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Multi-variant User Interfaces in E-commerce

A Practical Approach to UI Personalization

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I dedicate this book to my dad, who has always been there for me and supported me in every moment of my life.

Preface

In the rapidly evolving digital age, e-commerce has witnessed a significant transformation. The interplay between technology and consumer behavior has given rise to various approaches aimed at enhancing the online shopping experience for customers. Among these approaches, the multivariant user interface stands out as a key element for e-commerce companies striving to keep up with current and relevant trends.

The gateway to online shopping has always been the user interface. Initially, it was rudimentary, consisting of simple text-based web pages and clickable links. Users had to navigate through clunky menus, enduring long load times that left them with ambivalent feelings. However, as technology advanced, so did the expectations of online shoppers. Currently, there is an increasing need for engaging, efficient, and personalized experiences. This alteration in user expectations established the groundwork for the progression of e-commerce user interfaces. Additionally, as e-commerce platforms have expanded in both size and sophistication, the importance of user-centric personalization has gained recognition. A multivariant user interface goes beyond merely adapting interfaces to different devices; it represents a strategy for delivering a personalized experience to specific recipients. This transition to personalized tailoring marked a significant juncture in the development of e-commerce. A multivariant user interface allows information, products, and features to be presented in a manner that appeals to different customers. For instance, a visitor to an e-commerce site focusing on fashion may encounter a homepage showcasing popular trends, while a different user with a track record of outdoor gear acquisitions might be greeted with a presentation of new hiking gear. This level of personalization is made possible by algorithms that consider a user's past behavior, preferences, products of interest, and even real-time data.

The incorporation of extensive data analytics has played a crucial role in enabling personalization. In today's e-commerce landscape, platforms collect vast amounts of user interaction data, ranging from viewed products to time spent on separate pages. With the assistance of machine learning algorithms, this data can be analyzed and leveraged to create personalized product suggestions, fine-tune pricing policies, and optimize the overall user experience. Thus, the development of a multivariant

user interface in e-commerce is not solely focused on aesthetics; it is about creating an interface that adapts to the distinct requirements and inclinations of each user. Its primary goal is to deliver the right content at the right time and in the right manner, with the flexibility to expand as needs and technical possibilities evolve. One of the fundamental goals of a multi-variant UI is to enhance the user experience. As users increasingly interact with e-commerce platforms, they come to expect a seamless and enjoyable journey. The multivariant UI achieves this by reducing the gap between the user and the desired product. For example, during the checkout process, it allows the system to adapt to the user's preferences, offering a variety of payment options, shipping methods, and even personalized discounts or promotions. This not only streamlines the purchase process but also incorporates a level of personalization capable of satisfying any potential customer.

In summary, the development of multi-variant UIs in e-commerce represents a move away from rigid, one-size-fits-all interfaces toward flexible, customizable, and responsive user experiences. This advancement mirrors the changing demands of online shoppers and the innovative potential of present-day technology.

This publication covers the theoretical foundations, requirements, assumptions, implementation methods, and the results of validating and verifying a platform that comprehensively supports multivariant user interfaces in e-commerce. The research described here primarily focuses on the practical aspects of managing personalized layouts in online shops. The obtained results serve as a basis, but also an incentive, for the wider application of the proposed approach. Implementing a solution to offer dedicated user interfaces in e-commerce is a challenging task. Unlike mechanisms that suggest or advertise products, user interface variants require more extensive customer behavior data collection and a distinct processing approach. This demands a suitable architecture and carefully chosen analytical techniques. The comprehensive handling of this issue was addressed through research and development, and the findings are presented in this publication. As part of the project, an architecture for delivering custom interface variants in e-commerce was developed and practically verified. The results allowed the identification of clustering techniques that produced very good results in a specific business context. The experimental validation of the proposed concept and the tangible benefits of using personalized user interface modifications were also verified.

The issues discussed here hold significant relevance for those involved in developing e-commerce platforms seeking to exploit the opportunities offered by fully personalized user interfaces, surpassing the limitations of conventional solutions. The combination of machine-learning methods and personalization presents substantial opportunities for advancing e-commerce. This publication offers practical insights into the challenges associated with delivering dedicated user interfaces, highlighting risks, potential errors, and improvement opportunities. It provides a technical and business foundation for the widespread implementation of such personalization in e-commerce.

