Compositional modeling as a method of study the architectural heritage in educational design

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Abstract. The article presents the methodology of the authors' work with first-year students of architectural specialties INRTU on the topic of the course project "Compositional Analysis of an Architectural Object". This methodology is based on the search for analogies as a system of regularities that makes it possible to recreate plastic models and architectural drawings of lost temples. The result of this work was the creation of models for the museum of the Irkutsk customs. It was recreated as separate buildings and structures, and 19th century customs quarter with Chudotvorskaya church - the lost monument of architecture 18th – 19th centuries. Further research was related to the study of the complex Siberian Baroque temples in Irkutsk and various types of church architecture in the mid-18th - early 20th centuries. The article is illustrated with graphic and model research of the architectural composition of architectural monuments various types and historical periods. The main stages of the course project are presented from the construction of functional planning and volumetric models to the design of the figurative and structural characteristics of the object in the presentation of the tablet. There is also shown the comparison of models for the evolution of an individual temple and analogs.

The purpose of this publication is to show possible approaches for the participation of students in the study of the architectural heritage of Irkutsk in models and drawings. The article shows fragments of the teacher’s design and research work using the results of student’s compositional modeling. The object of research is the ensemble of monuments of temple architecture in Irkutsk XVIII - early XX centuries.

Since the beginning of the XVIII century in the architecture of Orthodox churches in Irkutsk, the regional trend of the Baroque style, which was called "Siberian Baroque", has become widespread. The Irkutsk school is of great interest in the development of this architectural style. The temples, built in a relatively short time, transformed the historical center of Irkutsk into an urban ensemble with an expressive silhouette and high-rise dominants of the temples, located in the main compositional and town-planning nodes. Initially laid down relative freedom, flexibility and variability in the volumetric-spatial composition of the temples, determined the harmonious integrity of the ensemble in subsequent eras, including the beginning of the XX century.

Three main periods can be distinguished in the evolutionary formation of the temple ensemble. 1. XVIII - early XIX century in the panorama of the city was dominated by tiered bell towers under spiers, completed with onion domes and cubic volumes of temples with domed completion. Open porches and
galleries were an integral part of the temple and its connection with the surrounding landscape. During this period, there was a rapid development of the original directions of the Siberian Baroque school in Irkutsk. 2. The influence of classicism spread by the middle of the XIX century and was reflected in the reconstruction of the vestibules with elements of the classics. From the second third of the XIX century, the ensemble was dominated by tiered bell towers under a dome with onion domes. The galleries and porch are replaced by a stone vestibule. The transition from baroque to classicism led to the transformation of churches in the spirit of modern times. 3. In the late 19th - early 20th centuries, the pseudo-Russian and Russian-Byzantine styles changed. In the architecture of churches of the second half of the 19th century, new forms were established, traditional for Old Russian architecture and Russian-Byzantine architecture as symbols of the national spirit. In the forms of Old Russian architecture, the Prince Vladimir Church (1888-1895). The Kazan Cathedral (1875-1894, lost) is being built in the Russian-Byzantine style - a new major dominant in the city's panorama, which has subdued the temple ensemble. The architectural style of the second half of the XIX - early XX century is defined as eclecticism or historicism. In the Vladimir Church (1775–1790, partially lost), at the end of the XIX century, instead of a porch, an eclectic porch was created, combining ancient Russian architecture and classical elements [1, p. 111]. As an example of a Roman Catholic religious building in Irkutsk, the Church of the Assumption of the Virgin Mary (called the Polish Church) in the neo-Gothic style was built in 1885.

In subsequent years with the growth of the city the town-planning ensemble of temples broke up into local ensembles in the system of the historical center which became an integral part of the cultural and public space. The work of restorers returned the lost forms to each surviving monument of religious architecture and emphasized individuality. Thus, in the Trinity Church, the classic four-column portico was removed as a typical and alien element of early extensions. The perspective portal in the style of the facade decoration of the temple has been restored. In 1985 according to the project of G.G. Oranskaya the hipped roof of the bell tower of the Epiphany Cathedral was recreated. After restoration (1960s –1980s) the Church of the Savior lost its northern aisle which built in 1777. In a dense urban environment, it became necessary to contrast the decor of initially white-stone churches with the help of color (Cathedral of the Epiphany, Holy Cross Cathedral).

