The goal of this project is to obtain new and simpler proofs of several known results in time-frequency Analysis, and to extend these results in some new directions.

Signals encountered in mathematical research, as well as in realistic situations, are often quite complicated. Therefore, the need to decompose a function, or approximate it, in terms of "simply structured" functions is common in pure mathematical research as well as a large body of its applications. In time-frequency Analysis we work with systems of "simply structured" functions called Gabor systems: Given $g \in L^2(\mathbb{R})$ and $\Lambda = \{(\lambda_n, \mu_n)\}_{n\in\mathbb{Z}} \subset \mathbb{R}^2$ the Gabor system $G(g,\Lambda)$ is defined by,

$$G(g,\Lambda) := \{e^{2\pi i\lambda_n t} g(t-\mu_n)\}_{(\lambda_n,\mu_n)\in\Lambda}.$$

(these systems are obtained by translating a single function g both in time and in frequency).

We will study the connection between the structure of Λ and the properties of the Gabor system $G(g,\Lambda)$, for example, the ability to approximate every function in $L^2(\mathbb{R})$ by linear combinations of function from $G(g,\Lambda)$ in a "good" way.

Prerequisites: introductory level courses in Fourier Analysis and in the theory of Hilbert spaces (including bounded linear operators).