Wrocław, Poland Adam Wasilewski
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Contents

Acronyms

ABS	Average Basket Size
ABV	Average Basket Value
ASP	Average Selling Price
AI	Artificial Intelligence
AJAX	Asynchronous JavaScript and XML
AOV	Average Order Value
API	Application Programming Interfaces
AR	Augmented Reality
B2B	Business to Business
B2C	Business to Customer
B2E	Business to Employer
B2G	Business to Government
BIRCH	Balanced Iterative Reducing and Clustering using Hierarchies
C2B	Customer to Business
C2C	Customer to Customer
C2G	Customer to Government
CBF	Content-based filtering
CF	Collaborative filtering
CLARA	Clustering Large Applications
CLARANS	Clustering Large Applications based on RANdomized Search
CLIQUE	CLustering In QUEst
CSS	Cascading Style Sheets
COVID-19	COronaVIrus Disease 2019
CR	Conversion Rate
CTR	Clickthrough Rate
CURE	Clustering Using Representatives
CVV	Customer Visit Value
DBSCAN	Density-Based Spatial Clustering of Applications with Noise
DCE	Distributed Computing Environment
DENCLUE	DENsity-based CLUstEring
DenGRID	Density Grid-based Clustering

ERP	Enterprise Resource Planning
EU	European Union
GA	Google Analytics
G2B	Government to Business
G2C	Government to Customer
G2G	Government to Government
GDPR	General Data Protection Regulation
GTM	Google Tag Manager
HDBSCAN	Hierarchical Density-Based Spatial Clustering of Applications with Noise
HTML	HyperText Markup Language
JS	JavaScript
KNN	K-Nearest Neighbor
KPI	Key Performance Indicator
ML	Machine Learning
OECD	Organisation for Economic Cooperation and Development
OPTICS	Ordering Points to Identify the Clustering Structure
OSF	Open Software Foundation
PAM	Partitioning Around Medoids
PCR	Partial Conversion Rate
PHP	PHP: Hypertext Preprocessor former Personal Home Page
PMM	Personalisation Maturity Model
PWA	Progressive Web Application
REST	REpresentational State Transfer
RFM	Recency, Frequency, Monetary
ROCK	RObust Clustering using linKs
SaaS	Software as a Service
SOAP	Simple Object Access Protocol
STAGE	STreaming Algorithm for Grid basEd Clustering
STING	STatistical INformation Grid
TMS	Tag Management System
UI	User Interface
UX	User eXperience
VDBSCAN	Voronoi-Based Density-Based Spatial Clustering of Applications with Noise
VPN	Virtual Private Network
TSNE	T-distributed Stochastic Neighbor Embedding
UMAP	Uniform Manifold Approximation and Projection
W3C	World Wide Web Consortium
WCAG	Web Content Accessibility Guidelines
WFS	Workflow System
WS	Web service
WHO	World Health Organization
WTO	World Trade Organization
WWW	World Wide Web

Chapter 1
Introduction to the Personalization in E-commerce

1.1 E-commerce

Electronic commerce (e-commerce) refers to any economic activity carried out using electronic media. The Organization for Economic Co-operation and Development (OECD) defines e-commerce as *all forms of transactions relating to commercial activities, including both organizations and individuals, that are based upon the processing and transmission of digitized data, including text, sound, and visual images* [1]. In turn, the World Trade Organization (WTO) defines e-commerce as the production, distribution, marketing, and sale or delivery of goods and services by electronic means [2].

E-commerce is commonly linked to diverse online retailers and auction platforms, which permit the buying and selling of tangible goods (e.g., books, cosmetics, and electrical appliances), intangible goods (e.g., e-books and specific kinds of digital software), and services (e.g., access to audiovisual content, education, and training). E-commerce refers to the process of conducting commercial transactions via the Internet or other computer networks, regardless of the tools or means used [3].

E-commerce can be considered multidimensional, and thus various classifications can be made. Nevertheless, the most popular classification of e-commerce is based on the relationship between the seller and the buyer [4]. Assuming that there are two groups in the market—companies (business—B) and individuals (customers—C), the following e-commerce models can be distinguished [5]:

- A company sells and a company buys, referred to as business to business (model B2B).
- A company sells and an individual buys, referred to as business to customer (model B2C).
- An individual sells and an individual buys, referred to as customer to customer (model C2C).

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