Evolutionary transformation in the architecture of the temple, representing a subject image, is a model of the worldview of a particular era, its cultural texts, symbolic heritage, the knowledge of which corresponds to the process of spiritual improvement of man and society. The authors previous publications are devoted to the study of the cultural and historical space in the structure of the city and the principles of compositional organization of public spaces [2, 3, 4].

Studying the architectural composition, the students turned to different periods of the development of the temple ensemble, depending on the tasks set and the availability of design material. The tasks of the teachers included the restoration of architectural drawings of the lost heritage. The following methods of work were used to solve them: comparative analysis of the functional planning structure, the evolution of the object in the plans and facades, volumetric composition, identification of proportional analogy, graph-analytical study of photographic materials. Subsequent design developments were carried out by the author in computer graphics and were a version of orthogonal drawings, which were used in educational design to build compositional models and approbation of research results.

The result of many years of painstaking work on the analysis of iconographic and archival information, comparison of historical photographs and drawings of artists, study of panoramic views in order to see the future facades of the lost temples was the restoration of architectural drawings of the Chudotvorskaya Church (three evolutionary periods), the creation of the first version of orthogonal drawings of the Tikhvin and Annunciation churches. This work was carried out with the participation of students. The results of the research on the Chudotvorskaya and Tikhvin Churches were published in previous editions [5, 6, 7].

Features of the approach to compositional analysis

1. Each temple is considered as an integral part of the town-planning ensemble and in relation to the surrounding landscape.
2. In the study of the temples of the Siberian Baroque, the stages of the evolutionary formation of the temple and the options for its architectural transformation are revealed.

3. To restore the architectural appearance of the lost temple, the method of analogy is used. The temple is considered in the system of similar monuments, their stylistic commonality and unique difference are revealed.

4. Compositional modeling as a method for analyzing the architectural composition of a monument is the basis for scientific research of the architectural heritage and the restoration of what was lost.

    Compositional modeling technique. Composition is defined as the structure of an architectural work, the location of its main elements and parts in a certain system and sequence. Each model, made for educational purposes, solves not only compositional problems, but also is an important link in the system of cognition of the relationship of an object with analogs and its evolutionary change. At the same time, two types of models are distinguished: search models containing a description of a particular quality of an object, or its transformation; and demonstration, fixing a certain state of the object, with an approach to its architectural appearance.

    The following topics of compositional modeling are distinguished: the functional structure of the plan, the plastic structure of the volumetric form, the compositional features of the facade, the analysis of the proportions of the plan and the facade, the construction of volumetric-spatial models, the compositional relationship with the place. The presentation of the project includes all the main models of the object with the identification of its imagery and compositional connection with the place.

    This publication is not intended to show the entire compositional analysis process. The article presents examples of use the compositional models created by students in a comparative analysis of a temple ensemble.

    Functional planning models

    Purpose of the assignment: study of the functional structure of the object plan for a comparative analysis of the planning composition. The task was to identify the main functional elements of the object structure plan in color graphics.

    Comparative analysis allows us to identify the compositional features of various types of temples (ship, basilica and cross-domed), continuity and differences in the functional planning organization (Figure 1). Figures 1a - 1e compare plans of baroque churches in Irkutsk in the 18th - early 20th centuries: Church of the Savior (1706 - 1713, bell tower in 1758) - the first stone church in the wall of a chopped prison has a longitudinal-axial compact plan shape; the Cathedral of the Epiphany (1718 - 1746) has a more developed planning composition and represents the type of a multi-sided temple; The Chudotvorskaya Church (1748 - 1765, lost) represents the initial period of the creation of a local school of Siberian Baroque in Irkutsk; Vladimir Church (1777 - 1780, partially lost) represents the final Baroque period in Irkutsk; Trinity Church (1763 - 1775) as an example of a monument of the Siberian Baroque, preserved in its original form.

