

# Skills Framework for Infocomm Technology (ICT)

## **Skills in Generative Artificial Intelligence (AI)**

The second National AI Strategy, or NAIS 2.0, was released in 2023. Singapore is committed to being a place where AI serves as a force for good, and to harness AI to uplift and empower our people and businesses. To quickly uplift the AI capabilities of our industries and workforce, IMDA and our partners have identified a preliminary set of skills in generative AI (GenAI), which serves as an additional reference to the [Skills Framework for ICT](#) that was developed earlier.

The skillsets outlined in this document are organised based on two archetypes of AI workers, namely AI Users (Chapter 1) and AI Practitioners (Chapter 2). Underpinning those skillsets are ethics and governance considerations (Chapter 3), that all AI workers should possess to exercise appropriate judgment and use AI in a responsible manner. As the field of AI evolves, we envision that this document may be updated as needed.

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## Chapter 1 - Generative AI Skills for AI Users

Workers across the economy, not just tech workers, now have access to many GenAI products and services that can enhance productivity, drive innovation and more. Examples include automating repetitive tasks, generating content, and deriving insights from large datasets.

To effectively harness the power of GenAI, these AI Users would need to be competent in applying the principles of GenAI to specific tasks, and utilising prompt design techniques to shape the outputs produced.

Table 1: Overview of GenAI Technical Skills & Competencies (TSCs) for AI Users

Skill Family	Technical Skills & Competencies (TSCs)
<b>Fundamentals</b>	New GenAI TSC #1 <b>Generative AI Principles and Applications</b>
	New GenAI TSC #2 <b>Prompt Design</b>

<b>Skill Name</b>	New GenAI TSC #1 <b>Generative AI Principles and Applications</b>		
<b>Skill Description</b>	Understand and apply the concepts, frameworks, applications, and implications of generative AI models.		
<b>Proficiency Descriptor</b>	<b>Basic</b>		
	Use generative AI to carry out specific tasks.		
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Fundamental purpose of generative AI (e.g., analysis, creation of content in different modes such as text, image, video or code).</li> <li>• Fundamental concepts of and theories governing generative AI.</li> <li>• Introduction to popular generative AI models and how they work, including machine learning.</li> <li>• Transformative potential of generative AI in various industries, including domains where generative AI could be used, and where it may not work.</li> <li>• Difference between generative AI and other AI paradigms.</li> <li>• Limitations of AI models in generating relevant outputs.</li> <li>• Fundamentals of responsible AI.</li> <li>• Fundamentals of data privacy and protection (e.g., data privacy laws and regulations such as Personal Data Protection Act).</li> </ul>		
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Write prompts to generate various types of generative AI outputs.</li> <li>• Analyse the accuracy and relevance of generative AI outputs for specific tasks.</li> <li>• Identify sensitive information in datasets.</li> <li>• Apply basic anonymisation techniques (e.g., data masking, perturbation, pseudonymisation).</li> <li>• Consider responsible AI aspects of application of generative AI.</li> </ul>		

<b>Skill Name</b>	New GenAI TSC #2 <b>Prompt Design</b>		
<b>Skill Description</b>	Craft effective prompts to shape outputs and elicit desired responses in AI models.		
<b>Proficiency Descriptor</b>	<b>Basic</b>		
<b>Knowledge</b>	Craft prompts to generate specific outputs. <ul style="list-style-type: none"> <li>• Concept of prompt design.</li> <li>• Principles of how prompts shape AI-generated content.</li> <li>• Techniques in prompt construction (e.g., zero shot prompting, one shot prompting, domain-based prompting techniques, instruction prompting, hyper-parameters such as temperature and sampling parameter).</li> <li>• Impact of prompts on different modes of AI output.</li> <li>• Techniques in troubleshooting AI tools.</li> <li>• Overview of data privacy regulations.</li> <li>• Guardrails to prevent prompts from creating unexpected outputs.</li> </ul>		
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Define the fundamental elements of a prompt.</li> <li>• Describe fundamental prompt design techniques.</li> <li>• Compare prompt designs and corresponding AI outputs, including their suitability for different use cases in different domains.</li> <li>• Identify best practices for designing effective prompts.</li> <li>• Recognise issues encountered with AI tools.</li> <li>• Follow standard troubleshooting procedures.</li> <li>• Apply basic anonymisation techniques (e.g., data masking, perturbation, pseudonymisation).</li> <li>• Identify common prompt misuses (e.g., lack of context, vague instructions) and risks.</li> </ul>		

## Chapter 2 - Generative AI Skills for AI Practitioners

Tech workers need skillsets to create, implement and deploy AI systems, models and algorithms in organisations, at scale. This is critical to supporting top-tier AI activity, translating innovation into products and services, and transforming our industries. These AI Practitioners could be in job roles such as Data Architect/Engineer, Generative AI Engineer, and Generative AI Scientist.

