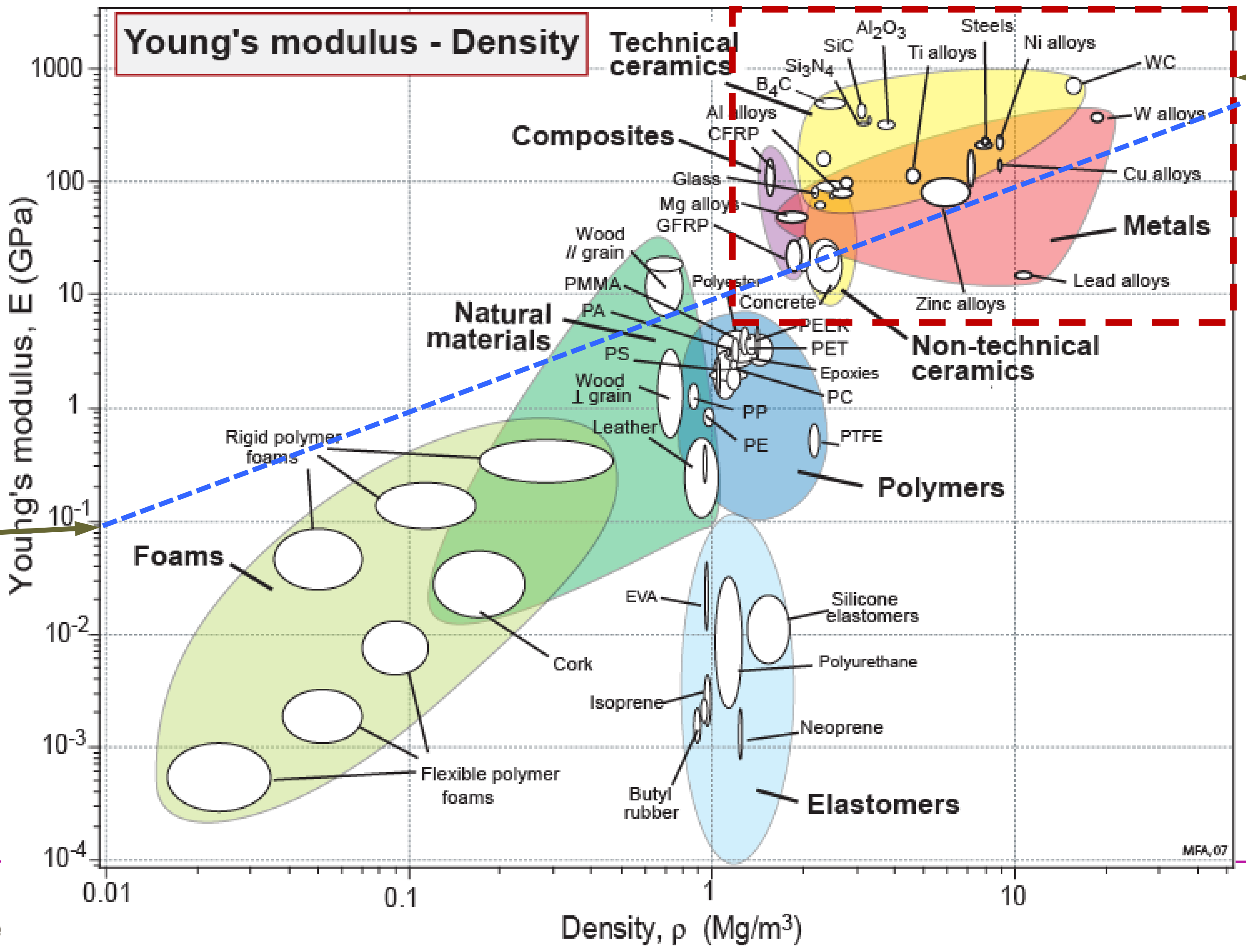
Bar-chart created with *GRANTA EduPack*



Bubble charts



Bubble chart created with GRANTA EduPack



Display line:
Materials with constant specific stiffness [E/ρ]

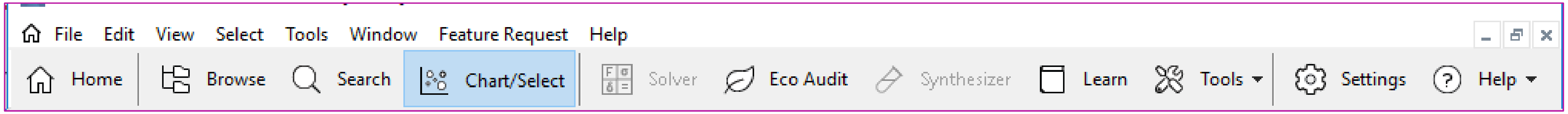
Display Box:
Materials with high Modulus and Density

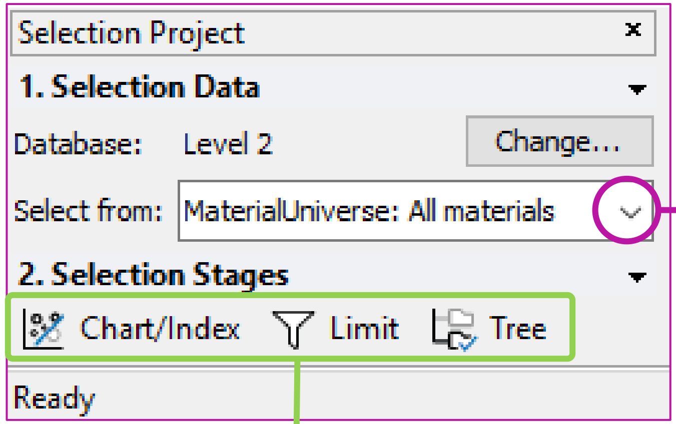
Table chart

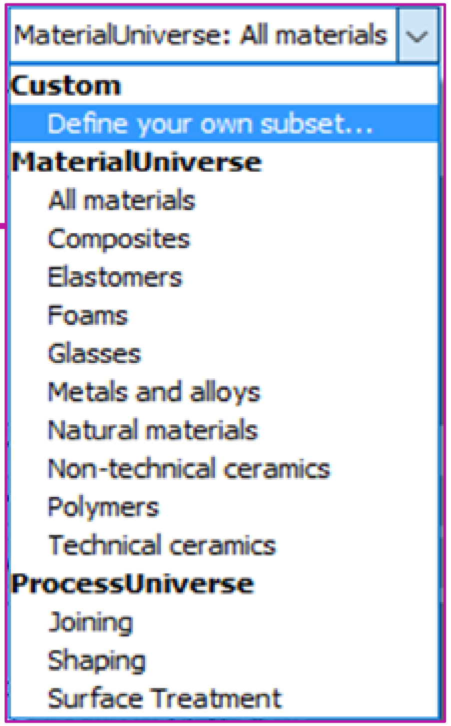
Discrete data

Composites	Plastics
Foams	Non-technical ceramics
Metals	Technical ceramics
Elastomers	Natural materials

Creating charts for selection

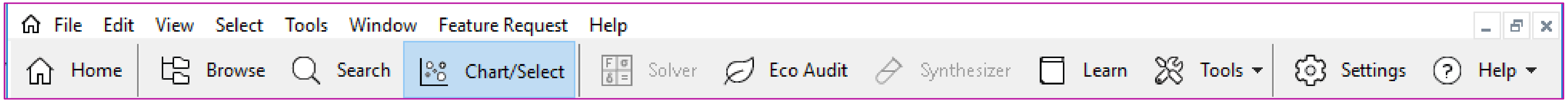


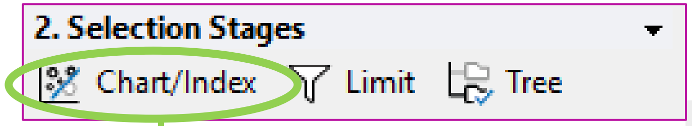




Plotting and selection tools

Creating charts for selection



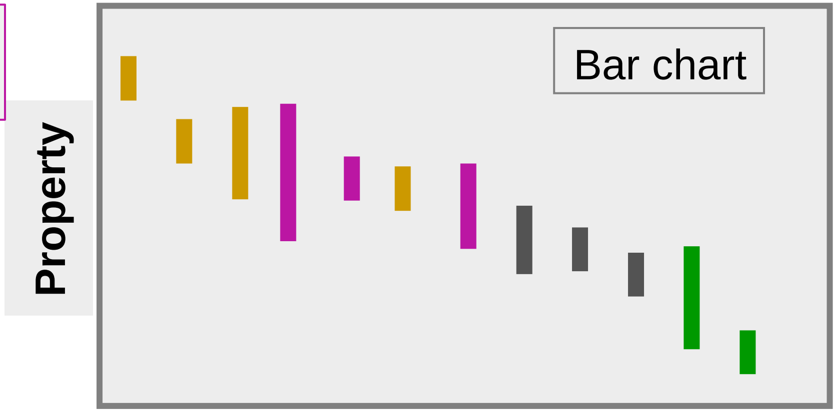


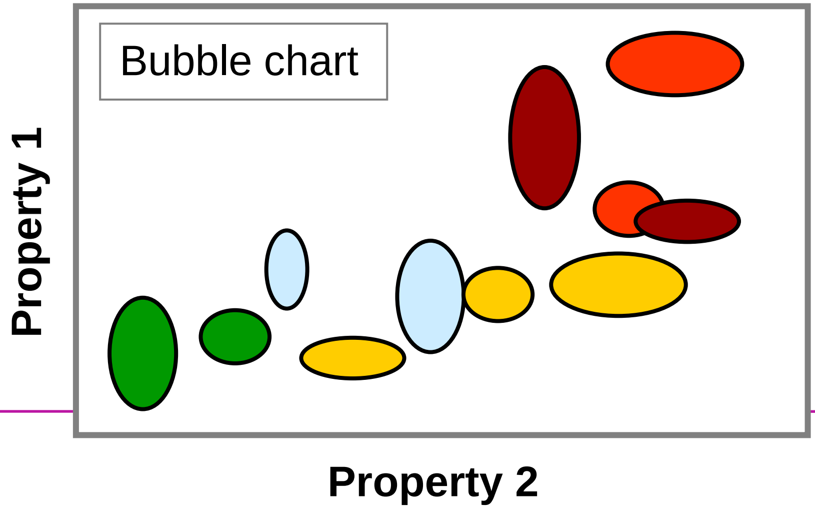
Choose:

X-Axis	Y-Axis

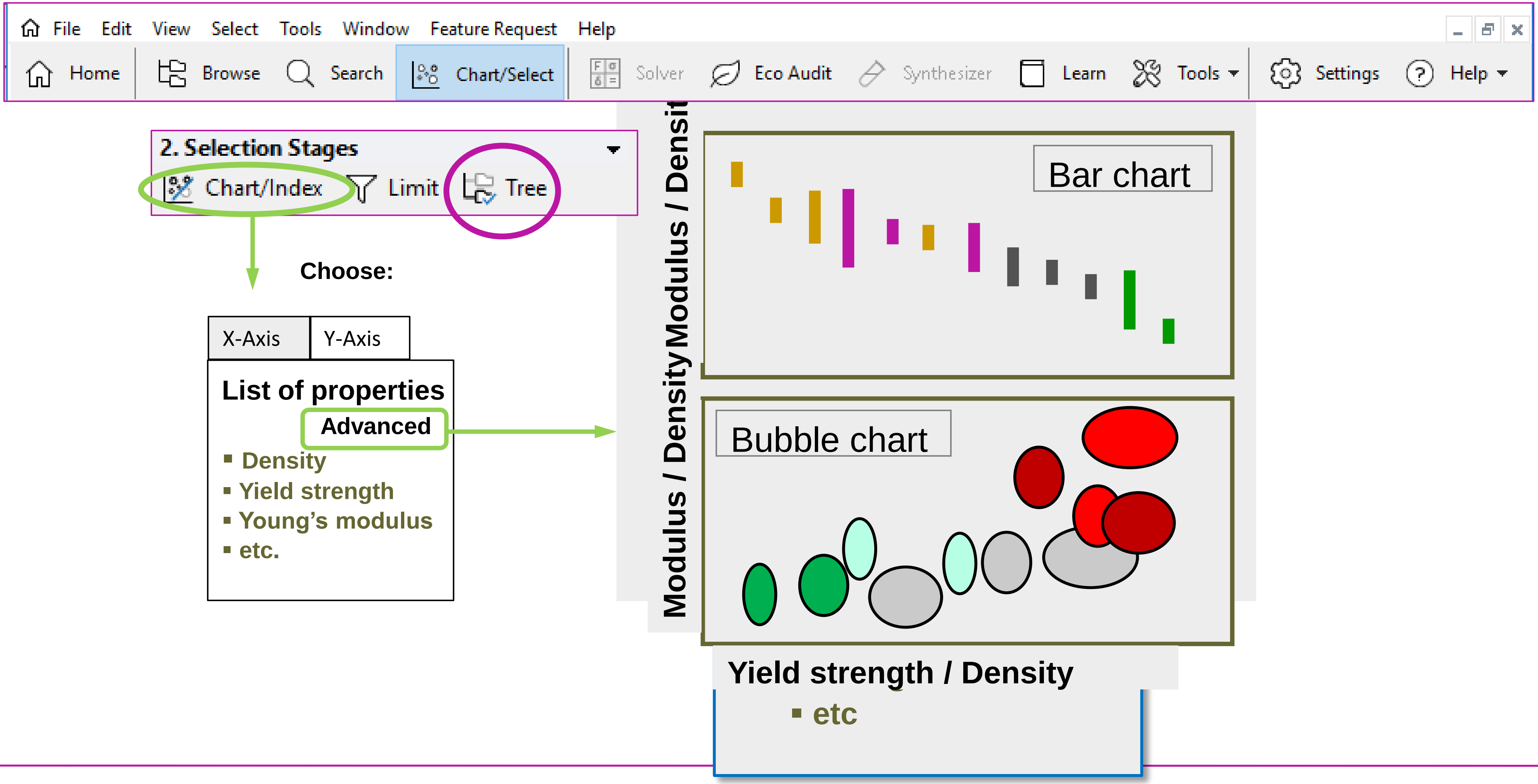
List of properties

- Density
- Yield strength
- Young's modulus
- etc.