    The functional structure of the plans corresponds to the Orthodox canon. According to the church hierarchy, the ship type of the church is divided into three parts: the altar - the main sacred part of the temple; temple (middle part) - the area of heavenly existence; porch (or meal) - the area of earthly existence. The entrance to the vestibule from the street is usually arranged in the form of a porch - a platform in front of the entrance doors, to which there are several steps that raise the temple (external vestibule). In the XVIII century, it was customary in Irkutsk churches to build a high porch (covered or without a roof) to rise to the second floor. A covered gallery-gulbische (terrace) connected the entrances of the upper chapels with external staircases. Each side temple had its own connection with the outer space from the west, as a separate church. In the Church of the Savior, such a gallery encircled almost the entire church [8, p. 82]. In Figure 1e, the plan for the Church of the Savior corresponds to the project for the restoration of the northern porch with part of the gallery made by "Irkutsk Promstroyproyekt" [9]. In the Miracle-Working Church, a covered gallery adjoined from the west, an external grand staircase led to the upper church (Figure 1b).
**Figure 1.** Functional planning models of Irkutsk churches of the 18th - early 19th centuries (performed by students of the group ARb-18-1): a - Cathedral of the Epiphany (performed by Solodova S.A.); b - Vladimir Church (performed by Chudnovskaja D.A.); c - Chudotvorskaya church (performed by Pundel I.A.); d - Trinity Church (performed by Novosartova A.E.); e - Church of the Savior (performed by Nosova E.V.); f - Prince Vladimir's Church (performed by Didenok A.A.); g - Kazan Cathedral (performed by Plyashechnik N.V.); h - Roman Catholic Church (performed by Chichigina A.S.).

Side-altars temples (adjoining or built-in) are important structural parts of an Orthodox church. Each side-altar consists of a middle section and an altar facing east. The plan of the Epiphany Cathedral demonstrates various options for adjoining the side chapels: to the quadrangle, to the refectory, as well as the arrangement of the chapel under the bell tower. A similar decision is also observed in the Chudotvorskaya church.

The composition of the plans traces a four-part structure characteristic of the churches of the Siberian Baroque - a vestibule with a bell tower, a quadrangle of a temple, an altar apse, as well as a refectory, which, according to church canons, is part of the vestibule, but stands out as an independent element that connects the vestibule with the quadrangle of the temple and its side-chapels.

The comparative analysis of the plans of baroque temples shows the variety of variations in the flexible planning composition. In the planning composition, there is a tendency of its development along the longitudinal axis from a freer asymmetric one in the first temples to axial symmetry in subsequent periods of development.

Figures 1f, 1h show basilic type plans. Polish Church (Figure 1h) - represents the basilical (hall) type of the temple. It originates from the early Christian basilica and in the late Gothic period it evolves into a hall type with an integral interior space and a compact volume. Three-part structure: narthex (narthex),
the temple itself, the altar. The altar part is highlighted by a transverse volume that reinforces the symbol of the Latin cross.

Prince Vladimir's Church (Figure 1f) is the only nave (hall) church among Orthodox churches in Irkutsk. In the plan, the compact rectangle is divided by pillars into 15 cells: 9 identical in the center and 3 narrower on the east and west sides. Three-part structure: porch (narthex), the temple itself, the altar. The Western scheme did not take root in its pure form for Christian churches and was reworked. The disadvantage of this scheme was the lack of a traditional Orthodox interior space and the inconvenience of placing additional side-altars. The plan demonstrates a more flexible option for developing the composition of the plan with additional extensions to the vestibule. The rectangular shape of the plan corresponds to the canons of the Christian church.

In Figure 1g, the cross-domed type represents the plan of the Kazan Cathedral. The plan is based on a combination of the canonical shapes of a rectangle and a cross. The centric compositional system is complemented by a longitudinal-axial one formed by a gallery and a distant perpendicular transverse volume of the vestibule with a bell tower.

**Volumetric composition in axonometric models**

Purpose of the assignment: preparation of illustrative information on objects for comparative analysis of volumetric plastic composition. Tasks: building an axonometric model of an object, identification of the volumetric shape in tonal graphics, in accordance with the orthogonal drawings of the object and scale proportions. Graphic design techniques should bring out the artistic quality of the 3D model.

Comparison of the volumetric composition of Irkutsk churches is presented in Figures 2. The models are not connected to the system by location but are shown in one scale to get an idea of the object’s scale. The common features and differences in the volumetric composition of various types of temples are also clearly traced: the ship-shaped (Figure 2a, 2c, 2d, 2f, 2g); basilical (Figure 2b, 2e); cross-domed (Figure 2h).