The skills required of an AI Practitioner can be categorised into three families: (1) GenAI fundamentals including application of GenAI principles and prompt engineering; (2) Skills required to effectively use existing GenAI models in GenAI product development and deployment life cycle; and (3) Skills required to develop new GenAI models.

Table 2: Overview of GenAI Technical Skills & Competencies (TSCs) for AI Practitioners

Skill Family	Technical Skills & Competencies (TSCs)
<b>Fundamentals</b>	Extension of New GenAI TSC #1 <b>Generative AI Principles and Applications</b>
	New GenAI TSC #3 <b>Prompt Engineering</b>
<b>Product Development and Deployment Life Cycle</b>	TSC in existing SFw Product Development Track <b>Research</b>
	TSC in existing SFw Infrastructure Track <b>Infrastructure Design</b>
	New GenAI TSC #4 <b>Generative AI Model Selection</b>
	New GenAI TSC #5 <b>Generative AI Model Evaluation</b>
	New GenAI TSC #6 <b>Generative AI Application Development and Deployment</b>
	TSC in existing SFw Software and Applications Track <b>User Testing and Usability Testing</b>
<b>Model Development</b>	New GenAI TSC #7 <b>Generative AI Model Development and Fine Tuning</b>

TSCs in the existing SFw under the Product Development, Infrastructure and Software Applications tracks can be accessed [here](#).

<b>Skill Name</b>	Extension of New GenAI TSC #1 <b>Generative AI Principles and Applications</b>		
<b>Skill Description</b>	Understand and apply the concepts, frameworks, applications, and implications of generative AI models.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	
	Use generative AI to carry out specific tasks.	Improve the quality of generative AI outputs by understanding underlying concepts and theoretical frameworks for generative AI.	
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Fundamental purpose of generative AI (e.g., analysis, creation of content in different modes such as text, image, video or code).</li> <li>• Fundamental concepts of and theories governing generative AI.</li> <li>• Introduction to popular generative AI models and how they work, including machine learning.</li> <li>• Transformative potential of generative AI in various industries, including domains where generative AI could be used, and where it may not work.</li> <li>• Difference between generative AI and other AI paradigms.</li> <li>• Limitations of AI models in generating relevant outputs.</li> <li>• Fundamentals of responsible AI.</li> <li>• Fundamentals of data privacy and protection (e.g., data privacy laws and regulations such as Personal Data Protection Act).</li> </ul>	<ul style="list-style-type: none"> <li>• Underlying principles, core concepts and theories governing generative AI.</li> <li>• Generative AI model workings including training data, algorithms, and outputs.</li> <li>• Impact of prompt engineering on the model outputs of generative AI.</li> <li>• Difference between generative and discriminative models.</li> <li>• Importance of data quality, preprocessing, model pipeline and model training (e.g., impact of data bias from training data).</li> </ul>	

	Basic	Intermediate	
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Write prompts to generate various types of generative AI outputs.</li> <li>• Analyse the accuracy and relevance of generative AI outputs for specific tasks.</li> <li>• Identify sensitive information in datasets.</li> <li>• Apply basic anonymisation techniques (e.g., data masking, perturbation, pseudonymisation).</li> <li>• Consider responsible AI aspects of application of generative AI.</li> </ul>	<ul style="list-style-type: none"> <li>• Apply understanding of generative AI principles to use cases.</li> <li>• Demonstrate the use of generation AI in diverse applications (e.g., summarisation, inference, reasoning, transformation of content, augmentation of content).</li> <li>• Analyse limitations and potential biases in AI-generated content.</li> <li>• Analyse generative AI models' performance metrics and evaluate the influence of prompt variations.</li> <li>• Identify the ethical implications and societal impact of AI-generated content.</li> </ul>	