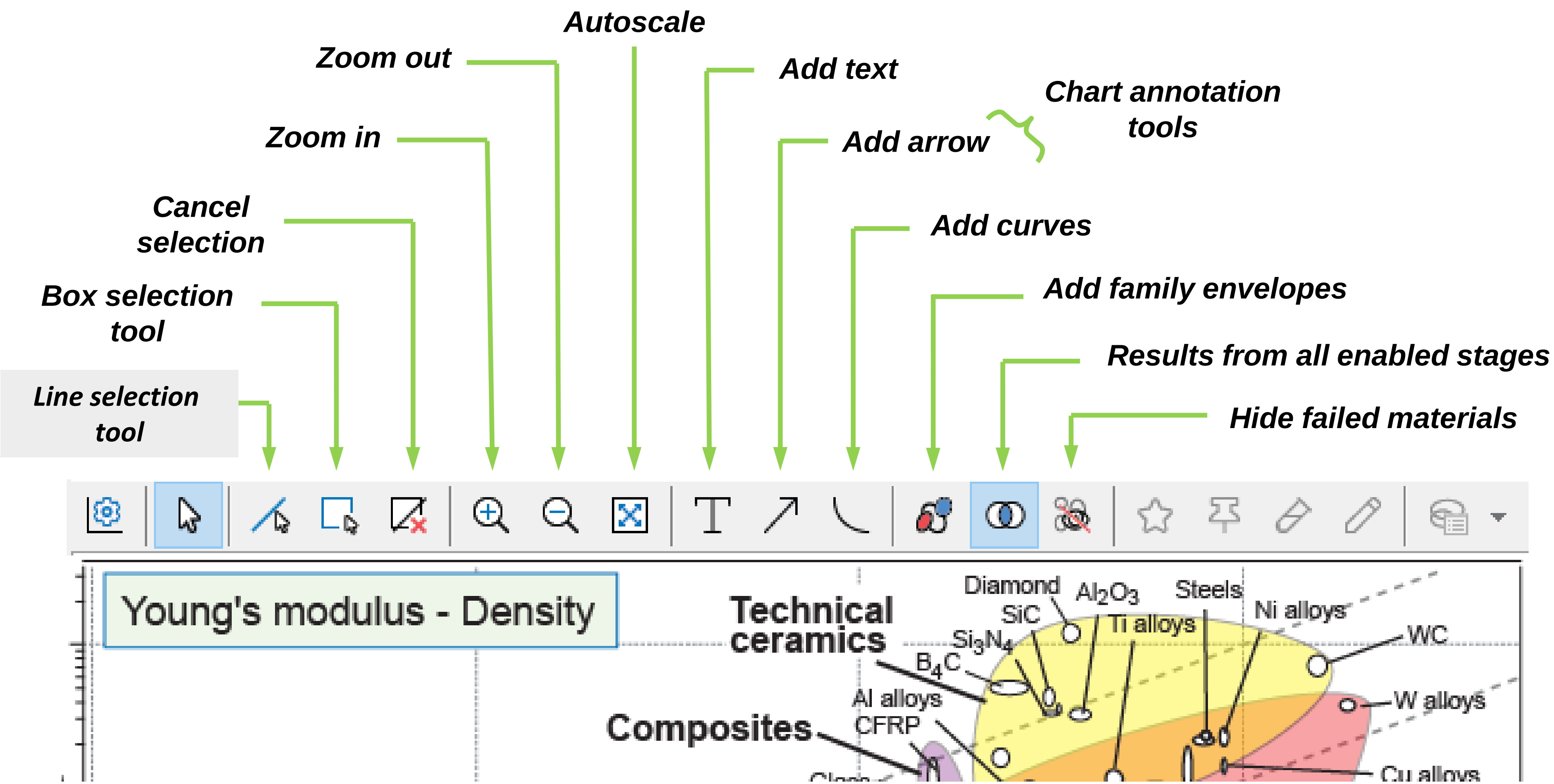




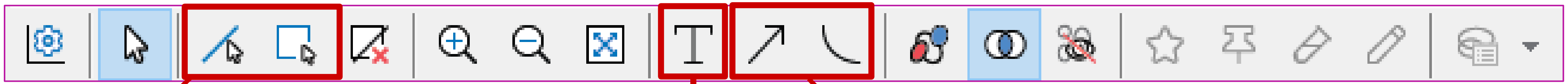
Creating advanced charts for selection



The chart-management tool bar



The line, box and curve tools

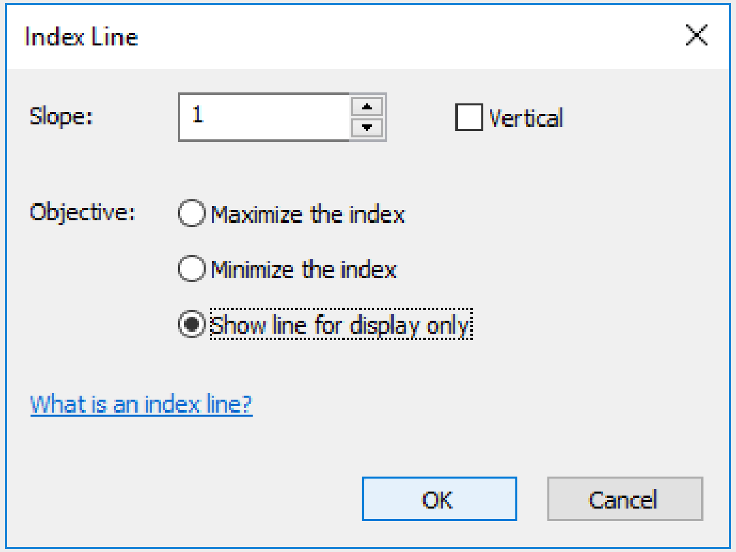


Add **boxes** and **lines**

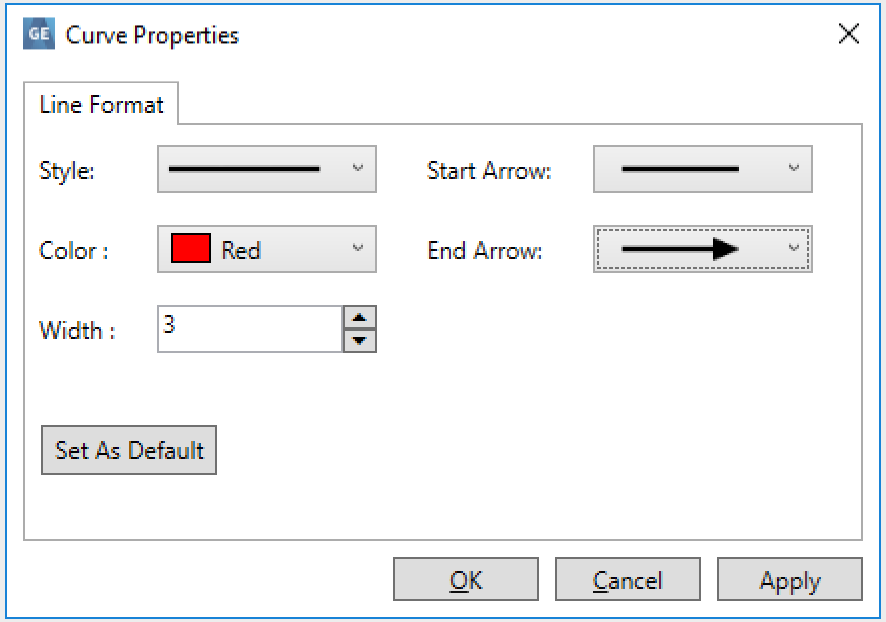
Add **text** to chart

Display **curves** and **arrows**

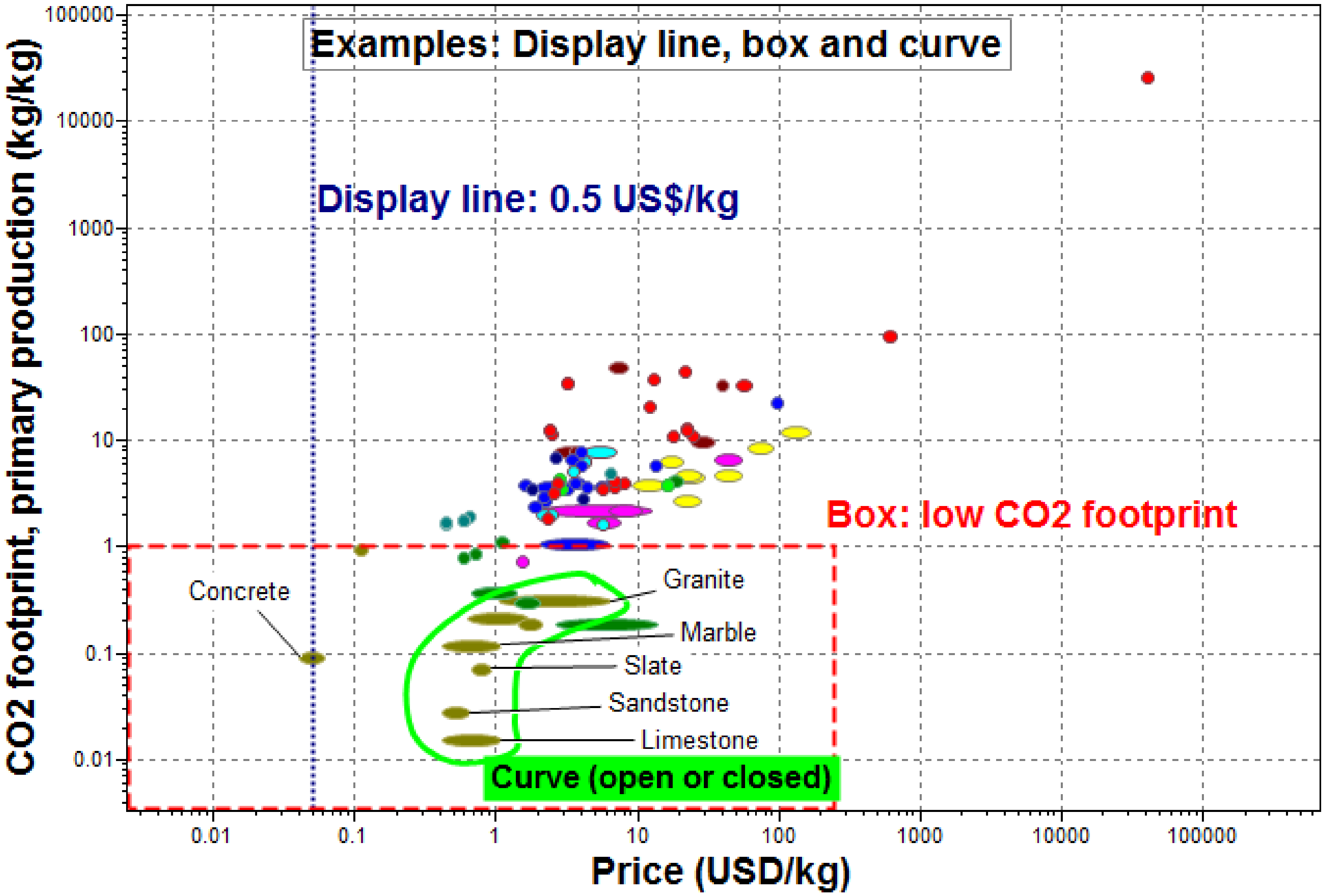
For annotation, select display only:



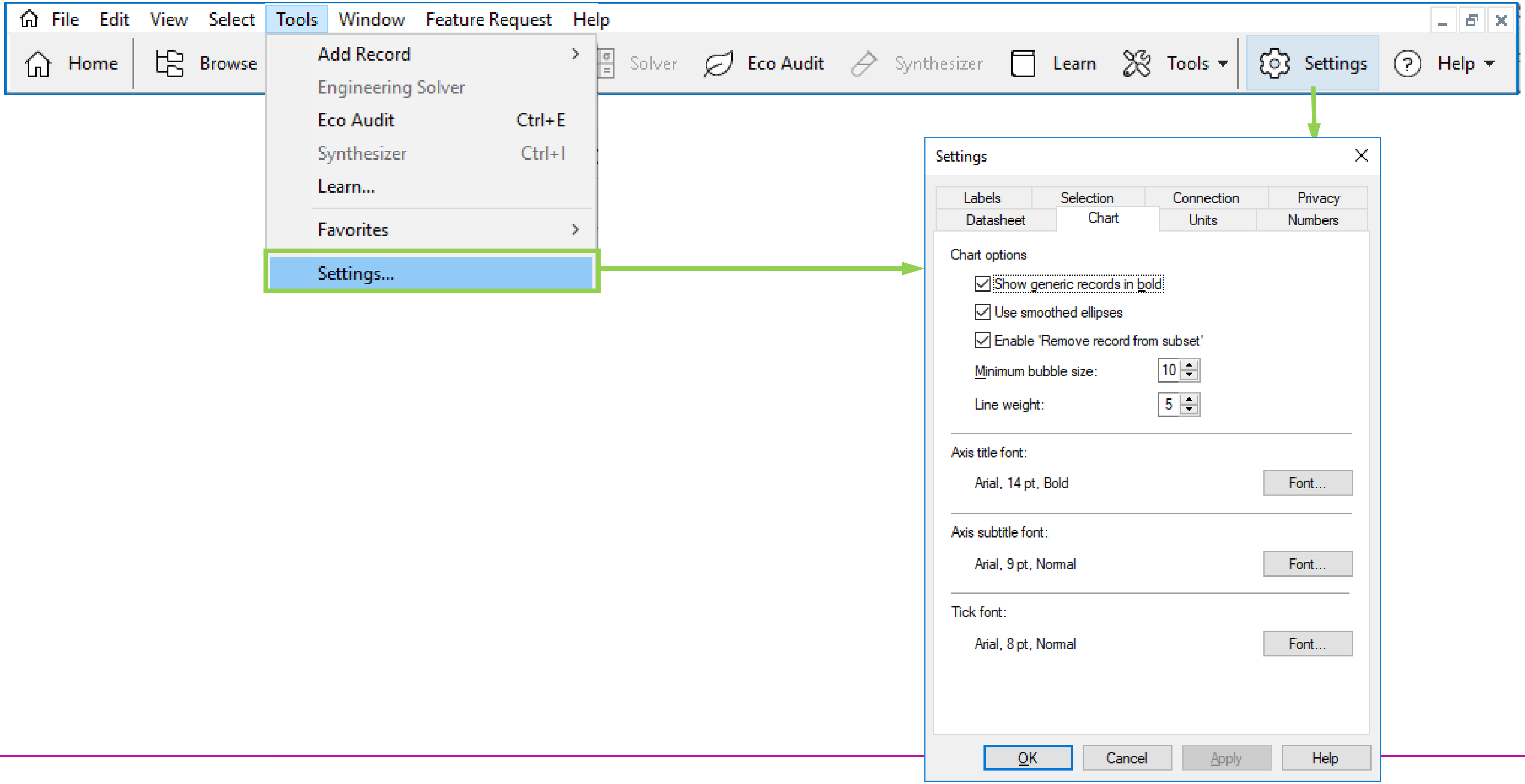
Right-click on line, box or curve to format:



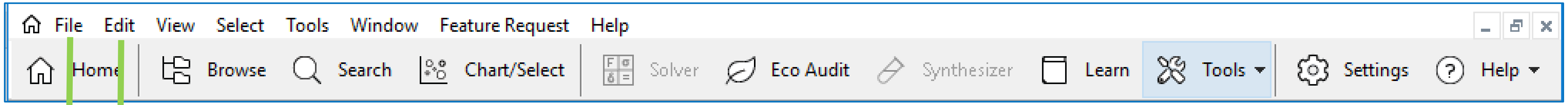
Annotation tools in charts



Changing the Chart settings (labels etc.)



Saving projects, report writing



Open project

Save

Print

Cut

Copy

Paste….

Clip-board

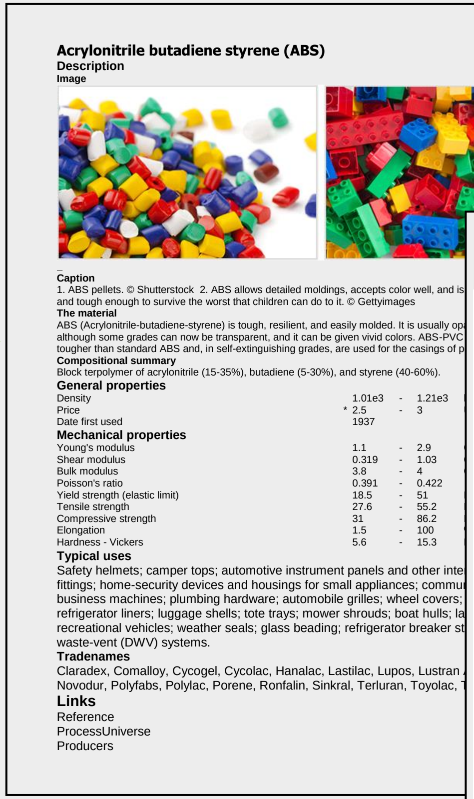
To WORD

For best results

Paste Special -

Device Independent Bitmap.

Paste



Acrylonitrile butadiene styrene (ABS)

Description

Image

Caption

1. ABS pellets. © Shutterstock 2. ABS allows detailed moldings, accepts color well, and is
and tough enough to survive the worst that children can do to it. © Gettyimages

The material

ABS (Acrylonitrile-butadiene-styrene) is tough, resilient, and easily molded. It is usually op
although some grades can now be transparent, and it can be given vivid colors. ABS-PVC
tougher than standard ABS and, in self-extinguishing grades, are used for the casings of p

Compositional summary

Block terpolymer of acrylonitrile (15-35%), butadiene (5-30%), and styrene (40-60%).

General properties

Density	1.01e3	-	1.21e3
Price	* 2.5	-	3
Date first used	1937		

Mechanical properties

Young's modulus	1.1	-	2.9
Shear modulus	0.319	-	1.03
Bulk modulus	3.8	-	4
Poisson's ratio	0.391	-	0.422
Yield strength (elastic limit)	18.5	-	51
Tensile strength	27.6	-	55.2
Compressive strength	31	-	86.2
Elongation	1.5	-	100
Hardness - Vickers	5.6	-	15.3

Typical uses

Safety helmets; camper tops; automotive instrument panels and other inte
fittings; home-security devices and housings for small appliances; commu
business machines; plumbing hardware; automobile grilles; wheel covers;
refrigerator liners; luggage shells; tote trays; mower shrouds; boat hulls; la
recreational vehicles; weather seals; glass beading; refrigerator breaker st
waste-vent (DWV) systems.

Tradenames

Claradex, Comalloy, Cycogel, Cycolac, Hanalac, Lastilac, Lupos, Lustran
Novodur, Polyfabs, Polylac, Porene, Ronfalin, Sinkral, Terluran, Toyolac, T