The ship-shaped temple type. The volumetric composition traces the functional structure of the plan. The formation of churches is strictly conditioned by the church canon. The visual image of the ship is expressed by a high mast-bell tower, sails-domes and altar apses, directed towards the sunrise. Means of compositional expressiveness of volumetric composition - dynamics and contrast and variability of different-height forms. The continuity of wooden temple building is traced - a high basement, "cellularity" in general, variations of combinations of four-eight, onion-shaped domes and the traditions of mansion architecture - each architectural volume stands out with a special completion, creating a dynamic multi-volume composition. The greatness and monumentality of the volumes, compactness and severity, the high basement floor are evidence of the continuity of the northern wooden temple building. The cubic quadrangle of the temple, the middle parts of the side-altars and the faceted apse are distinguished by domes and onion domes.

The five-domed completion of the temple was used only in important town-planning centers or to emphasize the cathedral status. The parish Vladimir Church (Figure 2c) had a five-domed completion, occupying an important urban planning position as a landmark of the Moscow highway. Initially, the quadrangle of the Cathedral of the Epiphany (Figure 2d) was crowned with five domes (until 1790), since it was immediately built as a cathedral church.

Basilical (hall) type of the temple (Figure 2b, 2e). The three-part structure of the plan is revealed by the volumetric forms of the narthex (narthex), the temple itself, and the altar. In the first example, the bell tower completes the western facade, towering over the narthex. In the second example, two more towers are attached to the narthex. The Prince Vladimir's Church has an unusual volumetric composition that has no analogues in the religious construction of Eastern Siberia. The core of the temple is a low volume between the altar and the bell tower, which does not have a domed completion, which is traditional for Orthodox church building. The dominant feature of the composition is a tiered tent-roofed bell tower above the narthex.
Figure 2. Comparison of the volumetric composition of Irkutsk churches in axonometric models: a - Holy Cross Cathedral (ARb -14-2 Karpovich S.D.); b - Roman Catholic Church (ARb-18-1 Petrova E.P.); c - Vladimir Church (DSb-16-2 Zhigunova A.Y.); d - Cathedral of the Epiphany (ARb -14-2 Danilova A.S.); e - Prince Vladimir's Church (ARb -18-1 Didenok A.A.); f - Church of the Savior (ARb -14-2 Krasikova K.V.); g - Church of the Sign (performed by student of the group ARb -18-1 Suhankina A.I.); h - Kazan Cathedral (ARb -18-1 Plyashechnik N.V).

The cross-domed type of the temple represents the Kazan Cathedral - a square-centered cross-domed church was built in accordance with the Russian-Byzantine tradition (Figure 2h). The basis of the structure of the cross-domed church is formed by a compact cubic volume with a pyramidal composition of five domes directed towards the central upper cross. The narthex with a bell tower is taken out of the side-altars of the temple and is connected with it by an extended gallery.

The axial continuation of the temple in the form of a gallery and a distant bell tower is not accidental. There are many meanings here. One of them is a tribute to tradition. This technique shows the continuity of the traditions of the first wooden temples, when the bell tower was built at a distance. Another idea is related to the urban planning situation and the problem of including a new dominant in the system of a historically established temple ensemble. The role of the Cathedral as the leading building of the ensemble is decided according to the principle of compositional contrast with the environment and the need for the subordination of contrasts. The proportionality of the bell tower and the temple with the high-rise dominants of the surrounding temple complex is an example of the interaction of the old and the new in the urban ensemble.

Facade modeling
When the restoration of the architectural appearance of a lost temple is limited to the final stage of its existence, there are many doubts about the shape of the object. Restoration of a complete picture of its evolutionary development, comparison with similar objects based on the analysis of historical continuity will help find answers to all the tasks.

Purpose of the assignment: preparation of illustrative information in comparison with analogs of different stages of the evolution of the object represented in the facade models. Tasks: to build a compositional model of the facade on a scale, to reveal the silhouette, the main articulation of cut-and-paste plastics or the planning of the frontal composition. Comparative analysis reveals the continuity in the evolution of objects and individual differences.

