# Research Statement

My research area is the representation theory of algebras, which deals with the structure of the categories of modules or the derived categories of algebras. I studied two subjects. 1. Construction of tilting objects of preprojective algebras. 2. Introducing mutation theory of Noetherian algebras and classification of torsion classes.

**1. Tilting objects of preprojective algebras**

A quiver $Q$ is a directed graph. For a field $K$, a quiver representation is obtained by putting a $K$-vector space at each vertex of $Q$ and by putting a morphism at each edge. The quiver representation is fundamental, since the module category of any finite dimensional algebras with global dimension one is equivalent to the category of the representations of some quiver. The preprojective algebra $\Pi(Q)$ of $Q$ was introduced to study all orientations of the underlying graph of $Q$.

In my research, I constructed a tilting object in the graded singular category associated to a preprojective algebra. Let $Q$ be a quiver. For an element $w \in W_Q$ of the Coxeter group $W_Q$ of $Q$, by using the preprojective algebra $\Pi = \Pi(Q)$, we have two triangulated categories, the singular category $\mathbf{D}_{\mathrm{sg}}(\Pi, w)$ and the graded singular category $\mathbf{D}^{\mathbb{Z}}_{\mathrm{sg}}(\Pi, w)$. Constructing tilting objects in a triangulated category is an important problem, since they induce triangle equivalences between triangulated categories. Because of my result, we can study $\mathbf{D}_{\mathrm{sg}}(\Pi, w)$ via the derived category which is equivalent to $\mathbf{D}^{\mathbb{Z}}_{\mathrm{sg}}(\Pi, w)$.

**2. Mutation theory and torsion classes of Noetherian algebras**

Mutation of tilting modules was introduced during last two decades in order to construct a new tilting module from a given one. Adachi-Iyama-Reiten introduced silting modules, which are generalization of tilting modules, to complete mutation of tilting modules over Artinian algebras.

Let $R$ be a commutative Noetherian ring. An $R$-algebra is called a Noetherian algebra if it is finitely generated as an $R$-module. I provided mutation theory of silting modules of Noetherian algebras. If $Q$ is an extended Dynkin quiver, then $\Pi(Q)$ is a Noetherian algebra. In this case, in joint work with Yuya Mizuno (Osama Metropolitan University), we classified silting modules via Coxeter group $W_Q$.

In joint work with Osamu Iyama (The University of Tokyo), we classified torsion classes of the modules categories of Noetherian algebras. Our result recovers Gabriels classification of Serre subcategories for commutative Noetherian rings.