<b>Skill Name</b>	New GenAI TSC #3 <b>Prompt Engineering</b>		
<b>Skill Description</b>	Create nuanced and strategic prompts that optimise AI model performance, combining different methodologies to generate innovative and effective prompts.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Craft prompts to generate specific outputs.	Shape and engineer prompts to effectively generate specific outputs.	Craft nuanced prompts, adapt strategies for diverse scenarios, and optimise model responses.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Concept of prompt design.</li> <li>• Principles of how prompts shape AI-generated content.</li> <li>• Techniques in prompt construction (e.g., zero shot prompting, one shot prompting, domain-based prompting techniques, instruction prompting, hyper-parameters such as temperature and sampling parameter).</li> <li>• Impact of prompts on different modes of AI output.</li> <li>• Techniques in troubleshooting AI tools.</li> <li>• Overview of data privacy regulations.</li> <li>• Guardrails to prevent prompts from creating unexpected outputs.</li> </ul>	<ul style="list-style-type: none"> <li>• Theoretical frameworks of prompt engineering techniques.</li> <li>• Definition and characteristics of Foundation Models and their limitations.</li> <li>• Use of words and structures through prompts to influence AI outputs (e.g., multi-lingual prompting, multi-turn prompting for conversations)</li> <li>• Context window limitations, long-context implications and strategies to work within them</li> <li>• Use cases of effective prompts</li> <li>• Relationship between prompt design, model behaviour, and output diversity</li> </ul>	<ul style="list-style-type: none"> <li>• Scenarios where prompt engineering significantly influences outputs.</li> <li>• Concepts in prompt engineering (e.g., conditional prompts, context manipulation, refining for specific outputs).</li> <li>• Nuances of prompt optimisation and its role in generating tailored outputs (e.g., sequencing of instructions in prompts).</li> <li>• Advanced prompt techniques (e.g., Chain-of-Thought, Tree of Thought prompting).</li> <li>• Techniques that extend capabilities of generative AI models (e.g., Retrieval Augmented Generation (RAG), external tools and libraries such as Langchain).</li> <li>• Use of prompt engineering tools and frameworks to streamline implementation of prompt engineering methods.</li> <li>• Modification of model configurations to optimise output (e.g., use of fine tuning based on RAG knowledge base).</li> </ul>

	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Define the fundamental elements of a prompt.</li> <li>• Describe fundamental prompt design techniques.</li> <li>• Compare prompt designs and corresponding AI outputs, including their suitability for different use cases in different domains.</li> <li>• Identify best practices for designing effective prompts.</li> <li>• Recognise issues encountered with AI tools.</li> <li>• Follow standard troubleshooting procedures.</li> <li>• Apply basic anonymisation techniques (e.g., data masking, perturbation, pseudonymisation).</li> <li>• Identify common prompt misuses (e.g., lack of context, vague instructions) and risks.</li> </ul>	<ul style="list-style-type: none"> <li>• Define prompt engineering.</li> <li>• Apply general best practices when interacting with Foundation Models.</li> <li>• Identify the types of prompt engineering techniques (e.g., zero-shot and few-shot learning applied to foundation models).</li> <li>• Apply prompt techniques as necessary for use cases.</li> <li>• Identify which prompt techniques are best suited for specific foundation models.</li> <li>• Identify potential prompt misuses.</li> <li>• Analyse potential bias in foundation model responses and design prompts that mitigate the bias.</li> </ul>	<ul style="list-style-type: none"> <li>• Create prompts to elicit precise and diverse responses from AI models.</li> <li>• Analyse the nuances of prompts and their influence on AI model behaviour.</li> <li>• Evaluate the performance and limitations of prompt engineering techniques.</li> <li>• Evaluate the effectiveness and adaptability of prompt engineering methods across diverse scenarios.</li> <li>• Apply prompt engineering strategies to refine model outputs and extend capabilities of models.</li> <li>• Devise innovative prompt strategies that enhance generative AI capabilities.</li> </ul>