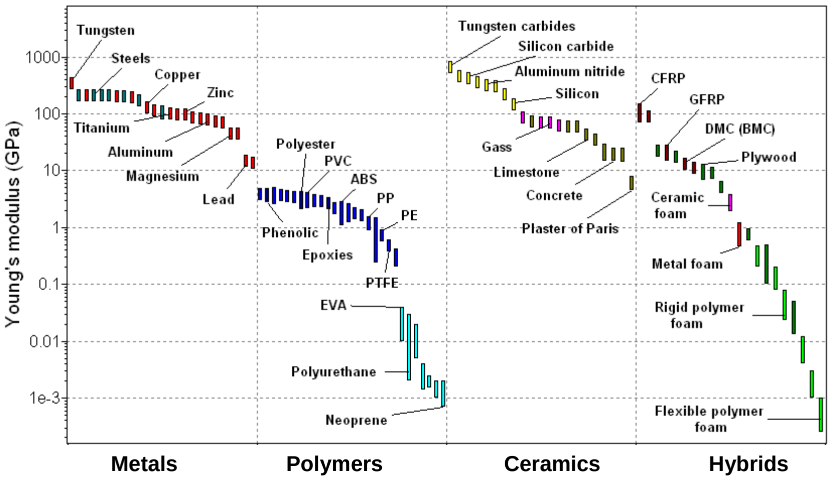
Links

Reference

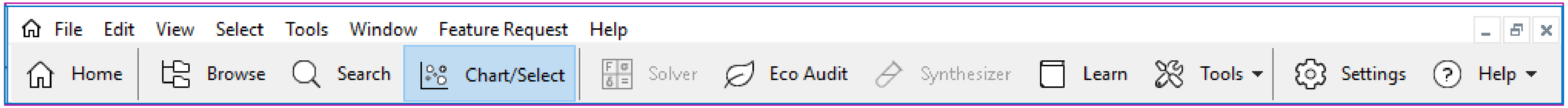
ProcessUniverse

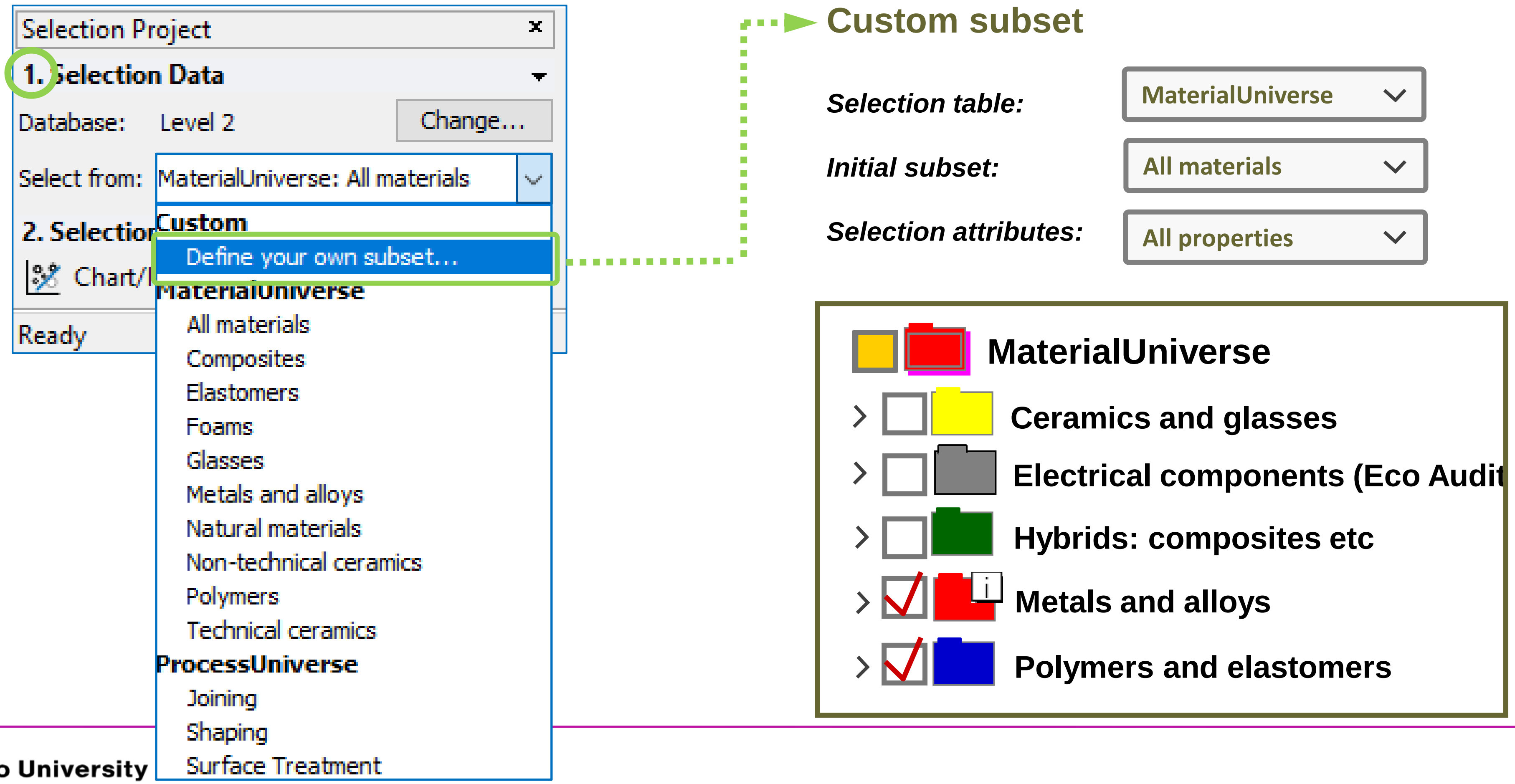
Producers

Copy - Paste

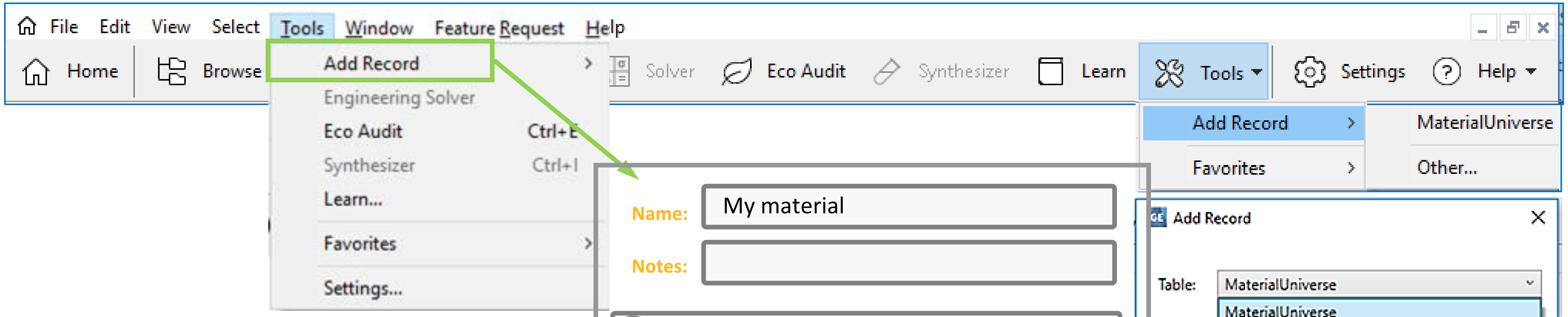


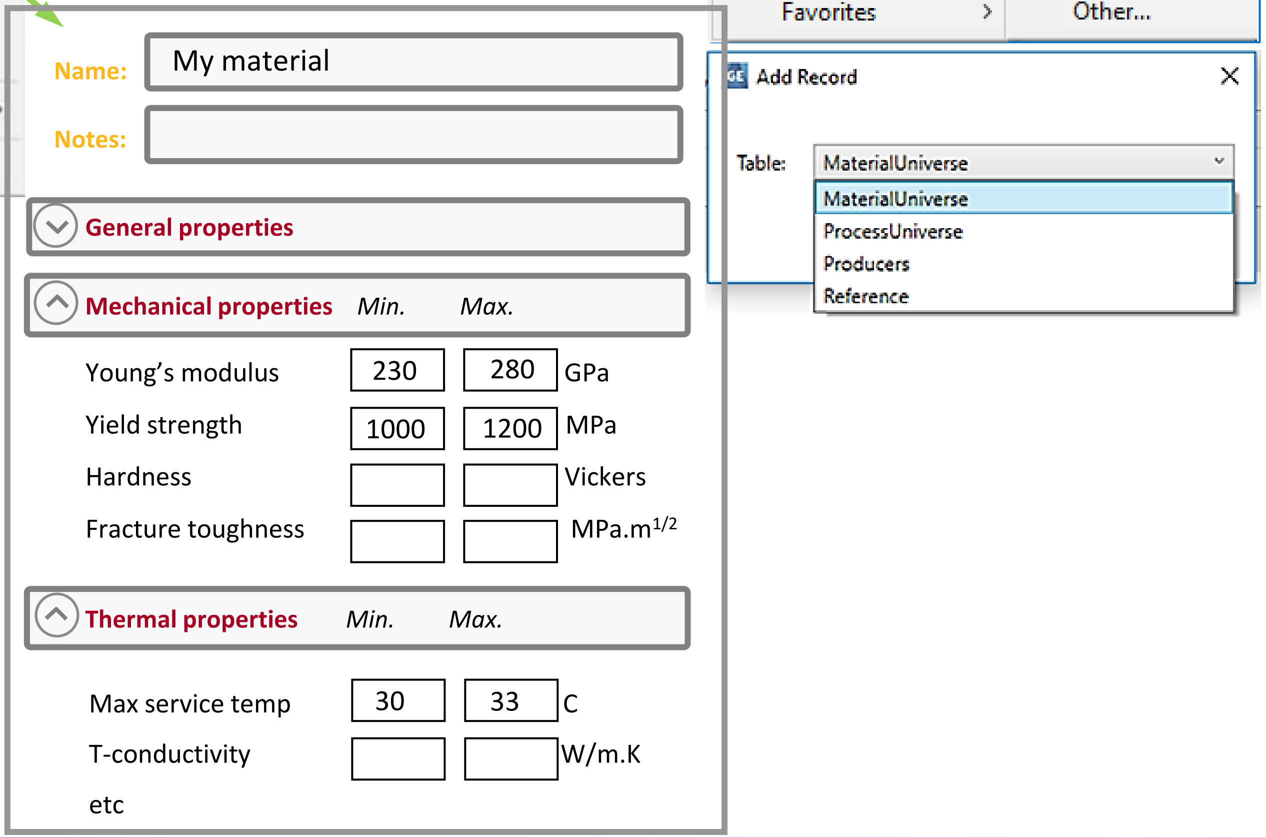
Custom subsets



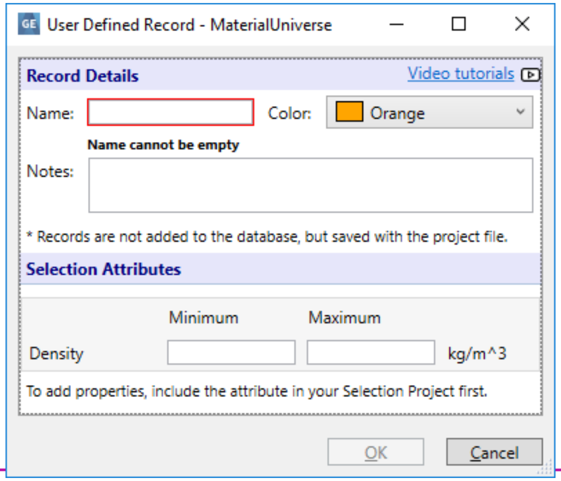


Making your own records

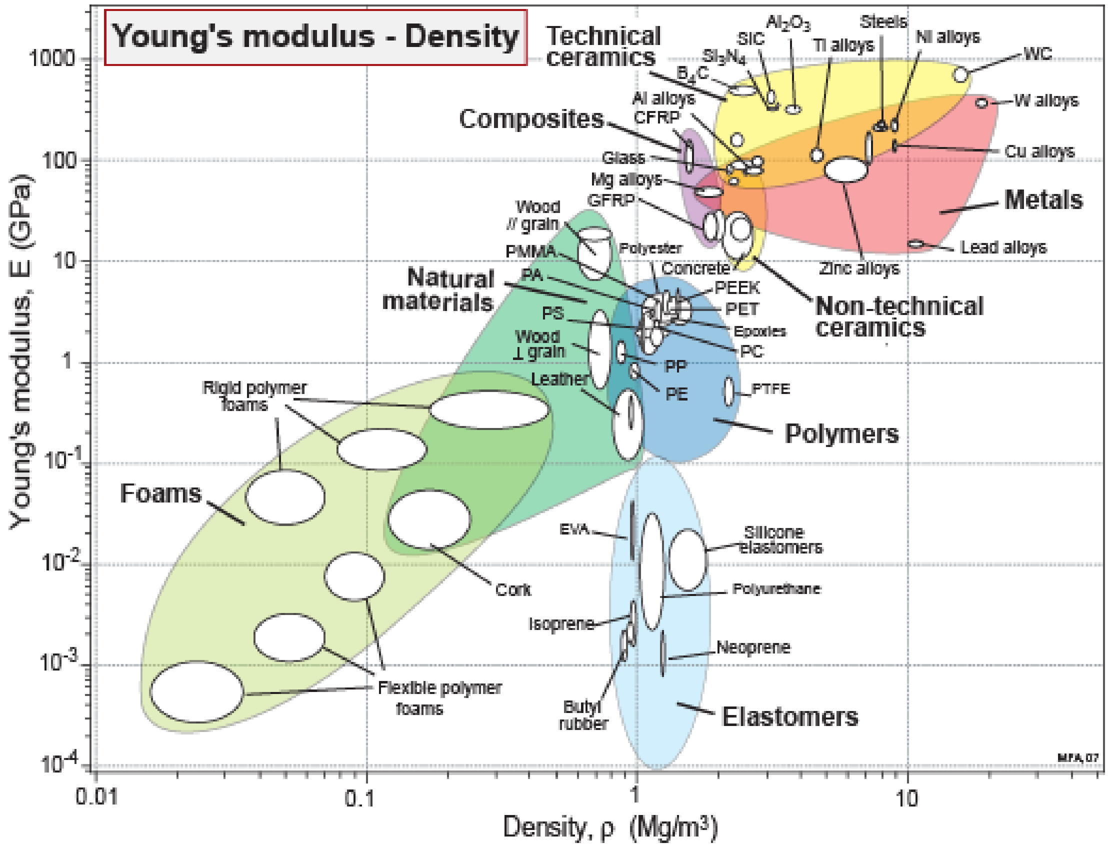




Or, right click on a chart to add limited data to it…



Selection procedure



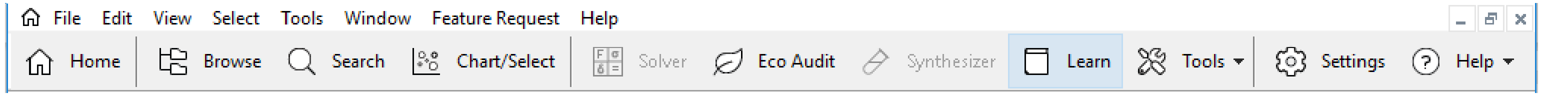
- Translation: deriving material index
- Screening: applying attribute limits
- Ranking: indices on chart
- Documentation