**Figure 3.** Comparison of evolutionary stages in orthogonal models of the north and south facades: a - the original appearance of the Chudotvorskaya and Vladimir Church of the mid-18th - early 19th centuries (DSb-16-2 Morozova A.S.); b - Chudotvorskaya and Vladimir churches of the middle of the XIX century - 1870s (DSb-16-2 Kaverina E.Y.); c - restoration of the last stage of the evolution of the Chudotvorskaya Church in the 1880s - 1920s in the model of the northern facade (DSb-16-2 Alekseeva V.O); d - restoration of the last stage of the evolution of the Chudotvorskaya Church in the model of the southern facade (ARB-14-2 Kashpur A.I.).
Figure 3 shows a comparison of the periods of evolution of the facades of the Chudotvorskaya Church with the Vladimir Church, which is an analogue in this study, allowing one to compare on a scale the variants of the evolutionary transformation of the Miracle-Working Temple. Figure 3d compares the southern facade of this temple vertically with the southern facades of an analogue of different evolutionary periods.

Figure 3a shows the first period of existence of the compared objects of the XVIII - early XX centuries, when the temples literally grew into the surrounding landscape with a system of stairs, galleries of ‘gulbishes’ and terraces. The plastic of the facades reveals the volumetric-spatial structure of the tiered church with the traditional method of arranging the main volumes and the dominance of the bell tower under the spire. With a common compositional structure, each temple has its own unique shape and diverse variation.

Figure 3b shows the average period of evolution of the compared objects: the first third of the XIX century - the second third of the XIX century. Under the influence of classicism, the tiered bell towers under a dome with onion domes, galleries and a porch were rebuilt with a stone vestibule. The ideas of the new era were reflected in the restructuring of the bell tower and the vestibules of the Chudotvorskaya church with elements of the classics. The façade has acquired a stricter outline. Thus, a three-storey porch takes the form of a portal completed with a triangular pediment; the bell tower is completed by one tier and ends with a dome instead of the old spire. The transverse volume of the vestibule brings order to the overall pictorial composition of the facade.

The Vladimir church completes the ensemble of the Irkutsk branch of the "Siberian Baroque" and is distinguished by its commitment to ancient Russian architecture. Models of its facades of the periods under consideration were compiled based on the materials of the book "Virgin-Vladimir church in Irkutsk: history and modernity" [10, p. 123, 331, 333].

Figure 3c shows the last period of the evolution of the Chudotvorskaya temple (1880s - 1920s). It begins with its restoration after the fire of 1879, which will take 6 years [11, p. 172-173]. In the 30s, the church was demolished. Passion for Old Russian architecture at the end of the XIX century. influenced the architectural appearance of the renovated temple. The decorative decoration in the form of kokoshniks at the base of the domes of the temple and the bell tower changed its image, strengthening the idea of spiritual combustion and the vertical aspiration of the composition.

Figure 3d shows the features of the Chudotvorskaya temple of this period in more detail using the example of the southern facade in identifying large-scale elements: decorative design of window openings, cornices and corners, domed finishes. The high basement, rebuilt as a temple, almost had no windows. Photographs of views of Irkutsk in the late XIX - early XX centuries helped to recreate the drawings and models of the final evolutionary period in the appearance of the temple. (Figure 2, 3a), as well as certain views and fragments of the temple, presented in photographs of famous Irkutsk photographers [1, p. 137-139]. The final architectural appearance was an eclectic fusion of style trends with the dominance of baroque forms. Each stage of evolution is presented as a harmonious architectural solution in accordance with the ideas of the era.

**Volume-spatial modeling**

The conditional spatial image of an object is a layout. It makes it possible to quickly obtain volumetric-spatial characteristics of the object under study that are close to nature. There are search layouts, to obtain certain volumetric-spatial characteristics of an object, and demonstration ones, which create an idea of the object's appearance and imitate its material and structural characteristics.

**Search models.** The purpose of volumetric-spatial modeling: mastering some techniques of compositional analysis of an architectural monument and skills in creating a volumetric-spatial composition. Tasks: along with the study of the main types of volumetric-spatial composition (frontal, volumetric, depth-spatial), the study of various compositional properties of an architectural work (its volume, interior, interaction with the environment). The results of volumetric-spatial modeling are the main illustrative material in the presentation of the course project (Figure 4).