<b>Skill Name</b>	New GenAI TSC #4 <b>Generative AI Model Selection</b>		
<b>Skill Description</b>	Choose the most appropriate model for the development of a generative AI system for a use case, from a variety of external models, and based on published metrics and user experiments.		
<b>Proficiency Descriptor</b>	<b>Intermediate</b>		<b>Advanced</b>
<b>Knowledge</b>	Discern and select appropriate generative AI models for specific tasks and improve output quality. <ul style="list-style-type: none"> <li>• Principles behind generative AI model operation and output generation (e.g., how model is trained, transformers and attention mechanisms, encoders and decoders in large language models, modality gap).</li> <li>• Process of generating content using various AI models, including prompt engineering techniques.</li> <li>• Model parameters for different use cases (e.g., modality, size, cost, features).</li> <li>• Steps in handling and interacting with generative AI tools.</li> </ul> Significance of dataset quality and model training, including data management (e.g., extract, transform and load process).		Select and implement generative AI models for diverse tasks, and evaluate their effectiveness. <ul style="list-style-type: none"> <li>• Applications and domains where generative AI models are used (e.g., large-scale and distributed computing clusters).</li> <li>• Concepts in generative AI, including model architectures, training strategies, and optimisation techniques (including pre-training vs fine-tuning for specialised tasks or domains).</li> <li>• Workflow of deploying and fine-tuning AI models.</li> <li>• Complexities of fine-tuning and customising AI models for specific tasks or outputs (including implications of models' size and features on the cost).</li> </ul>
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Apply different generative AI models for different use cases, and assess cost across different models available.</li> <li>• Implement models to create content in specific domains or styles.</li> <li>• Compare data compliances on where the generated content is stored upon creation.</li> <li>• Analyse model-generated content for quality and coherence.</li> <li>• Assess model performance under different settings.</li> <li>• Analyse the impact of model variations on output quality for specific tasks.</li> </ul>		<ul style="list-style-type: none"> <li>• Deploy existing models for a variety of specialised tasks or creative applications (including using techniques such as pre-training or fine-tuning).</li> <li>• Assess the effectiveness of models against diverse datasets and scenarios.</li> <li>• Evaluate the reliability and adaptability of advanced generative models for real-world applications.</li> <li>• Evaluate the use of LLMOps on the scalability of advanced generative models for real-world applications.</li> </ul>

<b>Skill Name</b>	New GenAI TSC #5 <b>Generative AI Model Evaluation</b>		
<b>Skill Description</b>	Assess the quality, performance, and potential impact of generative AI models across various domains and applications.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Implement task-specific evaluations for generative AI models, interpret the findings and propose refinements.	Design and implement custom evaluations for generative AI models.	Shape generative AI evaluation and best practices by developing and applying novel generative AI evaluation techniques.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>Machine learning libraries (e.g., TensorFlow, PyTorch, Keras).</li> <li>Fundamental evaluation criteria for generative AI (e.g., accuracy, diversity, coherence, novelty).</li> <li>Qualitative evaluation methods and user feedback analysis.</li> <li>Limitations of AI models in generating relevant outputs.</li> <li>Principles of human perception and judgment.</li> <li>Ethical considerations in AI development and deployment.</li> </ul>	<ul style="list-style-type: none"> <li>Theoretical foundations of generative AI evaluation.</li> <li>Generative AI evaluation metrics and techniques (e.g., BLEU score, Inception Score, Frechet Inception Distance).</li> <li>Data visualisation techniques for evaluating generative outputs.</li> <li>Task-specific evaluation criteria and success metrics.</li> <li>Fairness and explainability principles for generative AI evaluation</li> <li>Statistical analysis and hypothesis testing.</li> <li>Human-computer interaction principles for adaptive and personalised evaluation.</li> <li>Ethical frameworks and guidelines for responsible AI evaluation.</li> </ul>	<ul style="list-style-type: none"> <li>A/B testing and user studies for generative AI systems.</li> <li>Explainable AI (XAI) for understanding model decision-making.</li> <li>Frontiers of generative AI evaluation research (e.g., counterfactual effect, explainable evaluation).</li> <li>Cutting-edge research in generative AI evaluation methods.</li> <li>Ethical frameworks and guidelines relevant to AI development (including global standards or frameworks for data privacy).</li> <li>Ethical dimensions of AI through interdisciplinary perspectives (e.g. legal, cultural, socio-political aspects)</li> </ul>