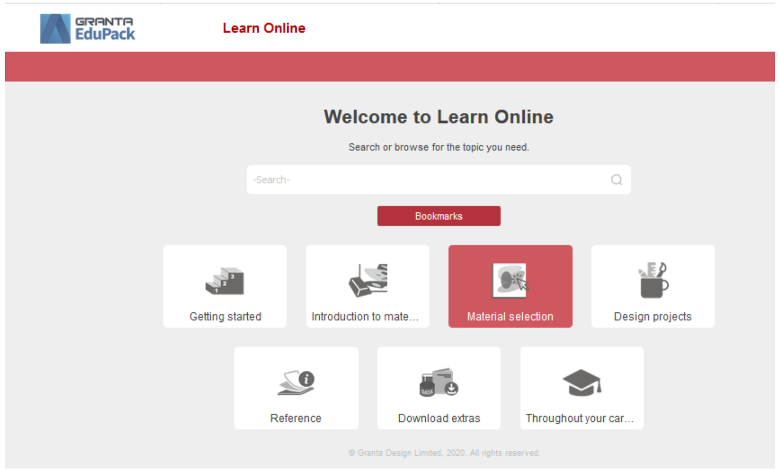
Material index

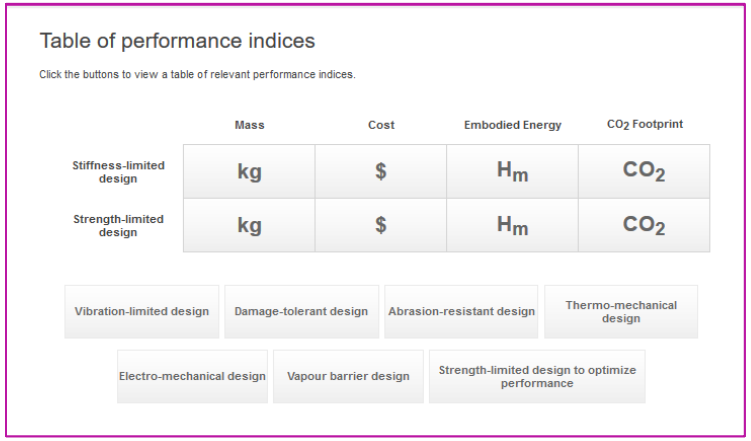
Component performance is limited by either:

- one single material property **e.g. tensile strength**, $\boxed{\sigma_{ts}}$
- a group of material properties. **modulus / density**, $\boxed{E / \rho}$

material index
for the design



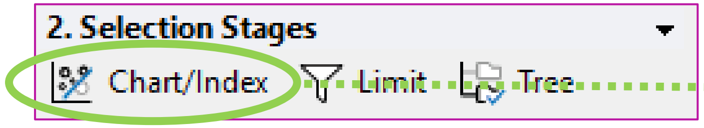


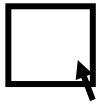


To maximize performance:

- First apply all **constraints**
- Then select materials with the **extreme index**