**Project submission.** The purpose of submitting a project is to reproduce the essential properties and forms of a specific object in the form of a layout and graphics. The submission of the project is the result
of the study of monuments of temple architecture and includes the main results of the analysis in various analytical models: geometric, structural, volumetric-spatial. Geometric models reveal the compositional features of the construction of orthogonal drawings (segmentation, outlines, dimensions). Structural models reveal rhythms, proportions, tectonic structures. Volumetric-spatial models reveal the patterns of construction of volumetric-spatial form: its facade, volume and interior, interaction with the environment, etc. Studying the objects of architectural heritage, students form their own view and concepts of the object, which is revealed in the interpretation of the artistic image using means of compositional expressiveness, techniques of architectural graphics and volumetric-spatial modeling.

**Figure 4.** Submission of the project "Compositional analysis of monuments of temple architecture": a - Chudotvorskaya Church. Restoration of the original architectural appearance (ARb-18-1 Pundel I.A.); b - Chudotvorskaya Church. Restoration of the final architectural appearance (ARb-14-2 Fedyukina Y.S.); c - Holy Cross Cathedral (ARb-18-1 Yuzhanin T.V.); d - Vladimir church (ARb-18-1 Chudnovskaja D.A.); e - Kazan Cathedral (ARb -18-1 Plyashechnik N.V.); f - Prince Vladimir's Church (ARb -18-1 Didenok A.A.).

**Demonstration models.** Figure 5b shows an example of the implementation of a spatial composition and a demonstration layout of the block of buildings and structures of the Irkutsk customs office and the adjacent site with the Chudotvorskaya temple. The model was made for the museum of the history of the Irkutsk customs. The demonstration model simulates the material and structural characteristics of buildings built of stone and wood, other buildings along the borders of the customs yard, as well as volumetric stacks of goods in the middle of the yard. This model reveals the compositional and spatial relationships of the Chudotvorskaya church with the surrounding space of the historical environment in which it has existed in recent years. From the moment the customs directorate ordered to recreate the historic quarter, the buildings of the customs administration and the Chudotvorskaya church as the
dominant feature of this ensemble, the history of restoration of the architectural appearance of this temple begins.

Figure 5. Reconstruction of the architectural ensemble of Irkutsk customs and Chudotvorskaya Church of the late 19th-early 20th centuries: a - model of the Irkutsk customs quarter with the Chudotvorskaya Church (DAS-07-1 Agumava A.B., Borisov B.V., Dushin G.A., Kuleshov D.A.); b - involute of the northern facades of the Chudotvorskaya Church and the buildings of the Irkutsk customs administration along Naberezhnaya Street. Reconstruction by Kozlova G.S. (the drawings of the customs buildings were made by the students of the group DAS-02-2 Yanov A.Y. and Pozdnyakov P.L.).

The Chudotvorskaya church received its final architectural appearance in the 1880s, when the construction of the buildings of the Irkutsk customs began on a neighboring site under the leadership of military engineer-captain V.N. Karazin. The old stone house, built in 1761 by the Irkutsk merchant M.I. Glazunov, was rebuilt into a customs building and was a classic example of stone buildings in the business part of Irkutsk in the XIX century. The main divisions of the facade are horizontal rods at the level of the basement and cornice, arched windows with platbands, rustication of corners, pilasters, and relief geometric elements. Nearby were erected a two-story wooden building of the main customs office - a symmetrical volume with a high, covered front porch, on a high plinth and a plank facade cladding with decorative processing of platbands and friezes. On the side of Naberezhnaya Street, new buildings and structures harmoniously complemented the ensemble of the Chudotvorskaya Church, which was being restored at that time after the fire of 1879. The surviving drawings of customs buildings, photographs of the panorama of the Naberezhnaya Street and the temple served as the basis for creation an involute of the facades of Chudotvorskaya Church (Figure 5b) and building a model of the entire quarter (Figure 5a).
The final appearance of the temple often differs from the original sample, sometimes historical documents have been preserved only in the drawings of artists. Reliance on modeling (graphic embodiment of an object or its layout) as a general scientific method of research makes it possible to clarify the important components of the interrelated stages of transformation of the architecture of temples in the process of evolution, to restore unknowns. The article presents the work of the authors with a new approach to compositional modeling, when the studied monument is viewed in space and time, is an inseparable part of Russian history and architectural culture. The proposed method gives new meanings to the study of the architectural heritage, expands the boundaries from the composition of a separate object to the creation of a system in harmony of proportions, allowing to recreate the entire urban planning ensemble.

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