	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Collect user feedback on generated content.</li> <li>• Interpret evaluation metrics for generative tasks.</li> <li>• Propose initial improvements based on evaluation findings.</li> <li>• Identify limitations and potential biases in generative models.</li> <li>• Identify ethical concerns in generated outputs.</li> </ul>	<ul style="list-style-type: none"> <li>• Implement custom evaluation pipelines for generative tasks.</li> <li>• Analyse complex data distributions and model outputs.</li> <li>• Analyse performance issues based on evaluation data.</li> <li>• Address ethical concerns to mitigate potential biases in generated content.</li> </ul>	<ul style="list-style-type: none"> <li>• Design and conduct large-scale user studies and A/B tests.</li> <li>• Integrate diverse data sources and modalities into evaluation frameworks.</li> <li>• Lead generative AI evaluation projects from conception to implementation.</li> <li>• Conduct independent research and contribute to the advancement of generative AI evaluation.</li> <li>• Translate research advancements into practical evaluation methodologies.</li> <li>• Develop innovative methodologies for evaluating the societal impact and ethical implications of generative AI.</li> <li>• Advocate for responsible and ethical development and use of generative AI technologies.</li> </ul>

<b>Skill Name</b>	New GenAI TSC #6 <b>Generative AI Application Development and Deployment</b>		
<b>Skill Description</b>	Design and build applications around generative AI models, integrating the language processing capabilities towards specific use cases and domains, and troubleshoot AI tools		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Build applications around generative AI models.	Build complex applications integrating multiple models and build in appropriate controls and safeguards against model risks.	Architect and build complex applications that apply novel techniques in context augmentation and guardrail deployments.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Concepts behind context augmentation for prompts (e.g., Retrieval Augmented Generation (RAG)).</li> <li>• Low-code, no-code application development.</li> <li>• Limitations of model capabilities and performance, including common error messages and issues in AI applications.</li> <li>• Developer tools and frameworks that accelerate development of generative AI applications.</li> <li>• Basic software troubleshooting steps (e.g., interpret help resources and documentation).</li> <li>• Fundamentals of system requirements and compatibility.</li> </ul>	<ul style="list-style-type: none"> <li>• Concepts of software integration.</li> <li>• Concepts of integrating multiple generative AI models, including common compatibility and integration issues.</li> <li>• Approaches to deploy models for inference using cloud platforms.</li> <li>• Concepts behind context augmentation techniques, such as knowledge graphs.</li> <li>• Designs of model pipelines.</li> <li>• Concepts behind AI governance and how to test and evaluate applications for safety and alignment.</li> <li>• Safeguarding Large Language Models (LLMs) with guardrails for content generation.</li> </ul>	<ul style="list-style-type: none"> <li>• Concepts behind compute efficiency (e.g., quantisation, similar efficiency techniques).</li> <li>• Guardrail and moderation techniques, and the effectiveness of guardrail methods.</li> <li>• Cutting edge context augmentation techniques.</li> <li>• Scripting and automation for troubleshooting.</li> <li>• Concepts on integrating generative AI models with emerging technologies.</li> </ul>

	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Apply effective prompt engineering and model configuration to integrate foundational models into applications.</li> <li>• Apply context augmentation using Retrieval Augmented Generation (using vector databases and retrieval algorithms).</li> <li>• Describe and appropriately escalate issues encountered with AI tools.</li> <li>• Troubleshoot performance issues (e.g., follow standard procedures).</li> <li>• Maintain proper software configurations and settings.</li> </ul>	<ul style="list-style-type: none"> <li>• Identify issues in generative AI models by analysing and interpreting error logs.</li> <li>• Design integration workflows between AI models and systems, such as batch processing, API integration, and multi-model orchestration.</li> <li>• Develop applications that integrate generative AI models via developer tools and cloud service offerings (e.g. Gradio and Stramlit interfaces).</li> <li>• Deploy existing guardrails and moderation controls to control inputs and outputs to prevent undesirable model behaviours.</li> <li>• Resolve compatibility issues with other software or systems (e.g., GitHub Copilot, CircleCI).</li> </ul>	<ul style="list-style-type: none"> <li>• Create applications that integrate multiple generative AI models and use context augmentation techniques.</li> <li>• Deploy generative AI models for inference using serving infrastructure (e.g., Text Generation Inference (TGI)/ Virtual Large Language Model (VLLM)).</li> <li>• Develop new guardrails and moderation controls to control inputs and outputs to prevent undesirable model behaviours.</li> <li>• Articulate trade-offs from using different context augmentation techniques.</li> <li>• Conduct research and advance the field of generative AI-powered applications.</li> <li>• Automate troubleshooting tasks by creating custom scripts or tools.</li> <li>• Document and update knowledge bases for AI tools and applications.</li> </ul>