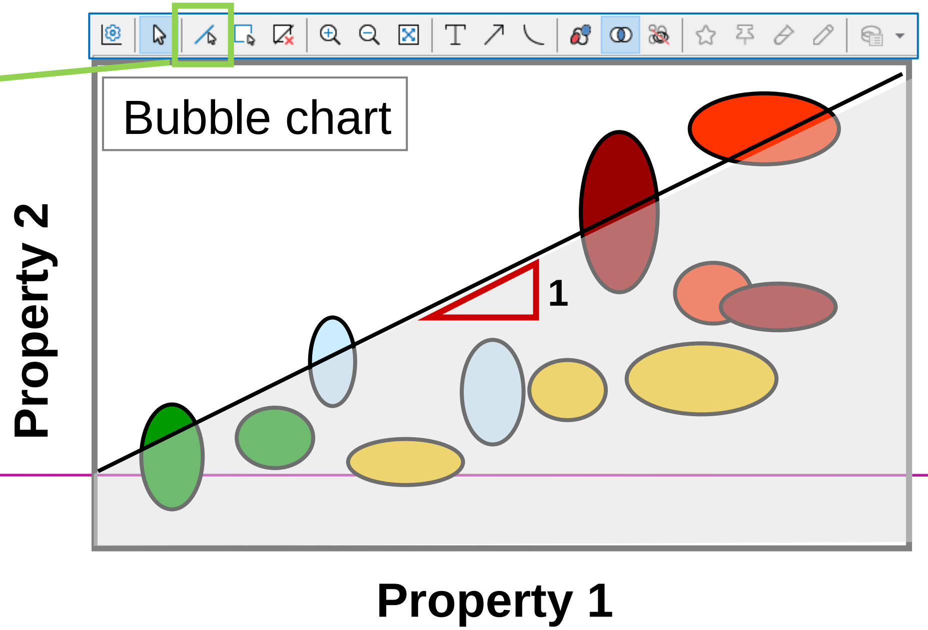
Screening with a CHART STAGE





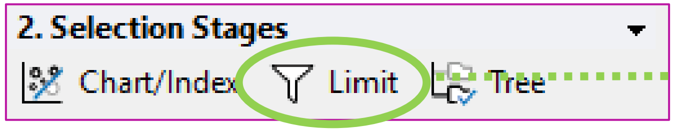
Box selection tool

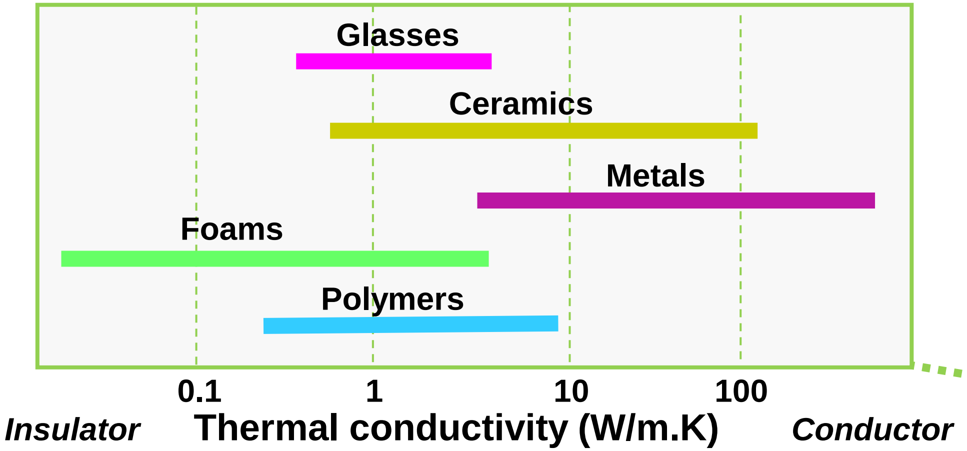
Line/gradient selection tool

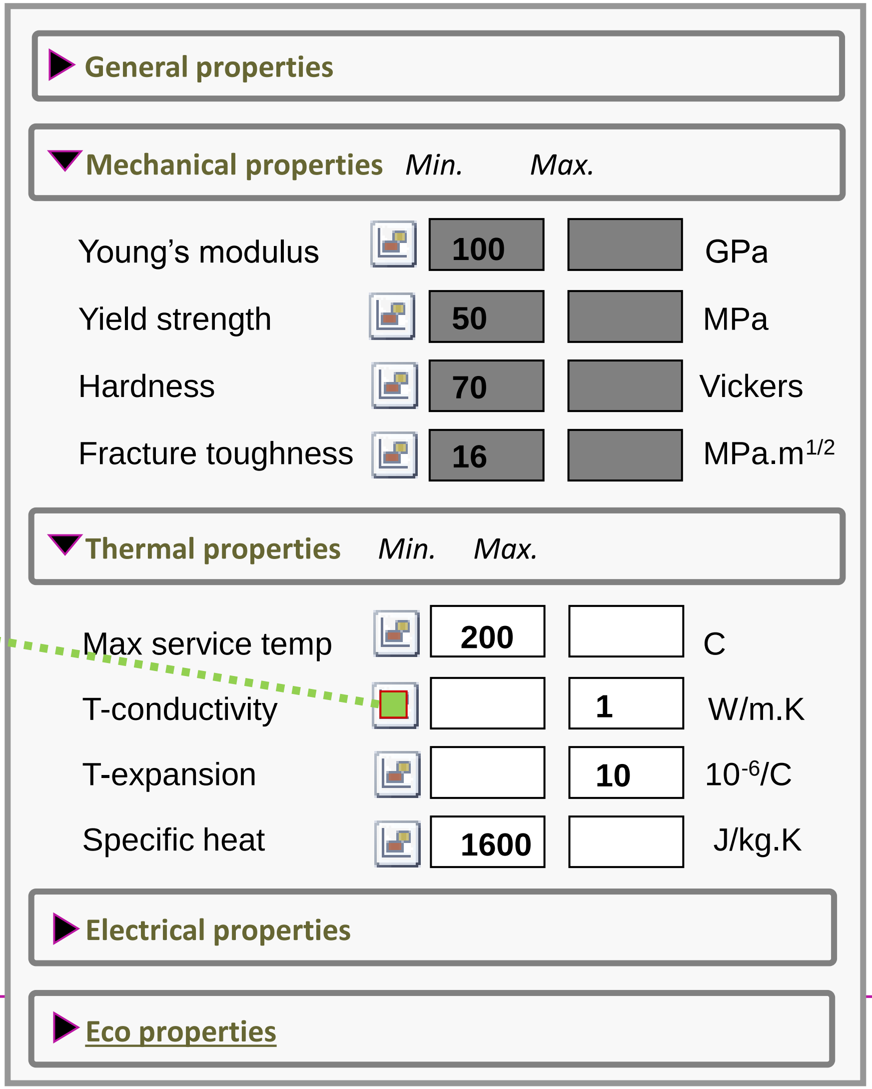


Results	***Ranking***	
X out of 100 pass	***Prop 1***	***Prop 2***
Material 1	2230	113
Material 2	2100	300
Material 3	1950	5.6
etc...		

Screening with a LIMIT STAGE

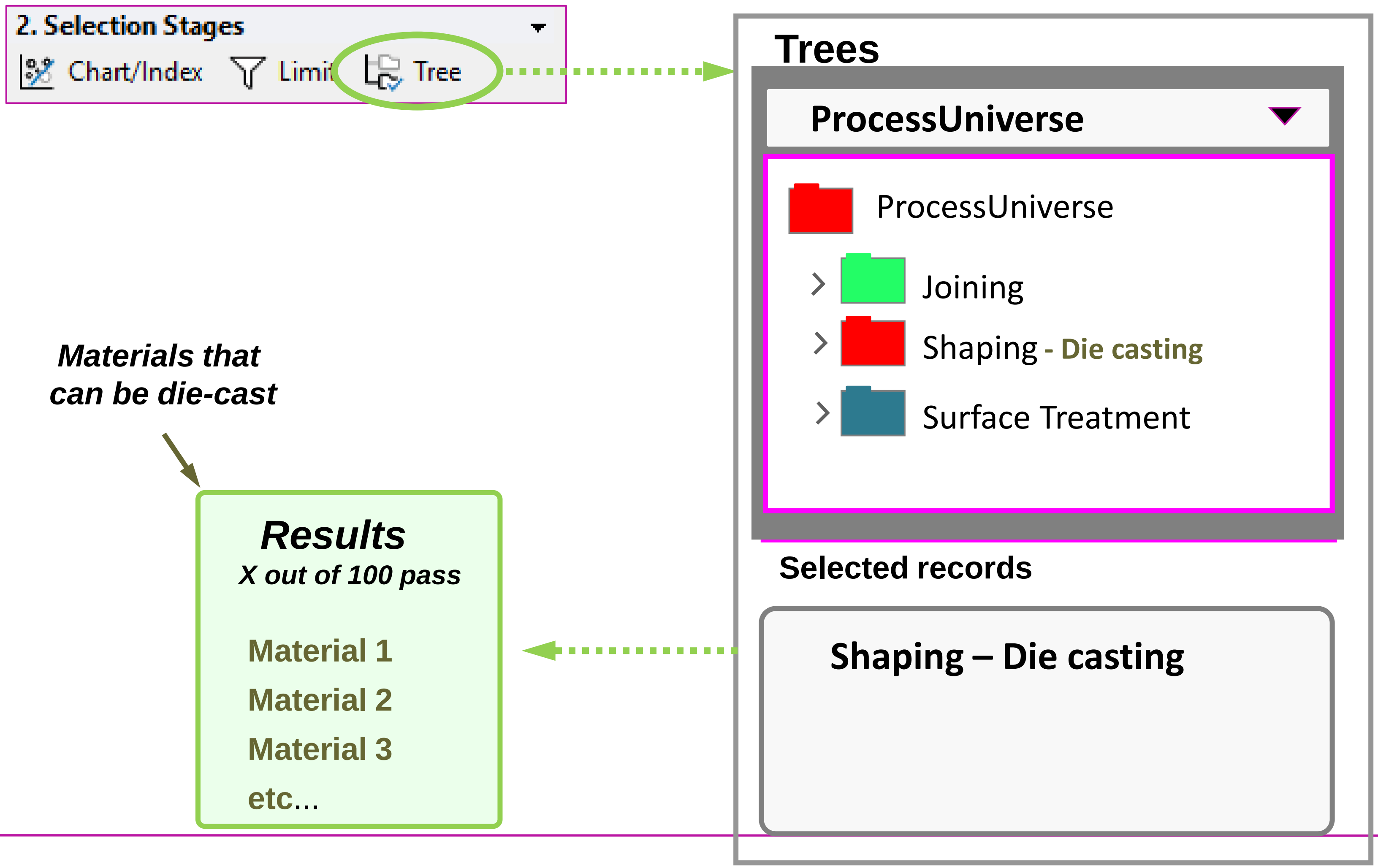






Results	***Ranking***	
X out of 100 pass	***Prop 1***	***Prop 2***
Material 1	**2230**	**113**
Material 2	**2100**	**300**
Material 3	**1950**	**5.6**
etc...		

Screening with a TREE STAGE



Ranking, using charts

Light stiff beam:

Index $\quad \mathbf{M} = \dfrac{\mathbf{E^{1/2}}}{\boldsymbol{\rho}}$

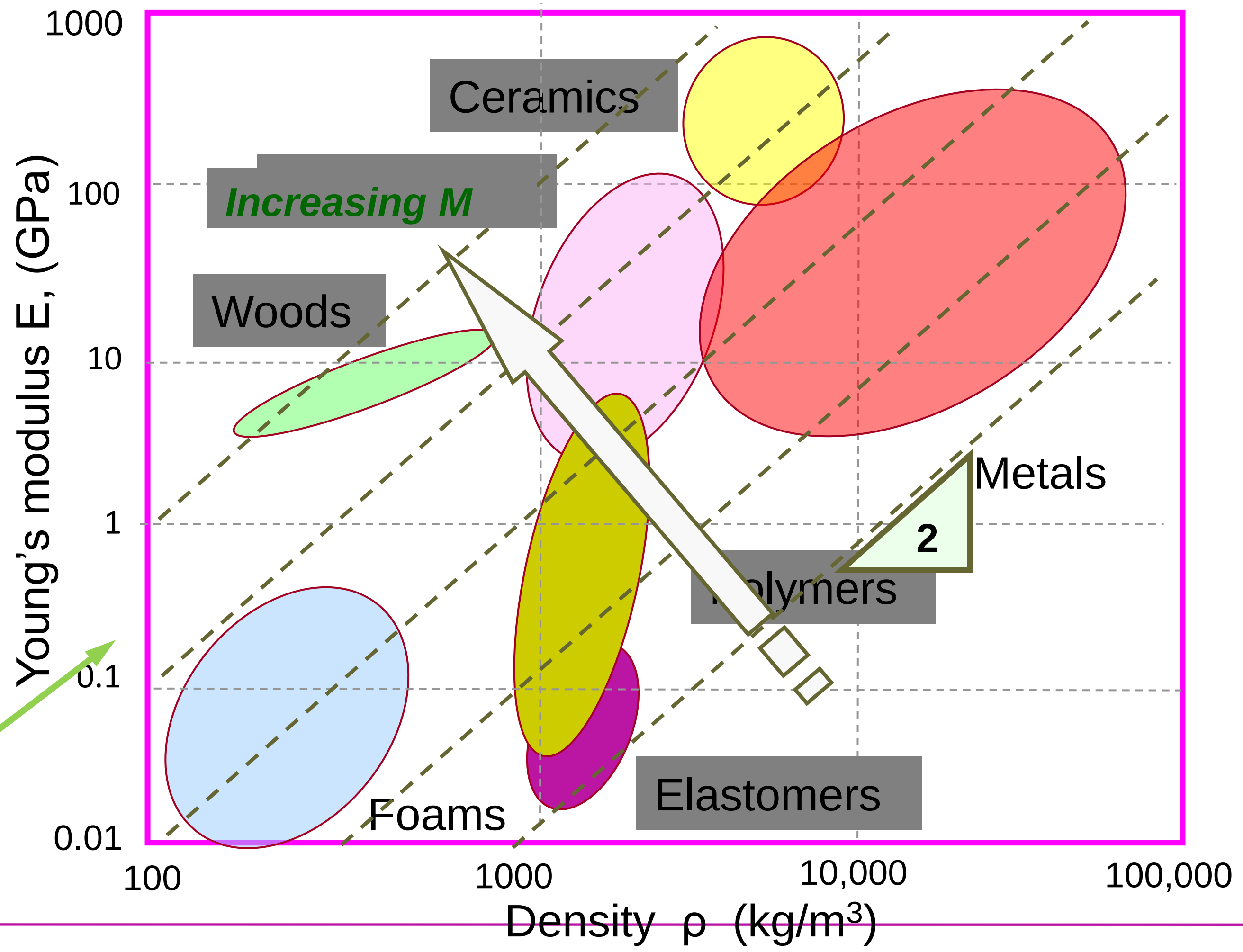
Rearrange:

$$E = \rho^2 M^2$$

Take logs:

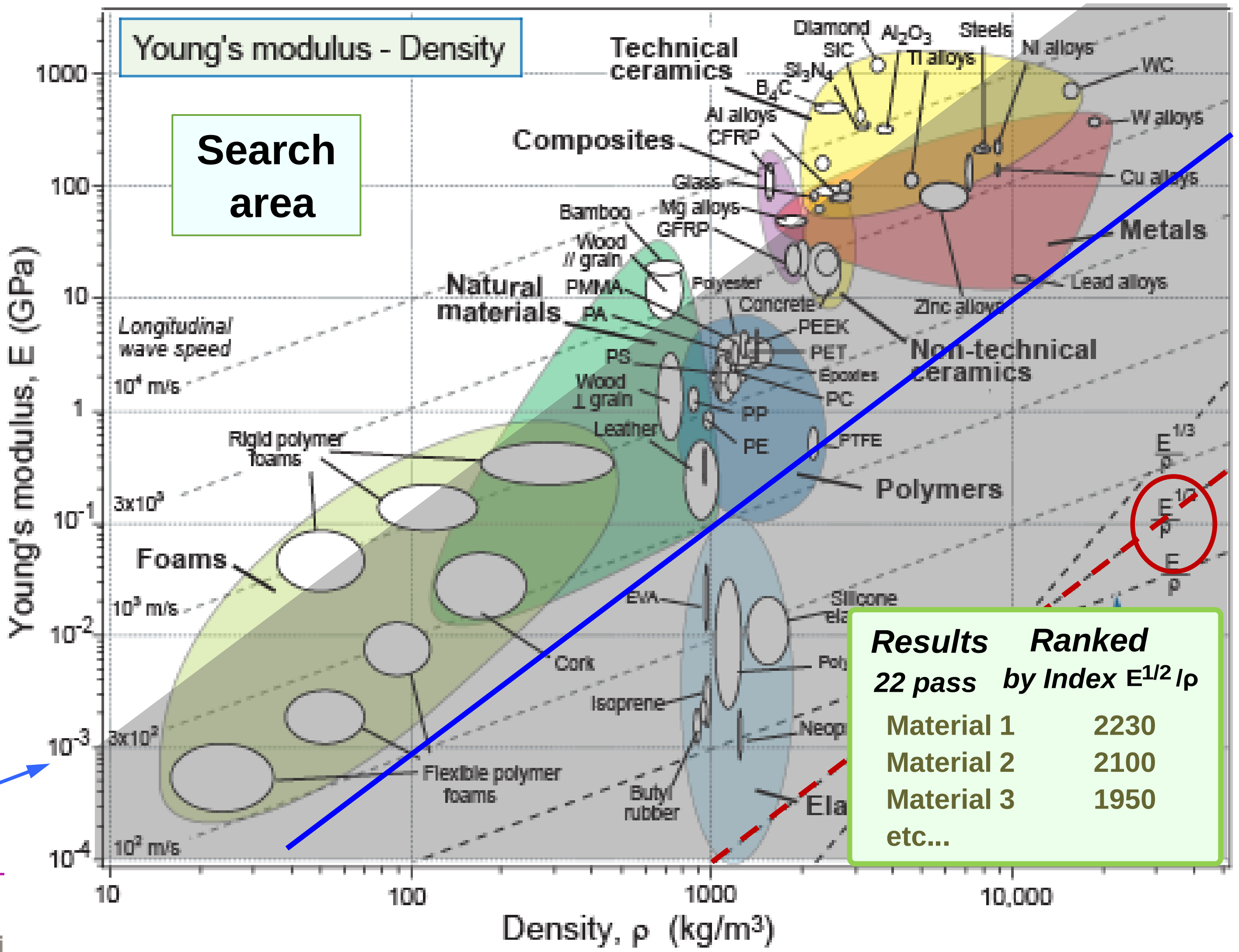
$$\text{Log } E = 2 \log \rho + 2 \log M$$

Function	*Index*	*Slope*
Tie	E/ρ	*1*
Beam	$E^{1/2}/\rho$	*2*
Panel	$E^{1/3}/\rho$	*3*



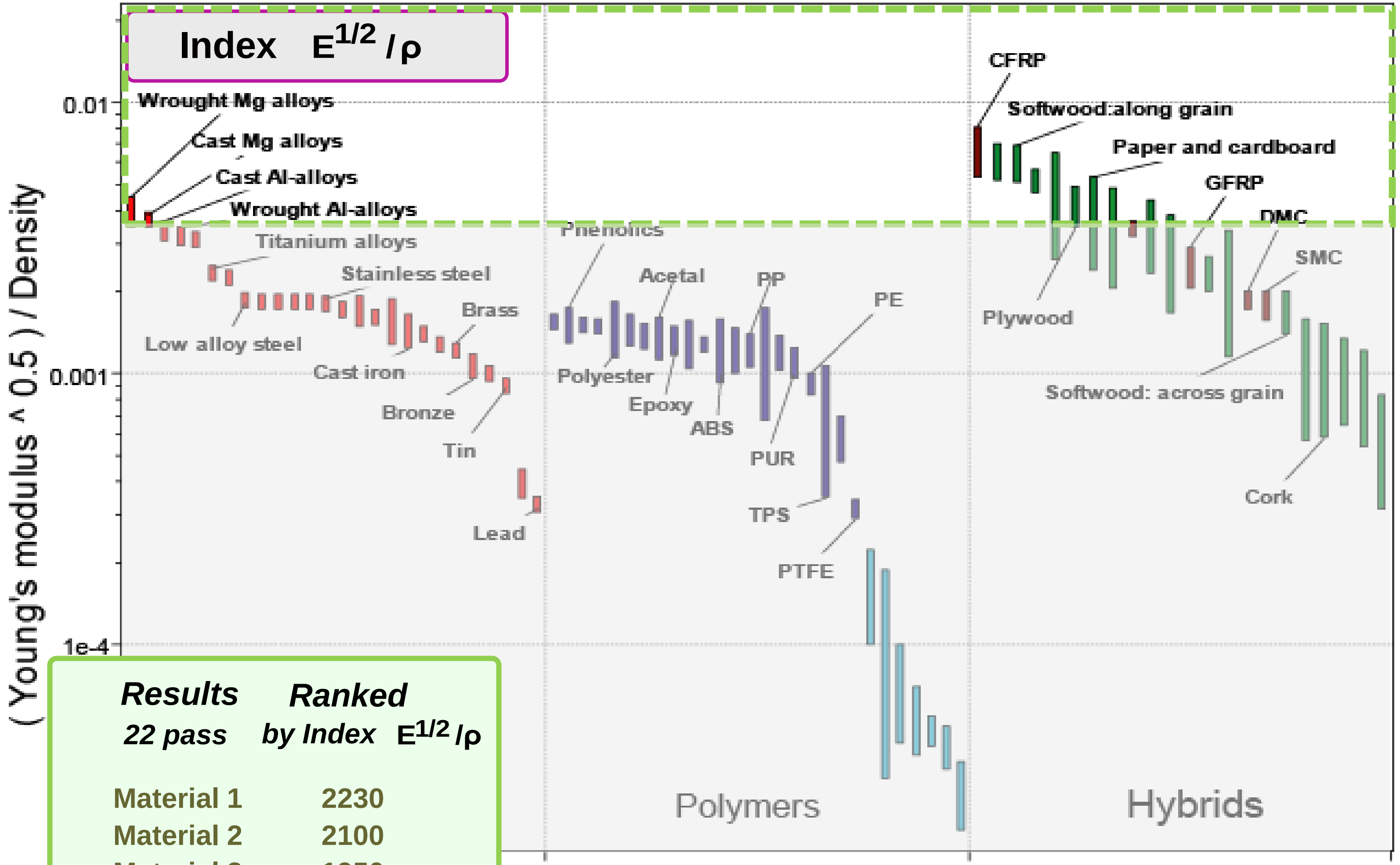
Selection using index in a bubble chart

$$\frac{E^{1/2}}{\rho} = M$$



Results	*Ranked*
22 pass	*by Index* $E^{1/2}/\rho$
Material 1	2230
Material 2	2100
Material 3	1950
etc...	

Selection using index directly on chart axis



Results ***Ranked***

22 pass *by Index* $E^{1/2} / \rho$

Material 1	2230
Material 2	2100
Material 3	1950
etc...	

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Task 1

Selection basics

Task 1.1: Read the case study 6.2 "Materials for Oars" from the textbook.

Now follow the same method to choose one material from the material group listed below for a wind turbine blade. In the simplest case, the blade is a beam in bending. It should be as light as possible and have a given bending stiffness.

- First, define the **design requirements** in a table, including functions, constraints, objectives, and free variables, etc.
- Secondly, derive the formula for the material performance index from the performance objective. Note that the **derivation** (step-by-step) of the material performance index **must** be included in your report.
- Then draw the **maps** with level 2 and explain what the correct material **selection lines** are for this task.

Hint: Draw the Material Selection Maps on level 2 with density and Young's modulus as axes.

Composites	Plastics
Foams	Non-technical ceramics
Metals	Technical ceramics
Elastomers	Natural materials

Task 1.2: Draw the maps from Task 1.1 on level 3. What differences do you notice? Give a detailed description based on your observation.

Summary

- **Material property charts** gives meaning to data
- You can **visualize** any database, and **add your own records**
- **Data** → **Visualization** (understanding the data) → **Selection** (using the data)