<b>Skill Name</b>	New GenAI TSC #7 <b>Generative AI Model Development and Fine Tuning</b>		
<b>Skill Description</b>	Apply deep learning expertise and statistical inference knowledge to design, implement, train, and evaluate generative AI models for various tasks and applications. Assess the quality, performance, and potential impact of generative AI models across various domains and applications.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Implement generative AI models based on existing architectures and evaluate their effectiveness.	Build custom deep learning architectures for specific needs. Analyse and debug performance issues in generative models.	Design novel generative architectures and algorithms for deployment, improve usability and optimise performance while mitigating potential risks and ethical concerns of generative AI.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>• Deep learning theory and algorithms (e.g., GANs, VAEs, Transformers).</li> <li>• Machine learning libraries (e.g., TensorFlow, PyTorch, Keras)</li> <li>• Probability theory and statistics (e.g., latent variables, probabilistic modelling).</li> <li>• Data pre-processing, de-duplication and cleaning techniques (including understanding of training data requirements for AI models, common data quality issues).</li> <li>• Embeddings and tokenisation.</li> <li>• Loss functions and evaluation metrics for generative tasks.</li> <li>• Optimisation techniques for training neural networks.</li> <li>• Fine-tuning techniques (e.g., supervised fine-tuning, parameter-efficient fine-tuning, perform inference).</li> </ul>	<ul style="list-style-type: none"> <li>• Generative concepts (e.g., transfer learning, distillation, explainability, self-supervised learning).</li> <li>• Cutting-edge research in generative AI architectures and techniques (e.g., conditional GANs, diffusion models, autoregressive models), hardware acceleration techniques (e.g., GPUs, TPUs), cloud computing platforms for training and scaling models.</li> <li>• Multi-modal embeddings and models.</li> <li>• Advanced loss functions and metrics for evaluating generative performance.</li> <li>• Optimisation strategies for achieving higher-quality outputs.</li> <li>• Model interpretability and explainability methods for generative models.</li> <li>• Techniques for mitigating bias and ensuring fairness in generative outputs.</li> <li>• Data handling techniques for model fine tuning (e.g., feature engineering and selection methods, data</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced theories of generative AI.</li> <li>• Concepts on integrating generative AI models with emerging technologies.</li> <li>• Hardware libraries (e.g., CUDA, Neuron libraries).</li> <li>• Frontiers of generative AI research (e.g., generative modelling for scientific discovery, Vision Transformers and NLP transformers).</li> <li>• Specialised uses of generative AI (e.g., protein generation, 3D model generation, world models).</li> <li>• Concepts of compute efficiency, (e.g., quantisation and similar efficiency techniques).</li> <li>• Advanced synthetic data generation and limitations.</li> <li>• Scalable data processing frameworks.</li> <li>• Advanced statistical inference techniques for generative tasks.</li> <li>• Advanced fine-tuning techniques and continuous pre-training techniques.</li> </ul>



	<ul style="list-style-type: none"> <li>• Common dataset formats and evaluation methodologies for generative tasks.</li> <li>• Parallel cluster training and inference.</li> </ul>	<p>augmentation strategies for generative models).</p> <ul style="list-style-type: none"> <li>• Synthetic data generation</li> <li>• Intermediate fine-tuning and introduction to continuous pre-training.</li> </ul>	<ul style="list-style-type: none"> <li>• Fine-tuning models to align with human preferences using reinforcement learning (e.g., Reinforcement Learning from Human Feedback (RLHF), Reinforcement Learning from AI Feedback (RLAIF)).</li> </ul>
<p><b>Abilities</b></p>	<ul style="list-style-type: none"> <li>• Analyse problem statements and requirements to select and implement appropriate generative models.</li> <li>• Implement generative models based on existing architectures.</li> <li>• Preprocess and prepare data for generative training (e.g., clean and format datasets, use libraries (e.g., Pandas, NumPy) for data manipulation, split data into training, validation and test sets).</li> <li>• Train generative models on benchmark datasets.</li> <li>• Identify limitations and propose initial improvements to models.</li> </ul>	<ul style="list-style-type: none"> <li>• Construct custom generative models for specific tasks and domains.</li> <li>• Monitor generative training processes for stability and convergence.</li> <li>• Analyse generative models against state-of-the-art benchmarks.</li> <li>• Develop data pipelines (e.g. extract transform load) to create fine tuning datasets.</li> <li>• Fine-tune pre-trained models for optimal performance.</li> <li>• Apply data transformation techniques to improve model learning.</li> <li>• Develop training pipeline to continue pre-training from an existing model checkpoint.</li> </ul>	<ul style="list-style-type: none"> <li>• Develop innovative methodologies for solving tasks with generative models.</li> <li>• Lead and manage generative AI projects from conception to deployment.</li> <li>• Optimise complex generative models for performance and efficiency.</li> <li>• Develop innovative pre-processing methodologies for complex and large-scale data sets (e.g., architect large-scale data pre-processing pipelines, develop custom pre-processing algorithms, optimise pre-processing for distributed computing environments).</li> <li>• Design agentic AI systems.</li> <li>• Design neuro-symbolic AI systems (e.g. incorporation of SAT/SMT solvers).</li> <li>• Conduct independent research and contribute to the advancement of generative AI.</li> <li>• Lead collaborative research and development of generative models.</li> <li>• Translate research advancements into practical applications.</li> </ul>

## Chapter 3 - Ethics and Governance for Generative AI

AI has risks. AI systems need to be developed and deployed in a safe, trustworthy and responsible manner, so that people can have the confidence that their interests are protected when interacting with AI.

All workers across the economy should be able to grasp the ethical and governance considerations in GenAI, and be able to exercise appropriate judgement and use AI responsibly. This includes aligning AI models with the appropriate set of human and cultural values. Depending on the individual's job role and purpose of using GenAI, the level of proficiency and extent of technical competency required would differ.

Table 3: Overview of GenAI Technical Skills & Competencies (TSCs) on Ethics and Governance

Skill Family	Technical Skills & Competencies (TSCs)
<b>Ethics and Governance</b>	New GenAI TSC #8 <b>Responsible AI and Generative AI Practices</b>
	New GenAI TSC #9 <b>Generative AI Models Technical Aspects of Security and Ethics</b>

<b>Skill Name</b>	New GenAI TSC #8 <b>Responsible AI and Generative AI Practices</b>		
<b>Skill Description</b>	Integrate and ensure compliance of ethical principles in AI projects. Drive framework creation for responsible AI development.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Draft guidelines for ethical AI usage based on common ethical concerns.	Integrate ethical implications into AI development.	Develop frameworks for ethical use of AI, evaluate and critique guidelines for usage of AI.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>Ethical principles in AI.</li> <li>Responsible AI principles and best practices for development and deployment, including intellectual property, data privacy and environmental impact considerations.</li> <li>Data anonymisation and de-identification techniques.</li> <li>Ethical considerations and potential risks of generative AI interaction.</li> </ul>	<ul style="list-style-type: none"> <li>Ethical considerations in AI development, (e.g., bias, privacy, transparency, accountability).</li> <li>Environmental impact of generative AI use (e.g., energy consumption).</li> <li>Implications of biased AI algorithms and potential societal impact.</li> <li>Trustworthy and transparent communication of generative model capabilities and limitations.</li> <li>Ethical frameworks and guidelines for generative AI-powered tools (including legal requirements for data protection).</li> </ul>	<ul style="list-style-type: none"> <li>Ethical frameworks and guidelines relevant to AI development (including global standards or frameworks for data privacy).</li> <li>Historical context and evolution of AI ethics.</li> <li>Ethical challenges in AI governance, policy-making, and global implications.</li> <li>Ethical dimensions of AI through interdisciplinary perspectives (e.g. legal, cultural, socio-political, environmental aspects), including potential societal impact.</li> </ul>

	Basic	Intermediate	Advanced
<b>Abilities</b>	<ul style="list-style-type: none"> <li>• Apply ethical principles in decision-making related to AI.</li> <li>• Compare ethical issues in AI applications.</li> <li>• Compare AI systems based on considerations such as compliance with intellectual property, data privacy and environmental impact.</li> <li>• Design guidelines or strategies for ethical AI use, including use of sensitive data in generative AI tools.</li> <li>• Apply privacy measures when handling data for AI applications (e.g., implement simple data anonymisation and de-identification techniques, secure data storage using basic encryption).</li> <li>• Exercise professional scepticism to exercise sound judgement on generative AI output.</li> </ul>	<ul style="list-style-type: none"> <li>• Apply ethical guidelines to AI development and use, considering fairness, accountability, transparency and sustainability etc.</li> <li>• Assess environmental impact (e.g., estimate energy footprint).</li> <li>• Implement strategies to mitigate bias and ethical risks in AI systems.</li> <li>• Evaluate the trade-offs between privacy and model performance.</li> <li>• Analyse the ethical implications of AI algorithms (e.g., assess bias and fairness concerns).</li> <li>• Analyse the impact of AI on different societal groups and cultures (e.g., minority groups). Evaluate ethical frameworks and guidelines in AI development.</li> <li>• Develop strategies to integrate ethics into AI development and evaluation of AI systems.</li> <li>• Champion best practices for responsible and ethical use of generative AI, addressing concerns about transparency, bias, and societal impact.</li> </ul>	<ul style="list-style-type: none"> <li>• Apply comprehensive ethical frameworks to AI projects.</li> <li>• Evaluate biases, limitations and ethical implications of models, including using an evaluation dataset from various sources.</li> <li>• Create adversarial datasets for the business use case.</li> <li>• Develop new privacy-preserving algorithms.</li> <li>• Analyse ethical dilemmas in AI governance, regulation, and global contexts.</li> <li>• Critique AI policies, regulations, and ethical guidelines.</li> <li>• Assess the interplay of AI ethics with legal, cultural, socio-political and environmental aspects.</li> <li>• Devise interdisciplinary approaches to address ethical challenges in AI, including moderating AI-generated content as required.</li> <li>• Create innovative ethical frameworks and guidelines for emerging AI domains.</li> <li>• Advocate for responsible and ethical development and use of generative AI technologies, including user privacy rights.</li> </ul>

<b>Skill Name</b>	New GenAI TSC #9 <b>Generative AI Models Technical Aspects of Security and Ethics</b>		
<b>Skill Description</b>	Ensure AI models and systems are secure and ethically sound, from development through deployment and operation.		
<b>Proficiency Descriptor</b>	<b>Basic</b>	<b>Intermediate</b>	<b>Advanced</b>
	Apply the principles of AI model security and testing, and comply with AI guardrails.	Implement AI security measures, configure guardrails, and monitor for compliance.	Develop advanced security protocols, refine AI guardrails, and lead trust and safety initiatives, with an emphasis on red teaming.
<b>Knowledge</b>	<ul style="list-style-type: none"> <li>Fundamental concepts of AI model security, including importance of monitoring and reporting risks.</li> <li>Basics of system testing pre-deployment (e.g., beta testing, systems integration, AI jailbreaks, model hallucinations).</li> <li>Introduction to AI guardrails and their purpose.</li> <li>General trust and safety practices post go-live.</li> </ul>	<ul style="list-style-type: none"> <li>In-depth understanding of AI security measures and system testing.</li> <li>Configuration and implementation of AI guardrails for content generation.</li> <li>Risk assessment methodologies.</li> <li>Best practices for maintaining AI trust and safety, including risk management frameworks (e.g., risk assessment matrix, bowtie analysis, agile risk).</li> </ul>	<ul style="list-style-type: none"> <li>Methodologies of AI model security and testing.</li> <li>Standard Operating Procedures (SOPs) in operational content moderation.</li> <li>Strategic development and refinement of AI guardrails.</li> <li>Red teaming for discovering vulnerabilities in generative AI models.</li> <li>Enterprise risk management frameworks.</li> <li>Quantitative risk analysis techniques (e.g., Monte Carlo simulation, decision tree analysis).</li> </ul>
<b>Abilities</b>	<ul style="list-style-type: none"> <li>Identify basic security vulnerabilities in AI models.</li> <li>Document risk-related information.</li> <li>Assist in pre-deployment system testing.</li> <li>Support configuration of AI guardrails.</li> </ul>	<ul style="list-style-type: none"> <li>Develop mitigation strategies for identified risks.</li> <li>Implement security measures to protect AI models (e.g., from large language model prompt hacks).</li> <li>Configure AI guardrails effectively.</li> <li>Conduct comprehensive risk assessments.</li> <li>Conduct comprehensive pre-deployment system testing.</li> <li>Monitor AI systems for trust and safety throughout project life cycle.</li> </ul>	<ul style="list-style-type: none"> <li>Refine comprehensive system testing procedures.</li> <li>Propose refinements and enhancements to AI guardrails.</li> <li>Lead operational content moderation and trust and safety initiatives.</li> <li>Apply red teaming to identify and mitigate security risks in AI systems.</li> <li>Develop organisational AI risk management policies.</li> <li>Implement strategies for designing and governing ethical AI systems (e.g., integrate risk management into AI strategy).</li> </ul>